

Standard Operating Procedure (SOP) 12: Quality Assurance Plan, Version 1.0

Southeast Alaska Network Water Quality and Streamflow Monitoring Protocol

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Please cite this Standard Operating Procedure as:

Goodwin, D., and T. Ziomek. 2022. Standard Operating Procedure (SOP) 12: Quality Assurance Plan, Version 1.0. Water Quality and Streamflow Monitoring Protocol, Southeast Alaska (SEAN) Inventory and Monitoring Network. National Park Service, Juneau, Alaska. Available online at <https://irma.nps.gov/DataStore/Reference/Profile/2291600>.

Revision History Log:

Previous Version #	Revision Date	Updated By	Changes Made	New Version #
-	February 2022	D. Goodwin, T. Ziomek	Initial version	1

Summary

The purpose of this Standard Operating Procedure (SOP) is to document standards used by the Southeast Alaska Inventory and Monitoring Network (SEAN) for the collection, processing, storage, analysis, and publication of monitoring data, as described in the Water Quality and Streamflow Monitoring Protocol (Goodwin et al. 2022). The policies and procedures outlined in this quality assurance plan complement the quality assurance plans for other monitoring activities conducted by the SEAN and supplement the Quality Management Plan published by the National Park Service (NPS) Inventory and Monitoring Division as a whole (in preparation). The plan also serves as a guide for all SEAN personnel who are involved in protocol-related activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Protocol Overview

The SEAN is one of 32 National Park Service Inventory and Monitoring networks established to identify and implement long-term monitoring of high-priority park resource condition indicators (Fancy et al. 2009). The SEAN comprises four park units: Glacier Bay National Park and Preserve (GLBA), Klondike Gold Rush National Historical Park (KLGO), Sitka National Historical Park (SITK), and coastal portions of Wrangell-St. Elias National Park and Preserve (WRST). Water quality and streamflow are among the core vital signs prioritized by the SEAN based on their natural ecological value and vulnerability to alteration by human stressors (Moynahan et al. 2008).

River water quality and streamflow are important indicators of Southeast Alaska aquatic and terrestrial ecosystem health. All SEAN units are concerned about the potential effects of climate change, human disturbance, pollution, urban development adjacent to park boundaries, and invasive or nuisance freshwater species. Watershed hydrologic dynamics, including streamflow, depend on land characteristics, soils, regional weather conditions, and human activity. One river in each of GLBA, KLGO, and SITK have been monitored since 2010/2011. Streams across inland WRST are presently monitored by the Central Alaska Inventory and Monitoring Network (Simmons 2017), with no sites yet established in the park's coastal region.

The SEAN's water quality and streamflow monitoring program measures five core parameters: temperature, specific conductance, pH, dissolved oxygen (DO), and turbidity (KLGO only, due to glacial influence). Changes in water quality can be rapid and short-lived, therefore the SEAN employs a continuous (hourly) sampling design to track variability throughout the ice-free season (minimum May – October). Interagency Agreements between the USGS and the SEAN are in place for SITK and KLGO to partially fund station operation and maintenance, providing streamflow data for resource monitoring and flood warning. The USGS remains responsible for all data management (QA/QC, daily and annual statistics, field measurements and rating curve updates) as well as serving real-time data on NWIS. The protocol narrative describes the regional setting, rationale, and program design (Goodwin et al. 2022) for the SEAN's water quality vital sign, with operational and analytical details in associated SOPs.

The SEAN's water quality and streamflow monitoring program objectives are to:

1. Track the status and trends of each core water quality parameter during the ice-free season (May through October).
2. Describe the timing and magnitude of seasonal variation for each core water quality parameter.
3. Evaluate whether relevant state and/or federal water quality standards are met or exceeded.
4. Track the status and trends of seasonal and annual streamflow by financially supporting USGS stream gage operations.

Site Selection

Site access was an important consideration for the SEAN, especially in GLBA where the lack of roads and trails, challenging terrain, and typically cold and wet climate greatly restrict safely reaching most park watersheds. In addition, the SEAN relies on existing, co-located USGS gages for streamflow monitoring, with many advantages from expert site selection and equipment purchase and upkeep, to real-time data broadcast with easy and open access, to already-developed rating curves and an archive of historic data. For these reasons, the SEAN Technical Committee agreed that the use of randomly or probability-based site selection could not be implemented for water quality.

GLBA's Salmon River is 32.7 km long within an 11,552 ha watershed featuring peatlands and forested uplands. The USGS gaging station is approximately 1 km downstream from the park boundary and the SEAN water quality sonde (no significant tributaries exist between these two sites) and 6 km upstream from the river mouth. The Salmon River was selected because it is accessible by foot year-round from Gustavus community roads, hosts an array of anadromous fish species, and is representative of other similarly sized, coastal, non-glacial streams in the park.

The Taiya River in KLGO is located west of Skagway. Approximately 29.2 km long, the river drains a 48,200 ha watershed that was, as of 2010, ~29% glacier covered. The USGS gaging station is on the downstream side of the highway bridge adjacent to the SEAN water quality sonde and 3.5 km upstream from the river mouth. The Taiya was chosen because it encompasses a larger watershed area with heavier visitor use than the Skagway River.

SITK has only one freshwater system, the Indian River. Approximately 20.8 km long, the river drains a steep 3,100 ha watershed with mixed land use. The USGS gaging station is upstream from Sawmill Creek Road adjacent to the SEAN water quality sonde and 1 km upstream from the river mouth.

High-resolution water quality data collected at a single fixed location generally captures the integrated status and trends of the upstream reach and can potentially represent some portion downstream. The SEAN monitoring program's scope of inference is limited to no more than a single watershed and may be altered by major changes in adjacent land use, forest type, physical/chemical modifications upstream, or station location.

Protocol Activities

Data are collected under the Southeast Alaska Water Quality and Streamflow Monitoring Protocol (Goodwin et al. 2022) at Glacier Bay National Park and Preserve, Klondike Gold Rush National Historical Park, and Sitka National Historical Park during the course of 13 activities (Table SOP 12.1).

The primary objective of the protocol is to determine seasonal and annual water quality status and trends for five parameters (temperature, specific conductance, pH, dissolved oxygen, and turbidity) at target sites using fixed, continuous data loggers in three NPS units. The SEAN's river monitoring stations are co-located (or nearly) with USGS streamflow gages, enabling assessment of connections between water quality dynamics and discharge events.

Table SOP 12.1. Protocol activity matrix for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Activity Type	#	Activity	Description	SOP
Site Establishment	1	Reconnaissance and Establishment	Site selection for fixed monitoring locations based on reliable access under varying water levels, safety, river representativeness, and proximity to USGS gaging station. At establishment, GPS coordinates and sonde housing infrastructure photos taken.	Narrative
	2	Maintenance	Monthly site visits verify no significant changes in integrity of installation or location. Observed damage and/or maintenance actions recorded on site visit datasheet.	SOP 1
	3	Modification	If location must be modified, SEAN Program Manager and Project Leader confer with park regarding rationale and options. Change reason documented and new site detailed with GPS coordinates, photos, and description on site visit datasheet.	Narrative
Field Observations	4	Monthly Site Visit	Sensor check and recalibration data collected during monthly site visits. Temperature, specific conductance, pH, dissolved oxygen, and turbidity readings are taken and verified against NIST-certified thermometers and standard solutions. Recorded on site visit datasheet, including site name, observer, date/time, sonde serial number, battery status, pre-/post-cleaning and post-calibration readings, and observer comments.	SOP 1
Sensor Data	5	Temperature	Water temperature data collected every hour during ice-free season.	SOP 1
	6	Specific Conductance	Specific conductance data collected every hour during ice-free season.	SOP 1

Table SOP 12.1 (continued). Protocol activity matrix for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Activity Type	#	Activity	Description	SOP
Sensor Data	7	pH	pH data collected every hour during ice-free season.	SOP 1
	8	Dissolved Oxygen	Dissolved oxygen concentration and saturation data collected every hour during ice-free season.	SOP 1
	9	Turbidity	Turbidity data collected every hour during ice-free season.	SOP 1
External Data	10	River Discharge	Streamflow (discharge in cubic meters per second) data derived from river stage measurements and site rating curves. Obtained from USGS NWIS.	N/A
QA/QC Data	11	Annual Service Records	Sonde and sensor manufacturer (YSI) annually services and calibrates all program equipment to ensure consistent and accurate operation. Sensors replaced when do not meet calibration criteria or otherwise fail.	SOP 4
	12	Data Grading and Correction	In Aquarius software, sensor data outside minimum/maximum allowable ranges and from intervals of instrument failure or dry conditions are manually flagged. Data evaluated, graded, and annotated. Fouling drift corrections applied where appropriate.	SOP 7
	13	Data Validation, Certification, and Publication	Using data management applications, all deliverables are validated against defined mandatory and optional criteria before certification and publication. The SEAN Data Management Plan further describes these processes (Johnson and Moynahan 2008).	SOP 3, 4, 5, 8, 9, 11

Sampling Design

Information regarding the sampling design is provided in Table SOP 12.2. Water quality sampling occurs during the ice-free season, defined as 1 May – 31 October, though in some years it is possible to extend the deployment by several weeks. Streamflow measurements are made year-round. One site at each of three parks is monitored.

Table SOP 12.2. Activity-level sample design matrix for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Numbers match those in the protocol activity matrix (Table SOP 12.1).

Activity Type	#	Activity	Sampling Design	Revisit Design
Field Observations	4	Monthly Site Visit	Targeted	Revisit monthly, or more frequently as needed for data/sensor concerns
Sensor Data	5	Temperature	Targeted	Continuous, recorded hourly
	6	Specific Conductance	Targeted	Continuous, recorded hourly
	7	pH	Targeted	Continuous, recorded hourly
	8	Dissolved Oxygen	Targeted	Continuous, recorded hourly
	9	Turbidity	Targeted	Continuous, recorded hourly
External Data	10	River Discharge	Targeted	Continuous, recorded at 15-minute intervals (managed by USGS)

Data Quality Objectives

Data quality objectives are qualitative and quantitative statements that clarify observation intentions, define appropriate types of data, and specify acceptable levels of uncertainty. They provide the framework for planning data collection and serve to establish the quality and quantity of data needed to support management decisions.

Both data quality values (Table SOP 12.3), which are desired qualitative characteristics, and measurement quality objectives (Table SOP 12.4), which are quantitative requirements for precision, bias, resolution, etc., are important. Because values for core water quality parameters are expected to be well within the manufacturer-established ranges of the chosen sensors, method detection limits and minimum levels of quantification are not reported.

Table SOP 12.3. Data quality values (DQVs) for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Data Quality Category	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width, position) or classes (species, types, or categories). Includes components of precision and bias.	Multiparameter sondes and sensors are serviced by YSI prior to each field season. Sensors are calibrated prior to each field season and sondes/handhelds configured (SOP 1). Sensor calibration is checked monthly, recalibrated if needed (SOP 1). Sonde continuous operation and monthly site visits conducted following schedule and methods of established protocol (Goodwin et al. 2022). Data collected in the field are assumed accurate representations of true values.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	Sampling occurs hourly at fixed sites throughout the monitoring season, capturing a broad range of natural streamflow conditions and weather events. Sites are located near downstream end of a major river in each park, integrating watershed processes and landscapes. Sites co-located with (or near) a USGS gaging station so matched streamflow data available to enhance water quality analysis and interpretation. Sensor fouling and calibration drift evaluated monthly during site visits. Data corrected as necessary in Aquarius according to procedures in Wagner et al. (2006).

Table SOP 12.3 (continued). Data quality values (DQVs) for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Data Quality Category	Data Quality Value	Definition	Protocol Considerations
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	Locations, sampling season, sonde/sensor models, and equipment configuration maintained between years and sites. Park Leads trained pre-season to ensure consistent protocol implementation. Detailed SOPs enable data comparability through time when sensors or staff change. Deployment, calibration, and site visit methods are compatible with other water quality monitoring programs and specified in detailed SOPs. Data processing and evaluation follow standard Aquarius procedures, are consistent between sites, and are specified in detailed SOPs.
	Timeliness / Currency	How recent the data need to be to be considered valid for their intended use. Data represents conditions and/or is available and in a format for use at the appropriate time in the decision-making process.	Data processing occurs at the end of the monitoring season. Data validation, certification, and publication occur prior to the start of the next monitoring season. Annual updates based on certified data shared with parks and the public following each monitoring season. No NPS management decisions are based on this dataset.
	Completeness	All data/ measures required to evaluate accuracy representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	Methods, sampling program, and analyses are designed and implemented to yield a complete dataset across sites and the ice-free season. Sonde/sensor failure, high/low water events, and logistical complexities may cause data gaps. Monthly data review throughout the field season catches and resolves most gaps, which are identified and documented in the long-term record.
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	Standard definitions of data quality are provided. Provisional data that have been reviewed but not certified are not published. Certified data are those that have been reviewed, QA/QC checked, and edited; only validated and certified records are published and used for analyses/reporting. Data grades and flags are standardized in Aquarius software and further defined in SOP 7.
Data Accessibility	Secure	Access to data, products, and systems limited to appropriate audiences.	No sensitive or protected data result from the SEAN water quality monitoring program. Once certified, all data collected through this protocol will be available to the public on the IRMA Data Store.

Table SOP 12.4. Measurement quality objectives for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Activities match those in the protocol activity matrix (Table SOP 12.1). Quality objectives for continuous sensor measurements are from YSI (2021).

Activity	Measure / Quality Indicator	Quality Objective
Site Establishment	Location Accuracy	Co-locate site with USGS gaging stations where possible. Collect GPS coordinates (latitude/longitude) with a horizontal accuracy of +/- 1 m during initial establishment.
	Location Description	Describe with enough detail to relocate site without use of GPS equipment. Maps and narrative directions provided for fieldwork.
Temperature	Sensor Type / Units	Thermistor / degrees Celsius (°C)
	Accuracy	± 0.2 °C
	Resolution	0.001 °C
	Range	-5 – 50 °C
	Reporting	Report to one decimal place
	Maximum allowable difference	± 1 degree from NIST-certified thermometer
Specific Conductance	Sensor Type / Units	4-electrode nickel cell / milliSiemens per centimeter (mS/cm)
	Accuracy	± 1% of reading or 0.002 mS/cm, whichever is greater
	Resolution	0.0001 to 0.01 mS/cm, range dependent
	Range	0 – 100 mS/cm
	Reporting	Report to three decimal places
	Maximum allowable difference	± 0.05 mS/cm from standard
pH	Sensor Type / Units	Glass combination electrode / standard pH units
	Accuracy	± 0.1 pH units within ± 10°C of calibration temp
	Resolution	0.01 units
	Range	0 – 14 units
	Reporting	Report to two decimal places
	Maximum allowable difference	± 0.1 unit from standard
Dissolved Oxygen	Sensor Type / Units	Optical, luminescence lifetime / milligrams per liter (mg/L) and % saturation
	Accuracy	± 0.1 mg/L or 1% of reading, whichever is greater
	Resolution	0.01 mg/L, 0.1% saturation
	Range	0 – 50 mg/L, 0 – 500% saturation
	Reporting	Report to two decimal places
	Maximum allowable difference	± 0.5 mg/L from calculated level

Table SOP 12.4 (continued). Measurement quality objectives for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Activities match those in the protocol activity matrix (Table SOP 12.1). Quality objectives for continuous sensor measurements are from YSI (2021).

Activity	Measure / Quality Indicator	Quality Objective
Turbidity	Sensor Type / Units	Optical, 90° scatter / formazin nephelometric units (FNU)
	Accuracy	± 0.3 FNU or 2% of reading (<999 FNU), ± 5% of reading above
	Resolution	0.01 FNU (at 0 – 999 FNU), 0.1 above
	Range	0 – 4000 FNU
	Reporting	Report to one decimal place
	Maximum allowable difference	± 5 FNU for 0 FNU standard, ± 7 FNU for 124 FNU standard
River Discharge	Sensor Type / Units / Standards	Set and managed by USGS following Turnipseed and Sauer (2010)

Table SOP 12.5. Data protection standards for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Data Type	Type of Data	Protection Level	Rules for Publication
Continuous water quality data	Sensor measurements	Unprotected	Data published through IRMA Data Store, available to the public
Location data	Permanent monitoring sites	Unprotected	Included in metadata and shown in reports
Personally identifiable information (PII)	Personal information	Legally protected	PII not included in published deliverables

Quality Assurance Procedures

The following quality assurance procedures are designed to ensure that collected or generated data meet specified requirements (Table SOP 12.6).

Table SOP 12.6. Quality assurance procedures for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Numbers correspond to those in the protocol activity matrix (Table SOP 12.1).

Activity Type	#	Activity	QA Procedure	SOP
Site Establishment	1	Site Establishment	Designated sites with fixed sonde housings (SITK, KLGO) ensure consistent location. Verify site GPS coordinates at deployment (GLBA).	Narrative
	1	Site Establishment	Deploy sondes in a consistent manner at all sites. Step-by-step instructions provided.	SOP 1
	1	Site Establishment	Use identical sondes and sensors (same manufacturer and model) at all sites.	SOP 1
Field Observations	4	Monthly Site Visit	SOPs reviewed and updated yearly, provided to Park Leads before monitoring season.	SOP 11
	4	Monthly Site Visit	Pre-season training for Park Leads provided by Project Leader, plus technical support throughout year.	Narrative
	4	Monthly Site Visit	Site visit datasheet template provided to Park Leads so observations are consistent across sites, visit dates, and years.	SOP 1
	4	Monthly Site Visit	Site visit datasheet has separate fields for different observations to reduce errors and missing information.	SOP 1
	4	Monthly Site Visit	Checklist of equipment for site visits provided in SOP.	SOP 1
	4	Monthly Site Visit	Inventory of calibration standards and expiration dates maintained by Park Leads and Project Leader to ensure out-of-date solutions are not used. Resupplied each year.	Narrative
	4	Monthly Site Visit	Sensor check and calibration step-by-step instructions provided to Park Leads.	SOP 1
	4	Monthly Site Visit	All sensors evaluated for fouling and calibration drift monthly.	SOP 1
Sensor Data	5 - 9	All Sensor Data	Sondes and handhelds programmed pre-season by Project Leader so settings consistent across sites and years. Detailed in SOP.	SOP 1
	5 - 9	All Sensor Data	Sondes and sensors tested and calibrations checked by Project Leader pre-season following manufacturer service.	SOP 1
	5	Temperature	Thermistor calibrated by manufacturer pre-season. Verified by comparison to NIST-certified thermometer monthly. Calibration and sensor check records maintained for individual sensors.	SOP 1

Table SOP 12.6 (continued). Quality assurance procedures for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Numbers correspond to those in the protocol activity matrix (Table SOP 12.1).

Activity Type	#	Activity	QA Procedure	SOP
Sensor Data	6	Specific Conductance	Sensor calibrated by manufacturer pre-season. Verified by comparison to 1.000mS/cm standard monthly. Single-point recalibration as needed. Calibration and sensor check records maintained for individual sensors.	SOP 1
	7	pH	Sensor calibrated by manufacturer pre-season. Verified by comparison to 7.0 and 10.0 standards monthly. Two-point recalibration as needed. Calibration and sensor check records maintained for individual sensors.	SOP 1
	8	Dissolved Oxygen	Sensor calibrated by manufacturer pre-season. Verified by water-saturated air method monthly. Single-point recalibration as needed. Calibration and sensor check records maintained for individual sensors.	SOP 1
	9	Turbidity	Sensor calibrated by manufacturer pre-season. Verified by comparison to 0 and 124 FNU standards monthly. Two-point recalibration as needed. Calibration and sensor check records maintained for individual sensors.	SOP 1
	5 - 9	All Sensor Data	Step-by-step instructions for data transfer from sonde to computer and software settings provided to Park Leads.	SOP 2
	5 - 9	All Sensor Data	Season's cumulative data record transferred from sonde during each monthly site visit, minimizing data loss in event of sonde failure or damage.	SOP 2
External Data	10	River Discharge	River stage measured by USGS infrastructure and instrumentation. USGS conducts field observations annually to verify and adjust stage/discharge curve. All gaging station operations follow Turnipseed and Sauer (2010).	All QA by USGS
QA/QC Data	12	Data Management	Data management plan (Johnson and Moynahan 2008) established at project initiation. File naming and folder system used consistently across parks and years.	SOP 3, 4, 5, 8, 9, 11
	12	Data Grading and Correction	Step-by-step instructions provided for site visit and continuous data import to Aquarius.	SOP 6
	12	Data Grading and Correction	List of criteria and allowable Aquarius grades/annotations are specified in SOP.	SOP 7
	12	Data Grading and Correction	List of criteria and allowable Aquarius approval levels are specified in SOP.	SOP 7
	13	Data Validation and Certification	Mandatory and optional validation criteria defined for all deliverables.	SOP 3, 4, 5, 8, 9, 11
	13	Data Validation and Certification	Step-by-step instructions for validation and certification of deliverables provided in SOPs.	SOP 3, 4, 5, 8, 9, 11

Quality Control Procedures

The quality control procedures designed to ensure collected or generated data meet specified requirements and are appropriately annotated or corrected are outlined in Table SOP 12.7.

Table SOP 12.7. Quality control procedures for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Numbers correspond to those in the protocol activity matrix (Table SOP 12.1).

Activity Type	#	Activity	QC Procedure	SOP
Site Establishment	2	Site Maintenance	Park Leads observe and document any debris around sonde or sensors, damage to site infrastructure or instruments, and river water level during monthly site visits. Also confirm sonde remains in established location.	SOP 1
Field Observations	4	Monthly Site Visit	Incomplete, suspect, or ambiguous information in site visit datasheets verified with Park Leads monthly. Notes and corrections made in datasheets and, where relevant, in Aquarius.	SOP 2
	4	Monthly Site Visit	Monthly electronic datasheet validation: filename, file format, data type and completeness	SOP 3
Sensor Data	5 - 9	All Sensor Data	Raw data files opened in sonde software to verify format and contents. Filename compared to required format.	SOP 2
	5 - 9	All Sensor Data	Completeness of raw data record evaluated (full date range without gaps).	SOP 2
	5 - 9	All Sensor Data	Data reviewed monthly for sensor drift and/or failure, and to ensure no settings or parameter units were modified during site visit. Sensors replaced if providing erroneous data or failed to calibrate.	SOP 2
External Data	10	River Discharge	River stage measured by USGS infrastructure and instrumentation. USGS conducts field observations annually to verify and adjust stage/discharge curve. All gaging station operations and data QC follow Turnipseed and Sauer (2010).	All QC by USGS
QA/QC Data	12	Data Grading and Correction	Monthly review of site visit datasheets for completeness.	SOP 3
	12	Data Grading and Correction	Review of Aquarius imported data for accuracy against original source.	SOP 6
	12	Data Grading and Correction	Data compared to minimum/maximum acceptable values. Outliers and suspect readings verified, graded, and annotated in Aquarius.	SOP 7
	12	Data Grading and Correction	Data and documented circumstances compared to evaluation criteria. Readings verified, graded, and annotated in Aquarius.	SOP 7

Table SOP 12.7 (continued). Quality control procedures for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program. Numbers correspond to those in the protocol activity matrix (Table SOP 12.1).

Activity Type	#	Activity	QC Procedure	SOP
QA/QC Data	12	Data Grading and Correction	Magnitude of fouling drift assessed in Aquarius where complete suite of site visit checks permit. If above minimum allowable error, correction applied over defined interval.	SOP 7
	13	Data Validation and Certification	Deliverables are validated and certified according to the criteria specified in SOPs	SOP 3, 4, 5, 8, 9, 11
	13	Data Validation and Certification	Deliverable tracking spreadsheet (Johnson and Moynahan 2008) used to record dates and steps accomplished for QA/QC procedures and data certification.	SOP 3, 4, 5, 8, 9, 11
	13	Data Publication	Deliverables published to IRMA Data Store with FGDC-compliant metadata (Johnson and Moynahan 2008)	SOP 3, 4, 5, 8, 9, 11

Roles and Responsibilities

Many individuals contribute to data collection, processing, storage, and analysis for the SEAN water quality monitoring program. Each has a role in ensuring the data quality objectives and standards described above are satisfactorily met, as described in Table SOP 12.8. Some program participants also have required training and accreditation.

Table SOP 12.8. Roles, responsibilities, and accreditation for persons involved with implementation of the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Position	Responsibilities and Accreditation
Park Leads	Responsibilities: Maintain site check and sonde cleaning supplies. Conduct monthly site checks and sensor calibrations. Record monthly site check readings on field datasheets. Transfer data from sonde to computer. Transmit data monthly to Project Leader. Monitoring site maintenance. Communicate about troubleshooting and site changes. Accreditation: Participation in training provided by SEAN Project Leader. Demonstrated ability to operate water quality monitoring equipment and software, safely handle chemical solutions, and document field observations.
SEAN Project Leader	Responsibilities: Prepare equipment; provide consumables, SOPs, and field datasheets to Park Leads. Train Park Leads. Technical support and troubleshooting through field season. Monthly data review. End-of-season data QC in Aquarius and certification. Analysis and reporting. Protocol review and revision. Overall protocol implementation. Ensure data meet quality objectives. Consistency of interpretation. Science communications. Accreditation: Working knowledge of water quality equipment and software, Excel, and Aquarius. Ideally, completion of one or more water quality monitoring and river data analysis courses.
SEAN Data Manager	Responsibilities: Aquarius database and validation application development and maintenance. Coordinate data import, validation, certification, storage, and publishing. Ensure data meet quality objectives. Ensure data management meets NPS and federal information management standards. Accreditation: Working knowledge of Aquarius. Skilled in SQL Server and .NET application development and Excel.
SEAN Quantitative Ecologist	Responsibilities: Identify appropriate statistical methods. Data synthesis and modeling analyses. Synthesis reporting.
SEAN Program Manager	Responsibilities: Program coordination. Oversight of protocol development and implementation. Guide selection of Park Leads. Ensure data meeting quality objectives. Facilitate protocol and reporting peer review. Budget. Coordinate monitoring with parks.
Alaska Region Inventory and Monitoring Program Manager	Responsibilities: Protocol and QAP approval. Ensure data meet quality objectives.

Data Quality Evaluation

This QAP, along with the associated protocol narrative and SOPs, describes how the water quality and streamflow monitoring program will be implemented and how data quality objectives will be met. In complement, it is important to evaluate how procedures are working and identify appropriate improvements. Data quality evaluations are outlined in Table SOP 12.9.

Table SOP 12.9. Data quality evaluations for the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Review	Purpose and Description	Frequency
Operational Review	Project Leader solicits feedback from Park Leads and SEAN Data Manager to identify successes and opportunities for improvement in operations, protocol/ SOPs, technical support, QA/QC and safety. Ideas are discussed and changes made as appropriate.	Annual, at end of field season
Data Completeness	Assess days sampled over season relative to expected and identify reasons for data gaps.	Annual
Data Quality Objective Review	Ensure that data quality objectives are appropriate to meeting stated monitoring objectives.	Data quality reviewed annually. Data quality objectives evaluated every five years during formal scientific review.
Formal Scientific Review	Evaluate whether the protocol is meeting stated monitoring objectives, producing the best available science, and supporting park-specific management goals.	Every five years

Data Management and Documentation

Proper documentation and data management are essential to effective long-term monitoring programs. Records maintained as part of the water quality and streamflow project include protocol documents and SOPs, field observations, certified sensor data, metadata, and reports (Table SOP 12.10). Data undergoes validation and certification prior to publication; data not yet certified are considered provisional. All reports, analyses, and published data for public or park use are based on certified deliverables. Certification confirms that data have been through all QA/QC procedures, meet specified quality standards or not (if not, data are identified and annotated, or removed from the certified record), are documented in associated metadata, and are suitable for general use. All subsequent modifications to certified data are documented with a description, date, and name; previously published deliverables are versioned to clearly identify the current authoritative product.

Table SOP 12.10. Required records of the Southeast Alaska Inventory and Monitoring Network water quality and streamflow program.

Category	Record Type	Format	Archive Location(s)
Protocols	Protocol Narrative	PDF	SEAN Server, IRMA Data Store
	Standard Operating Procedures	PDF	SEAN Server, IRMA Data Store
	Site Visit Datasheet Template	Excel	SEAN Server
Field Observations	Completed Site Visit Datasheets	Hard copy	SEAN Office
	Completed Site Visit Excel Files	Excel	SEAN Server, IRMA Data Store
	Periodic Site Photographs	JPG or other	SEAN Server
Sensor Data	Continuous Sonde Data Files	BIN	SEAN Server, IRMA Data Store
	Certified Sensor Data Files	CSV	SEAN Server, IRMA Data Store
Database	Database System	Aquarius, SQL Server	Aquarius, SEAN Server
QA/QC	Quality Control Tracking	Aquarius	Aquarius
	Deliverable Tracking	DM spreadsheet	SEAN Server
	Federal Geographic Data Committee compliant metadata	XML	SEAN Server, IRMA Data Store
Data Analysis and Reporting	Data File(s) Used in Analysis	CSV	SEAN Server, IRMA Data Store
	Data Analysis Code	R Script	SEAN Server, Synthesis Report Appendix
	Annual Updates	HTM, PDF	SEAN Server, NPS website, IRMA Data Store
	Draft Synthesis Report (submitted for peer review)	PDF	SEAN Server
	Synthesis Peer Review Comments and Author's Response	PDF	SEAN Server
	Final Synthesis Report	PDF	SEAN Server, IRMA Data Store
	NRR Publication Submittal Forms	PDF	SEAN Server

Literature Cited

- Fancy, S. G., J. E. Gross, and S. L. Carter. 2009. Monitoring the condition of natural resources in US national parks. *Environmental Monitoring & Assessment* 151:161–174.
- Goodwin, D. S., C. L. Amundson, and T. R. Ziomek. 2022. Water quality and streamflow monitoring protocol: Version FQ–2022.1, Southeast Alaska Network. Natural Resource Report NPS/SEAN/NRR–2022/2403. National Park Service, Fort Collins, Colorado.
<https://doi.org/10.36967/nrr-2293702>.
- Johnson, W. F., and B. J. Moynahan. 2008. Data management plan: Southeast Alaska network. Natural Resource Report NPS/SEAN/NRR—2008/058. National Park Service, Fort Collins, Colorado.
- Moynahan, B. J., W. F. Johnson, D. W. Schirokauer, L. Sharman, G. Smith, and S. Gende. 2008. Vital sign monitoring plan: Southeast Alaska Network. Natural Resource Report NPS/SEAN/NRR—2008/059. National Park Service, Fort Collins, Colorado.
- National Park Service (NPS). 2012. Records and electronic information management. National Park Service.
- Oakley, K. L., L. P. Thomas, and S. G. Fancy. 2003. Guidelines for long-term monitoring protocols. *Wildlife Society Bulletin*, 31(4):1000–1003.
- Simmons, T. 2017. Monitoring stream ecosystems in the Central Alaska Network: Protocol narrative. Natural Resource Report NPS/CAKN/NRR—2017/1470. National Park Service, Fort Collins, Colorado.
- Turnipseed, D. P., and V. B. Sauer. 2010. Discharge measurements at gaging stations: Techniques and methods book 3, chapter A8. United States Geological Survey, Reston, VA.
<http://pubs.usgs.gov/tm/tm3-a8/>
- Wagner, R. J., R. W. Boulger Jr., C. J. Oblinger, and B. A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors: station operation, record computation, and data reporting. U.S. Geological Survey Techniques and Methods 1–D3, p. + 8 attachments.
- Yellow Springs Instruments (YSI). 2021. EXO user manual: Advanced water quality monitoring platform, revision K. YSI/Xylem: Yellow Springs, OH.
<https://www.ysi.com/file%20library/documents/manuals/exo-user-manual-web.pdf>