



GEOGRAPHIC INFORMATION SYSTEMS (GIS) LAYER REQUIREMENTS AND OBJECTIVES FOR ENABLING GEOSPATIAL CALL ROUTING FOR NEXT GENERATION 911 IN THE COMMONWEALTH OF PENNSYLVANIA

I. PURPOSE

A major priority for the Pennsylvania Emergency Management Agency's Statewide Next Generation 911 (NG911) project is to enable geospatial call routing at the time when a Public Safety Answering Point (PSAP) is cutover to NG911 service. To achieve this outcome, each county within the Commonwealth of Pennsylvania is required to furnish a set of GIS layers in an NG911 ready state. The conditions for being considered NG911 ready are further defined later in this document. GeoComm, the Commonwealth's vendor for NG911 GIS services, will manage this data via their GIS Data Hub Spatial Interface (SI) solution. Each county will participate in an in-depth regional training session, facilitated by Comtech and GeoComm, on how to use the GIS Data Hub and gain a detailed understanding of its functionality and capabilities. County GIS personnel will also be assigned login credentials prior to their training session. The goal of this training will be to equip counties and regions in preparing for their migration. A county's NG911 ready GIS data should be uploaded to the GIS Data Hub no later than 30 days prior to its NG911 Service Region's planned cutover date. A schedule of planned regional cutover dates is included later in this document as a point of reference.

This document is intended to support county GIS and public safety personnel in preparing their local required GIS layers so that these layers are in an NG911 ready state one month prior to their region's planned service cutover date and are able to support geospatial call routing at the time of cutover. This document outlines the key requirements, objectives, and deadlines that a county must meet to achieve this outcome. It also provides guidance on PEMA's 2021 round of Interconnectivity Fund grant opportunities to further support NG911 GIS layer development. Additionally, it includes a detailed overview of grant deliverables, eligible project costs and key deadlines and tasks for preparing Interconnectivity Fund grant applications.

PEMA, along with our contracted NG911 vendors, is slated to begin regional PSAP migrations to NG911 service tentatively starting in March 2022 and concluding by June 2023. Though these dates are tentative and are subject to change, they highlight both the urgency and importance for counties and NG911 service regions to begin preparing their GIS data now for their upcoming NG911 service migration so that geospatial call routing can be enabled at the time that their respective region cuts over to NG911 service.

II. CONTINUED FINANCIAL SUPPORT FOR NG911 GIS EFFORTS

Since 2017, PEMA has awarded counties and regions a total of \$8,162,483 in statewide Interconnectivity Fund grant awards to 49 projects focused on the development and improvement of NG911 required GIS layers. The statewide NG911 system is currently being built out across the Commonwealth and the first PSAPs are expected to migrate to NG911 service in early 2022, with the entire Commonwealth being fully migrated by mid-2023. **Counties should be actively preparing their GIS data now to ensure that it is in an NG911 ready state at least 30 days prior to their region's planned service cutover date.**

To further support this outcome, during the 2021 Statewide Interconnectivity Fund grant cycle, PEMA is again prioritizing funding to assist counties and regions in ensuring that their GIS data is in an NG911



ready state and able to support geospatial call routing at the time of their region's NG911 service cutover. Projects funded this year will be narrowly focused on assisting counties with meeting the requirements and objectives outlined in Section III of this document. We anticipate that less funding will be available to support this priority area in the future and this round of funding is intended to identify and close any remaining gaps in GIS data readiness as counties and regions prepare for their migration to NG911 service. This document was developed as an additional resource for county GIS staff and county 911 coordinators to prepare their data for the upcoming service migration and supplements PEMA's 2021 Statewide Interconnectivity Funding Guidelines document, published in June 2021.

Key Dates:

- **August 15th, 2021:**
 - Deadline for meeting with PEMA's Geospatial Analyst for 911 ([Christian Przybylek](#)) to discuss your project.
 - Deadline for starting your grant application in the PEMA Webtool*.

- **October 31st, 2021:**
 - final Interconnectivity Fund grant applications are due.

*Note: Typically, only 911 coordinators, and in some cases select PSAP personnel, have access to the 911 Webtool. County GIS stewards for NG911 will need to work with the 911 Coordinator or applicable PSAP personnel to submit an application. Also please be aware that both deadlines listed above fall on Sundays, plan accordingly. **Projects that are not previously discussed with PEMA's geospatial analyst and started in the PEMA Webtool by August 15th, 2021 and applications not formally submitted by October 31st, 2021 will not be considered for funding.**

III. SUMMARY OF REQUIREMENTS AND OBJECTIVES:

To ensure that a county's GIS data will be in an NG911 ready state and capable of supporting geospatial call routing at the time that its PSAP is cutover to NG911 service, a county must provide the following deliverables **no later than one month prior to their region's cutover date:**

- **Produce and provision accurate and current versions of the following required GIS layers to the GeoComm GIS Data Hub:**
 - Road Centerlines
 - Site/Structure Address Points
 - PSAP Boundary
 - Provisioning Boundary
 - Emergency Service Boundaries for Fire, Police, and Emergency Medical Services

These layers are further described in Addendum A.

- **These layers must also meet a robust set of criteria to be in an NG911 ready state, including:**



1. The attribute tables for the above-listed GIS layers must include required fields and be populated with mandatory and conditional values that correspond to the data model published by the National Emergency Number Association (NENA) in its document titled **NENA Standard for NG9-1-1 GIS Data Model** ([NENA-STA-006.1.1-2020](#)).

Additionally, to assist our county and regional GIS partners in building the required GIS layers and ensuring that their layers are NG911 ready, PEMA and its NG911 GIS Working Group have published two best practices guides, which are based on the NENA Standard for NG9-1-1 GIS Data Model referenced above, to guide in the GIS layer development and improvement process. **PEMA strongly recommends that counties and regions use its best practices guides as a starting point for developing plans for building their set of NG911 required GIS layers.** Links to both documents are embedded below (note that these can also be found on PEMA's NG911 webpage):

- a. [Public Safety Answering Point \(PSAP\) Emergency Service and Provisioning Boundaries Best Practices Guide](#)
- b. [Road Centerlines and Site/Structure Address Points Best Practices Guide](#)

As important change to note that is not reflected in the best practices documents linked above is that **counties are not responsible for building Service URIs**. Instead, these will be provided by PEMA's NG911 vendors for each county and will be automatically populated via the GIS Data Hub.

Note: it is important to acknowledge that the **NENA Standard for NG9-1-1 GIS Data Model** document, referenced above, is not intended to be a static document, and will undergo periodic updates over time. PEMA and our NG911 GIS Working Group members are engaged with NENA and are tracking proposed changes to the NENA Data Model and other guidance documents. As changes are published, PEMA may, in consultation with the NG911 GIS Working Group and our NG911 project vendors, make updates to its best practices guides as is deemed necessary and appropriate. Any changes to the best practices guides will be shared with PEMA's NG911 GIS stakeholders and shared on [PEMA's NG911 webpage](#).

Note: PEMA partnered with Pennsylvania's community of county GIS professionals to develop the PA NG911 GIS data model, which is primarily based on the NENA Standard for NG911 GIS Data Model but does include a few Pennsylvania specific fields. It is expected the PA NG911 GIS Data Model will be formally adopted in the Summer of 2021 as part of the new **Minimum Technology, Operations, and Planning requirements for PSAPs**.

Note: the attribute fields and values of a county's GIS layers *do not necessarily* need to be maintained in the NENA Standard for NG9-1-1 GIS Data Model. ***GIS data can be maintained in another data schema if the values stored within that data schema can be field mapped to corresponding fields and values detailed in the NENA Standard for NG9-1-1 GIS Data Model.*** **All mandatory, conditional, and optional attribute field values are defined in the PEMA Best Practices and NENA Data Model documents referenced above.** As an early step in the NG911 migration process, GeoComm will reach out to each county to complete a field mapping spreadsheet. This spreadsheet will allow GeoComm to configure the GIS Data Hub SI to perform



Extract, Transform, and Load (ETL) processes on local GIS data if that data is maintained in a data schema different from the NENA data model's data schema.

2. Each of the above listed required layers must also pass a robust series of Quality Control (QC) checks that will automatically be performed by the GeoComm GIS Data Hub SI after data has been provisioned by a county. These QC checks confirm the presence or absence of required attribute fields and values and verify that there are no topological, data, geometry, or other errors. The errors that the GeoComm GIS Data Hub SI will look for are classified in order of importance, with those coded as either **Ingestion Errors** or **Critical Errors** being the most important ones to resolve prior to your region's planned NG911 migration date. **County GIS data must be free of Ingestion Errors and Critical Errors prior to NG911 service cutover to enable geospatial call routing.** In the data production and improvement process, **correcting Ingestion Errors and Critical Errors should be prioritized over correcting non-critical errors.** It is important that non-critical errors are also addressed, but these types of errors are a less urgent priority. If you have a mix of error types, Ingestion Errors and Critical Errors should be addressed first. The QC checks that will be performed are fully detailed in Addendum B and are categorized by the type of error (e.g. Ingestion Errors, Critical Errors, Warnings ...etc).

As an additional point of reference, the QC checks performed by the GeoComm GIS Data Hub are closely aligned to the QC checks that were run in the [Statewide GIS Data Gap Analysis](#) that was conducted by GeoComm in 2019. The final statewide report that resulted from that analysis is linked above and is also available on PEMA's website. It is important to note that all county PSAP jurisdictions in the Commonwealth were provided with copies of more detailed county-level gap analysis reports. PEMA retains copies of the county-level GIS Data Gap Analysis reports and accompanying GIS datasets for all PSAP jurisdictions in the Commonwealth and may provide copies of these items upon request. Please reach out to PEMA's [Geospatial Analyst](#) for these items, if needed.

As a general guideline, prior to being onboarded to the GeoComm GIS Data Hub, the results from the 2019 county-level GIS Data Gap Analysis reports may provide a county with a precise indicator of their GIS data's NG911 readiness, recognizing that the GIS layers used for these reports are about two years old, potentially making these findings slightly outdated.

After your region has been configured with the GeoComm GIS Data Hub SI, you will have the ability to run an initial QC check on your NG911 GIS layers to record a baseline of where your data is at today in terms of NG911 readiness. A copy of these baseline findings will be retained by PEMA to assist you in tracking your progress. You can then use the GIS Data Hub to measure progress in your data quality over time. Results from the QC checks performed in the GeoComm GIS Data Hub will be made available to the provisioning county or jurisdiction no later than 72 hours/3 business days after it has been uploaded, but likely sooner.

Note: early in the NG911 migration process, each region will be onboarded to the GeoComm GIS Data Hub and county GIS staff will receive an in-depth training on how to use it.

Note: For counties that are not scheduled to be onboarded to the GIS Data Hub SI solution in July 2021, and are interested in accessing updated QC results, please reach out to [Christian Przybylek](#) at PEMA to discuss solutions. PEMA may be able to run current county NG911 GIS data through the Data Hub ahead of your scheduled onboarding and will share and interpret



the results for you, allowing you to get a head start in preparing your NG911 GIS data for migration.

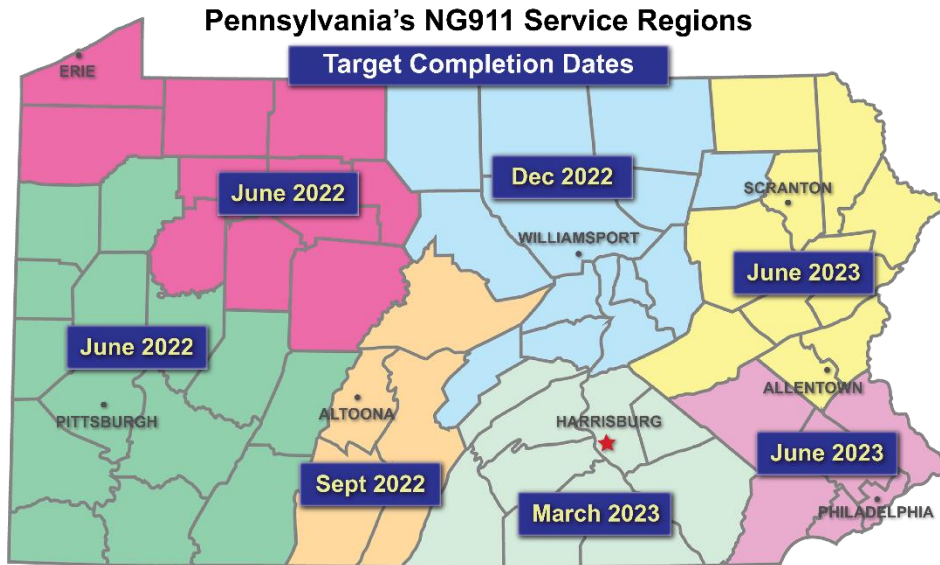
3. Each required layer must be provisioned to the GeoComm GIS Data Hub no later than 30 days prior to a region's planned NG911 service cutover date (see map 1, below, for tentative regional cutover dates). Additionally, this data must be free of Ingestion Errors and Critical Errors. If other error types are found, they must also be addressed, but will not prohibit geospatial call routing. These other errors types may result in slower call routing and therefore will also need to be addressed within a reasonable timeframe.

Note: after a region has completed its NG911 migration, and geospatial call routing has been enabled, counties within that region must address any errors in their data within three business days.

4. A county's PSAP Boundary, Provisioning Boundary, and Emergency Service Boundaries for Fire, Law and Emergency Medical Services GIS layers must be topologically clean and free of gaps and overlaps.
5. A county's Automatic Location Information (ALI) to Road Centerlines layer synchronization match rate must meet or exceed 98%.

PEMA will be working with each NG911 Service Region to finalize their respective network design and migration plans. The anticipated timeframes for counties and regions to be cutover to NG911 service are provided below in Map 1 and Table 1. These are being provided as general guidelines, but these dates are tentative and subject to change. If dates do change, PEMA and its NG911 vendors will notify our county GIS stakeholders as soon as possible.

Table 1 also includes anticipated dates for when regions will have access to and training on the GeoComm GIS Data Hub, along with Target GIS Readiness dates. Counties should aim to meet the Target GIS Readiness date to ensure geospatial call routing can be deployed within your region at the time of NG911 service cutover. Counties must have their data NG911 ready **no later than 30 days prior to their region's planned cutover date.**



map 1: planned NG911 service cutover dates by NG911 service region

Note: the current NG911 Service Regions are different from past iterations of Pennsylvania's 911 Service Regions. The boundaries were updated to maximize efficiencies for the statewide deployment of NG911.

NG911 Service Region	GeoComm GIS Data Hub Onboarding and Training	Target GIS Readiness	PSAP Migration Timeframe (2-month process)
1. Northern Tier	July 2021	February 2022	March – May 2022
2. WestCORE	July 2021	March 2022	April – June 2022
3. South Central Mountain	January 2022	June 2022	July – Sep 2022
4. North Central	March 2022	September 2022	October – December 2022
5. South Central	June 2022	December 2022	January – March 2023
6. NECORE	September 2022	March 2023	April – June 2023
7. SEPA	September 2022	March 2023	April – June 2023

table 1: important dates for each NG911 service region (dates are subject to change)

IV. Interconnectivity Funding: Project and Application Development Process

- To apply Interconnectivity Funds towards projects that assist a county or NG911 service region in meeting the requirements and objectives for enabling geospatial call routing as outlined in this document, you must first coordinate with PEMA's [geospatial analyst](#) to define your project, application and requested amount. **To ensure adequate time is available, counties should begin working with PEMA as soon as possible. Sunday, August 15th, 2021 is the final deadline for counties/regions to initiate project coordination with PEMA's geospatial analyst and to begin their applications in the PEMA Webtool. Projects cannot be started in the PEMA Webtool after August 15th, 2021.**
- **Note:** Typically, only 911 coordinators, and in some cases select PSAP personnel, have access to the 911 Webtool. County GIS stewards for NG911 will need to work with the 911 Coordinator or applicable PSAP personnel to submit an application



- Final applications (including supporting documentation for requested costs) for statewide Interconnectivity Fund grants are **due by 11:59 pm on Sunday, October 31st, 2021**. PEMA's intent is to have all GIS related projects and costs fully defined by this date to enable detailed planning and budgeting in order to meet the funding needs of as many counties as possible. This will also allow for the rapid award and distribution of grant funds.
- **Note:** both the August 15th and October 31st deadlines both fall on Sundays. Please plan accordingly.
- **Additionally, counties should be working now to obtain quotes from vendors that they may use for building or improving NG911 ready GIS layers.**
- In situations where grant requests exceed PEMA's total available funds, PEMA will prioritize GIS projects based on the earliest Target GIS Readiness Date, which are provided for reference in Table 1 above.
- Grant applications may be submitted by a single county government or by a regional collaborative consisting of multiple county governments.
- It should further be stated that the buildout of the Statewide NG911 system will add substantial costs to the statewide Interconnectivity Fund funding cycle in calendar years 2021 and 2022. As a result, PEMA expects that fewer funds will be available for grants during these funding cycles compared to previous years. **The ability to award funding for GIS projects is contingent on the availability of funds.**
- PEMA has sole discretion in whether to award full, partial, or no funding to a project. Project proposals that are clearly defined and most closely aligned to the requirements and objectives and provide the deliverables described in this document are more likely to receive funding.
- **PEMA will coordinate with counties and regions to develop and populate applications. These must be started no later than August 15th, 2021.**

V. Eligible Costs for Interconnectivity Funding

To be eligible for Interconnectivity Fund grants that support your county or region's efforts to ensure GIS data is complete and in an NG911 ready state at the time of NG911 service cutover, your project must clearly demonstrate how you plan to use Interconnectivity Funds to achieve the deliverables described in Section III, above. Additional details on some specific costs that are eligible for Interconnectivity Fund grant awards are outlined below.

Costs eligible to be covered by Interconnectivity Fund grants include:

1. Personnel and/or contracted services costs



- Personnel or contracted services costs are strictly limited to the development of GIS data and layers that meet the requirements and objectives outlined in this document.
- Costs for routine or regular GIS work are not eligible for statewide Interconnectivity Fund grant funding.

2. Software & Data Solutions

- Costs related to purchasing relevant GIS software, including licensing, licensing extensions, and maintenance fees may be considered if those software purchases are funding NG911-related GIS work. When software supports both NG911 and other functions, only the percentage of the cost representing NG911 use is eligible.
- Costs related to maintenance of GIS portals or NG911 GIS layer data storage solutions.
- Costs related to purchasing GIS datasets may also be considered for funding.

3. Hardware

- Costs related to PC workstations, laptops, monitors, printers and data storage devices and other hardware used for creating and maintaining GIS data for NG911 may be considered for funding.
- When hardware supports both 911 and other functions, only the percentage of the cost representing 911 use is eligible.



Addendum A: Overview of NG911 Required GIS Data Layers

The GIS layers required for NG911, and their definitions as set by NENA, are detailed below.

Road Centerlines (RCLs): these are line features and represent the estimated centerline of a real-world roadway. The attribute tables of Road Centerline GIS layers include a data schema containing information on street names, address ranges, jurisdictional boundaries, and other attributes that are further outlined in the [PEMA Road Centerlines and Site/Structure Address Points Best Practices Guide](#).

Prior to provisioning GIS layers to the GeoComm GIS Data Hub, Road Centerlines should be named as follows: "RCL_CountyName". For example, a Road Centerlines layer for Susquehanna County would be named "RCL_Susquehanna".

Site /Structure Address Points (SSAPs): these are point features and represent the location of a site or structure or the location of an access/egress point to a site or structure. They can also represent landmarks. Address points have the ability to locate sites that otherwise may not geocode correctly using the Road Centerline data, areas of unusual addressing (i.e. odd addresses on even side of a road centerline and vice versa), and other areas where the data is available. Some addressable locations may be problematic near boundaries.

The address number, street name, and place name attributes (e.g. Incorporated Municipality, Unincorporated Community, Neighborhood Community) in the Site/Structure Address Points layer should be consistent with the address number range, street name, and left/right place name attribute combinations found in the Road Centerlines layer.

Prior to provisioning GIS layers to the GeoComm GIS Data Hub, Site/Structure Address Points Layers should be named as follows: "SSAPs_CountyName". For example, a Site/Structure Address Points layer for Allegheny County would be named "SSAP_Allegheny".

Public Safety Answering Point (PSAP) Boundary: PSAP boundaries are polygon features that are used by the Emergency Call Routing Function (ECRF) to perform a geographic query to determine the proper PSAP to route an emergency request to.

Prior to provisioning GIS layers to the GeoComm GIS Data Hub, PSAPs should be named as follows: "PSAP_CountyName". For example, a PSAP layer for Lancaster County would be named "PSAP_Lancaster".

Emergency Services Boundaries (ESBs): an ESB layer defines the geographic area for the primary providers of response services. Each of these layers is used by the ECRF to perform a geographic query to determine which Emergency Service Providers are responsible for providing service to a location in the event a selective transfer is desired, to direct an Emergency Incident Data Document to a secondary PSAP for dispatch, or to display the responsible agencies at the PSAP. In addition, Emergency Service Boundaries are used by PSAPs to identify the appropriate entities/first responders to be dispatched. Each Emergency Service Boundary layer may contain one or more polygon boundaries that define the primary emergency services for that geographic area. There MUST be a separate Emergency Service Boundary layer for each type of service, including:



- **Law**
- **Fire**
- **Emergency Medical Services(EMS)**

Prior to provisioning GIS layers to the GeoComm GIS Data Hub, Emergency Service Boundary layers should be named as follows: “ESB_Type_CountyName”. For example, an ESB Law layer for Erie County would be named “ESB_Law_Erie”.

Provisioning Boundaries (PBs): these are polygon features that define the area of GIS data provisioning responsibility, with no unintentional gaps or overlaps. This layer can be used by an ECRF to facilitate exclusion of erroneous features that extend beyond the boundary, for geoprocessing purposes, and can also be used by the Forest Guide to determine coverage for a data provisioning authority. When provisioning data for an ECRF and LVF through the GeoComm GIS Data Hub, a 9-1-1 Authority (or 9-1-1 Authority designee) **must** only include GIS data for their geographic area of responsibility and **must** ensure the data includes coverage for the entire extent of that area.

Prior to provisioning this layer to the GeoComm GIS Data Hub, Provisioning Boundaries should be named as follows: “PB_CountyName”. For example, a provisioning boundary layer for Centre County would be named “PB_Centre”.



Addendum B: Overview of GeoComm GIS Data Hub SI Quality Control (QC) Checks

Ingestion Errors and Critical Errors: these types of errors will cause issues with NG911 call routing and location validation functions and will not be accepted in the NG911 Core Services components. They are found under the red heading.

Other Errors: these types of errors have the potential to cause delays in the call routing and location validation functions, however additional features within the system will ensure that calls are routed correctly. Non-critical errors will not prevent data from being provisioned from the GIS Data Hub Spatial Interface into Next Generation Core Services but they may cause delays in responses times. These are found under yellow headings.

GeoComm GIS Data Hub SI QC Checks by Error Type			
Ingestion Errors Provisioning Halted			
No.	Issue	Testing Method	Effect on provisioning of GIS data to ECRF and LVF
1	Corrupt data in a file geodatabase	Upon ingest, GIS Data Hub verifies that the file geodatabase can be opened, and its contents can be read for processing.	Causes ingestion failure and no GIS data will proceed to quality control process or provisioning to ECRF and LVF.
2	Invalid geometry in any layers	Empty Geometry and Invalid Geometry QC Checks.	Causes ingestion failure and no GIS data for the affected layer will proceed to quality control process or provisioning to ECRF and LVF.
3	Features containing a vertex count higher than 1,000,000 per feature	Invalid Geometry QC Check.	Causes ingestion failure and no GIS data for the affected layer will proceed to quality control process or provisioning to ECRF and LVF.
4	Data schema changes without prior notification	Upon ingest, GIS Data Hub compares layer names and fields names to ensure they match existing layer mappings.	Causes ingestion failure and no GIS data for the affected layer will proceed to quality control process or provisioning to ECRF and LVF. Schema changes require a “Pause” of processing and a notification to the



			GeoComm team to make needed schema changes.
5	Stacked address points with the exact same attributes	Duplicate Values QC Check	Causes ingestion failure and no address point features will proceed to quality control process or provisioning to ECRF and LVF. NGUIDs are included when evaluating features with the exact same attributes.
6	NG9-1-1 Unique ID (NGUID) population in every layer	Globally Unique ID QC Check	Unique IDs should be unique throughout entire dataset. This allows for a full reporting feedback loop using unique ID for reference back to the GIS data submitter.
7	Missing projection of GIS Data	Verify Projection (Precheck)	Causes ingestion failure and no GIS data for the affected layer will proceed to quality control process or provisioning to ECRF and LVF. A known projection is required upon upload of the GIS data.
8	Multi part geometry	Multi Part Geometry (Road Centerlines & Polygons)	The check identifies multipart features that may lead to unexpected behavior in the consuming application.
Critical Errors (9-1-1 call routing) Provisioning Halted			
	Issue	Testing Method	Effect on provisioning of GIS data to ECRF and LVF
9	Invalid or missing ServiceURN attribute in PSAP boundary layer polygons	Unacceptable Values and Null Value in a Field QC Checks	Area covered by this feature cannot be identified as a service boundary to which a 9-1-1 call can be routed.
10	Invalid or missing ServiceURI attribute in PSAP boundary layer polygons	Unacceptable Values and Null Value in a Field QC Checks	Area covered by this feature cannot be used to route a call to a PSAP, and the call will be routed based on default policy routing rules.



11	Gaps in the provisioning boundary layer polygons	Polygon Compare (Gaps) QC Check	The Provisioning boundary submitted by each entity must create a seamless coverage of the Commonwealth's NG9-1-1 coverage area. Quality control check confirms no features in the road centerline and Site/Structure address point layers fall outside the individual GIS data submitter's provisioning boundary.
12	Unintentional gaps/overlaps in PSAP boundary layer polygons	Single Layer Polygon Gap and Polygon Overlaps QC Checks	Overlaps and gaps in the PSAP layer will cause any call located within that gap/overlap to default route to a PSAP specified in the policy routing rules.
13	Road centerlines not broken at PSAP boundary polygon	Features Broken at Polygon QC Check	Addresses found in road centerline ranges at the beginning or end of a road segment that crosses the PSAP boundary may route to the incorrect PSAP.
14	Complex geometry on road centerlines layer features	Complex Geometry QC Check	Nonstandard geometry (self-intersecting, curve, surface, multicurve, multi-surface) is simplified during the ingest process, which may introduce alignment issues between boundaries and road centerlines that are not visible in the source data.
15	Address range overlaps on features in the road centerline layer	Address Range Overlaps QC Check.	Road centerline address range overlaps can cause an address to be found in more than one location. This can affect a call transfer if the locations found fall within different



			emergency service boundaries.
16	Duplicate address attributes on features in the Site/Structure address point layer	Duplicate Values QC Check	Duplicate address attributes on different point features found in the same community (Incorporated Municipality) causes ambiguity in exact location of an address. This can affect a call transfer if the addresses fall within different emergency service boundaries.
17	Missing CLDXF compliant attributes in the road centerlines layer and Site/Structure address point layer	Unacceptable Values and Null Value in a Field QC Checks	CLDXF compliant attribute population is 100% mandatory in the road centerline and the Site/Structure address point layers. All fields identified as mandatory in the CLDXF standard are required to be populated. Fully spelled out CLDXF fields to be checked; street name Null only; acceptable values Pre/Post Directional; Pre/Post Type; Pre Type Separator
18	Missing attributes in the legacy street name component field of the road centerline layer and Site/Structure address point layer	Unacceptable Values and Null Value in a Field QC Checks	Legacy street names must be 100% populated in the road centerline and the Site/Structure address point layers. Legacy street name Null only; acceptable USPS Pub 28, Appendix C values Legacy Pre/Post Directional; Legacy Post Type.
Warnings – Call Transfers Provisioning Continued			



	Issue	Testing Method	Effect on provisioning of GIS data to ECRF and LVF
19	Invalid or missing ServiceURN attribute in emergency service boundary layer polygons	Unacceptable Values and Null Value in a Field QC Checks	Area covered by this feature cannot be identified as a service boundary for a specific response type.
20	Invalid or missing ServiceURI attribute in emergency service boundary layer polygons	Unacceptable Values and Null Value in a Field QC Checks	Area covered by this feature cannot be used to determine a transfer route of a call to a specific responder, and the call will be routed based on responder default policy routing rules.
21	Road centerline features not broken at emergency service boundary layer polygons	Features Broken at Polygon QC Check	Addresses found in road centerline ranges at the beginning or end of a road segment where it crosses an emergency service boundary may cause a call transfer to the incorrect emergency service responder or secondary PSAP.
Warnings – PSAP Mapping & CAD Systems Provisioning Continued			
	Issue	Testing Method	
22	Unacceptable Values	Identifies records containing forbidden values identified within a domain value list.	
23	Road Centerline Topology	Identifies roads not broken or snapped where they intersect with other roads, which may affect vehicle routing or intersection look-ups.	
24	NULL Value in a Field	Verifies that a target field does not have <null> values present in fields required for specific software functionality.	
25	Acceptable Values	Identifies data entry errors in features that	



		contain values outside of a domain value list.	
26	Duplicate Values	Identifies where data records occur multiple times in the dataset. Duplicate values occur when two or more records contain the same information.	
27	Field Comparison	Compares two or more fields in a single layer to test concatenated column values.	
28	Line to Polygon Attribute Compare	Identifies disparity between a line feature that intersects with a polygon feature to locate attribute discrepancies between a line segment and its corresponding polygon.	
29	Point to Polygon Attribute Compare	Identifies disparity between a point feature that intersects with a polygon feature to identify attribute discrepancies between a point and its corresponding polygon.	
30	Polygon Overlaps	Identifies areas where overlaps exist in a polygon layer. Can be used on municipal boundaries, neighborhood boundaries, etc.	
31	Single Layer Polygon Gap	Identifies areas where gaps exist in a polygon layer. Can be used on municipal boundaries, neighborhood boundaries, etc.	
32	Polygon Compare (Gaps)	Identifies gaps in coverage between two polygon layers.	
33	Polygon Compare (Overhangs)	Identifies where one polygon layer extends	



		past the outer limits of another polygon layer.	
34	Features Broken at Polygon	Identifies road centerlines not broken where NG9-1-1 GIS Data Model attributes change, causing incorrect boundary values to be referenced.	
35	Features Outside of Polygon	Identifies where lines and points are outside of a polygon layer such as provisioning boundary.	
36	Address Points to Road Centerlines	Identifies where the address points data is inconsistent with the road centerlines address data.	



Addendum C: How to Perform a Topology Analysis in ArcGIS Pro

1. Prepare your data:

- Follow the steps outlined in the methods section of the PSAP Boundary Analysis Report to prepare your data. If you need a copy of this document, contact [Christian Przybylek](#) at PEMA.
- You can either create your own file geodatabase (FGDB) or download PEMA's template NG911 FGDB, [here](#). If you create your own FGDB, be sure to create a feature dataset to store your boundary layers in and set its projection to WGS84. The PEMA template FGDB already has its default projection coordinate system set to WGS84.
- Note that you will need PSAP boundaries for neighboring counties. You are encouraged to reach out to your neighboring PSAPs/counties to obtain the most recent iteration of their PSAP boundary data. Alternatively, PEMA has a PSAP boundaries shapefile that was built on data provided in October 2020. You can email [Christian Przybylek](#) at PEMA to request these files, but they will likely not be as current or accurate as GIS data that is being maintained by neighboring counties.
- Once you have the PSAP Boundary layers, you can import them into your FGDB. If you are using the PEMA template FGDB, import the PSAP layers into the Boundaries feature dataset. Otherwise, create a new feature dataset in your FGDB. This is an important step. You must have a feature dataset to build topology rules.

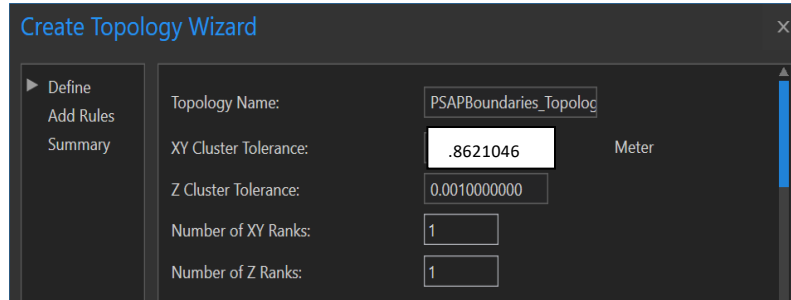
2. Once your data is pre-loaded into a FGDB feature dataset, you can set topology rules.

- To do this, navigate to the Catalog panel and right click on your feature dataset in the FGDB, then select New > Topology.

3. Establish an XY Cluster Tolerance

- This defines your acceptable margin of error. Esri's default value is .003 feet (0.001 meters). As of this writing, PEMA has not formally endorsed an XY Cluster Tolerance value but is considering values between .003 feet and 2.828427 feet. We recommend not exceeding 2.828427 feet (.8621046 meters). *The lower this value is, the more sensitive and accurate your topology check becomes.*

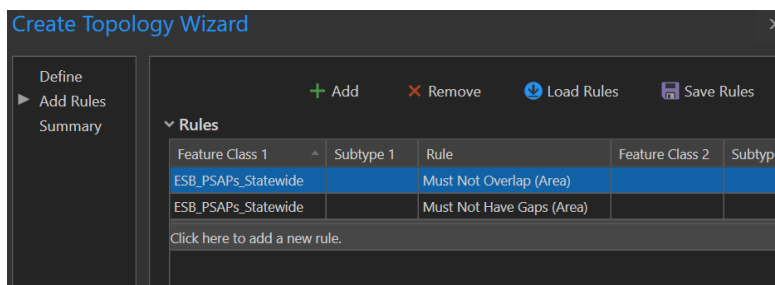
Figure 1: setting the XY Cluster Tolerance to .8621046 meters (2.828427 feet)



4. Next, you can select a set of topology rules

- Start by selecting “Add Rules” on the left-hand side of the Create Topology Wizard window and then choose the rules listed below from the dropdown menu.
 - **Must Not Overlap (Area):** Polygons of the first feature class or subtype must not overlap with polygons of the second feature class or subtype. Polygon errors are created where polygons from the two feature classes or subtypes overlap. Use this rule when polygons from one feature class or subtype should not overlap polygons of another feature class or subtype. **Applying this rule will allow you to detect overlaps between PSAPs.**
 - **Must Not Have Gaps (Area):** Polygons must not have a void between them within a feature class or subtype. Line errors are created from the outlines of void areas in a single polygon or between polygons. Polygon boundaries that are not coincident with other polygon boundaries are errors. Use this rule when all of your polygons should form a continuous surface with no voids or gaps. **Applying this rule will allow you to detect gaps within and between PSAP layers.**

Figure 2: configuring the topology rules



- *If you have a provisioning boundary, also include this rule:*
 - **Must Be Covered by Feature Class Of:** The polygons in the first feature class or subtype must be covered by the polygons of the second feature class or subtype. Polygon errors are created from the uncovered areas of the polygons in the first feature class or subtype. Use this rule when each polygon in one feature class or subtype should be covered by all the polygons of another



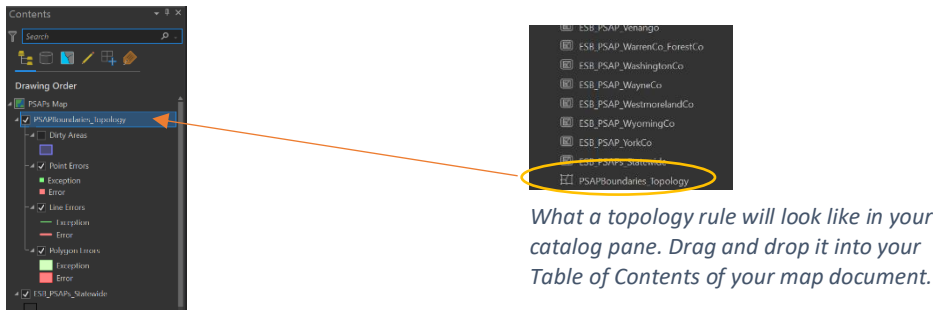
feature class or subtype. This will allow you to determine whether a PSAP are covered by a provisioning boundary (formerly called authoritative boundaries).

- To learn more about Esri’s topology rules, see the [Esri documentation](#).

5. Running Topology Checks

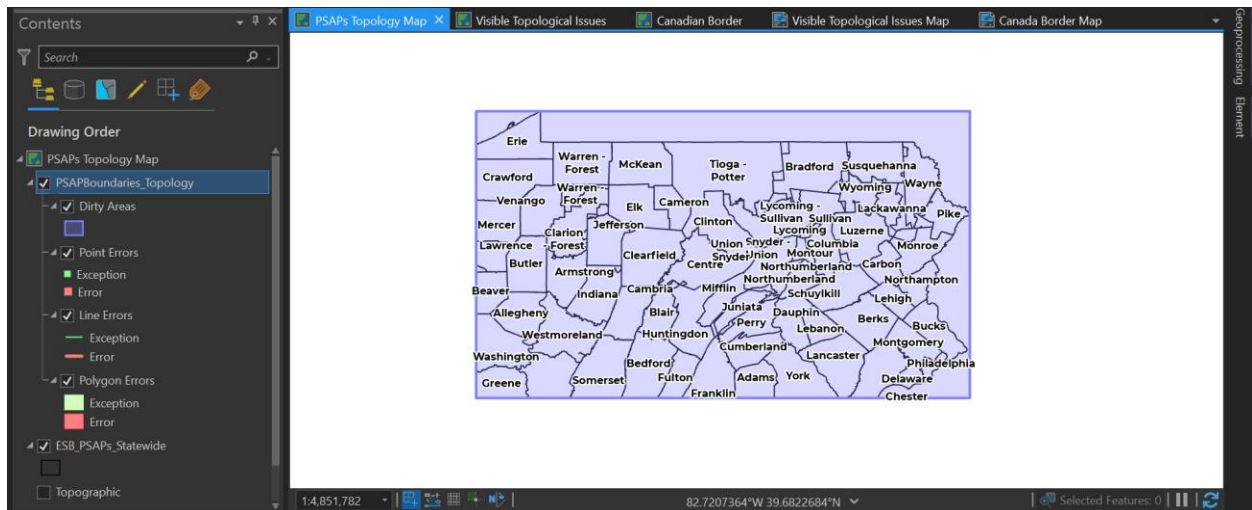
- With the above topology rules set up, a topological analysis can now be performed. To do this, drag and drop the topology rules from the feature dataset in the FGDB into the map’s table of contents.

figure 3: the topology rules in the Table of Contents of our map



- Next, zoom out to the full extent of your area of interest
- This will ensure that all areas on your map are included in the topological analysis. If an area of your map is not included in the topology check, it will show up on the resulting map in purple as a “Dirty Area”, meaning it has not been validated. To correct this, zoom to that area or zoom out to include your entire region of interest and re-validate your topology.

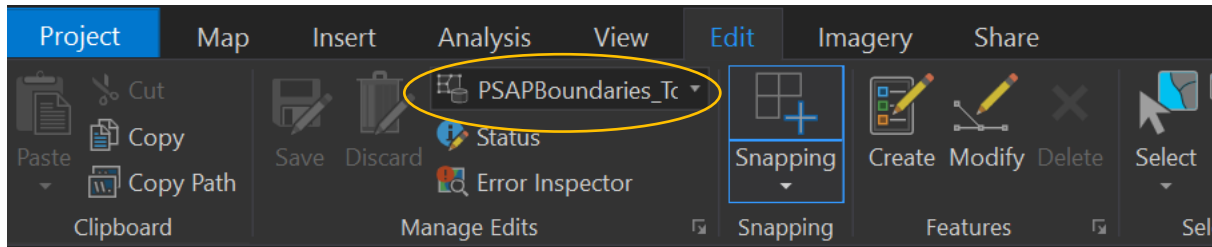
Figure 4: zoom out to your region of interest’s full extent





- Under the Edit tab, under the Manage Edits group, click on Topology and select the rules we just created from the dropdown list.

Figure 5: select and enable the topology rule

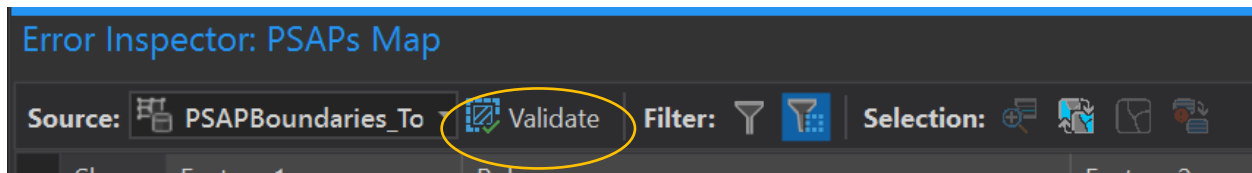


- Following this, select Error Inspector, found in the Manage Edits group. Click Validate. This process may take a few moments to complete.

6. Validate Your Topology

- **Select the Validate Button.** This will enable ArcGIS to validate your data and will identify and flag all gaps and voids. Note that this may take a few moments.

Figure 6: select validate



7: View and Correct

- You can view your errors both on the map and in an attribute table. To view the attribute table, select the Error Inspector. This will pull up a data table that allows you to highlight specific errors, zoom to them, and either correct them or mark them as exceptions if there is a reason for them to be present.

Figure 7: error inspector

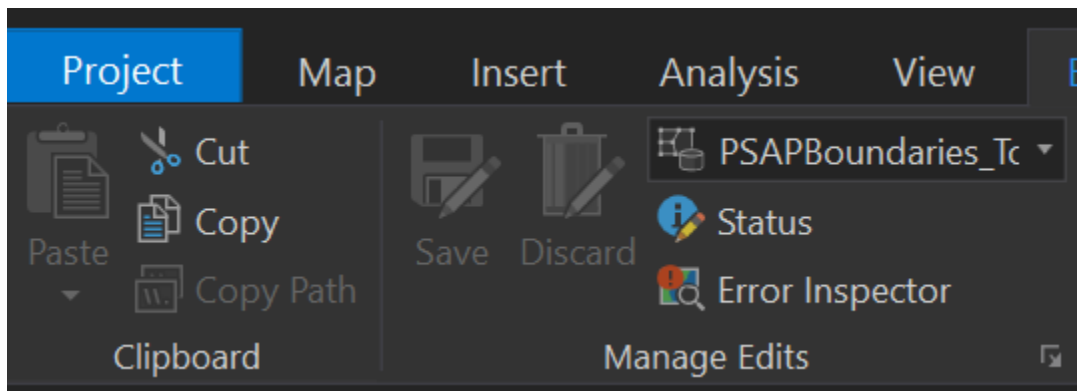
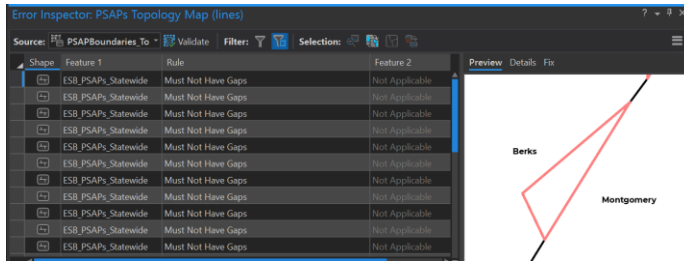


Figure 7.2: error inspector results table



- It should be noted that the results in the error inspection table will adjust to areas that you zoom to on your map. For example, if you were to zoom into Berks County, you would no longer see errors for other counties if the data table.

Additional Resources/On Your Own Learning:

Esri Topology Rules Poster:

http://webhelp.esri.com/arcgisserver/9.3.1/java/geodatabases/topology_rules_poster.pdf

Esri Topology Rules Video Demo/Tutorial:

https://www.youtube.com/watch?v=Evx3EysA_hw