Datashed: An online tool for managing amd treatment systems and restoration of impacted watersheds

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Extended Abstract

Acid mine drainage (AMD) is one of the largest sources of pollution in Pennsylvania with over 8,800 km (5,500 mi) of streams currently impaired. The largest portion of AMD emanates from abandoned (pre-1977 US federal Surface Mining Control and Reclamation Act) legacy coal mine sites. Across Pennsylvania, watershed groups, government agencies and other organizations are working to restore these streams by completing land reclamation projects and by constructing active and passive water treatment systems. These systems combined treat more than 150×10^9 L (40×10^9 gal) of AMD per year resulting in many miles of improved streams. Many of these streams now have good water quality and reproducing fish populations; however, once these projects are constructed, they need to be monitored to make sure they continue to work properly and to identify when maintenance is needed to ensure long-term sustained improvements of water quality.

To help support these watershed restoration efforts, Stream Restoration Incorporated, a nonprofit organization, created Datashed (www.datashed.org), a free to use, web-based, GIS-enabled database that functions as a maintenance and data management tool. The website can store a variety of information related to both individual projects and overall watershed restoration efforts including for example water quality data, maps, engineering design and as-built drawings, reports, Operation & Maintenance plans, treatment technologies, photographs, sampling point locations. Datashed provides an open centralized repository to preserve this important information so that anyone with internet access can view, print, or download. User accounts are only needed for approved users who will be adding or editing the stored information.

Datashed contains project details and data that has been collected by scientists, engineers, government agencies, volunteers, and other interested participants to compile information on over 400 restoration and treatment projects across Pennsylvania. Approximately 360 of these projects consist of AMD passive treatment systems, all of which collectively discharge into over 100 streams. Each specific project has its own unique webpage where users can find information on project participants, ownership, location (city, township, watershed, coordinates, etc.), funding information, and more for projects with such information available.

The website provides students, researchers, and engineers with real data from existing treatment systems to conduct research and improve designs. Datashed can also be utilized for education/outreach efforts of watershed groups to highlight their projects and provides a certain level of transparency as funding agencies are able to observe the effectiveness of the projects. Select features are described in more detail below.

One prominent feature on Datashed that is specific to each project is the Water Quality Report (Fig. 1), which provides water quality data for parameters integral in AMD assessments, including flow, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), temperature, conductivity, alkalinity, acidity, metal concentrations (total and dissolved iron, manganese, and aluminum), sulfate concentrations, and total suspended solids (TSS).

Sample Point - JVFP1
Download Sample Point Report CSV / Inflow: No / Outflow: No

Date	Method of Flow	Flow - Field (gal/min)	pH - Field (S.U.)	pH - Lab (S.U.)	ORP - Field (mvolts)	DO - Field (mg/L)	Temp - Field (C)	Cond - Lab (umhos/cm)	Alkalinity - Field (mg/L)	Alkalinity - Lab (mg/L)	Acidity - Lab (mg/L)	T. Fe - Lab (mg/L)
2023-05-11	Bucket	146	7.53	7.06	-174	2.98	17.9	1178	100	78.25	-77.62	0.13
2023-11-14	Bucket, Combined	57.5	6.93	7.71	-284	--	10.8	1260	89	87	-61	0.05
2023-11-30	Bucket, Combined	48.3	7.14	7.55	-169	--	4.3	1320	65	73	-56	0.08
Minimum:	0	48.3	6.93	7.06	-284	2.98	4.3	1178	65	73	-77.62	0.05
Maximum:	0	146	7.53	7.71	-169	2.98	17.9	1320	100	87	-56	0.13
Average:	0	84	7.20	7.44	-209	2.98	11.0	1,253	84.67	79	-64.9	0.09
Range:	0	97.7	0.6	0.65	115	0	13.6	142	35	14	21.62	0.08
Median:	0	57.5	7.14	7.55	-174	2.98	10.8	1260	89	78.25	-61	0.08
Loading (lb/day):									91.58	79.94	-70.3	0.1

Sample Point Description:

Jennings Vertical Flow Pond 1;

Figure 1 Screenshot of a portion of a dynamically generated water quality report for the Oven Run B project

This water quality data is compiled from various data sources and includes both laboratory analysis of collected samples and field measurements taken at specific sampling point locations. Such sampling points include AMD discharges, inflows and outflows of treatment components, final effluents of treatment systems, and receiving stream points for each project, most of which have descriptions and coordinates available on Datashed. By maintaining specific sampling point locations, consistency is maintained, making comparisons of data and therefore determinations of the effectiveness of each system possible over time. Owing to the documentation of specific sampling locations, numerous projects contain water quality data that span back decades, with some projects containing data beginning in the early 1990's. Situated at the bottom of each sample point report is a statistical summary of minimum, maximum, average, range, and median values for each parameter measured. One key parameter to water quality analysis and treatment assessments is flow. The collection of flow measurements allows for the computation of loading (lb/day) of alkalinity, acidity, and metals in a system. With this loading information, load reductions from the influent (raw discharge) to the effluent of systems can be calculated to approximate the amount of acidity being neutralized and the quantity of metals being removed from mine drainage through treatment in a specific system. Such loading information is averaged and summarized at the bottom of each project page within the "Project Performance" table, only when there is sufficient flow data available. While the automatic loading computations serve a useful purpose, a major limitation to this tool and data set can be inconsistencies in the frequency of flow measurements at the influent and effluent of every system. When flow measurements are not taken, or are only estimated, there is no way to accurately estimate how much AMD pollution is being removed through treatment. Stream Restoration Incorporated continues to educate and encourage users to collect and report this important data parameter.

An additional feature that provides access to valuable project information is the "Documents" tab located at each Project page. For many of the projects, design plans are archived in the Documents tab, and these design plans have information on the project vicinity, project boundaries, shapes and sizes of proposed treatment components, piping systems, spillways, ditches, distribution boxes, as well as close-up sketches of treatment technologies all prepared by engineers and scientists. Design plans most commonly detail what has been planned prior to the construction of projects, so As-built drawings are often supplemented to provide information on how the systems were actually constructed. Information sheets are present for most projects to detail the exact location, project participants, contact organizations, property ownerships, accessibility to the site, location of data, Operation & Maintenance plans, funding information,

and more for interested users. Technical and final grant reports are present for many projects, most of which state what had been completed during project construction, rehabilitation, and/or maintenance, including what treatment components were installed, what funding was obtained, partnerships, and what improvements had been observed in the receiving watersheds. Generalized Operation & Maintenance (O&M) manuals have been created and uploaded onto Datashed for guidelines on how to monitor and maintain passive treatment systems, and specialized O&M manuals have been developed over the years for specific systems and uploaded to their designated projects. O&M reports are uploaded to projects that have had maintenance conducted to document changes to specific systems over time. Schematics for specific systems are uploaded to most projects to show a diagram of treatment components and exact locations of sample point locations. Other documents that may be found within the Documents tab of specific projects includes but are not limited to watershed restoration plans, monitoring plans, site summaries, total maximum daily loads (TMDLs) for receiving streams, and reports on biological and/or physical surveys. By having these documents readily available to users, important information on project locations, treatment components, system maintenance, and more can be easily accessed to make continued operation of these numerous systems possible. Further benefits to having all this information available to the public includes transparency of treatment design success when coupled with water quality data and loading information. With this information, engineers and scientists may presume which treatment technologies are most successful in certain situations.

Another feature that may help users find specific project locations is the Map tool. Projects and their sample point locations may be found on Datashed's mapping tool, with projects appearing in dark blue and sampling points in light blue. Only projects and points with coordinate information appear on the map. A list of all the project names is shown to the right of the map, and project locations can be searched and zoomed into by clicking project names within the list. This feature may be helpful to users because locations of projects relative to other projects, streams, watersheds, and sampling points can be visualized and explored with on the interactive map.
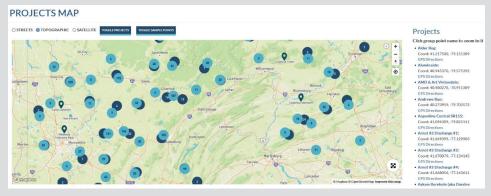

Figure 2 Screenshot of mapping tool on Datashed showing clusters of sample points (light blue) and clusters of projects (dark blue). Individual point names appear when zoomed in

Datashed was created and maintained by Stream Restoration Incorporated to provide a useful tool to assist with the management of watershed restoration efforts in Pennsylvania as well as the potential to be utilized for research to improve reclamation practices and water treatment technologies. The website has been primarily funded by the Pennsylvania Department of Environmental Protection and the Foundation for

Pennsylvania Watersheds. Stream Restoration Incorporated will continue to work on developing the website to both expand upon available features and improve the user experience. Datashed could potentially be expanded or duplicated to cover a larger geographic area or potentially worldwide, but additional support of funding and other resources would be needed.

References

Lenahan, Gregory. "Acid Mine Drainage Treatment Facilities – Reversing Hundreds of Years of Pollution to Bring Pennsylvania's Streams and Rivers Back to Life." Our Common Wealth, Department of Environmental Protection, 30 Mar. 2022.

Datashed, Stream Restoration Incorporated, 2023, www.datashed.org.