

SOP 2.1: Management of MIDN Benthic Macroinvertebrate Field and Lab Data

This document provides guidelines for the management of the Mid-Atlantic Network's (MIDN) benthic macroinvertebrate (BMI) field and laboratory data including data entry guidelines, data storage procedures, lab data import procedures, and schedule of related activities.

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I. Equipment

- Completed Field Forms
- Scanned PDFs of Paper Field Forms
- Laboratory taxa count results Excel spreadsheets
- MIDN Computer
 - MIDN BMI front-end Database
 - MIDN BMI backend Database
- Access to MIDN Server

II. Data Handling Guidelines

A. Data Collection

Data collection procedures and data sheet templates are provided in Site Visit Procedures for Collection of BMI Field Data (SOP 1.2).

No later than three business days following the conclusion of yearly field sampling, the protocol lead will obtain collected data sheets from all of the sampled parks and complete the following data management procedures.

B. Field Data Handling

The MIDN uses paper field forms to collect field data during yearly site visits (In-stream Transect, Habitat Assessment). Field forms are printed on write-in-the-rain paper and responses marked with pencil. Prior to data entry, all field forms are reviewed to check for data anomalies (Tables 1 and 2). Any changed, missing, censored, or out of range values must be annotated on the paper data sheet with the initials of the investigator responsible for reviewing the data. Where appropriate, a note will be entered into the visit comment field regarding the reason for the field data anomalies.

Table 1. Benthic macroinvertebrate metrics collected with the MIDN Macroinvertebrate Data Sheet, their definitions, and sample response values.

Field Value	Definition	Data Format
Site	Unique identification code for the sampling location, consisting of a Four-letter park code and a two digit numeric designation.	VAFO_01
Date	Date of the sampling event.	YYYY/MMM/DD
Observers	Initials of the observers performing the sampling.	NTD
Sample Type	Type of Habitat sampled during the event. The three categories are: VA Piedmont (single habitat), PA Piedmont (single habitat), and VA Coastal Plain (multi-habitat).	Circle appropriate sample type
Microhabitats Sampled	For VA Coastal Plain sites only. Microhabitats sampled using a D-net during macroinvertebrate collection. The four microhabitats are Riffle, Snags, Banks Vegetation	Circle all habitats where organisms were collected
Jabs	For VA Coastal Plain sites only. Number of D-net jabs completed in each sampled microhabitat	Integer value, 1 to 20
Total	For VA Coastal Plain sites only. Calculated total of jabs performed across all microhabitats sampled at a sampling event.	Integer value, 1 to 20
Transect	Distance along the sampling transect measured in meters from the start of the transect to the downstream terminus of the transect (0, 25, 50, 75, and 100 meters).	0, 25, 50, 75, 100

Photos	Indicate if all four photos were captured for each transect	Y/N
Additional Notes	Observer may record additional information that may affect the interpretation of the collected data, or other observations of interest found during data collection.	

Table 2. Benthic macroinvertebrate metrics collected with the Habitat Assessment data sheets, their definitions, and sample response values. Field values unique to High and Low gradient streams are noted in bold. For more information refer to Barbour et al. (1999) or Shull and Lookenbill (2018).

Field Value	Definition	Data Format
Stream Name	Unique identification code for the sampling location, consisting of a Four-letter park code and a two digit numeric designation.	VAFO_01
Date	Date of the sampling event.	YYYY/MMM/DD
Time	Time of habitat assessment (24-hr clock); Eastern Standard Time	14:30
Form Completed By	Initials of the observers performing the Habitat Assessment.	NTD
Epifaunal Substrate/ Available Cover	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Instream Cover	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Embeddedness	High Gradient streams only: Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Velocity/Depth Regime	High Gradient streams only: Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Pool Substrate Characterization	Low Gradient streams only: Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Pool Variability	Low Gradient streams only: Current condition divided into four categories with corresponding quality scores: optimal (16-	Integer value, 0 to 20

	20), suboptimal (11-15), marginal (6-10), and poor (0-5).	
Sediment Deposition	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Channel Flow Status	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Channel Alteration	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Frequency of Riffles (or bends)	High Gradient streams only: Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Channel Sinuosity	Low Gradient streams only: Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Integer value, 0 to 20
Bank Stability (score each bank)	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Left and right bank are each scored as integers 0-10, then combined for a total score
Vegetative Protection	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Left and right bank are each scored as integers 0-10, then combined for a total score
Grazing or Other Disruptive Pressure	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	
Riparian Vegetative Zone Width	Current condition divided into four categories with corresponding quality scores: optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5).	Left and right bank are each scored as integers 0-10, then combined for a total score

Individual completed field forms will be scanned as Adobe PDF files and saved to the MIDN server in the “Field_Forms” Folder (see IV. A.) with the naming convention below (Table 3). Field forms will be further organized by State and then Park within the Field_Forms folder.

Table 3. MIDN scanned field form naming convention.

Field Form	Naming convention
MIDN Macroinvertebrate	BMI_YEAR_SITE_Transect
Habitat Assessment	BMI_YEAR_SITE_Habitat

C. Lab Data Handling

Benthic macroinvertebrate samples will be collected, field processed, and sent for identification according the procedures outlined in SOP 1.1 and 1.2. The laboratory will pick and identify individual organisms from the samples provided and return the results in an Excel spreadsheet. These data will be imported into the MIDN BMI database as outlined in section III. B. below.

III. Data Entry, Import, and Maintenance Procedures

The MIDN employs a Microsoft Access relational database for entry, storage, and maintenance of benthic macroinvertebrate field and laboratory data, as well metadata, including site documentation. The database is split into two separate Access files: a front-end data entry application (named MIDN_BMI_FE_VX.XX_MASTER_DDMYYYYY.accdB) and back-end data storage file (named MIDN_BMI_BE_VX.XX_MASTER_DDMYYYYY.accdB). The front-end application manages the links between the two files, allowing the user to view which backend file is in use, and to re-link to other backend files as needed.

Front end forms allow a user to enter field data quickly and easily, while also preventing data entry errors through the use of front and back end validation rules that prompt the user to make corrections when needed. Data entry of all field form data is outlined in section III. A. below. Lab data must be imported by the data manager after field data entry and validation is complete. Lab data import is outlined in section III. B. below.

The MIDN BMI database also contains queries for performing quality control checks, and allowing for exporting the data in a batch flat file format analysis and visualization.

A. Field Data Entry

Field observations cannot be entered into the MIDN BMI database until the metadata for each sampling location has been added to the database. During protocol development, sampling locations and their associated metadata are entered into the database table tbl_locations. When a user is ready to complete data entry, they must request access to a copy of the most recent front-end and Master backend from the MIDN data manager. To complete data entry, follow the instructions below:

- (1) Connect the MIDN BMI front-end database to the appropriate master backend file.
 - a. Begin by opening the front-end file and click on the “Connect data tables” button on the switchboard form (Figure 1). This will open up the “Update data table connections” form (Figure 2).
 - b. Click the “Browse” button to navigate to the backend file you wish to enter data into.
 - c. Click the “Update Links” button to complete the table linking process (Figure 2).

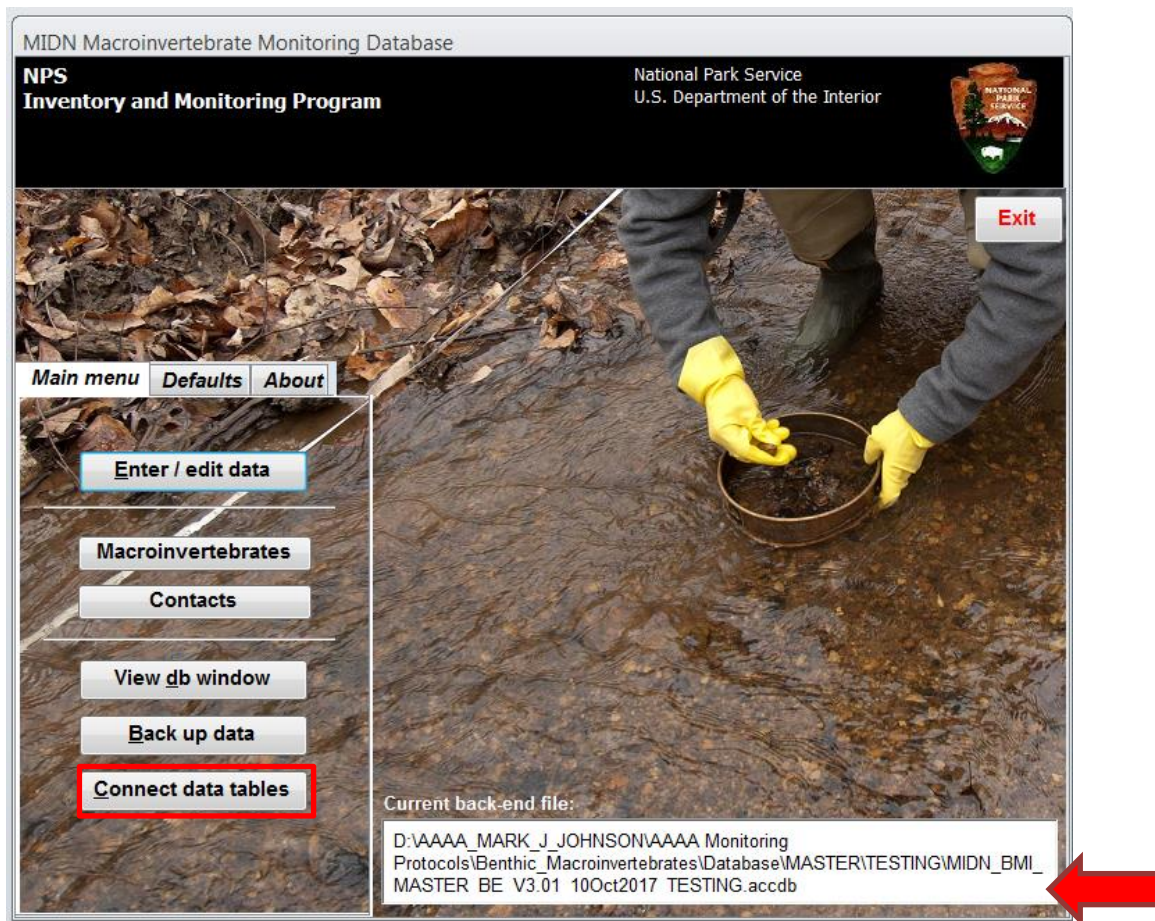


Figure 1. MIDN BMI switchboard form with the “Connect data tables” button highlighted in red. The arrow is pointing to the window that displays the file path to the current connected back end file.

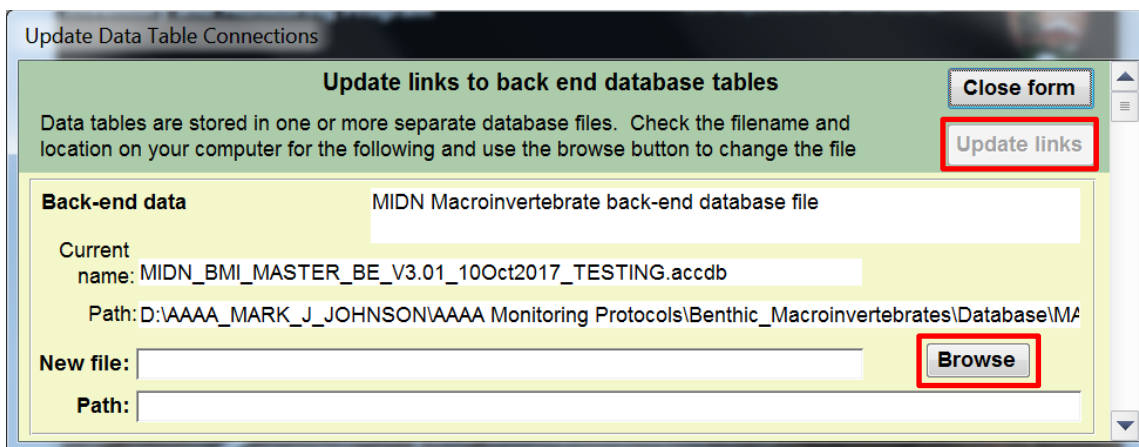


Figure 2. MIDN BMI Update Data Table Connections form with the “Browse” and “Update links” buttons highlighted in red.

- (2) Once returned to the switchboard form, begin entering field data by clicking the “Enter/edit data” button, which is surrounded in blue (Figure 1).
 - a. You will be prompted to set application default values (figure 3). Choose your user name and click OK. You should not alter any of the other values on this form.

Set application default values

OK

User: Mark Johnson

Park: MIDN

Datum: NAD83

UTM Zone: 18N

Protocol: Macroinvertebrate Monitoring

Project: MIDN Macroinvertebrate Monitoring

New user

Figure 3. MIDN BMI default value form with User field highlighted in red.

- b. You will be taken to the Data Gateway form that allows for browsing through existing event data, and the creation of new records (Figure 4). To add data for a new event, click the “Add a new record” button.

Sample Data Gateway - List of data that have been entered

* Double-click on the field label to change sort order. Double-click on a Location Name to open the Locations form for that record or a Visit Date to open the Data Entry form for that record.

Add a new record Close

Filters

Park: [dropdown] Location Name: [dropdown] Year: [dropdown] Visit Date: [dropdown] Filter Is On

Unit*	Site Name*	Location Name*	Entered/updated*	Year*	Visit date*	Protocol*
APCO		APCO_02	2011 Nov 04 11:11	2017	21 Mar 2017	Macroinvertebrate Monitoring
APCO		APCO_03	2011 Nov 04 11:11	2017	21 Mar 2017	Macroinvertebrate Monitoring

Figure 4. MIDN BMI Data Gateway form with “Add a new record” button highlighted in red.

- (3) Adding a new record will bring you to the Data Entry form, which captures all of the field data for a BMI sampling event. (Figure 5). Access will save any data change automatically, so there is no need to remember to hit save as you are working.
 - a. Begin in the top left section of the form that has the blue background. Choose the site that was sampled from the picklist next to “Location”, then enter the date of the sampling event in the field next to “Sample Date” (Figure 5 red highlighting). Do not alter any other fields in this section.
 - b. Next enter the names of the field team present during the sampling event under “Contact” and choose their team role under “Role” (Figure 5 purple highlighting).
 - c. Next enter In-stream transect data on the instream habitat tab (Figure 5 green highlighting).
 - i. Choose the flow direction in the top left. This should always be Down.

- ii. Enter the remaining data in the appropriate transect, tabbing across the row as needed.
- iii. Add additional notes from the form in the “Notes” box at the bottom right.
- iv. If any additional invertebrate taxa are mentioned in the notes on the form, choose the correct taxa in the box on the bottom left of the tab.

Data Entry Form - Filter by sampling event

Location: **APCO_02** Add New Edit
 Plain Run above confluence with App. River in App. CH NHP Unit Code: APCO
 Stream Gradient: High X/Y X: 164572.023708 Y: 4143978.01371
 Protocol Name: Macroinvertebrate Monitoring
 Sample Date: **3/21/2017**

Contact: Dammeier, Nathan Crew leader
 Johnson, Mark Notetaker
 Hiner, Steve Voucher ID Spec
 Wofford, Jeb Notetaker

Instream Habitat: Riparian Habitat Microhabitat / Taxa Data Add a person Delete record New record

Flow: Down

Instream Transect Data:

Transect	Width	Depth	Left		Center		Right		Photos			
			Substrate	Embed	Depth	Substrate	Embed	Depth	Substrate	Embed	Left	Right
0m	5.2	27 P	L	L	21 G	L	14 G	M	Y	Y	Y	Y
25m	3.6	10 P	L	L	14 C	L	15 P	L	Y	Y	Y	Y
50m	3.8	7 P	L	L	6 P	L	27 C	L	Y	Y	Y	Y
75m	2.9	36 G	L	L	15 P	L	6 C	L	Y	Y	Y	Y
100m	3.9	22 G	L	L	17 C	L	6 G	L	Y	Y	Y	Y

Additional Macroinvertebrates: Taxa: Aeshnidae Antocha *

Notes: Rained two days before sampling event, water level slightly higher than normal.

Figure 5. MIDN BMI Data Entry form with event data highlighted in red, contact information highlighted in purple, and instream habitat data highlighted in green.

- (4) To enter data from the Habitat Assessment field form, click on the Riparian Habitat tab to the right of the Instream Habitat tab (Figure 6).
 - a. Enter the values for each habitat score on the field form, hitting the enter key to move down the list.

The screenshot shows the 'Data Entry Form - Filter by sampling event'. The 'Location' is 'APCO_02' and the 'Unit Code' is 'APCO'. The 'Stream Gradient' is 'High'. The 'Protocol Name' is 'Macroinvertebrate Monitoring' and the 'Sample Date' is '3/21/2017'. The 'Contact' list includes 'Dammeyer, Nathan' (Crew leader), 'Johnson, Mark' (Notetaker), 'Hiner, Steve' (Voucher ID Spec), and 'Wofford, Jeb' (Notetaker). The 'Riparian Habitat' tab is highlighted in red. The 'Microhabitat / Taxa Data' section contains the following fields:

Epifaunal Substrate / Available Cover:	20
Embeddedness:	18
Velocity / Depth Regime:	19
Sediment Deposition:	19
Channel Flow Status:	17
Channel Alteration:	17
Frequency of Riffles (or Bends):	20
Left Bank Stability:	8
Right Bank Stability:	9
Left Vegetation Protection:	8
Right Vegetation Protection:	8
Left Riparian Vegetative Zone Width:	10
Right Riparian Vegetative Zone Width:	10

Figure 6. MIDN BMI Data Entry form with Riparian habitat tab highlighted in red.

- (5) The last piece of data entry that should be performed is to add the microhabitats that were sampled at the event from In-stream transect field form.
 - a. Click on the Microhabitat/Taxa Data tab (Figure 7).
 - b. Choose the microhabitats that were sampled from the drop box on the left of the form.
 - c. Leave the other fields blank, as they will be populated by the data manager during lab data import.

The screenshot shows the 'Data Entry Form - New record'. The 'Location' is 'HOFU_02' and the 'Unit Code' is 'HOFU'. The 'Stream Gradient' is 'High'. The 'Protocol Name' is 'Macroinvertebrate Monitoring' and the 'Sample Date' is '3/16/2017'. The 'Contact' list includes 'Dammeyer, Nathan' (Crew leader) and 'Wofford, Jeb' (Notetaker). The 'Microhabitat / Taxa Data' tab is highlighted in red. The 'Microhabitats Sampled' section contains the following table:

Microhabitat	Sample	Process_Date	Identified_By	Verified_By	
RIF					Taxa Count Data
					Taxa Count Data

Figure 7. MIDN BMI Data Entry form with Microhabitat /Taxa Data tab, Microhabitat type highlighted in red, and Taxa Count Data button highlighted in purple.

- (6) To make corrections to any taxa counts after lab data import follow the instructions below.
 - a. Navigate to the appropriate event using the Data Gateway form (Figure 4).
 - b. Click on the Microhabitat /Taxa Data tab (Figure 7).

- c. Click the “Taxa Count Data” button for the appropriate microhabitat sample that was counted (Figure 7).
- d. Adjust count for the appropriate tax on the pop out form (Figure 8) and close the form when finished.

Macroinvertebrate:	Count:	Comments:
Maccaffertium	2	
Ephemerella	17	
Eurylophella	2	
Gomphus	1	

Figure 8. MIDN BMI Data Entry form with Microhabitat /Taxa Data tab.

- (7) To close out of the database when finished, follow these steps:
 - a. Choose the “Close” button on the top right of the Data Entry form (Figure 6).
 - b. Choose “Exit” at the top right of the Switchboard form (Figure 1).
 - c. Answer the prompt regarding saving a backup of the data. It is highly recommended that you save frequent backups as you are working.

B. Lab Data Import:

The macroinvertebrate laboratory data must be manually imported by MIDN’s data manager using a series of insert queries that match the lab results to the appropriate field sampling event data. Prior to and after import, the laboratory results must pass a series of quality control checks outlined in below in section III. C.

C. Quality Assurance and Quality Control Procedures:

The MIDN staff will perform a series of Quality Assurance and Quality Control (QA/QC) procedures to ensure that the collected data meet minimum standards set forth in source protocols.

- (1) Field Data Quality Assurance and Quality Control procedures.
 - a. The front end and back end databases use field validation rules, and data entry picklists to prevent data entry errors, and prompt users to correct values that do not meet predefined field parameters.
 - b. After data entry is complete, a 100% validation of all paper data sheets entered will be completed by MIDN staff.
 - c. The MIDN data manager will perform a 10% check of a random sample of data entered.
 - d. The aggregate data for a season will be reviewed by the data manager and project lead for any data anomalies.
- (2) Laboratory Data Quality Control Procedures.

- a. Sample processing and taxonomic QA/QC procedures are established in each of the protocols and implemented through this PIP by the contract laboratory.
 - i. The contract laboratory provides QA/QC reports along with the taxonomic data delivery.
 - ii. MIDN staff ensure that all QA/QC standards established in the state protocols are achieved by the contract laboratory prior to importing any data to the MIDN database.
- b. Prior to import, the laboratory results will be reviewed by the project lead and data manager for any data anomalies that could affect the import of the data.
- c. Identified taxa will be checked for outliers, and newly identified taxa not matching the MIDN BMI database taxa list. Any necessary changes will be applied to the MIDN BMI database prior to import.
- d. Laboratory staff will be contacted regarding any data anomalies that cannot be resolved by MIDN staff, and any required corrections applied to the laboratory results.
- e. Upon completion of all updates, the data manager will import the laboratory results to the MIDN BMI database.
- f. After import is complete, the MIDN data manager will perform the following checks:
 - i. The total rows imported match the total from the laboratory results spreadsheet.
 - ii. A validation of 10% random sub-sample of the laboratory data imported will be performed by the data manager or assigned MIDN staff.

D. Data Finalization

Data finalization occurs after all QA/QC procedures have been completed from field preparations through data management. Data finalization is the last step prior to accepting the data, and indicates that the data is available for distribution to MIDN parks upon request. Data acceptance occurs after a final check of all QAQC procedures.

E. Data Transfer to IRMA

On an annual basis, after data has been finalized, the final copy of the MIDN BMI back-end database, the final scanned datasheets, and any other relevant files are transferred to the MIDN server. A copy of the back-end database is placed onto the IRMA data store by the MIDN data manager.

IV. Data Storage

Benthic macroinvertebrate monitoring data is stored and backed up daily using MIDN's central server. The folder structure is outline below.

A. Folder Structure:

The folder structure below can be found on the server in the yearly monitoring folder at the following path Z:\Monitoring\BenthicMacroinvertebrates\20XX. In each yearly monitoring folder, each park's data will be maintained in a separate subfolder.

All data converted to an electronic format is maintained under the Database subfolder while all scanned data sheets are maintained under the Fieldforms subfolder.

- \ 01_Planning – Store Information related to yearly performance of the protocol...
 - \ Personnel
 - \ PositionDescriptions
 - \ Schedules
 - \ Travel
- \ 02_Protocol – Store documents related to any protocol documentation or SOPs
- \ 03_Data – Store all documentation of field data collection, electronic data, PDFs, photographs, and spatial data
 - \ Database – Store all electronic documentation of the data collected during the field season
 - \Front End
 - \Back End
 - \ FieldForms – Store PDF scanned copies of field data sheets
 - \PA
 - \VA
 - \ Photos
 - \ Spatial Data
- \ 04_Analyses – Store all files related to analyses
- \ 05_Reports - Store all documentation regarding published reports
 - \ Drafts
 - \ Final

V. Schedule of Tasks

Outlined below is the schedule of activities for management of benthic macroinvertebrate data. Tasks are listed in chronological order and the target timeline for completion of each task.

Table 1. Schedule of event related to benthic macroinvertebrate data management.

Task	Timeline
the protocol lead, or designated staff, will gather all paper data sheets for data entry	3 days after completion of data collection
Enter field observations in the MIDN BMI Access database	3 days after completion of data collection
Error check field observation values	Manually during data entry
Perform Quality Control Checks on field data	Within 1 day of completion of electronic data entry for all sampled parks
Perform Quality Control Checks on laboratory data	Within 1 week of completion of electronic data delivery from contract laboratory
Enter needed data changes electronically	Immediately following completion of all data checks
Note any data changes or censored data on paper data sheets	Immediately following completion of any changes made to the data
Scan paper sheets and place on server	Once all data checks have been performed and changes noted on paper data sheets
Transfer a copy of MIDN BMI Access database back-end to IRMA after data has been finalized	Annually

Literature Cited

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: Periphyton, benthic macroinvertebrates and fish. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, DC.

Shull, D. R., and J. Lookenbill (editors). 2018. Water Quality Monitoring Protocols for Streams and Rivers. Pennsylvania Department of Environmental Protection, Harrisburg, Pennsylvania.