User Manual for the MSDGC Integrated Prioritization System (IPS) and Data Exploration Tool (Version 2.0)
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User Manual for the MSDGC Integrated Prioritization System (IPS) and Data Exploration Tool

Version 2.0

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Foreword

The Metropolitan Sewer District of Greater Cincinnati (MSDGC) and Hamilton County initiated the development of an Integrated Prioritization System (IPS) in 2011 for the purpose of determining priorities for their response to the CSO Consent Decree and for Capital Improvement Planning affiliated with Project Groundwork. The development of the IPS relies on a baseline of biological, chemical, and physical data from a rotating watershed assessment design that was initiated in 2011. The first round of monitoring through all Hamilton Co. watersheds that includes 11 subwatersheds and 3 major mainstem rivers was completed in 2014 and in accordance with the requirements of the NPDES permit for MSDGC CSOs. A second round of the rotating basin monitoring will be initiated in 2016-19 to provide for the tracking of changes in aquatic and recreational use attainment, the iterative development of the IPS database and tool, and documenting effectiveness of abatement projects accomplished by MSDGC.

The IPS Dashboard provides ready access to both recent (2011-14) and historical data (pre-2011). It provides MSDGC with the capability to integrate environmental information about sites, reaches, and watersheds in support of the development of projects in response to the CSO Consent Decree. The IPS also includes information about overlapping influences such as stormwater, habitat alterations, and point source discharges, thus it can be useful for managing those sources across Hamilton Co. and adjacent counties as well. This User Manual (Version 2.0) and the IPS Dashboard underwent intensive beta testing and is now ready for use by MSDGC for planning purposes and responding to the Consent Decree. This manual provides instructions for using and navigating the IPS Dashboard. A separate document entitled Integrated Prioritization System (IPS) Documentation an Atlas of Biological Stressor Relationships for Southwest Ohio (MBI Technical Report MBI/2015-10-11; MBI 2015) provides the underlying rationale and stressor analyses that support the assignment of the Restorability rankings for impaired sites and reaches and the Susceptibility and Threat rankings for attaining sites and reaches.
User Manual for the MSDGC Integrated Prioritization System (IPS) and Data Exploration Tool (Version 2.0)

The MSDGC Data Exploration Tool
The MSDGC Integrated Priority System (IPS) Data Exploration Tool was developed to assist in the prioritization of environmental restoration projects by synthesizing and analyzing large amounts of data collected over a number of years, an adequate range of conditions, and presenting it in a comprehensive database format. The tool presents an understandable picture of the current condition of stream and river sites, reaches, and watersheds within the MSDGC service area. Both high quality and impaired (i.e., not meeting Water Quality Standards [WQS]) sites and reaches are identified and assigned a restorability rating for impaired sites and a threatened and susceptibility rating for sites that are attaining their applicable WQS. This information is intended to assist in the setting of priorities for restoration projects and capital planning and also to assist in planning for future growth of the MSDGC service area.

Introduction
A User Manual for the IPS and Data Exploration Tool (version v2.0) was produced for use and application by MSDGC staff for the development of abatement projects in response to the CSO Consent Decree. Managing water quality in stream reaches and watersheds that include pollution sources such as Combined Sewer Overflow (CSOs), Sanitary Sewer Overflows (SSOs), Pump Station Overflows (PSOs), stormwater runoff, industrial and municipal point sources, and instream and riparian habitat alterations is a complex task. The IPS Dashboard is an Excel based tool that provides ready access to both recent (2011-14) and historical data (pre-2011) collected in the Mill Creek, Little Miami River, and Great Miami River portions of the MSDGC service area. It provides MSDGC with the capability to integrate environmental information about sites, reaches, and watersheds. The IPS Dashboard also includes information about overlapping influences such as stormwater, habitat alterations, and point source discharges, thus it can also be used for managing those sources across Hamilton Co. and adjacent counties.

IPS Conventions
To ease the interpretation of complex environmental data the individual stressor and response components of the IPS were ranked on a consistent and intuitive scale (Table 1). This scale is also linked to the tiered aquatic life uses that are codified in the Ohio WQS. Both the biological and stressor data are used to convey overall quality (e.g., excellent, good, fair, poor, or very poor quality), the severity and extent of impairments (e.g., degree of departure from a biocriterion, miles of stream or river in an impaired condition, and the frequency of stressor threshold exceedances). Based on complements of individual stressor and response results distinct Restorability factors were derived for all impaired waters and distinct Susceptibility/Threat factors for waters that are attaining the applicable biological criteria. The Restorability and Susceptibility/Threat scores are each based on a 0-100 scale to normalize stressor and response scales of measurement.
Table 1. IPS conventions for ranking individual stressor and response variables (first three columns) and for total scores for Restorability, Susceptibility, and Threat (last three columns).

<table>
<thead>
<tr>
<th>Individual Stressor and Response Variables (0-10 Scale)</th>
<th>Summary Restorability, Susceptibility and Threat Scores (0-100 Scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative Condition Scale/Aquatic Life Use Tier¹</td>
<td>Restorability</td>
</tr>
<tr>
<td></td>
<td>Susceptibility</td>
</tr>
<tr>
<td></td>
<td>Threat</td>
</tr>
<tr>
<td>Excellent (EWH)</td>
<td>0.1-2.0</td>
</tr>
<tr>
<td>Good (WWH)</td>
<td>2.01-4.0</td>
</tr>
<tr>
<td>Fair (MWH)</td>
<td>4.01-6.0</td>
</tr>
<tr>
<td>Poor (LRW)</td>
<td>6.01-8.0</td>
</tr>
<tr>
<td>Very Poor</td>
<td>8.01-10.0</td>
</tr>
</tbody>
</table>

¹ – EWH = Exceptional Warmwater Habitat (“Excellent”); WWH = Warmwater Habitat (“Good”); MWH = Modified Warmwater Habitat (“Fair”); LRW = Limited Resource Waters (“Poor”); “Very Poor” is below minimum acceptable condition under the CWA.

**Individual Stressor and Response Variables**

To achieve consistency across multiple stressor and response variables that vary in their respective measured units, each was normalized to a 0-10 scale. Most variables were ranked from 0.1 to 10 with 0.1 being equivalent to the highest quality conditions and 10 the lowest quality conditions (see Table 1). This approach also standardizes each variable along the biological condition gradient of the tiered designated use biocriteria. For example, the aquatic life uses designated for reaches of streams or rivers (e.g., Exceptional Warmwater Habitat, EWH; Warmwater Habitat, WWH; Modified Warmwater Habitat, MWH; and Limited Resource Water, LRW) represent the attainable goals for protection and restoration which was determined by a use attainability analysis (UAA) process that is applied before an impairment determination is made. Specific details about the technical development of the ranking process are described in an appendix to a companion document entitled *Integrated Prioritization System (IPS) Documentation and Atlas of Biological Stressor Relationships for Southwest Ohio (Technical Report MBI/2015-12-15. [MBI 2015]).* Blue shaded results represent conditions consistent with Exceptional Warmwater Habitat (EWH) and green shaded results are consistent with Warmwater Habitat (WWH). Yellow, orange, and red shading represent increasing departures from the WWH use which represents the minimum goal of the CWA (Section 101[a][2]). “Minor” deviations from individual stressor benchmarks do not always coincide with a biological impairment. Sites that meet their biological criteria, but which have deviations in stressor benchmarks may be considered “threatened.” The probability of aquatic life being impaired generally increases as the stressor exceedances become more severe and when more than one stressor deviates from acceptable levels. By ranking stressors in accordance with their likely influence on aquatic life, it makes comparisons of values from reach to reach and watershed to watershed more standardized.
Using the IPS

Getting Started
The IPS tool allows a user to query, view, map, and export data summarizing the restorability, susceptibility, and threat status of Hamilton Co. streams and rivers in order to view the associated causes of impairment or threat to these waters. Given the importance and complexity of this information built-in help and information guides in textual sidebars and in Power Point presentations are provided to explain the various data categories, concepts, and basis of the IPS tool.

Installation of the Tool
For MSDGC users the IPS tool will be installed on the MSDGC server and work stations. The installation details are described in Appendix D. The screen is designed for a typical desktop monitor. If parts of the tool are out of view, the magnification or zoom function at the bottom of the page can be adjusted (located in the lower right tray of the Excel window – see below). The slider bar is used to adjust the magnification of the window to fit the contents within the screen. If the user clicks on the “100%” value a zoom screen pops up to allow the user to select from a series of pre-set magnifications or the user can enter a custom zoom value.
Launching the IPS

When the IPS tool is selected the user will be taken to an opening “Home” screen\(^1\) (see below) that allows a user access to all of the main functions of the tool with the menu bar at the top of the page. This includes menu choices for Home, Overall Restorability, Restorability Details, CSO/SSO Search, Susceptibility Details, PIR Maps & Graphs, CSO and CIP Identification, Interactive Map, and Help. A menu bar is found on each page of the tool and will include back and forward buttons to ease navigating the IPS dashboard. The opening window includes a short, self-playing Power Point presentation that summarizes the IPS tool. Selecting the MDSCG or MBI Logos will take you to the respective web sites. There are also buttons on the opening page for Biocriteria Model, Reports, and Site Photographs which are purely informational. For example the Biocriteria Model button takes the user to a page (see right) that illustrates a photo version of the Five Factors model that describes the primary environmental factors that influence biological integrity in streams and rivers sequencing from activities that generate pollution to indicators of stress and exposure and biological response as the endpoint of concern. The purpose of this page is to summarize each of the factors in the model with brief PowerPoint modules. The remainder of the User manual is organized by each of the major menu choices along the top of the screen.

\(^1\) The IPS tool will open to the page last saved by the user. For example, if the user was editing the overall restorability table and saves changes before exiting the Tool, the next time it is launched, the IPS Tool will open to the restorability table.
**Reports**

The Reports button takes the User to a page that describes the timeline for the MSDGC service area rotating watershed surveys by year both past and future. For the years 2011-2014 there are hyperlinks to each annual Biological and Water Quality report and the Level 3\(^2\) Project Study Plans for each year as well. An overarching Bioassessment Plan which details the rationale for the survey design and indicators for the rotating watershed assessments is located to the left (see below). After accessing one of these documents the User will need to leave Adobe or use the Windows Finder to navigate back to the IPS home page. The User can also navigate to another page using the blue rectangular Menu Buttons located at the top of the page or by using the green Previous and Next arrows to navigate to another page of the IPS dashboard.

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**Site Photographs**

As part of the four year rotating watershed monitoring at least two site photograph(s) were obtained at the time of data collection at each site. Included are a photo of the site description sheet which locates the site, an upstream (UST) view, and a downstream (DST) view. The dropdown menu on this page encourages Users

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\(^2\) Level 3 Credible Data per the Ohio Credible Data Law (ORC 6111.3) and Regulations (OAC3745-4).
to select the site of interest by choosing the appropriate SITE ID. Sites with an “UST” in the name are the upstream view and those with a “DST” in the name are the downstream view. Viewing photos of a site can add important context for the general setting, stream size, and visible stressors, particularly for those associated with habitat, flow, and land uses.

**Overall Restorability**

The Overall Restorability menu button sends the User to a summary spreadsheet of all impaired sites for the 2011-2014 rotating watershed surveys (see below) and includes all of the CSO/SSO/PSO/WWTPs that are within 5 miles downstream from that site. This feature is designed to permit the User to extract data for sites that are pre-sorted by Restorability scores and also by reach and Huc12 watershed. The opening spreadsheet provides a Quick List of Restorability scores by Reach. Columns in the spreadsheet include the Restorability Rank, Reach ID, Reach Name, Reach Restorability Score, and Huc12 Watershed Restorability score.
The green button (Click here to Sort Reach Restorability Details) on the left allows a User to view sites within these reaches in more detail including other CSOs/SSOs/PSOs in the vicinity. This takes the User to an Excel table that is presorted by the site Restorability score (see first below). The Excel Sort function can be used to further sort on any column - most typically a User would sort by the Site, Reach, or Watershed Restorability score. On each column label there is a pull down that allows a User to Sort from smallest to largest or largest to smallest values (see right). The User can then select the cells of interest and then copy to their own worksheet to further manipulate and/or link to other data outside of the IPS tool. An example is presented at the end of the manual about how this data can be used along with other features of the IPS tool to conduct an exploration of restoration scenarios and options.

The spreadsheet also includes data about the three closest CSOs/SSOs/PSOs to each sampling site with the distance upstream provided in miles and the source type and number (e.g., CSO 651; see below). It summarizes the number of sources within 1, 3 and 5 miles upstream of the site (see below). The table also identifies any Capitat Improvement Plan (CIP) project within two miles of each site (next page, top). Again, the purpose is to provide Restorability rankings such that a User can further manipulate the results to fit specific planned or future restoration projects.
Restorability Details

Whereas the Restorability Summary presents the Restorability scores by Site, Reach or Watershed, the Restorability Details allows a User examine the information underlying the Restorability score including the biological, physical, land use, and water quality parameters that are used to derive the Restorability rankings. The Restorability Details menu button sends a User to the “heart” of the IPS tool which is the Southwest Ohio streams database that is summarized by Watershed, Stream Reach, or an individual...
Site. To ease the selection of data a User is first directed to the Watershed scale to initiate a data query and, based on that initial selection, a User can “drill down” into the Reach and Site levels on separate pages. On the Restorability Details page a User can select a single Watershed or multiple Watersheds on the data “slicer” by selecting the first watershed of interest, then holding down the CTRL key and selecting the remaining the watersheds. Watersheds on the data slicer tool are in alphabetical order. When Users are finished viewing the Restorability Details at any time they may select the “Return to Main IPS Dashboard” button.

The following are the features, menus, and graphs that appear on the Restorability Details Page:

**Refine Data Pull Down Menu** – A User has the option of selecting one of four sets of data: 1) MSDGC Sites, 2) Primary Headwater Sites, 3) Reference Sites and 4) Historical Data. If a User selects a different set of data from the pull down menu, they must manually refresh all charts and pivot tables to recognize and incorporate this new dataset. The baseline data used to derive the Restorability scores included the headwater and larger streams and rivers from the 2011-2014 rotating watershed sampling [i.e., MSDGC Sites] that were designated to one of the Warmwater Habitat suite of uses (i.e., EWH, WWH, MWH, or LRW). The Restorability spreadsheets in the IPS does include historical data in Hamilton County or the larger SW Ohio study area across which the stressor thresholds were derived. It excludes the Primary Headwater Habitat (PHWH) classified sites in Hamilton County because these will not likely be part of any Consent Decree related decision-making. However, the IPS could easily include the PHWH sites and the historical data if a need arises in the future. The historical data, however, can be incomplete for some of the variables so there may be the need to supplement the database with new data or qualify the resulting Restorability (also applies to Susceptibility and Threat) scores and rankings.

**Data Scale Selection Funnel** – The data selection funnel allows a User to view data at the Watershed, Reach, or Site level. When one or more Watersheds are selected, and Reach is selected on this funnel, the available Reaches to view will be constrained to those within the Watershed of interest. If a User wishes to view a reach that is not listed; they must return to the Huc12 watershed selector and choose a different watershed(s).

**Aquatic Life Use Pie Chart** – Based on the Watershed or Watersheds selected, the pie chart illustrates the proportion of monitored sites in the Watersheds by designated Aquatic Life Use category. Knowing this helps in interpreting the context for examining Stressors, Restorability, Susceptibility, and Threats. The context will be different in a watershed predominated by EWH and WWH uses (e.g., Whitewater River) versus a watershed with mostly MWH and LRW uses (e.g., Lower Mill Creek, Duck Creek).
Restorability Speedometer Graphic – The speedometer on this page points to the Watershed average Restorability Score (normalized to a scale of 0-100) based on sites within the Watershed that do not attain the WWH aquatic life use. In the speedometer example (shown to the right) the average Restorability is on the high side of “intermediate.” None of the corresponding “colors” associated with the tiered aquatic life uses are used because the Restorability Score is a relative rather than an absolute value.

Restorability is only applicable at sites that are impaired and Susceptibility applies only to attaining sites, so a Watershed with 100% attaining sites will not have a Restorability Score and a Watershed with 100% impaired sites will not have a Susceptibility score. In such cases the speedometer labels and needle will disappear.

When one or more Watersheds are selected a User can use the Reach button on the funnel (or select the green “Next” arrow in the upper right corner of the screen) to advance to a new page with summary information at the reach scale (see below). Note that the Data Slicer for the Reach page includes only Reaches within the Watershed(s) that were selected on the Watershed page. Using the Data Slicer the User can view summarized data on one or more of the Reaches within the Watersheds selected. In the screen capture that shows data selected for all three reaches of Lower Mill Creek (Lower Mill Creek mainstem, West Fork Creek and tributaries) there is a mix of WWH and MWH uses and the average Restorability is low (see example on next page).
The speedometer and pie chart on the Reach page are the same as those on Watershed page except where they reflect the average of the Reaches that are selected with the Data Slicer. When only Mill Creek is selected the aquatic life use is 100% MWH and the average Restorability is even lower (see below) than the watershed average. When West Fork Creek only is selected (second below), the sites are 100% WWH and the Reach Restoration score is higher. West Fork Creek drains the Mt. Airy Forest and the sites are upstream from a highly modified reach of West Fork Creek that is designated LRW.

At this point a User will most likely move to view data at the Site scale by selecting the Sampling Site button on the Funnel. If a User prefers to select a different Watershed the WATERSHED button can be selected on the Funnel or the by using the Back Arrow. Before one or more new Watersheds are selected the previous selection must be cleared by clicking on the small funnel icon in the upper right corner of the slicer (see right).

The hyperlink at the bottom of this page will take a User to the Poseidon application on the MSDGC Intranet that is zoomed to the selected watershed.

**Site Specific Data View**

Selection of the Sampling Site button on the Funnel takes the User to a page that depicts the site specific data for all sites selected within the Reaches previously chosen on the Reach page. The primary information on this page is a color coded table that identifies each Site ID, Year Sampled, Aquatic Life Use and Status, River Mile and summary Restorability Rank. It also provides the biological information (fish IBI and macroinvertebrate ICI) and ranks, summary habitat ranks at the Huc12 and Site level, channel state (natural channel, recovered, recovering, recent or impounded) and the rank for the Hydro-QHEI. The table also provides summary ranks for nutrients (nitrate, TKN, total P) and organic enrichment
parameters (minimum DO, BOD), ionic strength parameters (chloride, conductivity), pH, toxic parameters including metal rank (lead, copper) and ammonia rank, and two land use ranks (catchment land use and within 1 km upstream riparian buffer (30 m) land use). Gray shading indicates missing data due to the parameter not being sampled.

The default table on this page shows summary ranks, not the raw parameter values. Summary data is sufficient to identify the key limiting factors. In the above example, the upstream site in Muddy Creek (MU05) is impacted by a CSO resulting in poor or very poor ranks for nutrients, organic enrichment, and ammonia, each of which are associated with CSOs. These conditions lessen downstream and at river mile 2.25 (MU02) the biological assemblages were both in good condition and attained the WWH aquatic life use. Restorability ranks are in the intermediate range at most sites in Muddy Creek because of good local habitat and the demonstrated attainment of the biocriteria at one site. Characteristics such as a high urban catchment land use and organic enrichment kept the Restorability score from being higher. Local habitat conditions are mostly good except for the most downstream site (MU01) at RM 0.15 which is in the Ohio River backwater. While catchment land use is urban, Muddy Creek has a good riparian buffer that at least offsets the high urban land use in the catchment and provides potential opportunities for protection and enhancement. If the ranks do not provide a User with sufficient detail there are six tabs (see right) that lead to the raw stressor values as well as ranks for a subset of parameters in categories including; 1) habitat, 2) nutrients and organic enrichment, 3) metals and toxic parameters, 4) land use parameters, 5) parameters that are signatures of CSO impacts, and 6) ionic strength parameters. Each of these detailed tables provide the same Site ID, River Mile, Aquatic Life Use, and the IBIs and ICIs and their respective ranks, but additionally provide the raw values of the parameters and individual effect ranks for additional stressors.

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3 To be considered in attainment of the WWH aquatic life use the IBI and ICI both need to in attainment and the ranks need to be green or blue; to attain EWH both the IBI and ICI ranks both need to be blue if data on both indices is present. If only the IBI or ICI is available, it would need to be green for WWH or blue for EWH.
**Habitat Stressor Parameter Table**

This table (see below) provides information on key habitat stressors that can influence aquatic life and includes the overall QHEI (physical habitat) score and rank, the QHEI channel score and rank, the Huc12 average QHEI score, the QHEI substrate score, the HydroQHEI, and the land use indicators. The inclusion of the substrate and channel metrics can identify sites where channel features are intact (i.e., natural channel and good QHEI channel score, but substrate scores are reduced by siltation from urban runoff).

<table>
<thead>
<tr>
<th>Site ID</th>
<th>River Mile</th>
<th>Restorability Rank</th>
<th>IBI Score</th>
<th>IBI Rank</th>
<th>ICI Score</th>
<th>ICI Rank</th>
<th>Habitat Rank</th>
<th>Substrate Rank</th>
<th>Channel Rank</th>
<th>Hydro QHEI Rank</th>
<th>Channel State Rank</th>
<th>Flow Rank</th>
<th>Buffer Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>MU05</td>
<td>6.35</td>
<td>53.8</td>
<td>12</td>
<td>10</td>
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<td>9.8</td>
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<td>2</td>
<td>6.7</td>
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<td>9.8</td>
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<td>2.8</td>
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<td>0.17</td>
<td>51.9</td>
<td>28</td>
<td>6.6</td>
<td>30</td>
<td>2</td>
<td>3.4</td>
<td>5.2</td>
<td>6.5</td>
<td>5.1</td>
<td>10</td>
<td>6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Nutrients and Organic Enrichment Parameter Table**

This table provides information on nutrient and organic enrichment indicators that can influence aquatic life. The upper Muddy Creek site (MU05) is clearly limited by parameters associated with CSO impacts and exhibit a pattern of downstream recovery to MU02 where the WWH aquatic life use is fully attained.

<table>
<thead>
<tr>
<th>Site ID</th>
<th>River Mile</th>
<th>Aquatic Life Use</th>
<th>IBI Score</th>
<th>IBI Rank</th>
<th>ICI Score</th>
<th>ICI Rank</th>
<th>Nitrates Rank</th>
<th>Nitrate Rank</th>
<th>TKN Rank</th>
<th>TNK Rank</th>
<th>BOD Rank</th>
<th>Min. DO Rank</th>
<th>Org. Enrich. Rank</th>
<th>Ammonia</th>
<th>Ammonia Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>MU01</td>
<td>0.17</td>
<td>28</td>
<td>6.6</td>
<td>18</td>
<td>1.9</td>
<td>3.22</td>
<td>7.5</td>
<td>0.985</td>
<td>10</td>
<td>6</td>
<td>4.2</td>
<td>6</td>
<td>0.05</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>MU02</td>
<td>2.25</td>
<td>40</td>
<td>2</td>
<td>10</td>
<td>6</td>
<td>0.893</td>
<td>3.6</td>
<td>0.3587</td>
<td>1.9</td>
<td>2</td>
<td>3.2</td>
<td>9</td>
<td>0.03</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>MU03</td>
<td>2.72</td>
<td>40</td>
<td>2</td>
<td>10</td>
<td>6</td>
<td>0.46</td>
<td>3.4</td>
<td>0.4635</td>
<td>3.3</td>
<td>2</td>
<td>2.2</td>
<td>5.2</td>
<td>0.03</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>MU04</td>
<td>5.4</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>9.6</td>
<td>1.221</td>
<td>4.4</td>
<td>0.671</td>
<td>4.3</td>
<td>2</td>
<td>2.2</td>
<td>5.9</td>
<td>0.07</td>
<td>1.6</td>
<td>0.7</td>
</tr>
<tr>
<td>MU05</td>
<td>6.35</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>9.6</td>
<td>0.061</td>
<td>0.3</td>
<td>3.093</td>
<td>1.9</td>
<td>2</td>
<td>2.2</td>
<td>6.7</td>
<td>0.07</td>
<td>1.6</td>
<td>0.7</td>
</tr>
<tr>
<td>MU06</td>
<td>0.6</td>
<td>36</td>
<td>4.9</td>
<td>30</td>
<td>4</td>
<td>0.51</td>
<td>1.6</td>
<td>0.629</td>
<td>4.2</td>
<td>2</td>
<td>2.2</td>
<td>4.4</td>
<td>0.07</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>MU07</td>
<td>0.6</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>9.6</td>
<td>0.552</td>
<td>1.7</td>
<td>0.25</td>
<td>1.3</td>
<td>2</td>
<td>2.2</td>
<td>4.2</td>
<td>0.07</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>MU08</td>
<td>0.6</td>
<td>26</td>
<td>7</td>
<td>2</td>
<td>9.6</td>
<td>0.366</td>
<td>1.1</td>
<td>0.95</td>
<td>4.9</td>
<td>2</td>
<td>2.2</td>
<td>6.7</td>
<td>0.28</td>
<td>3.7</td>
<td>0.7</td>
</tr>
<tr>
<td>MU12</td>
<td>0.6</td>
<td>26</td>
<td>7</td>
<td>2</td>
<td>9.6</td>
<td>0.138</td>
<td>0.4</td>
<td>3.084</td>
<td>9.1</td>
<td>2</td>
<td>2.2</td>
<td>8.4</td>
<td>1.55</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>MU13</td>
<td>0.6</td>
<td>26</td>
<td>7</td>
<td>2</td>
<td>9.6</td>
<td>0.138</td>
<td>0.4</td>
<td>3.084</td>
<td>9.1</td>
<td>2</td>
<td>2.2</td>
<td>8.4</td>
<td>1.55</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

**CSO Parameter Table**

This table provides information on key stressors that are associated with CSOs such as BOD, minimum dissolved oxygen (D.O.) and ammonia. Levels are in the very poor range at the upstream-most site (MU05) which is just downstream from a CSO in the upper reaches of Muddy Creek.
Ionic Strength Parameter Table
This table provides information on key dissolved parameters that can influence aquatic life. Although CSOs and stormwater impact Muddy Creek they are not delivering heavy loadings of chloride or other ions that would be of concern.

Metals and Toxicants Parameter Table
This table provides information on key metals and other toxic stressors that can influence aquatic life.
Future versions will include sediment metals and sediment PAHs and ranks which can be informative especially when these toxicants are episodic and easily missed by grab chemical sampling events.

**Land Use and Environmental Flows Parameters Table**

This table provides information on key land use parameters at the catchment scale and within the riparian buffer (within 1 km of a site) and an indirect indicator of flow in the form of the Hydro-QHEI and impervious surface. If available, daily flow data could also be used to calculate measures such as flashiness, but imperviousness has been shown to be a suitable surrogate.

**Copying and Printing of Data Tables**

Once a User obtains the data table they can readily print or copy the data with a few easy steps. First, highlight the rows and columns of data including the titles to print or copy – this selects the rows and
columns (see below). To print go to the file menu, select print selection, and then print (see next page). If you do not select print selection the entire page will be printed. Similarly to copy the data, select the data as before and paste the table into another spreadsheet, Word file, etc.

**Susceptibility Details**

This section of the IPS tool allows the User to focus on details for sites attaining the WWH benchmark. The susceptibility details lets the User examine the information behind the susceptibility score including biological, physical, land use and chemistry characteristics that are used to estimate Susceptibility. The scores for Watersheds, Reaches, and Sites are provided in a separate part of the IPS tool so as to avoid confusion with the Restorability scores and ranks.

**Susceptibility Speedometer Graphic** – The speedometer on this page illustrates the Watershed average Susceptibility Score (normalized to a scale of 0-100) based on sites within the watershed that fully attain the WWH aquatic life use. The average Susceptibility Score in this example is on the high side of “low” which means that it has a high susceptibility to increases in any of the stressors.

**Threat Speedometer Graphic** – The second speedometer on this page illustrates the Watershed average Threat Score (normalized to a scale of 0-100) based on sites within the watershed that fully attain the WWH aquatic life use, but which may have stressors levels at a fair, poor, or very poor level. The more stressors that are elevated or the magnitude of elevation (increased stress) results in a higher Threat score. The Threat Score in this example (see right) is on the high side of “low” indicating that the threat of impairment is low.

**CSO and CIP Identification Table**

The CIP button takes a User to an aquatic life use “attainment” table with monitoring data by site from the 2011-2014 rotating watershed surveys that contains information about the CSOs/SSOs/PSOs in the
vicinity of current and future Capital Improvement Projects (CIP). Each row represents a sampled site. Columns include the Site ID and River Mile, the biological indices (IBI, MIwb, and ICI), the QHEI, Aquatic Life Use Attainment Status, and the causes and sources assigned to impaired sites. The information on CIPs is also found on the Reach Restorability details spreadsheet. More detailed discussion of this data is found in the respective biological and water quality assessment report for each of the four years of baseline watershed assessment.

**PIR (Pollution Impact Reaches) Maps, Graphs, and Summaries**

The next main menu button provides a User with the option to select from a series of maps and graphics about what are defined as Pollution Impact Reaches (PIR). There are 25 PIRs and each has a map of the reach and tributaries with the sampling sites and CSOs, SSOs, PTOs, and WWTPs indicated (see next page). Some PIRs are combined on the same map and graphics where the geographic overlap is high. For example West Fork Creek and the MWH designated segment of Lower Mill Creek are on the same plot. The graphics include the biological indices (IBI, ICI) plotted by mainstem river mile with all tributary sites included. Major pollution sources including CSOs, SSOs, PSOs, and WWTPs are listed across the top of the x-axis at their point of discharge to the mainstem. This was done to provide an appropriate spatial context in relation to the monitoring
results and the proximity of each source. The monitoring results reveal the response of the biological indices to the array of pollution sources in a PIR and convey information about the extent of severity of the impacts and impairments measured in 2011-14 via the rotating watershed assessments.

The PIRs can be selected via a pull down menu on the upper left of the page (see right). A one page narrative of the status, causes and sources of impairment, and restorability issues are summarized for each PIR. An example narrative is provided in Appendix D. Figure 1 (next page) illustrates the PIR map and graphic for the assessment of Muddy Creek in 2014. The pattern of biological responses shown by the line graphs showed a severe impairment downstream from multiple CSOs and SSOs located in headwater tributaries. Elevated levels of chemical constituents associated with raw sewage occurred at these same sites and coupled with the longitudinal pattern in the biological indices led to the assignment of the impairment to these sources. Biological recovery was evident in improved biological index scores with full recovery to WWH occurring at river mile 2.0. A decline at the most downstream site was due to the habitat modification resulting from the influence of the backwater effect from the Ohio River. This graph, along with other parameter data in the IPS tool, demonstrate a severe impact from CSOs/SSOs in the headwater reaches and recovery to WWH attainment within 4 miles. In this case the monitoring results demonstrate the clear impact from wet weather sources, a demonstrated potential to attain WWH, and localized influences such as the modified habitat at the
mouth. These can also be used with the stressor rankings to add context to the Restorability score for the PIR which indicates an intermediate level of restorability. Compared to most of the other CSO/SSO impacted PIRs that have comparatively low Restorability scores, Muddy Creek would have a higher return on CSO/SSO abatement expenditures.

Figure 1. Example pollution impact reach profile map (top) and line graphs of the fish IBI and macroinvertebrate ICI (bottom) for Muddy Creek.

Interactive Map
Internal MSDGC Users of the IPS dashboard tool will have the ability to access the Poseidon mapping application using the button on the right or by clicking on the Hyperlinks on the Data Page. Poseidon is anticipated to be the primary mapping application for MSDGC Users. In order to provide a similar service for Users outside of MSDGC, an interactive map is included in the IPS using ESRI Maps for Office.
This interactive map does not provide as many features as the Poseidon mapping program. However, this free Microsoft add-in provides critical spatial context of the data presented in the IPS tool. Three layers are available for Users that include the Restorability, Susceptibility and Threat scores for each site. Screen captures of the Restorability by site and Susceptibility by sites are provided below. Identical color schemes are applied in the interactive map for direct comparison to the speedometers and tables presented elsewhere in the IPS tool.

**Example: Using Restorability Data**
An example of how the IPS tool and data analysis features can be used to address major reaches impaired by CSOs/SSOs uses data from the PIR that includes SSO 700. This is the largest SSO by volume in the MSDGC system and discharges to Mill Creek at RM 13.7 in Sharonville. SSO 700 provides for collection system relief during large storm events.

**Background**
The summary Restorability page of the IPS tool lists Restorability scores by reach for all impaired waters
where CSOs/SSOs are present in or upstream of a reach. To better focus on the SSO 700 impacted reach of Mill Creek the site and reach restorability were copied into a separate spreadsheet. A plot of site-specific and reach level restorability scores were plotted for Mill Creek based on the 2011 results (Figure 9). Restorability is highest in the upper reaches of the Mill Creek mainstem declining downstream into the lower, MWH designated reach of Lower Mill Creek. Thus from a restorability perspective, restoration actions in the upper reaches that include SSO 700 would be prioritized over the more challenged downstream reaches where restorability is lower (Figure 2).

None of the sites sampled in Mill Creek fully attained WWH in 2011 although individual index scores attained their respective biocriteria. Figure 3 (below) shows a longitudinal plot of the IBI for the Mill Creek mainstem along with major tributaries and showing CSO/SSO locations. It is clear that impacts to the fish assemblage begin upstream of SSO 700 and continue to accumulate downstream. The IPS tool allows a User to examine the ranks and values associated with key stressors at sites within specific reaches of interest. The stressor data extracted from the stressor details spreadsheet in the IPS dashboard was graphed by river mile overlaid with co-occurring CSOs/SSOs that included SSO 700.

Figure 2. Plot of site and reach restorability vs. river mile for sites sampled in Mill Creek during 2011. Horizontal lines reflect quartile breaks of 0-100 restorability scores.

Figure 3. Plot of the fish IBI vs. river mile in Mill Creek from 2011 with locations of WWTPs, CSOs, SSO, and PSOs indicated along the upper x-axis.
A plot of the QHEI (habitat) also taken from the IPS spreadsheet shows fair-good habitat upstream and in the vicinity of SSO 700 (Figure 4, upper left) and declining to poor and very poor quality in the modified lower reach of Mill Creek. The orange bands on these graphs reflect the WWH and MWH aquatic life based stressor thresholds derived for southwest Ohio. Impervious land cover in the Mill Creek watershed at most sites hovers around 25% (Figure 10, upper right) which sits at the breakpoint between the “impacted” and “non-supporting” categories of the Impervious Cover Model of Schueler et al. (2009). Schueler et al. (2009) recognized that the 25% impervious cover threshold is not necessarily determinative, but also depends on the moderating influence of riparian buffers and does not include any benefits derived from stormwater management. Figure 4 (upper left) also depicts heavy urban land use in the 30m riparian buffer within 1 km of each site. It also reflects variable impervious land cover and generally above thresholds at most sites where WWH conditions were observed (orange band).

The plot of conductivity vs. river mile (Figure 4, lower left) reveals highly elevated values that originate from the Butler Co. Upper Mill Creek WWTP via the East Fork of Mill Creek (see 2011 Mill Creek Biological and Water Quality report). While the extremely high values declined steadily downstream, they remained well above the regional reference range and exceeded the ionic strength thresholds for

![Figure 4](https://example.com/figure4.png)

**Figure 4.** Plots of key stressors vs. river mile in Mill Creek during 2011 including QHEI, land use, conductivity and total ammonia. Light green bars illustrate median and 75th percentile values at reference sites and orange bars represent threshold values for WWH and MWH wadeable streams in Southwest Ohio.
both WWH and MWH aquatic assemblage conditions (orange band). BOD values (Figure 4, lower right) were also above regional reference levels at all sites, but were below the WWH stressor thresholds until the lower five miles of Mill Creek where values were above the WWH threshold (lower boundary of band).

Each of the graphic analyses were derived from the data in the IPS spreadsheets. Other stressor parameters (metals, chlorides, nutrients) can also be explored in the same manner. Restorability scores were low in the lower reaches of Mill Creek, increasing in an upstream direction and in selected tributaries (e.g., West Fork Creek). From an aquatic life perspective, restoration efforts would have a greater likelihood of near-term success in the upper reaches of Mill Creek that include SSO 700 and other CSOs/SSOs. It is clear from these analyses that factors in addition to SSO 700 and other CSOs/SSOs are also limiting aquatic life in Mill Creek. Habitat, flow, riparian land use, and urban land use related stressors each limit and contribute to the comparatively low restorability scores for Mill Creek mainstem reaches. More detailed descriptions of the causes of impairment are found in the four Biological and Water Quality reports completed between 2011 and 2014\(^4\).

References


Ohio EPA. 1997. A guide to developing local watershed action plans in Ohio. Ohio EPA, Division of Surface Water, Columbus, Ohio


Appendix A. Example PIR Reach Summary: WAU 01-05 – West Fork Creek, Lower Mill Creek Watershed Summary

Sixteen sites were sampled in the West Fork Creek - Lower Mill Creek watershed including eight Mill Creek sites. In this lower reach Mill Creek sites are Modified Warmwater Habitat (8 sites); three sites in West Fork Creek are WWH and the remainder are PHW (Three PHW2 and two PHW3. Of the eight MWH sites, six are impaired (partially) and the two are fully attaining the MWH biocriteria. The three WWH sites in West Fork Creek are impaired. Most impairments are associated with organic enrichment and nutrients from CSOs/SSOs and urban runoff, sedimentation from hydromodification and altered hydrology from urban runoff.

Lower Mill Creek reach generally has low restorability scores (mean = 32) with reach values ranging from 6.8 (concrete channel MWH site in Mill Creek) to 55.4 (West Fork Creek). There are elevated ranges of stressors related to urban runoff (e.g., flow, chlorides) and a high level of urban development in most of the watershed (very poor) except for West Fork Creek where the land use was good (e.g., includes Mt. Airy Forest, Cincinnati’s largest park) and the buffer excellent at several sites. Instream habitat is generally poor to fair in lower Mill Creek with the exception being West Fork Creek and tributaries where habitat is generally good (upstream of a concreted and channelized reach below Montana Road). Habitat restoration opportunities may be limited by concrete channels and poor buffer land uses in the Mill Creek itself; however, West Fork Creek because of good habitat and good to excellent buffer land use in reaches provides opportunities for restoration and protection of the physical template that would support recovery from CSO and SSO impacts in the West Fork Creek watershed.

<table>
<thead>
<tr>
<th>Stream</th>
<th>No. of Sites</th>
<th>Size (mi.²)</th>
<th>Habitat Evaluation</th>
<th>Fish Evaluation</th>
<th>Macroinv. Evaluation</th>
<th>Recommended ALU</th>
<th>Causes of Impairment</th>
<th>Sources of Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill Creek (23-001)</td>
<td>8</td>
<td>165</td>
<td>Fair-Good</td>
<td>Poor-Fair</td>
<td>Poor-Marg. Good</td>
<td>MWH</td>
<td>Habitat Alteration; Sedimentation; Ammonia; D.O.; Nutrients</td>
<td>CSOs/SSOs, Hydromodification; Altered Hydrology; Urban Runoff</td>
</tr>
<tr>
<td>West Fork Creek (23-002)</td>
<td>4</td>
<td>4.4</td>
<td>Fair-Good</td>
<td>Very Poor- Poor</td>
<td>Fair-Marg. Good</td>
<td>PHW, WWH</td>
<td>Habitat Alteration; Sedimentation; D.O.; Nutrients;</td>
<td>Altered hydrology; urban Runoff, CSOs/SSOs</td>
</tr>
<tr>
<td>Trib to West Fork Creek at RM 2.41 (23-013; MC90)</td>
<td>1</td>
<td>1.5</td>
<td>Fair</td>
<td>Poor</td>
<td>-</td>
<td>PHW-IIIA</td>
<td>Habitat Alteration; Sedimentation; D.O.; Ammonia</td>
<td>CSOs/SSOs, Urban Runoff Hydromodification; Altered Hydrology;</td>
</tr>
<tr>
<td>Trib to West Fork Creek at RM 2.54 (23-027; MC93)</td>
<td>1</td>
<td>1.5</td>
<td>Good</td>
<td>Very Poor</td>
<td>-</td>
<td>PHW-IIIA</td>
<td>Habitat Alteration; Sedimentation; D.O.; Ammonia</td>
<td>Hydromodification; Altered Hydrology; Urban Runoff</td>
</tr>
<tr>
<td>Trib to West Fork Creek at RM 1.24 (23-028; MC97)</td>
<td>1</td>
<td>0.8</td>
<td>Good</td>
<td>Very Poor</td>
<td>-</td>
<td>PHW-II</td>
<td>Sedimentation; D.O.; Nutrients</td>
<td>Altered Hydrology; Urban Runoff</td>
</tr>
<tr>
<td>Trib to West Fork at RM 2.24 (MC95)</td>
<td>1</td>
<td>0.97</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>PHW-IIM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E. Loading the IPS Tool and Arc Map

The IPS Tool has been made available through Dropbox; Users of the Tool may create an account free of charge (https://www.dropbox.com/). Email notifications are sent granting access to download the file. Recipients may then log into Dropbox, navigate to the file, and click on the empty space to the right of the folder. By doing so, a set of options appear at the top of the page (Figure 1), select “Open”. The files may then be re-located to any preferred location on the User’s personal computer.

![Figure B-1. Opening the Dropbox IPS File.](image)

System requirements for the IPS Tool includes Microsoft Office 2013, ESRI Maps for Office and an ArcGIS Online Username/Password (if Users wish to access the interactive map within the tool), as well as a connection to MSDGC’s internal network (in order to access the Poseidon mapping function). When using the tool, begin with opening the Excel File named “IPS_V2.0”.

![Figure B-2. The IPS File Structure.](image)

Once the file containing the IPS tool is located in its final destination, it is imperative NOT to move or re-name any of the individual files (i.e. Excel, PDF, PowerPoint Shows) in order to maintain the integrity of the file structure. Figure 2 depicts the overall outline of this Tool. Insuring the folder name remains the same as well as the internal structure, maintains all links within the tool with the exception of the PRI and Photo selector dropdowns. Both of these features require a manual update directing the Tool to the current location of these .PNG and .JPG files.
Updating the PIR and Site Photograph Dropdowns

The particular locations of the Sampling Site Photographs (.JPG files) and the PIR Plots, Maps, and Summaries (.PNG files) requires the User to manually update the location at which they are currently located. In detail, the cells requiring this update are located in the following sheets and cells: Site Photographs, Cells H9 to H665 and PIR Maps & Graphs Cells G11 to G21.

Installing ESRI Maps for Office

The IPS Tool has two available mapping functions, ESRI Maps for Office and Poseidon. The latter of the two is managed through MSDGC and any related questions should be directed towards their office. To provide a mapping capability for those unable to access MSDGC’s network, data has been added to an interactive mapping tool within the IPS Dashboard Tool. For this to be available to Users, the free ESRI Maps for Office v3.1 Add-In (http://www.esri.com/software/arcgis/arcgisonline/apps/download) must be installed. It is strongly suggested that Users select the 64-bit version. Once the installation process is complete, Users may customize the Ribbon located at the top of the Excel Sheet by right clicking at the top of the Excel file, selecting “Customize the Ribbon”, then selecting “Add-Ins” on the left, followed by “Go” at the bottom of the screen (Figure 3). A new window will appear listing the available Add-Ins, select ESRI Maps and a new tab will then be added to the Excel Ribbon (Figure 4).
Once the Excel Ribbon has been customized with the ESRI Maps for Office Extension, Users must log into ESRI Maps. Select the ESRI MAPS tab, followed by the “Sign In ArcGIS” link (Figure 4). It is the User’s responsibility to have access to an ArcGIS account in order to log in.

Figure B-4. Logging into ESRI MAPS.