

REDMOND PAIRED WATERSHED STUDY IMPLEMENTATION: WATER YEAR 2025

In February 2014, the Washington State Department of Ecology (Ecology) approved a Citywide Watershed Management Plan (WMP) for the City of Redmond (City) that allows use of a watershed approach for implementing required stormwater best management practices (BMPs) pursuant to the Phase II municipal stormwater permit. Through the implementation of this WMP, the City will focus stormwater BMPs in a subset of priority watersheds that are moderately impacted by urbanization and therefore expected to respond more quickly to rehabilitation efforts. This provides a unique opportunity to study the effectiveness of stormwater BMPs for improving receiving water conditions on an accelerated timeframe. Recognizing this opportunity, the City is implementing the Redmond Paired Watershed Study (RPWS) to quantify improvements in receiving water conditions based on routine and continuous measurements of various hydrologic, chemical, physical, and biological indicators of stream health. This study will be implemented over an anticipated ten-year timeframe with funding from Ecology's Stormwater Action Monitoring (SAM) program.

To guide its implementation, Herrera Environmental Consultants (Herrera) developed a quality assurance project plan (QAPP) for the RPWS through a previous contract with the City. This QAPP provides detailed descriptions of the procedures that will be used for the following components of the study's experimental design:

- Hydrologic monitoring
- Water quality monitoring
- Sediment quality monitoring
- Physical habitat monitoring
- Biological monitoring

To date, the City has authorized Herrera to implement the monitoring identified in the QAPP over a period that extends from water year 2016 through the end of water year 2025 (a water year is defined as the 12-month period that extends from October 1 in any given year through September 30 of the following year). This scope of work amends this previous contract to extend the monitoring implementation through the end of WY2025. No further monitoring for the RPWS is planned beyond WY2025.

SCOPE OF WORK

Pursuant to this scope of work, Herrera will take the lead role for implementing all the components of the study's experimental design identified above except hydrologic monitoring; King County will lead this component of the study under a separate contract with the City.

The QAPP for the RPWS indicates trend analyses reports should also be prepared following 4, 6, 8, and 10 years of study implementation. These reports summarize the results of statistical analyses that are described in the QAPP to identify relationships between rehabilitation efforts and improving receiving water conditions. The trend analyses reports following 4 and 8 years of study implementation were prepared under previous contract amendments. The trend analysis report following 6 years of study implementation was also eliminated through a previous contract amendment; this change was made with Ecology's concurrence to reduce the overall budget for the study while allowing for a longer period of data collection before conducting analyses to identify relationships between rehabilitation efforts and improving receiving water conditions. This scope of work includes a task for preparing the trend analysis report following 10 years of study implementation.

This scope of work includes a discussion of the activities, assumptions, deliverables associated with the following tasks:

- Task 18.0 - Water Year 2025 Study Implementation
- Task 19.0 - Trend Analysis Report: Water Years 2016 - 2025

The cost by deliverable, and schedule by deliverable for work to be performed by Herrera are included in a separate payment schedule (Exhibit B).

TASK 18.0 – WATER YEAR 2025 STUDY IMPLEMENTATION

Under this task, Herrera will implement required monitoring activities identified in the QAPP for the RPWS over water year 2025 (October 1, 2024, through September 30, 2025). This would include field measurement collection, data management and quality assurance review, and reporting. These activities are described in more detail under the following subtasks:

Subtask 18.1 - Hydrologic Monitoring

The hydrologic monitoring component of the RPWS involves continuous flow monitoring at 12 stations. Data from the continuous flow monitoring is processed to calculate a suite of indicators for evaluating hydrologic impacts from urban development. King County is leading the implementation of the hydrologic monitoring component of the study under a separate contract with the City. Herrera's involvement will entail the post processing of data compiled by King County to generate summary statistics (e.g., antecedent dry period, flow at time of sample collection) from the flow record for storm and base flow events that were sampled for water quality under Subtask 18.2. Herrera will also coordinate with King County to summarize the

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continuous flow monitoring data for each station for presentation in the data report described in Subtask 18.6.

Assumptions

- King County will make available continuous flow monitoring data in an electronic format for post processing by Herrera. King County will perform a quality assurance review on these data that will clearly identify any limitations to their use and interpretation.

Deliverables

- Table with flow summary statistics for sampled storm and base flow events from 12 stations.

Subtask 18.2- Water Quality Monitoring

The water quality monitoring component of the RPWS involves the collection of up to twelve grab samples over the water year during storm events (three each quarter) at 12 stations. In addition, up to four grab samples will be collected over the water year during base flow (one each quarter) at these stations. Each sample will be analyzed for the following indicators for evaluating water quality impacts from urban development:

- Total suspended solids
- Turbidity
- Hardness
- Dissolved organic carbon
- Fecal coliform bacteria
- Total phosphorus
- Total nitrogen
- Copper, total and dissolved
- Zinc, total and dissolved

In addition, probes will be used for continuous in-situ monitoring of temperature at all 12 stations.

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Under this subtask, Herrera will oversee the collection of grab samples during both storm and base flow events. This will include the following activities that will be performed in accordance with the QAPP for the study:

- Weather tracking and go/no go decision coordination
- Mobilization of field crews for sampling during the event
- Delivery of samples to the laboratory after the event
- Auditing of laboratory analytical results within seven days of their receipt
- Entry of the analytical results into the study's data management system
- Preparation of a data validation memorandum that will establish the usability of all the data
- Preparation of graphical and tabular summaries for the data report described in Subtask 18.6.

King County will oversee the continuous in-situ monitoring at each station under a separate contract with the City. Herrera will coordinate with King County to summarize these data in the data report described in Subtask 18.6.

Assumptions

- Storm event sampling will be performed by two teams of two Herrera staff. Sampling for each event will be performed over an 8- hour period including travel but not including storm tracking and go/no go decision coordination. A 15 percent contingency is included to account for sampling event false starts and to allow for make-up sampling.
- Nominally, all 12 stations will be sampled during each storm event. If specific stations are not sampled because a sampling event was terminated, they will be prioritized for sampling in subsequent events to ensure the annual sampling goals established for the study are met for every station.
- Base flow event sampling will be performed by one team of two Herrera staff. Sampling for each event will be performed over a 10- hour period including travel.
- King County will provide continuous water quality monitoring data in an electronic format for review by Herrera. King County will perform a quality assurance review on these data that will clearly identify any limitations to their use and interpretation.

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- Obtaining storm event samples may not be possible during particularly dry quarters. If this should occur, efforts will be made to conduct makeup sampling in subsequent quarters to obtain twelve grab samples from each station over the water year.

Deliverables

- Laboratory analytical results and documentation of Herrera audits from water quality sampling at 12 stations during 3 storm events and 1 base flow event per quarter; these data will be uploaded to the Environmental Information Management (EIM) database.
- Data validation memorandum.

Subtask 18.3 - Sediment Quality Monitoring

The sediment quality monitoring component of the RPWS involves the collection of sediment samples once during the water year at 17 monitoring stations. Each sample will be analyzed for the following indicators for evaluating sediment quality impacts from urban development:

- Total organic carbon
- Copper
- Zinc
- Polycyclic aromatic hydrocarbons
- Phthalates

Under this subtask, Herrera will oversee the collection of these sediment samples. This includes the following activities that will be performed in accordance with the QAPP for the study:

- Mobilization of field crews for sampling
- Delivery of samples to the laboratory after the event
- Auditing of laboratory analytical results within seven days of their receipt
- Entry of the analytical results into the study's data management system
- Preparation of a data validation memorandum that will establish the usability of all the data
- Preparation of tabular summaries for the data report described in Subtask 18.6

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Assumptions

- Sediment samples and the benthic macro invertebrate samples described in Subtask 18.5 will be collected during the same field visit to each station. This sample collection will be performed by one team having two Herrera staff. Collection of these samples from 3 stations will require approximately 8-hours of field time including travel.

Deliverables

- Laboratory analytical results and documentation of Herrera audits from sediment sampling at 17 stations.
- Data validation memorandum.

Subtask 18.4 - Physical Habitat Monitoring

Under this subtask, Herrera will conduct physical habitat monitoring for the RPWS once during the water year at 17 monitoring stations. Herrera will coordinate with Ecology's Environmental Assessment Program (EAP) for training, data management, and quality control of habitat data. At each station, the characteristic bed-form type will be recorded as a whole, and physical habitat quality indicators will be measured at 11 cross sections and one longitudinal (thalweg) profile. Pursuant to the QAPP for the study, the following indicators will be measured at each cross-section:

- Bank-full width, wetted width, and cumulative bar width
- Bank-full depth, wetted depth, substrate class and embeddedness
- Fish cover
- Riparian shading
- Riparian vegetation structure

The following indicators will be measured along the thalweg profile:

- Thalweg depth and the presence of bars and/or edge pools
- Main channel slope and bearing
- Large woody debris tally, including notation of diameter, length, category, zone, and key-pieces

Upon completion of field work, physical habitat monitoring data will be uploaded to the EIM. Based on post processing of these data within this system, Ecology will provide a suite of

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indicators for assessing physical habitat quality that are consistent with those being used for the broader SAM program. Herrera will summarize these indicators for presentation in the data report described in Subtask 18.6.

Assumptions

- Two Herrera staff will participate in an Ecology sponsored 2-day training session on the physical habitat monitoring protocols developed for the SAM program. These staff will coordinate an additional 1-day training session for two additional Herrera staff that will be involved in the monitoring.
- Physical habitat monitoring will be performed by two teams having two Herrera staff. Physical habitat monitoring at each station will require approximately 8-hours of field time including travel.
- Data from the physical habitat monitoring will be recorded on custom forms while in the field. The custom forms will be reviewed in the field upon completion of the monitoring at each station to ensure all required data have been collected. In an office setting, data from the custom forms will then be transferred to the electronic field data collection software that has been developed by Ecology to ensure completeness in field data collection and facilitate upload of these data to Ecology's Watershed Health database in the EIM. Ecology's Environmental Assessment Program (EAP) will perform quality assurance review of the compiled physical habitat monitoring data and calculate metrics for assessing physical habitat conditions using scripts that have been developed to work with the Watershed Health database in the EIM. Costs for EAP's support for these activities are not included in the cost proposal for this scope of work.
- A delay of approximately 6 to 8 months can be expected for obtaining processed indicators for assessing physical habitat conditions from EAP via the Watershed Health database in the EIM system.

Deliverables

- Results from physical habitat monitoring at 17 stations that are uploaded to Watershed Health database in the EIM.

Subtask 18.5 - Biological Monitoring

Under this subtask, Herrera will conduct biological monitoring for the RPWS once during the water year at 17 stations. Pursuant to the QAPP for the study, this entails the collection of a composite sample of benthic macro invertebrates from specific locations along the cross-sections for physical habitat monitoring. These samples will be submitted to an analytical laboratory where they will be processed to compute the following indicators for use in evaluating stream health:

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- Benthic Index of Biotic Integrity
- Taxa Richness
- Ephemeroptera Richness
- Plecoptera Richness
- Trichoptera Richness Clinger Percent
- Long-Lived Richness
- Intolerant Richness
- Percent Dominant
- Predator Percent
- Tolerant Percent

Assumptions

- Benthic macro invertebrate samples and the sediment samples described in Subtask 18.3 will be collected during the same field visit to each station. This sample collection will be performed by one team having two Herrera staff. Collection of these samples from 3 stations will require approximately 8-hours of field time including travel.
- A delay of approximately 6 to 8 months can be expected for obtaining processed indicators for evaluating stream health from the analytical laboratory.

Deliverables

- Laboratory results from macroinvertebrate sample analysis for 17 stations entered into the Puget Sound Stream Benthos database.

Subtask 18.6- Water Year Data Summary Report

Herrera will prepare a data summary report with tabular and/or graphical summaries of all data that were collected over the water year in connection with the following monitoring components of the RPWS: hydrologic, water quality, sediment quality, physical habitat, and biological. This report will provide a detailed description of any quality assurance issues associated with these data based on results from audits and data validation memoranda. Any corrective actions that were undertaken to address quality assurance issues will also be described. Finally, this report will document all rehabilitation efforts that have occurred in the Application watersheds over the previous year. Included will be detailed information on the

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design and operational status of structural stormwater controls and the frequency and geographic extent of nonstructural stormwater control implementation.

Herrera will collaborate with King County to prepare a preliminary draft of the data summary report for review by the City. Based on comments received from the City, Herrera will then prepare a revised draft for review by Ecology and the technical advisory committee (TAC) that has been established for the study (see Subtask 18.7). Herrera will then prepare a finalized version of the report based on comments received.

Deliverables

- Preliminary draft data summary report.
- Draft data summary report.
- Final data summary report.

Subtask 18.7 -Technical Advisory Committee Coordination

The TAC for this study includes representation from the following agencies: City of Redmond, City of Kirkland, City of Seattle, King County, US Geological Survey, and Ecology. Under this subtask, Herrera will coordinate and participate in up to two meetings to obtain input from the committee on technical issues related to the study over water year 2025. It is anticipated that one of these meetings may occur after the release of the data report from Subtask 18.6 to review and discuss the monitoring results from the water year. Contingency budget is also provided for a second, optional meeting to address unforeseen issues that may arise during implementation of the RPWS over the water year.

Assumptions

- Technical advisory committee meetings will last 2-hours and be attended by up to 3 Herrera staff.

Deliverables

- Meeting notes documenting discussion items and consensus decisions from the technical advisory committee.

Subtask 18.8 - Project Management

Herrera will be responsible for ongoing contract administration of this project, including preparing invoices and progress reports, as well as coordination of all work efforts with the designated City point of contact and the Project Team. The Herrera project manager (John Lenth) will have phone and e-mail contact with the City on an as-needed basis.

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Deliverables

- Monthly invoices and progress reports.

TASK 19.0 – TREND ANALYSIS REPORT: WATER YEARS 2016 - 2025

Following completion of required monitoring for water year 2025 and preparation of the associated data summary report, Herrera will prepare a trend analysis report covering data collected over 10 years of study implementation (water years 2016 – 2025). This report will summarize results from statistical analyses performed to detect improving or degrading trends in receiving water conditions in the seven watersheds that are the focus of monitoring efforts for the RPWS. A detailed discussion of these trends will be provided with a specific emphasis on relationships between trends and rehabilitation efforts in the Application watersheds relative to trends in the Reference and Control watersheds. A summary of major conclusions from these analyses will also be provided.

Statistical analyses will follow procedures that are described in the QAPP and documented in minutes from the TAC meeting that occurred on July 29, 2019. The following specific procedures will be performed in connection with these analyses:

- Correlation analyses to detect trends over time in water and sediment pollutant concentration data and computed indicators from hydrologic and biological monitoring.
- Computation of annual mass load estimates from data for a subset of parameters from water quality monitoring; correlation analyses would then be performed on these estimates to detect trends over time.
- Comparisons of data from physical habitat monitoring to reference conditions from Puget Sound lowland ecoregion streams.

Herrera will collaborate with King County to prepare a preliminary draft of the trend analysis report for review by the City. Based on comments received from the City, Herrera will then prepare a revised draft for review by Ecology and the TAC that has been established for the study. Herrera will then prepare a finalized version of the report based on comments received.

Herrera will create two (2) presentations that summarize major findings from the trend analysis report and the RPWS more broadly for permittees and stakeholders. One of these presentations will be made to the Stormwater Work Group. The other can be made at a conference with a stormwater and regional focus (e.g. MuniCon), upon agreement with the City and Ecology (SAM Coordinator). Herrera will also create a SAM factsheet for distribution on the SAM website.

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Assumptions

- Comments on the draft and revised draft trend analysis reports will be provided using a standardized template to be provided by Herrera.

Deliverables

- Preliminary draft trend analysis report.
- Draft trend analysis report.
- Final trend analysis report.
- Two presentations on study design and findings to date.
- SAM factsheet on project findings to date.

EXHIBIT B: PAYMENT SCHEDULE
Redmond Paired Basin Retrofit Effectiveness monitoring Implementation - Water Year 2025

Task/Deliverable	Target Completion Date	Quantity	Unit Cost	Total by Deliverable
Task 18.0 – Water Year 2025 Study Implementation				
<i>Subtask 18.1 – Hydrologic Monitoring</i>				
Table with flow summary statistics for sampled storm and base flow events from 12 stations	Mar 2026	1	\$ 9,300	\$ 9,300
<i>Subtask Total</i>				\$ 9,300
<i>Subtask 18.2 – Water Quality Monitoring</i>				
Laboratory analytical results and documentation of Herrera audits for 12 stations x 16 sampling events		16	\$ 9,230	\$ 147,680
Data validation memorandum	Mar 2026	1	\$ 16,400	\$ 16,400
<i>Subtask Total</i>				\$ 164,080
<i>Subtask 18.3 – Sediment Quality Monitoring</i>				
Laboratory analytical results and documentation of Herrera audits for 17 stations		1	\$ 20,300	\$ 20,300
Data validation memorandum	Mar 2026	1	\$ 5,080	\$ 5,080
<i>Subtask Total</i>				\$ 25,380
<i>Subtask 18.4 – Physical Habitat Monitoring</i>				
Results from physical habitat monitoring at 17 stations	Mar 2026	1	\$ 72,900	\$ 72,900
<i>Subtask Total</i>				\$ 72,900
<i>Subtask 18.5 – Biological Monitoring</i>				
Laboratory results from macroinvertebrate sample analysis for 17 stations	Mar 2026	1	\$ 17,100	\$ 17,100
<i>Subtask Total</i>				\$ 17,100
<i>Subtask 18.6 – Water Year Data Summary Report</i>				
Preliminary Draft / Draft data summary report	May 2026	1	\$ 25,900	\$ 25,900
Final data summary report	Jun 2026	1	\$ 6,480	\$ 6,480
<i>Subtask Total</i>				\$ 32,380
<i>Subtask 18.7 – Technical Advisory Committee Coordination</i>				
Meeting notes documenting discussion items and consensus decisions	Apr 2026	2	\$ 2,150	\$ 4,300
<i>Subtask Total</i>				\$ 4,300
<i>Subtask 18.8 – Project Management</i>				
Monthly invoices and progress reports	Sep 2025	12	\$ 3,180	\$ 38,160
<i>Subtask Total</i>				\$ 38,160
Task Total				\$ 363,600

EXHIBIT B: PAYMENT SCHEDULE

Redmond Paired Basin Retrofit Effectiveness monitoring Implementation - Water Year 2025

Task/Deliverable	Target Completion Date	Quantity	Unit Cost	Total by Deliverable
Task 19.0 – Trend Analysis Report: Water Years 2016 - 2025				
Preliminary Draft / Draft data analysis report	May 2026	1	\$ 42,900	\$ 42,900
Final data analysis report	Jun 2026	1	\$ 10,720	\$ 10,720
Stormwater Work Group and Conference Presentation	Jul - Sep 2026	2	\$ 2,000	\$ 4,000
Fact Sheet	Sep 2026	1	\$ 3,400	\$ 3,400
Task Total				\$ 61,020
Project Total				\$ 424,620