HOLISTIC WATERSHED MANAGEMENT FOR EXISTING AND FUTURE LAND USE DEVELOPMENT ACTIVITIES: OPPORTUNITIES FOR ACTION FOR LOCAL DECISION MAKERS: PHASE 2 – FDC APPLICATION MODELING (FDC 2A PROJECT)

SUPPORT FOR SOUTHEAST NEW ENGLAND PROGRAM (SNEP) COMMUNICATIONS STRATEGY AND TECHNICAL ASSISTANCE

TASK 0 WORK PLAN

FIRST DRAFT OCTOBER 22, 2021

Prepared for:

U.S. EPA Region 1

Prepared by:

Paradigm Environmental

Great Lakes Environmental Center

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1 PROJECT UNDERSTANDING

The project is a continuation of EPA's flow duration curve (FDC) Phase 1 (FDC1) modeling work that was conducted for three selected second and third-order headwater stream segments, tributaries to Wading River located in the Taunton basin, Massachusetts. The modeling work from Phase 1 quantifies the impacts of land cover and climate change on FDCs and investigates the ability of distributed Stormwater Control Measures (SCMs) to influence the frequency and distribution of long-term stream flows. The work provides the foundation for an analytical framework that includes tools (Opti-Tool) and metrics (i.e., ecosurplus and ecodeficit) to help quantify both the hydrologic impacts of the existing condition and the potential benefits of hydrograph restoration associated with stormwater management activities.

This project (FDC2A), the modeling portion of Phase 2, will build upon existing calibrated continuous simulation hydrologic and watershed management models developed during Phase 1 for the Wading River portion of the Taunton River watershed. The FDCs will be used to investigate the impacts of next-generation new development and/or redevelopment (nD/rD) practices, or Conservation Development (CD) practices, on watershed hydrology and stream health. FDC2A will demonstrate the efficacy of using FDC through the modeling of differences between subwatershed development scenarios, including a pre-development forest condition, the current built state, future development conditions, a scenario that incorporates the State of Massachusetts' stormwater standards, and several potential management scenarios that consider potential climate change and future land development conditions.

This project is about envisioning a different future for watershed management. Practitioners will be asked to compare and consider likely scenarios ranging from inaction (status quo policies) to actions that incorporate flooding risks, stream-channel stability, increased pollutant export, and reduced base flows. Phase 2 is very much about communicating the results so that practitioners can appreciate the impact of nD/rD on the future of their watersheds.

The GLEC Team will also be leading the Flow Duration Curve Phase 2, Task Order B: Next-Generation Watershed Management Practices for Conservation Development (FDC2B) project. Both project teams; the FDC2A project team and the FDC2B project team assure EPA and other involved parties that both projects will progress seamlessly and efficiently and will result in cohesive products.

The following sections provide our FDC2A project team's approach to completing the tasks outlined in the Performance Work Statement (PWS) and the key staff proposed to provide project management and technical leadership.

2 DRAFT WORK PLAN

The following draft Work Plan and methodology will serve as the starting point for discussion related to task expectations, deliverables, staffing, and schedule.

Task 0: Work Plan, Budget, and Schedule

This document serves as our draft work plan, and it outlines our approach and staffing for each task included in the PWS. Our proposed level of effort and schedule for key milestones and deliverables are provided at the end of this section.

Task Lead: Khalid Alvi and Mick DeGraeve
Key Support Staff: John Riverson and Dave Rosa
Schedule: The final work plan will be delivered to EPA within 1 week of receiving comments from EPA and TSC members after the first TSC meeting.
Deliverable: Final work plan, including the level of effort, final schedule, and deliverables

Task 1: Prepare Quality Assurance Project Plan (QAPP)

Our team will develop a draft QAPP that addresses all aspects of this project no later than October 22, 2021. The QAPP will be based on the QAPP developed by our team for the Holistic Watershed Management for Existing and Future Land Use Development Activities: Opportunities for Action for Local Decision Makers: Phase 1 – Modeling and Development of Flow Duration Curves (FDC 1 Project), Quality Assurance Project Plan; Task 1, Version 1.2, dated January 12, 2021. A final QAPP will be delivered within 1 week of receiving EPA comments on the draft. Any QAPP revisions that become necessary as the project progresses will also be developed and delivered to EPA for review and approval.

Task Lead: Mick DeGraeve and Khalid Alvi
Key Support Staff: John Riverson, Dave Rosa, and Dale White
Schedule: The draft QAPP will be delivered to EPA with the final Work Plan (Task 0) and a final QAPP will be delivered within 1 week of receiving EPA comments on the draft.
Deliverable: Draft and final QAPP's (any required revisions will be developed as appropriate)

Task 2: Project Management and Administration

The following highlights our approach to completing the subtasks identified in the PWS.

Subtask 2A. Kickoff Meeting

The GLEC Team will initiate the planning for a kickoff meeting. We will work with EPA to determine the attendees and we will plan on scheduling the kickoff meeting so that it occurs within one month of the Task Order (TO) award. The kickoff meeting will provide a critical opportunity for coordination and information sharing with the EPA Project Team. Before the meeting, we will deliver the Task 0 draft Work Plan (this document) and the Task 1 draft QAPP for EPA's review. Our team will have compiled additional information and will come to the meeting prepared to actively participate in project-related details. Attendees from our team will include Mick DeGraeve, Khalid Alvi, John Riverson, and David Rosa. We will take notes for the duration of the meeting and will develop a meeting summary for distribution to the meeting attendees and any others as directed by EPA.

It is anticipated that a Zoom video conference meeting will be held tentatively the week of October 25-29, 2021. We will provide teleconferencing details in advance of the kickoff call. We are proposing to conduct a joint kickoff meeting for both Task Order 2A and 2B as the GLEC Team will also be leading the Flow Duration Curves Phase 2, Task Order B: Next-Generation Watershed Management Practices for Conservation Development (FDC2B) project. A joint kickoff meeting will help with better understanding and expected coordination across Task Order 2A and 2B.

Subtask Lead: Mick DeGraeve and Khalid Alvi
Key Support Staff: John Riverson and David Rosa
Schedule: A pre-kickoff call took place the week of the Task Order award; a kickoff meeting will be scheduled to occur within one month of the TO award.

Deliverable: A kickoff meeting summary will be provided within one week of the meeting. The meeting notes will summarize key points, scheduling decisions and milestones, and action items.

Subtask 2B. Conference Calls, Meetings, and Project Team Support

We will schedule and participate in monthly progress calls to keep the EPA Project Team apprised of the progress of all tasks as well as planned activities during the next month. We will coordinate with EPA on the best approach to scheduling and notifying attendees of call details in advance of the call. Working with EPA, we will develop an agenda for each call, but will also leave time on each call to discuss topics of interest to the EPA Project Team. Each call will be attended, at a minimum, by Khalid Alvi and Mick DeGraeve. Call notes, with action items, will be distributed via email to project team members within 3 days of the call.

Our FDC2A project team and FDC2B project team will work closely and will participate in the monthly progress meetings with EPA as needed. This will provide efficacy, smooth progress, and successful completion of tasks on time.

Subtask Lead: Mick DeGraeve and Khalid Alvi
Key Support Staff: David Rosa and Ryan Murphy
Schedule: Monthly progress calls and calls summary notes
Deliverable(s): Monthly calls; monthly call notes (distributed via email)

Task 3: Technical Steering Committee (TSC) Meetings

We successfully supported the formation and management of the TSC under Phase 1 of this project. We will continue providing support for preparation and participation in up to two (2) additional TSC meetings to be held in a videoconference format. We will also provide technical assistance with setting up virtual meetings if requested. We will also coordinate with EPA to ensure the efforts under FDC2B are presented to offset any redundancy and facilitate the efficient use of TSC members' time and availability.

We will present the draft work plan at the first TSC meeting and will finalize the work plan based on the feedback from the TSC members and EPA project team. At the first meeting, we will also discuss how FDC2A and FDC2B efforts will be aligned. We will present the draft project report at the second TSC meeting to share and get guidance on how to best present the project outcome clearly and concisely to develop the outreach material and disseminate the key findings through a webinar.

Task Lead: Khalid Alvi
Key Support Staff: John Riverson and David Rosa
Schedule: First meeting four weeks after submitting the draft work plan (Task 0) and second meeting three weeks after submitting the draft project report (Task 6).
Deliverable(s): Attendance and support for up to two TSC meetings, assuming virtual with an option for in-person if pandemic conditions improve; summary of responses to TSC comments.

Task 4: Develop Future Land Cover Data for Taunton River Sub-Watershed Modeling and Hydrologic Response Unit Analyses

The following highlights our approach to completing the Task 4 subtasks identified in the PWS.

We will develop a methodology to estimate associated percent impervious coverage for the projected new development conditions. The future development land use and land cover data sets for the Taunton River Watershed will be reflective of projected watershed conditions in the year 2060.

We have already developed the Hydrologic Response Units (HRUs) representing the land use, land cover, soil, and slope characteristics in the Taunton River watershed in Phase 1 of the project (Figure 1). Our team has already built efficiencies for the steps involved in developing HRU raster layers. Our team will leverage the experience from Phase 1 and will make sure to be consistent for developing HRUs for future land use conditions in the Taunton River watershed.

The methodology includes these key steps:

- Reclassify future land uses into nine major land uses used in Opti-Tool
- Reclassify existing soil info into hydrological soil groups (HSGs)
- Reclassify existing slope into low, medium, and high categories
- Develop HRU categories to be consistent with the Opti-Tool used in Phase 1
- Estimate effective impervious areas (EIA) for the future development land use using Sutherland's equations (Southerland, 2000).
- Develop an HRU spatial raster layer showing future development land use and EIA footprint using the peppering technique in the GIS platform.

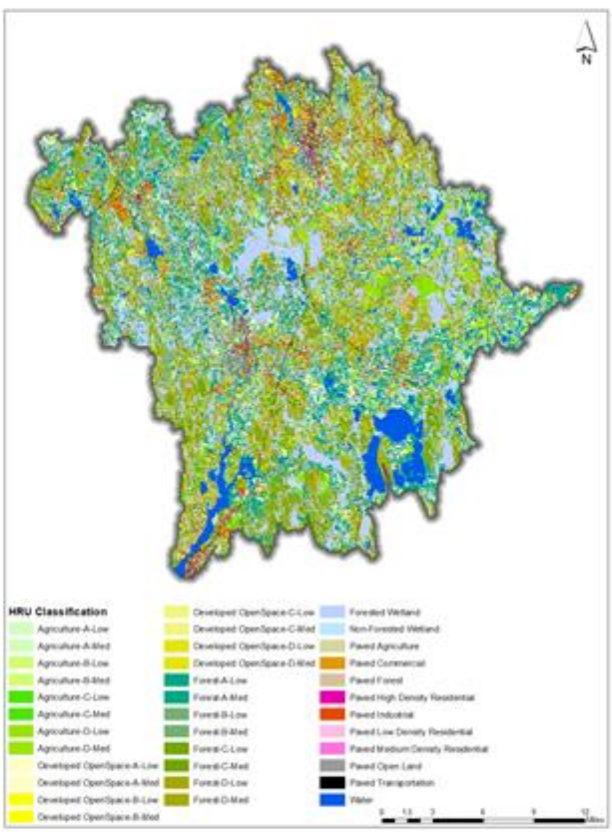

Figure 1. HRU map for the Taunton River watershed.

We have developed a 'peppering' approach to developing rasters based on historic or projected land-use changes (Figure 2). The approach uses a probabilistic raster reclassification algorithm to modify an existing HRU raster and replace individual HRUs with new ones. The result of the probabilistic reclassification is a raster that has reclassified pixels scattered throughout it. The raster peppering approach may be used to convert the 2060 future development assumptions, which may not be spatially resolved across the entire watershed, into a future land use distribution to incorporate into the HRU raster. A similar technique was applied in the Phase 1 model development when building the existing conditions land use spatial data set. This peppering approach is therefore a consistent and defensible methodology to spatially represent changes from the existing condition raster to both historical and future conditions.

We will prepare a Technical Memorandum (TM) that documents the approach taken and compares the results between the existing and projected future land cover conditions including future estimates of IC (assuming conventional development patterns) and estimates of unattenuated average annual runoff volume yields, groundwater recharge, and nutrient load export for both existing and future climatic conditions.

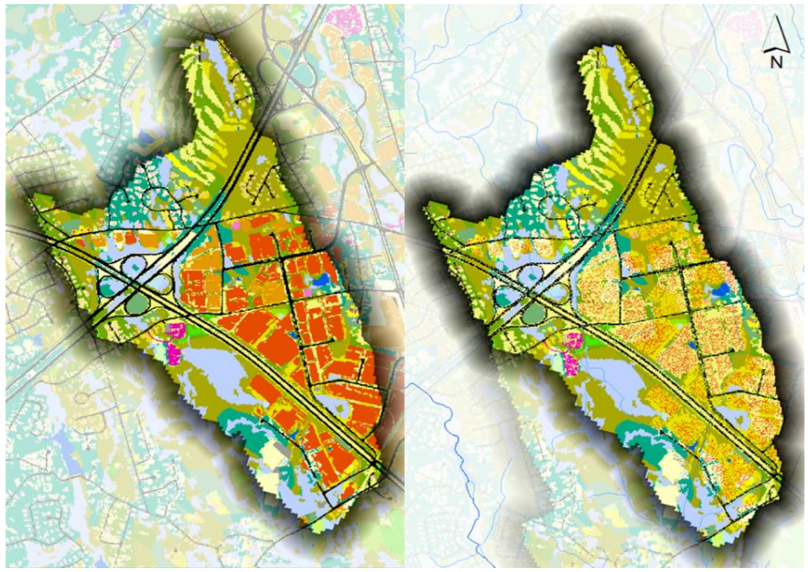

Figure 2. An existing condition HRU raster showing Mapped Impervious Areas (left) and Effective Impervious Areas (right) for the Upper Hodges Brook in Wading River.

Task Lead: Khalid Alvi
Key Support Staff: Dale White, David Rosa, and Yige Yang
Schedule: Draft within 12 weeks of TO award, Final within 10 business days of receipt of EPA comments
Deliverable(s): Draft Technical Memorandum, Final Technical Memorandum

Task 5: Opti-Tool Enhancements: Green Roofs and Temporary Runoff Storage with IC Disconnection

The following highlights our approach to completing the Task 5 subtasks identified in the PWS.

Our team will incorporate two new green infrastructure stormwater control measures (GI SCM) into the Opti-Tool to support the management alternative analyses presented in Task 6. The Opti-Tool will be configured to simulate (1) green roof technologies, and (2) temporary runoff storage (e.g., cistern) combined with IC disconnection. EPA Region 1 will perform research and provide information on current green roof technology designs. Conceptual schematics of both GI SCM (green roof and cistern with IC disconnection) controls will be developed to illustrate the key simulation processes.

Green Roofs

A summary of the parameters required to represent the key processes of both GI SCMs will be developed and presented to EPA Region 1 for feedback. This summary will include proposed default model parameters for simulating green roof technologies in SUSTAIN based on published research and best professional judgment. Key parameters that will be evaluated will include soil media depth, porosity, ponding depth, vegetation density, evapotranspiration rate, and pollutant removal rates. Schematic diagrams (Figure 3) will be used to communicate the key processes represented by green roofs in the SUSTAIN model.

IC Disconnection with Storage

Representation of temporary runoff storage will leverage the cistern and rain barrel features currently implemented in SUSTAIN. The IC disconnection option will allow for partial hydrologic IC disconnection based on the ratio of IC drainage area to receiving pervious area (PA) as is currently represented in the current MA and NH MS4 permits. We will work closely with EPA to design this feature in a way that is consistent with local watershed modeling and representative of the New England landscape. EPA will provide unit cost information for the two new GI SCMs to be included in the Opti-Tool enhancements.

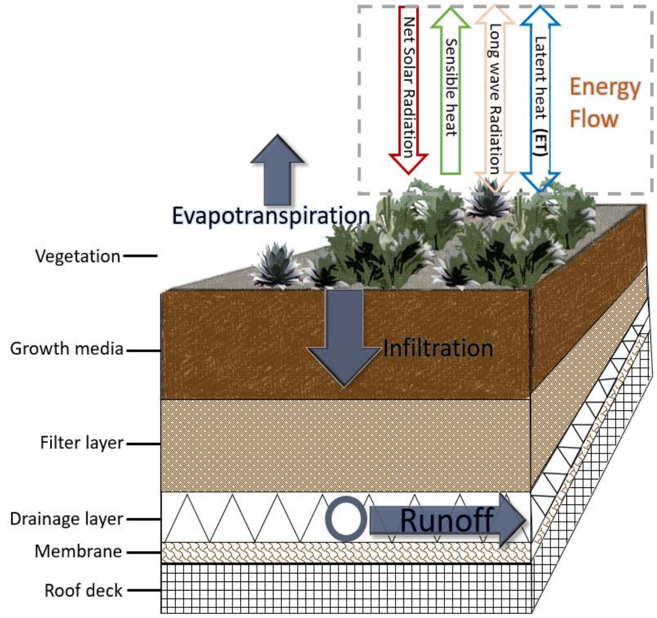

Figure 3. Example green roof schematic illustrating key-BMP processes.

We will prepare a TM documenting the research and process of developing these conceptual GI SCM representations and providing the supporting information and references for the enhancements made to Opti-Tool to simulate green roof technologies and temporary storage with varying partial IC disconnection. The Task 5 TM will be finalized with an accompanying summary of the response to all comments within 10 business days from the date of receiving comments from the Task Order Contractor Officer Representative (TOCOR). The TOCOR will be responsible for obtaining input from the TSC. We will also deliver the enhanced Opti-Tool (version 2.1) and updated User's Manual upon completion of Task 5.

Task Lead: Khalid Alvi
Key Support Staff: John Riverson and Yige Yang
Schedule: Draft within three (3) months of TO award, Final within 10 business days of receipt of EPA comments
Deliverable(s): Draft and Final TM, Updated Opti-Tool, and User's Guide

Task 6. Modeling Analyses for Projected Future Land Development Conditions at Sub-watershed and Site-Development Project Scales; Responsibilities of and Coordination between FDC2A and FDC2B Project Teams

The objective of this task is to conduct modeling simulations using the Phase 1 calibrated models including Opti-Tool to assess impacts and benefits associated with projected future watershed development conditions and various management alternatives at both the sub-watershed and site-development project scales. Task 6 is divided into three sub-tasks to delineate the process of modeling across multiple land use, stormwater management, and future climate scenarios. The matrix of the anticipated GI SCM modeling scenarios conducted under Task 6A and Task 6B are summarized in Table 1 and Table 2, respectively. Table 3 outlines the expected coordination between the FDC2A and FDC2B project teams. Optimized sub-watershed management opportunities will be developed using the enhanced Opti-Tool (Task 5) and provided to the FDC2B project team.

Table 1. Summary of GI SCM modeling scenarios at sub-watershed scale for Task 6A

Scenario	Alternative Option	Development Condition	Climate Boundary Condition
1	Current MA SW standards	Conventional Development Practices (nD/rD)	Historical Climate (2000 - 2020)
2			Future Climate 1 (2079 - 2099)
3			Future Climate 2 (2079 - 2099)
4			Future Climate 3 (2079 - 2099)
5		GI and CD Practices (nD)	Historical Climate (2000 - 2020)
6			Future Climate 1 (2079 - 2099)
7			Future Climate 2 (2079 - 2099)
8			Future Climate 3 (2079 - 2099)
9	Next-Generation Local Bylaws	Conventional Development Practices (nD/rD)	Historical Climate (2000 - 2020)
10			Future Climate 1 (2079 - 2099)
11			Future Climate 2 (2079 - 2099)
12			Future Climate 3 (2079 - 2099)
13		GI and CD Practices (nD)	Historical Climate (2000 - 2020)
14			Future Climate 1 (2079 - 2099)
15			Future Climate 2 (2079 - 2099)
16			Future Climate 3 (2079 - 2099)

Table 2. Summary of GI SCM modeling scenarios at site project scale for Task 6B

Scenario	Alternative Option	Development Condition	Development Sites	Climate Boundary Condition
1	Current MA SW standards	Conventional Development Practices	Low Density (nD)	Historical Climate (2000 - 2020)
2				Future Climate 1 (2079 - 2099)
3				Future Climate 2 (2079 - 2099)
4				Future Climate 3 (2079 - 2099)
5			Medium Density (nD)	Historical Climate (2000 - 2020)
6				Future Climate 1 (2079 - 2099)
7				Future Climate 2 (2079 - 2099)
8				Future Climate 3 (2079 - 2099)
9			High Density (nD)	Historical Climate (2000 - 2020)
10				Future Climate 1 (2079 - 2099)
11				Future Climate 2 (2079 - 2099)
12				Future Climate 3 (2079 - 2099)
13			Low Density (rD)	Historical Climate (2000 - 2020)
14				Future Climate 1 (2079 - 2099)
15				Future Climate 2 (2079 - 2099)
16				Future Climate 3 (2079 - 2099)
17			Medium Density (rD)	Historical Climate (2000 - 2020)
18				Future Climate 1 (2079 - 2099)

Scenario	Alternative Option	Development Condition	Development Sites	Climate Boundary Condition
19				Future Climate 2 (2079 - 2099)
20				Future Climate 3 (2079 - 2099)
21			High Density (rD)	Historical Climate (2000 - 2020)
22				Future Climate 1 (2079 - 2099)
23				Future Climate 2 (2079 - 2099)
24				Future Climate 3 (2079 - 2099)
25		GI and CD Practices	Low Density (nD)	Historical Climate (2000 - 2020)
26				Future Climate 1 (2079 - 2099)
27				Future Climate 2 (2079 - 2099)
28				Future Climate 3 (2079 - 2099)
29			Medium Density (nD)	Historical Climate (2000 - 2020)
30				Future Climate 1 (2079 - 2099)
31				Future Climate 2 (2079 - 2099)
32				Future Climate 3 (2079 - 2099)
33			High Density (nD)	Historical Climate (2000 - 2020)
34				Future Climate 1 (2079 - 2099)
35				Future Climate 2 (2079 - 2099)
36				Future Climate 3 (2079 - 2099)
37	Next-Generation Local Bylaws	Conventional Development Practices	Low Density (nD)	Historical Climate (2000 - 2020)
38				Future Climate 1 (2079 - 2099)
39				Future Climate 2 (2079 - 2099)
40				Future Climate 3 (2079 - 2099)
41			Medium Density (nD)	Historical Climate (2000 - 2020)
42				Future Climate 1 (2079 - 2099)
43				Future Climate 2 (2079 - 2099)
44				Future Climate 3 (2079 - 2099)
45			High Density (nD)	Historical Climate (2000 - 2020)
46				Future Climate 1 (2079 - 2099)
47				Future Climate 2 (2079 - 2099)
48				Future Climate 3 (2079 - 2099)
49			Low Density (rD)	Historical Climate (2000 - 2020)
50				Future Climate 1 (2079 - 2099)
51				Future Climate 2 (2079 - 2099)
52				Future Climate 3 (2079 - 2099)
53			Medium Density (rD)	Historical Climate (2000 - 2020)
54				Future Climate 1 (2079 - 2099)
55				Future Climate 2 (2079 - 2099)
56				Future Climate 3 (2079 - 2099)
57			High Density (rD)	Historical Climate (2000 - 2020)
58				Future Climate 1 (2079 - 2099)

Scenario	Alternative Option	Development Condition	Development Sites	Climate Boundary Condition
59				Future Climate 2 (2079 - 2099)
60				Future Climate 3 (2079 - 2099)
61		GI and CD Practices	Low Density (nD)	Historical Climate (2000 - 2020)
62				Future Climate 1 (2079 - 2099)
63				Future Climate 2 (2079 - 2099)
64				Future Climate 3 (2079 - 2099)
65			Medium Density (nD)	Historical Climate (2000 - 2020)
66				Future Climate 1 (2079 - 2099)
67				Future Climate 2 (2079 - 2099)
68				Future Climate 3 (2079 - 2099)
69			High Density (nD)	Historical Climate (2000 - 2020)
70				Future Climate 1 (2079 - 2099)
71				Future Climate 2 (2079 - 2099)
72				Future Climate 3 (2079 - 2099)

Table 3. Expected coordination between FDC2A and FDC2B project teams

Scenario Type	Scale	Responsible Team
GI SCM optimization results for historical land use (2016)	Sub-watershed	FDC2A
GI SCM optimization results for future land use (2060)	Sub-watershed	FDC2A
Concept site-development plans for alternative option 1	Site Development Projects	FDC2B
Implementation rules for alternative option 1	Sub-watershed	FDC2A/FDC2B
Site-development Project scale modeling results for alternative option 1	Site Development Projects	FDC2A
Sub-watershed scale modeling results for alternative option 1	Sub-watershed	FDC2A
Concept site-development plans for alternative option 2	Site Development Projects	FDC2B
Implementation rules for alternative option 2	Sub-watershed	FDC2A/FDC2B
Site-development Project scale modeling results for alternative option 2	Site Development Projects	FDC2A
Sub-watershed scale modeling results for alternative option 2	Sub-watershed	FDC2A

The GLEC Teams (FDC2A and FDC2B) will coordinate closely with EPA to achieve the overall objectives of the two projects and this task. The GLEC Teams will work closely with EPA R1 Project Team for inter-project coordination between the FDC2A and FDC2B Task Orders. Close inter-project coordination will be important for the success of both projects including providing baseline information to characterize impacts and benefits of management opportunities (FDC2A to FDC2B), informing the development of management alternatives (FDC2B to FDC2A), and numerous conceptual site-development scale scenarios (FDC2A to FDC2B) that will be modeled as specified under this task. The FDC2A project team has extensive experience collaborating with independent project teams to translate real-world SW management design into modeling assumptions using conceptual schematics and parameter templates (Figure 4). Collaboration for Task 6 will generally occur through the following, iterative sequence of modeling simulations and information sharing/outputs between FDC2A and FDC2B project teams:

BMP Component	SUSTAIN Parameter	Description	Value by Hydrologic Soil Group				Units
			A	B	C	D	
Surface	DDAREA	Maximum Drainage Area per BMP	Variable, see BMP Drainage Area				acres
	WIDTH	BMP Width	4	4	4	4	ft.
	LENGTH	BMP Length	Variable, see BMP Opportunity				ft.
	WEIRH	Weir Height / Ponding Depth	0.5	0.5	0.5	0.5	ft
	WEIRW	Weir Width	2	2	2	2	ft
	ET_MULT	BMP Specific multiplier on PET	1.0	1.0	1.0	1.0	--
Soil Media	SDEPTH	Soil Depth	1.5	1.5	1.5	1.5	ft.
	POROSITY	Media Porosity	0.35	0.35	0.35	0.35	0.0-1.0
	FCAPACITY	Soil Field Capacity	0.3	0.3	0.3	0.3	ft/ft
	WPOINT	Soil Wilting Point	0.15	0.15	0.15	0.15	ft/ft
	AVEG	Vegetative Parameter A	1	1	1	1	0.1-1.0
	FINFILT	Media Infiltration Rate	5	5	5	5	in/hr
Underdrain Media	UNDSWITCH	Consider Underdrain?	0	0	1	1	0 or 1
	UNDDEPTH	Underdrain Depth	--	--	1	1	ft.
	UNDVOID	Media Porosity	--	--	0.4	0.4	0.0-1.0
	UNDINFILT	Background Infiltration Rate	1.5	1	0.3	0.05	in/hr
Cost Function	LinearCost	Cost per unit length of the BMP structure	0	0	0	0	$/ft
	AreaCost	Cost per unit area of the BMP structure	9.438	9.438	17.688	17.688	$/ft^2
	TotalVolumeCost	Cost per unit total volume of the BMP structure	2.165	2.165	2.165	2.165	$/ft^3
	MediaVolumeCost	Cost per unit volume of the soil media	2.64	2.64	2.64	2.64	$/ft^3
	UnderDrainVolumeCost	Cost per unit volume of the under drain structure	0	0	3.3	3.3	$/ft^3
	ConstantCost	Constant cost	0	0	0	0	$
	PercentCost	Cost in percentage of all other cost	0	0	0	0	%
	LengthExp	Exponent for linear unit	1	1	1	1	--
	AreaExp	Exponent for area unit	1	1	1	1	--
	TotalVolExp	Exponent for total volume unit	1	1	1	1	--
	MediaVolExp	Exponent for soil media volume unit	1	1	1	1	--
	UDVolExp	Exponent for underdrain volume unit	1	1	1	1	--

Figure 4. Example BMP parameter template for developing key assumptions.

1. The FDC2A project team will conduct subwatershed optimization simulations for the baseline SW management scenarios and provide these outputs to the FDC2B project team.
2. The FDC2B project team develops and provides the 'Alternative 1' level of control (LOC) Concept Site Development Plans (e.g., As-Built Plans) to the FDC2A project team for modeling. The FDC2A project team works closely with EPA Region 1 to interpret the site design into a set of rules (i.e., assumptions) that can be applied at the subwatershed scale. With approval from EPA Region 1 on these assumptions, the FDC2A project team conducts further modeling simulations for Alternative 1 concept Site Development Plans and Alternative 1 Subwatershed Modeling Simulations. The FDC2A project team provides modeling outputs to the FDC2B project team.
3. The FDC2B project team develops and provides 'Alternative 2' level of control (LOC) Concept Site Development Plans (e.g., As-Built Plans) to the FDC2A project team for modeling. The FDC2A project team works closely with EPA Region 1 to interpret the site design into a set of rules (i.e., assumptions) that can be applied at the subwatershed scale. With approval from EPA Region 1 on these assumptions, the FDC2A project team conducts further modeling simulations for Alternative 2 concept Site Development Plans and Alternative 2 Subwatershed Modeling Simulations. The FDC2A project team provides modeling outputs to the FDC2B project team.

Subtask 6A. Sub-watershed Modeling and Alternative Management Analysis for Project Future Land Use Conditions

The FDC2A project team will simulate alternative watershed management scenarios for the Upper Hodges Brook pilot study sub-watershed area tributary to the Wading River for projected future land use development conditions under both existing and up to three (3) future climatic conditions. We will conduct the sub-watershed SW/hydrologic management modeling approach as described in the Task 0 Work Plan.

We will first perform a GIS analysis to update FDC1 GIS SW management analyses (Figure 5) to identify potentially effective stormwater management opportunities including Phase 1 GI SCMs and the two new GI SCMs (green roofs and storage with IC disconnection) to be incorporated into Opti-Tool under Task 6 of this Task Order. The GIS analysis will reflect projected future land use development conditions assuming conventional development patterns (i.e., "business as usual") occurs in the selected sub-watershed in preparation for performing EPA R1's Opti-Tool stormwater management optimization simulations and model simulations that evaluate alternative local SW management regulatory requirements.

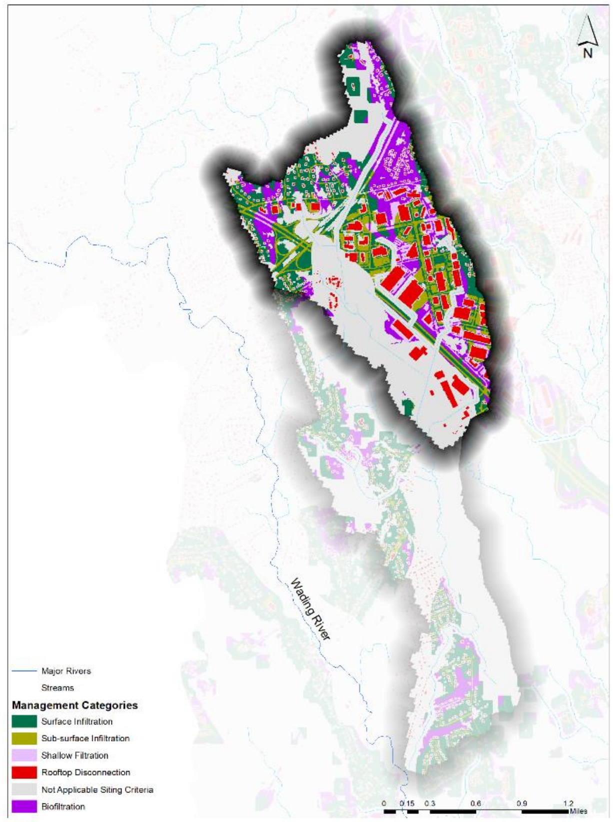

Figure 5. FDC1 SW management opportunity analysis for the Upper Hodges Brook watershed.

Optimization analysis of GI SCM opportunities will be conducted in the Upper Hodges Brook sub-watershed area for projected future development conditions assuming conventional development IC amounts. We will perform the optimization analyses using EPA's R1 Opti-Tool to restore and protect watershed hydrologic and pollutant attenuation functions (e.g., groundwater recharge, evapotranspiration, pollutant reduction, etc.) using FDC evaluation factors and other metrics for driving optimization analyses (e.g., pollutant load export, runoff yields, etc.) for both existing and future climatic conditions. The purpose of this analysis will be to support the selection of additional alternative management scenarios for further evaluation using model-generated FDC results designed for specific environmental outcomes (e.g., nutrient export, maintain low flows, etc.). We will conduct up to three (3) optimization simulations for the selected sub-watershed to identify cost-effective scenarios that could address multiple management objectives such as channel stability, low flow conditions, and pollutant load export.

The FDC2A project team will coordinate with EPA R1 and the FDC2B project team to support the selection of up to two (2) alternative management scenarios for modeling and evaluation: 'Alternative 1' in which MA SW standards would be applied and 'Alternative 2' which represents next-generation local bylaws that include stringent on-site SW management and site design standards that lead to CD practices. For example, MA's SW standards for new development are currently applicable to projects creating 1 or more acres of IC. The modeling analysis of this scenario will require applying estimates of how much of projected future development activities would be subject to MA SW standards. For this alternative, EPA will, in coordination with MassDEP and FDC2B, develop estimates of future land development activities that would be subject to MA SW standards for the FDC2A project team to use in developing the modeling scenario. The FDC2A project team will work with EPA to interpret and apply these estimates in the sub-watershed modeling of this scenario for two modeling simulations that reflect (1) application of SW management practices only for conventional development (2) Use of GI and emphasis of CD practices to meet MA SW standards.

The sub-watershed modeling results will include:

- The optimized GI SCM solutions on the cost-effectiveness curves developed for the historical and future land use development assuming conventional development approaches. The selected solutions will summarize the selected BMP types, optimal design storage volume, and modeled BMP design specifications for the Upper Hodges Brook subwatershed.
- The FDC comparisons to showing the difference between different flow regimes (e.g., high flow and low flow) and annual average flow volume/pollutant load reductions for the two alternative management scenarios.
- The FDC2A project team will coordinate with the FDC2B project team and provide any additional information to inform the development of concept site development plans under Task 6B.

Task Lead: Khalid Alvi
Key Support Staff: John Riverson and David Rosa
Schedule: Optimization within four (4) months of TO award, Alternative 1 within six (6) months of TO award, Alternative 2 within eight (8) months of TO award, Schedule to be finalized based on FDC2B project team schedule
Deliverable(s): Modeling Results for Sub-watershed Modeling and Alternative Management Analysis for Project Future Land Use Conditions

Subtask 6B. Site Development Project Scale Modeling Alternative Analysis

Under this subtask, we will apply Opti-Tool to evaluate alternatives for up to three (3) new site-development project-scale scenarios (e.g., low, medium, and high-intensity development sites) and up to three (3) redevelopment scenarios, totaling six (6) potential site development scenarios. The scenarios and management alternatives to be simulated under this Subtask will be developed by the FDC2B project team in consultation with EPA R1 and provided to the FDC2A project team. In addition, the FDC2A project team will have the opportunity to coordinate and provide input to the FDC2B team for alternative development and the types of SCMs to be simulated in the various site-development scenarios and alternatives.

The FDC2A project team will simulate predevelopment conditions for the 3 new site-development scenarios. Up to 108 modeling simulations will be performed to estimate project site-scale hydrologic and pollutant export conditions inclusive of the scenarios outlined in Table 1 through Table 2 plus predevelopment conditions. The resulting hydrologic conditions (e.g., runoff duration curves, average annual runoff volume, average annual recharge to groundwater), pollutant export rates, carbon sequestration, and heat exchange will be quantified for each scenario and alternative modeling simulation. The results of modeling conducted under this Subtask will be provided to the FDC2B project team as part of the municipal engagement process occurring under that work order. The FDC2A project team will work closely with the EPA R1 Project Team and the FDC2B project team to put together a summary of the results for each modeling simulation performed in a format compatible with the FDC2B workflow(s).

Task Lead: Khalid Alvi
Key Support Staff: John Riverson and David Rosa
Schedule: Alternative 1 within six (6) months of TO award, Alternative 2 within eight (8) months of TO award, Schedule to be finalized based on FDC2B project team schedule
Deliverable(s): Modeling Results for Site-Scale Modeling and Alternative Management Analysis for Project Future Land Use Conditions

Subtask 6C. Final FDC2A Project Report and Project Summary Overview

Under this subtask, we will compile all technical memorandums developed under each subtask and prepare a draft written project report that documents all work performed during the FDC2A project. We will address the comments received on the draft report from the TSC and the EPA Project Team. The final project report will describe how the work conducted under FDC2A could be applied to support local entities in developing wise water resource management strategies to build resiliency, restore and protect local and regional waterways from the impact of future development. The report will include quantified estimates of the impacts associated with existing and future watershed development and IC conversion. The potential benefits associated with future SW management requirements evaluated in the optimization and alternative management scenarios will also be quantified and presented. The report will include a mix of summary tables and technical graphics (e.g., flow duration curves) to communicate the long-term cumulative impacts and management benefits for the identified critical streamflow regimes/metrics. Summary information quantifying SW runoff pollutant load export, groundwater recharge, evapotranspiration, carbon sequestration, and heat loss exchange will also be presented.

In addition, we will prepare up to three (3) sets of summary materials that provide project information in a brief format for communicating key messages, lessons learned, and valuable water resource management information to local, state, and federal government representatives. These summary materials will be delivered as a Technical Support Document (TSD) in the form of a fact sheet. The TSD / fact sheet will be developed to effectively communicate key findings including discussion of relationships between watershed function, land use development, and water resource impacts in low-order stream systems and larger down-gradient waters resources (e.g., lakes, coastal waters, aquifers, etc.) and evaluated water resource management strategies. The information summaries will be designed with accompanying graphics and tables to convey water resource impacts associated with inadequately managed IC conversion and the potential quantitative benefits of feasible watershed restoration activities/strategies identified in this study. The TSD / fact sheet will be up to four (4) pages in length, including figures and tables.

Task Lead: Khalid Alvi
Key Support Staff: John Riverson and David Rosa
Schedule: Draft within ten (10) months of TO award, Final within two (2) weeks of receipt of EPA comments
Deliverable(s): Draft and Final Phase 2 report, Draft and Final TSD / Fact Sheet

Task 7. Phase 2A Project Webinar to SNEP Region

We will prepare for and participate in a webinar to present the FDC2A study results and findings. It is assumed that the webinar logistics will be provided by the SNEP program and EPA project team.

Task Lead: Khalid Alvi
Key Support Staff: John Riverson and David Rosa
Schedule: Before TO expiration
Deliverable(s): Webinar presentation

Schedule

Table 4 presents the proposed schedule of key activities and deliverables for this project. The FDC2A project team will work with EPA Project Team to modify this as necessary during the execution of this Task Order. We will discuss it in detail at the kickoff meeting.

Table 4. Proposed Task and Deliverable Schedule.

Project Elements/Sub-Tasks	Deliverables
Task 0: Work Plan, Budget, and Schedule	
Draft work plan, budget, and schedule	10/22/2021
Final work plan, budget, and schedule	11/19/2021
Task 1: Prepare Quality Assurance Project Plan	
Prepare draft QAPP	10/22/2021
Final QAPP	12/31/2021*
Task 2: Project Management and Administration	
Kickoff meeting and summary	10/28/2021*
Monthly progress calls and summaries	Monthly
Task 3: Technical Steering Committee Meetings	
TSC Meeting 1: Completion of draft work plan	11/11/2021*
TSC Meeting 2: Completion of draft project report	9/15/2022*
Task 4: Develop Future Land Cover Data for Taunton River Sub-Watershed Modeling and Hydrologic Response Unit Analyses	
Draft technical memo	12/17/2021
Final technical memo	12/31/2021
Task 5: Opti-Tool Enhancements: Green Roofs and Temporary Runoff Storage with IC Disconnection	
Draft technical memo	12/17/2021
Final technical memo	12/31/2021
Task 6: Modeling Analyses for Projected Future Land Development Conditions at Sub-watershed and Site-Development Project Scales	
Draft project report and project summary overview	8/26/2022
Final project report	9/30/2022
Task 7. Project Webinar to SNEP Region	
Draft presentation slides	9/23/2022
Webinar presentation	9/30/2022*

*=tentative, to be finalized in consultation with EPA
As needed, 1 call each month

References

Sutherland, R. 2000. Methods for Estimating the Effective Impervious Area of Urban Watersheds. The Practice of Watershed Protection (Edited by T. R. Schueler and H. K. Holland). Technical Note #58. Center for Watershed Protection, Ellicott City, MD: 193-195.

3 STAFFING

The GLEC Team is pleased to provide EPA Region 1 with an impressive group of scientists and engineers to support this challenging project. The following provides short bios for each of our proposed key personnel. Each of these staff will be available in the roles proposed for the duration of this project.

Mick DeGraeve (Ph.D.), P4 - Program Manager

Ph.D., Aquatic Biology, 1979, University of Wyoming, Laramie, Wyoming
Master of Science, Biology, 1970, Eastern Michigan University, Ypsilanti, Michigan
Bachelor of Science, Biology, 1968, Eastern Michigan University, Ypsilanti, Michigan

Dr. DeGraeve will manage the GLEC Team at the contract level and assure that EPA's needs and expectations are met for this procurement. He is the founder of GLEC, and for the past 45 years has interacted regularly with professionals in a wide range of disciplines, and with representatives of industry, government, and academia. Mick's technical aquatic biology/ toxicology professional experience has included managing EPA Office of Water level of effort contracts for GLEC for 20+ years. Over that period, he has had responsibility for the technical and financial oversight of 11 EPA Office of Water contracts; five for the Health and Ecological Criteria Division (HECD), three for the Standards and Health Protection Division (SHPD), one for the Permits Division of the Office of Wastewater Management (OWM), and two for the Office of Ground Water and Drinking Water's (OGWDW) Technical Support Center.

Mr. Khalid Alvi (PE), P4 – Project Manager/Senior Project Engineer

Master of Science, Civil and Environmental Engineering, 1999, Asian Institute of Technology, Thailand
Bachelor of Science, Civil Engineering, 1993, University of Engineering and Technology Lahore, Pakistan
Professional Engineer, Virginia No. 0402046509 (since 2010)

Mr. Khalid Alvi will be the Project Manager and modeling technical lead for this project. Mr. Alvi led the support for Phase 1 of this project and requires no learning curve to seamlessly continue project progress. Mr. Alvi is a Professional Engineer and an experienced TMDL, stormwater, watershed, and water quality modeler, and data and GIS application developer with more than 15 years of experience in the development of TMDLs and watershed and BMP modeling systems. He has extensive experience in developing practical solutions for a variety of management objectives (e.g., flow volume reduction or pollutant load reduction target) by identifying the best mix of cost-effective stormwater controls using state-of-art optimization algorithms at the watershed

> It would be difficult to overstate the significance of your project work to EPA Region 1 programs. All of your work has been technically outstanding, and I know that both myself and my colleagues appreciate both your contributions and the manner in which you have carried out each project. We admire your personal character and integrity and are grateful for the ways you have worked with us to meet the challenges ahead. Your expertise in the field of water resource engineering and generous willingness to go above and beyond has consistently led to achieving the best outcomes in all the projects you have worked on. – Mark Vorhees, EPA Region 1, letter to Khalid Alvi

scale. Alvi was the project manager and technical lead for the development of Opti-Tool, a spreadsheet-based stormwater best management practices optimization tool. The Opti-Tool is designed for use by municipal SW managers and their consultants to assist in developing technically sound and optimized cost-effective SW management plans. The Opti-Tool uses EPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) optimization module as a back-end computational engine to identify the best mix of cost-effective stormwater controls. He co-led (with Paradigm's John Riverson) the development of EPAs Loading Simulation Program C++ (LSPC) to modernize the watershed model HSPF and EPA's SUSTAIN - a decision support system for the EPA's Office of Research and Development to develop, evaluate, optimize, select and place BMPs based on cost and effectiveness. Mr. Alvi, as a primary developer of EPAs LSPC, SUSTAIN, and Opti-Tool, has an unmatched understanding of the underlying modeling algorithms used in the tool. He has demonstrated the application of the Opti-Tool through several projects, including for the Town of Tisbury, MA, Buzzard Bay watershed located in the Town of Fairhaven, MA, and Mystic River watershed located in the city of Medford, MA. For the recently completed work for the Town of Tisbury and EPA R1, he was the modeling lead for applying the Opti-Tool for two selected outfall catchments to optimize the cost-effective GI SCM opportunities that minimize the frequency and duration of the flooding events within the urbanized drainage area to those outfalls pour points. He expanded the Opti-Tool analysis to the entire town of Tisbury to explore the benefits of GI SCM opportunities in terms of stormwater volume captured and nutrient (total nitrogen) load removed at the zoning district level for planning purposes. Alvi was the key developer in SUSTAIN code updates for US EPA Region 10 to add the functionality of groundwater/aquifer components to track the baseflow and groundwater recharge through the infiltration process of GI SCM controls. He also enhanced SUSTAIN optimization codes to implement the FDC as an evaluation factor to identify the optimal sizing and strategic locations of GI SCM that can restore the existing condition to pre-development condition. He managed the two-year technical support contract with EPA Region 10 to enhance the SUSTAIN version 1.2 and to provide guidance and technical support in applying the enhanced modeling features to the case studies in the State of Washington. There are no other modelers with the experience and understanding of the Opti-Tool, HSPF/LSPC, and SUSTAIN models that will be necessary to complete and incorporate innovation into the Taunton River modeling effort.

David Rosa, P3 - Senior Water Resource Scientist

Ph.D., Natural Resources: Land, Water, Air, 2017, University of Connecticut
Master of Science, Natural Resources: Land, Water, Air, 2013, University of Connecticut
Bachelor of Science, Natural Resources, 2006, University of Vermont

Dr. Rosa will provide modeling support as well as scientific and technical analysis for the duration of this project. He has extensive experience in watershed hydrology, watershed modeling, and BMP implementation. David has experience with surface-water, watershed, water quality, and stormwater modeling systems including the Storm Water Management Model (SWMM), Opti-Tool, the Hydrologic Engineering Center's River Analysis System (HEC-RAS), Soil and Water Assessment Tool (SWAT), Loading Simulation Program - C++ (LSPC) and System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN). His experience includes calibrating and validating continuous simulation models for watersheds, installing and monitoring LID practices, riparian buffers restoration, and applying hydrologic and hydraulic models to quantify the water quality benefits of reconnected floodplains. David has led modeling workshops for state officials and has expertise with a range of pollutants including phosphorus, nitrogen, chloride, suspended solids, and pathogens. David is a certified floodplain manager, and in his previous employment at the state of Vermont, Dr. Rosa worked at the state and local level to develop and implement municipal floodplain and river corridor ordinances to enhance and improve stream health and protect life and property based on fluvial geomorphic principals and the natural and beneficial functions of floodplains. David's work at Paradigm has included an Opti-Tool-based project for the town of Tisbury, MA, and EPA to explore innovative and cost-effective techniques for mitigating flooding issues related to the poor transmission of stormwater runoff from directly connected impervious cover. David supported the modeling of two selected outfall catchments as well as a town-wide assessment. During this work, David leveraged FDCs as an analysis and communication tool to investigate the effectiveness of GI SCM opportunities to reduce the percent of the time that specific discharges, including those that likely result in flooding events, were equaled or exceeded.

Ryan Murphy, P4 - Senior Environmental Scientist

Environmental & Water Resources Engineering, 2008-2010, Tufts University, Medford, MA
Bachelor of Science, Environmental Policy & Planning, 2005, Virginia Tech, Blacksburg, VA

Mr. Murphy combines an interdisciplinary background in water resources engineering, ecological planning, public policy, and computer science. He has extensive hands-on experience applying advanced computer systems to solve complex water resource and environmental challenges. Mr. Murphy's primary experience is with surface-water, watershed, water quality, and stormwater modeling systems including the Hydrologic Simulation Program Fortran (HSPF), Loading Simulation Program - C++ (LSPC), Storm Water Management Model (SWMM), and System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN). He honed this expertise through a combination of project-specific application, active software development, and facilitation of hands-on training workshops as part of several landmark water quality modeling studies and stormwater management plans. Through the application of these modeling systems, Mr. Murphy has become adept at leveraging both the Python and R scripting languages for extraction, transformation, and analysis of large datasets often distributed across multiple platforms (e.g., desktop/server, Windows/Unix). Mr. Murphy has experience recoding some existing USGS software tools and methods (e.g., HySEP) into contemporary scripting languages like Python for customized applications. He has actively contributed to significant, publicly funded software projects in which some of his runtime and post-processing utilities are incorporated into releases (e.g., SUSTAIN), and he continues to participate in public open-source initiatives (e.g., QGIS web client). Mr. Murphy champions leveraging open-source frameworks, including the QGIS and Python, for both scientifically focused and publicly funded initiatives, as well as the standard for day-to-day workflow application within Paradigm.

Yige Yang, P2 – Staff Scientist

Ph.D., Civil and Environmental Engineering, 2020, Syracuse University
Master of Science, Civil and Environmental Engineering, 2015, Syracuse University
Bachelor of Science, Environmental Science, 2013, Sun Yat-sen University

Dr. Yang is a water resources engineer with experience in green infrastructure research, stormwater treatment design, hydrologic and hydraulic modeling, MS4 permitting, and energy simulation. Her expertise includes assessing the performance of green infrastructure BMPs, including rain gardens, bioswales, and green roofs. She has experience spanning the full BMP life cycle, including public outreach, design, modeling, monitoring, and operation & maintenance. Yige also knows about evaluating evapotranspiration and thermal performance of green infrastructure via field measurement and hygrothermal simulations. Yige is proficient in the application of EPA's Stormwater Management Model (SWMM), Hydrus-1D, and the Army Corps of Engineers HEC-RAS and HEC-HMS modeling systems. She has experience in hydraulics, hydrologic, and water quality modeling and TMDL development using public domain tools such as Loading Simulation Program - C++ (HSPF) and Loading Simulation Program in C++ (LSCP), and she is gaining experience in optimization approaches using the System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN). She has successfully leveraged advanced computing systems and techniques, including the use of the R, Python statistical programming language, and GIS software, to synthesize data sets and communicate solutions to complex environmental problems.

John Riverson, P4 – Senior Modeler

Master of Science, Civil and Environmental Engineering, 1999, University of Virginia
Bachelor of Science, Civil and Environmental Engineering, 1997, University of Virginia

Mr. Riverson has 21 years of experience developing and applying hydrologic models and conducting supporting data analyses services, with a focus on public-domain models typically used to support water resources management and regulations and subject to peer review (e.g., HSPF, LSPC, SWMM, SWAT, TR-55, CE-QUAL-W2, QUAL2E/2K, SUSTAIN). He has an in-depth understanding of meteorological and hydrological processes and interactions, climate change assessment, watershed and stormwater management, water quality, and pollutant source characterization. With Mr. Alvi, John led the development of EPA's LSPC from 2003 and was responsible for designing system architecture and developing algorithms for most of the core LSPC modules including (1) high-resolution meteorological data (2) crop-associated irrigation, (3) hydraulic withdrawals and diversions and (4) the time-variable land use module. He was also a co-developer (with Mr. Alvi) of EPA's SUSTAIN, a decision support model for selection, placement, and cost-benefit optimization of stormwater management practices. He is proficient at engineering highly effective graphical and tabular displays for journal/report- and web-based publication media and has published his work in high-impact peer-reviewed journals (e.g., Water Resources Research, Water Research, Climatic Change). John is regularly sought by different agencies to provide third-party reviews and QA/QC of modeling applications. He is highly regarded for his ability to present highly technical content to a wide variety of audiences through in-person presentations, webinars, and on-site training workshops. Mr. Riverson and Mr. Alvi have collaborated on model development and application for more than 15 years and are each nationally recognized modeling experts with a reputation for delivering high quality, defensible and innovative products.

Robert Roseen (Ph.D., PE), P4 - Senior Project Engineer (Technical Lead for FDC2B project)

Ph.D., Civil-Water Resources Engineering, 2002, University of New Hampshire, Durham, NH
M.S., Environmental Science and Engineering, 1998, Colorado School of Mines, Golden, CO

Dr. Robert Roseen is the Principal and Founder of Waterstone Engineering. Dr. Roseen provides over 25 years of experience in water resources investigations. Rob is a recognized industry leader in green infrastructure watershed management, and nutrient control planning and the recipient of Environmental Merit Awards by the US Environmental Protection Agency Region 1 in 2010, 2016, and 2019. He consults nationally and locally on stormwater management and planning and directed the University of New Hampshire Stormwater Center for 10 years, and is deeply versed in the practice, policy, and planning of stormwater management.

Dale White (Ph.D.), P4 – Senior Aquatic Toxicologist

Master of Science, Environmental Engineering, 2009, Ohio State University
Ph.D., Physical Geography, 1988 Penn State University
Master of Science, M.S., Physical Geography, 1986, Penn State University
Bachelor of Science, B.S., Environmental Studies, 1983, Slippery Rock University of Pennsylvania

As an environmental engineer and physical geographer with over thirty years of experience, Dr. White has focused his career on using stressor-response frameworks and mechanistic and statistical environmental process models, inherently spatially varying, to solve environmental resource problems. He has contributed to developing and communicating advances in understanding water quality issues and watershed management solutions working for both regulatory agencies and academic institutions. He is an expert in applying advanced GIS, modeling, and statistical methods in water quality research. Dale is both a licensed professional engineer (Ohio) and a Certified GIS Professional (GISP).

Jennifer Hansen, P3 – GLEC Quality Assurance Officer

M.S., Biology/Conservation Biology, 2002, Central Michigan University, Mt. Pleasant, MI
B.S., Biotechnology, 1990, Ferris State University, Big Rapids, MI

Jennifer is the proposed Quality Assurance Officer and has a diverse background in the biological and biochemical sciences. She has extensive professional experience as a Quality Assurance Specialist, including the development and implementation of Quality Assurance Systems, data review and approval, laboratory auditing and approval, and non-compliance investigations. She has extensive professional experience in laboratory and field operations including water quality sampling, testing, and reporting.