Metadata Guide for FLE Tool Outputs

**Perimeters QAQC Tool 1 Output:** **"NIFC\_WFIGS\_FullHistory\_CY"+FireYear+"\_QAQC\_"+datetime**

**Tags**

Perimeter, Perimeters, QAQC, GIS, Environmental Modeling. National Interagency Fire Center, National Incident Feature Service, Fire Perimeters, Environmental Research, Wildfire, Fire, USFS, Forest Service, RMRS, Rocky Mountain Research Station, Geospatial

**Summary**

The Fireline QAQC and FLE is a tool developed by Alexander Arkowitz (Colorado State University/USFS Contractor) and Matt Thompson (US Forest Service Rocky Mountain Research Station). It aims to provide properly QAQCed perimeters from the National Interagency Fire Center (NIFC) National Interagency Feature Service (NIFS) data suitable for environmental modeling and as an input for steps 2+ of this model. This dataset is the output from running the first tool of this model that provides a QAQC of the NIFC Fire Perimeters. The tool allows users to optionally select a calendar year to filter fire perimeters and identify identical shapes of fire incidents, with the option to set an XY tolerance in meters for shape comparison. It also creates a feature class of potential "test" incidents by searching for invalid text keywords in the incident name field. Moreover, the tool detects autogenerated triangles in the perimeters to identify and report invalid geometry. Lastly, the tool highlights fire perimeters that fall outside of the USA in order to identify perimeters that may have the wrong projection or geometry attributed.

**Description**

The Fire Perimeter QAQC tool is a GIS tool integrated into an environmental GIS model, designed to facilitate the analysis and processing of fire perimeter and fireline data. The tool operates by accessing and utilizing data from the National Interagency Fire Center's (NIFC) National Incident Feature Service, specifically focusing on the WFIGS Historical Fire Perimeters data.

The primary functionalities of the tool includes:

Data Retrieval: The tool efficiently downloads the fire perimeters from the National Incident Feature Service to begin the analysis process.

Year-based Subsetting: The tool offers users the flexibility to filter fire perimeters based on a specific calendar year, enabling a more targeted analysis.

Geometry Repair and Projection: To ensure data accuracy and consistency, the FGCD tool repairs any inconsistencies in the geometry and, if needed, spatially projects the data to GCS\_WGS\_1984.

Geometry Validation: The tool identifies and reports fire perimeters with no valid geometry and informs the user of the total number of such features.

Acreage and Vertices Calculation: For each fire perimeter, the tool automatically calculates the acreage and vertices, providing valuable information for further analysis.

Invalid Incident Name Detection: The tool examines the incident name field and flags incidents with null or invalid names, including keywords like 'Erase,' 'Test,' 'None,' and user-defined input.

Duplicate IRWIN ID Identification: The tool detects and highlights any duplicate IRWIN IDs associated with fire incidents, aiding in data organization and deduplication.

Shape Comparison: The FGCD tool performs shape comparison, allowing users to identify identical incident shapes within an optional XY tolerance in meters, which can be set by the user.

Frequency and Duplicate ID Tracking: The tool keeps track of the frequency of identical shapes found and assigns a Duplicate ID to features that share the same geometry, enhancing data management and analysis.

Duplicated Acreage Calculation: The tool provides users with a summary of the total duplicated acreage resulting from the identification of identical incident shapes.

Detection of Non-US Features: The tool identifies and reports any fire incidents located outside of the United States, facilitating further analysis for international data.

By providing valuable insights into duplicate incidents, invalid geometry, and non-US features, the FGCD tool aids environmental GIS analysts in making informed decisions and conducting comprehensive fire incident analyses. Please reference the script “1\_NIFC\_Perimeters\_QAQC.py” to get a better understanding of the process.

**Credits**

This GIS product was created by Alexander Arkowitz (alexander.arkowitz@colostate.edu), a Forest Service contractor and Geospatial Research Associate IV at Colorado State University, and Dr. Matthew Thompson (matthew.p.thompson@usda.gov), a Research Forester for the US Forest Service in the Human Dimensions program.

**Use limitations**

The Fireline QAQC GIS product is provided "as is" and may contain errors. The user assumes all risks associated with its use and bears responsibility for determining its fitness for the intended purpose. The accuracy, resolution, completeness, and timeliness of the data may vary, as they are derived from various sources. The user should exercise caution and independently verify the data's accuracy and suitability for their specific applications. The data should not be considered legal documents or land surveys, and they should not be used as such. Official records should be referenced at the National Interagency Fire Center offices. Any errors identified in the data should be reported to the authors or the National Interagency Fire Center (NIFC). The authors should be cited as the data source in any products derived from these data. Any modifications made to the data by users should be described, and users should not misrepresent the data or imply that changes were approved or endorsed by the authors.

**Fireline QAQC Tool 2: “OpsData”\_ “QAQC”\_ Calendar Year\_ Incident Name\_ Run Date and Time**

**Tags**

Fireline, QAQC, GIS, Environmental Modeling, National Interagency Fire Center, National Incident Feature Service, Fire Perimeters, Environmental Research, Wildfire, Fire, USFS, Forest Service, RMRS, Rocky Mountain Research Station, Geospatial

**Summary**

The Fireline QAQC and FLE is a tool developed by Alexander Arkowitz (Colorado State University/USFS Contractor) and Matt Thompson (US Forest Service Rocky Mountain Research Station). It aims to provide properly QAQCed fireline data suitable for environmental modeling. The tool utilizes the National Interagency Fire Center's National Incident Feature Service data, specifically the Event Line data and the Historical Fire Perimeters data, to perform QAQC operations and attribute firelines accurately. This specific output is from tool 2, and provides the user with QAQCed firelines for a specific fire of interest that is provided by the user. This output shows the changes the tool performed on fields such as Incident Name and IRWIN ID and allows the user to manually accept or reject these changes.

**Description**

The Fireline QAQC GIS product is designed to enhance the quality of fireline data used for environmental modeling and tracking purposes. The tool retrieves the Event Line and Historical Fire Perimeters data from the National Interagency Fire Center's National Incident Feature Service (NIFS). The QAQC process involves filtering the event line data to identify completed firelines, cleaning up attribution, and ensuring accurate attribution to specific fires. The tool includes functionality to track changes made to fireline attribution, allowing users to accept or erase those firelines based on the changes. It also performs spatial analysis, such as buffering and intersection, to identify unattributed firelines near the incident of interest. The workflow begins by downloading the selected Event Line data for the specified calendar year (CY) from the NIFS public data. The downloaded data is then extracted and imported into a geodatabase within the tool's workspace. Subsequently, the user-provided fire perimeters are filtered to retain only the perimeters corresponding to the selected CY. This step ensures that the analysis focuses on the desired fire incidents. To ensure accurate attribution of firelines, several data cleanup and processing steps are performed. The tool examines the Event Line and Historical Fire Perimeters datasets to identify completed firelines. Only specific line types related to completed fire operations, such as burnout, dozer line, fuel break, hand line, mixed construction line, plow line, and road line, are retained for further analysis. Firelines marked for deletion or with certain feature statuses are also filtered out. Next, the tool conducts attribute cleanup by removing any extra spaces before or after the text in fields such as attr\_incidentnames and attr\_irwin IDs. This step ensures consistent and accurate comparison of attributes later in the process. Additionally, any missing IRWIN IDs in the attr\_irwin ID field are populated using the corresponding values from the poly\_irwinIDs field, provided the attr\_irwin ID is null. The Event Line data is then projected to GCS WGS 1984 for consistent spatial analysis, and any null geometry features are removed from the dataset. A geodesic acreage calculation is performed on the perimeter dataset, adding a field to store the calculated values. The tool further compares IRWIN IDs, incident names, and points of origin (POO) between the perimeters and firelines. This comparison identifies lines outside the buffer area but sharing the same IRWIN ID, incident name, or POO state. These lines are selected for inclusion in the analysis. The perimeter data is temporarily copied to the scratch workspace to facilitate the subsequent analysis steps.To determine the matching attributes between firelines and perimeters, the Event Line data is intersected with a polygon representing US states. The resulting data is joined with the perimeter attributes to identify the following conditions: Firelines with matching IRWIN IDs and incident names Firelines with matching IRWIN IDs but requiring the incident name from the matching IRWIN Firelines with matching incident names in the same state but requiring the IRWIN ID from the matching name. The respective fields in the dataset are populated accordingly, and any overwritten name or IRWIN ID values are stored in the "OldName" and "OldIRWIN" fields.Firelines that lack proper attribution to a specific fire are then identified as a subset for further examination. A buffer is created around the user-provided fire perimeter, an d intersecting firelines are selected within this buffer. The "Flag" field is populated based on the specific conditions, indicating whether the firelines are within the buffer but have missing or mismatched incident names and/or IRWIN IDs. The "OldName" and "OldIRWIN" fields are populated for lines with existing attribution that has been changed. To ensure data integrity, duplicate firelines are removed from the dataset. All firelines are converted to single-part features, and the Find Identical tool is utilized to identify duplicates based on shape, incident name, feature category, IRWIN ID, and fireline categorization fields. The duplicate features are dissolved to eliminate redundancy. Please reference the script “2\_NIFC\_Fireline\_QAQC.py” to get a better understanding of the process.

**Credits**

This GIS product was created by Alexander Arkowitz (alexander.arkowitz@colostate.edu), a Forest Service contractor and Geospatial Research Associate IV at Colorado State University, and Dr. Matthew Thompson (matthew.p.thompson@usda.gov), a Research Forester for the US Forest Service in the Human Dimensions program.

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**Fireline QAQC Tool 3 – 3\_Fireline\_FLE**

**Outputs:**

1. **FLEngageOutput = FLEngageOutputName+"\_"+datetime**
2. **BufferedLineOutput = FLEngageOutputName+"\_"+(str(FirelineEngagmentBuffer))+"m\_"+datetime**

This tool takes the output from tool #1 and #2 being the QAQCed perimeters and firelines from the user. It is made to work on a complex (multiple perimeters treated as one). It also takes the output name as text from the user as well as the fireline engagement buffer. The buffer signifies what distance from the fire perimeter a line is in order to classify it as held. If the user uses the default 100m, it will clip all firelines within 100 meters inside AND 100 meters outside of the perimeter and attribute it as held.

First, the tool identifies if multiple perimeters were supplied and dissolves all the perimeters into one complex of fires by using the attribution if IRWIN ID and Incident Name from the largest perimeter and applies it to all perimeters. It then attributes fireline engagement based on the user input fireline engagement buffer distance.

The buffered line output is then created in order to supply the user with firelines that are suitable for an overlay analysis. The firelines are buffered to the same distance as the held lines are clipped to from the fire perimeter, as we can assume that the spatial inaccuracies for the fire perimeter and the engagement status can also be applied to this line buffer distance. Therefore, if the user selected 100 meters, the lines will be buffered 100 meters each way from the center, creating a 200 meter buffered line across.

In order to create these buffered lines, the lines are buffered, converted to single part features, and areas where overlap between the buffered line features themselves are found, the tool prioritizes held, not engaged, and not held, in that order, only allowing for the top ranking engagement class to be used.

The same process is used to only attribute the highest “ranking” treatment for areas of fireline type overlap. The ranking goes as follows: 1 Completed Road as Line, 2 Completed Dozer Line, 3 Completed Hand Line, 4 Completed Mixed Construction Line, 5 Completed Fuel Break, 6 Completed Burnout, and 7 Completed Plow Line. This logic was created by [bradley.pietruszka@usda.gov](mailto:bradley.pietruszka@usda.gov) a fire management specialist with the US Forest Service/

**Tags**

Fireline, Engagement, QAQC, GIS, Environmental Modeling, National Interagency Fire Center, National Incident Feature Service, Fire Perimeters, Environmental Research, Wildfire, Fire, USFS, Forest Service, RMRS, Rocky Mountain Research Station, Geospatial

**Summary**

**Description**

**Credits**

This GIS product was created by Alexander Arkowitz (alexander.arkowitz@colostate.edu), a Forest Service contractor and Geospatial Research Associate IV at Colorado State University, and Dr. Matthew Thompson (matthew.p.thompson@usda.gov), a Research Forester for the US Forest Service in the Human Dimensions program.

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**Fireline QAQC Tool 4 – 4\_FLE\_Metrics**

**Outputs:**

1. **FLE Metrics Feature Class Output = "FLE\_"+IncidentName+"\_"+datetime**
2. **Excel XLS: FLE\_Metrics\_”+IncidentName+”\_"+datetime**

**Tags**

Fireline, Engagement, QAQC, GIS, Environmental Modeling, National Interagency Fire Center, National Incident Feature Service, Fire Perimeters, Environmental Research, Wildfire, Fire, USFS, Forest Service, RMRS, Rocky Mountain Research Station, Geospatial

Summary:

The Fireline Effectiveness (FLE) GIS product serves as a critical tool for the evaluation of large wildfire management strategies, with the overarching goal of fostering institutional learning and enhancing the effectiveness of fire management organizations. This product capitalizes on the increasing availability of spatially explicit fireline records, which provide valuable insights into the performance of containment strategies. FLE metrics, which are integral to this product, are based on easily quantifiable measures. These metrics center on assessing the length of the final wildfire perimeter and the extent to which firelines were successful in preventing the wildfire from advancing. This evaluation is achieved through overlay analysis, which compares the spatial locations of firelines relative to the final wildfire extent and perimeter on an incident-by-incident basis.

Description:

The Fireline Effectiveness (FLE) workflow involves a series of essential processing steps aimed at quantifying the efficiency of fireline containment strategies. This workflow begins with the input of fireline data that has undergone Quality Assurance and Quality Control (QAQC) obtained from the second tool associated with this model , and is then attributed to an individual fire as well as a perimeter dataset sourced from the National Interagency Fire Center (NIFC). The workflow comprises the following key steps:

Fireline Buffering: To consolidate adjacent firelines, the workflow initiates by buffering firelines within a 50-meter proximity of each other. Buffers are generated around the fire perimeter to identify distinct areas: held, not engaged, and burned over. A 50-meter buffer is applied, encompassing both 25 meters within and 25 meters outside of the fire perimeter.Firelines intersecting the held area are buffered to 75 meters, and clipped to the perimeter held area, effectively filling in the perimeter held area. This step computes the Held Area to Held Perimeter Area (HaPar) ratio, which is used by multiplying the fire perimeter length by HaPar to determine the length of held firelines. This method is chosen for its ability to account for perimeter complexity while ensuring that held fireline length does not exceed the perimeter. The workflow calculates not engaged and burned over line segments by halving the perimeter of the buffered fireline polygon. A perimeter-to-area ratio PrAr is calculated, recognizing that perimeter complexity and resolution can influence fireline metrics. A Fire Management Complexity Team attribute is included in the output, sourced from NIFC attribution, which enhances an understanding of perimeter complexity. Following these comprehensive processing steps, the workflow then calculates the various FLE metrics. The results are delivered in two formats: as a feature class, facilitating spatial analysis, and as an Excel sheet, enabling data manipulation and reporting.

These processing steps collectively enable the evaluation of fireline effectiveness at an incident level, considering factors such as containment strategy success, perimeter complexity, and the incident's operational context.

FLE Metrics:

The FLE metrics included in this product offer a nuanced understanding of containment strategy performance:

HTr (Held Line to Total Line Ratio): This metric quantifies the effectiveness of fireline containment efforts by determining the proportion of fireline that was successfully held in relation to the total length of fireline established during the incident.

Tr (Total Line to Fire Perimeter Ratio): Tr measures the extent of containment strategy implementation by evaluating the ratio of the total length of firelines constructed to the final extent of the wildfire's perimeter.

Er (Engagement Ratio): Er provides insights into the overall containment strategy's success by considering both held fireline and fireline that was burned over in relation to the total fireline length. This metric captures the comprehensive impact of containment efforts.

HER (Held Line Engagement Ratio): Focusing on the effectiveness of held fireline, HER calculates the proportion of fireline that was successfully held in comparison to the total of held and burned over fireline. It highlights the efficiency of containment in preserving established firelines.

BTR (Burned Over Line to Total Line Ratio): BTR quantifies the proportion of fireline that was burned over relative to the total length of fireline constructed during the incident. This metric offers insights into areas where containment efforts may have been less effective.

NeTr (Not Engaged Line to Total Line Ratio): NeTr evaluates the extent to which firelines were strategically placed to engage with the wildfire. It quantifies the proportion of fireline that did not engage with the wildfire relative to the total fireline length.

These metrics collectively can assist in a comprehensive assessment of containment strategy efficiency and investment.

Use Limitations:

Users of the Fireline Effectiveness (FLE) GIS product must consider several important limitations and responsibilities: The FLE GIS product is provided "as is" and may contain errors. Users assume all associated risks and are solely responsible for determining its suitability for their specific purposes. The accuracy, resolution, completeness, and timeliness of the data can vary due to multiple data sources. Independent verification of data accuracy is strongly recommended.This product should not be regarded as legal documents or land surveys, nor should it be utilized for such purposes. Official records available at the National Interagency Fire Center (NIFC) offices should be referenced for legal and land survey matters.Any identified errors in the data should be promptly reported to the authors or NIFC. Users are required to cite the authors as the data source when using this data in derivative products.Modifications to the data made by users should be accurately described. Users should refrain from misrepresenting the data or implying that modifications were approved or endorsed by the authors.The USDA Forest Service provides no warranties, expressed or implied, including merchantability and fitness for a specific purpose, and assumes no legal liability for the data's accuracy, reliability, completeness, or utility. Users are solely responsible for the appropriate use of this data. This data should not be used to determine title, ownership, legal descriptions, boundaries, legal jurisdiction, or land use restrictions on public or private land.The data may or may not depict natural hazards, and users should exercise caution in areas indicated in the data.As the data is dynamic and subject to change, users must verify data limitations and use the data accordingly.