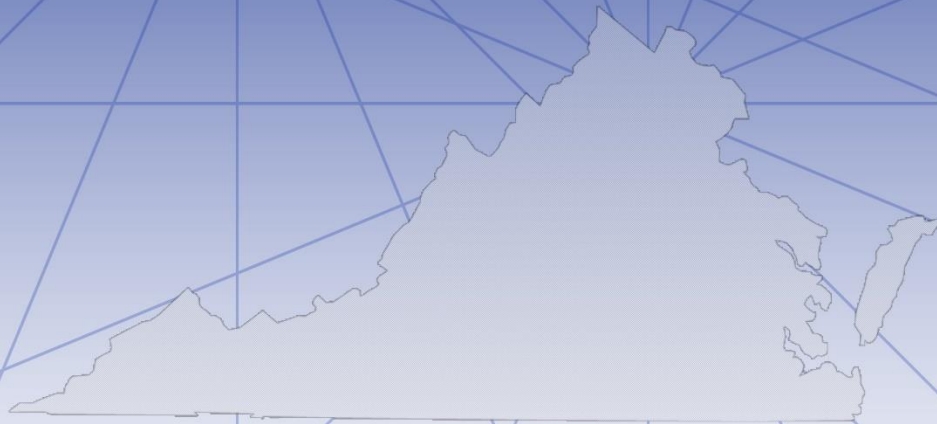


Virginia Information Technologies Agency



NG9-1-1 GIS Data Provisioning and Maintenance



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Commonwealth of Virginia

NG9-1-1 GIS Data Provisioning Guidelines

This document provides an overview on the provisioning of GIS data to support NG9-1-1 services. This document is intended to provide guidance to local GIS and PSAP authorities on the following:

- The required GIS datasets to support the i3 Emergency Call Routing Function (ECRF) and Location Validation Function (LVF)
 - The validation processes to synchronize the GIS datasets to the Master Street Address Guide (MSAG) and Automatic Location Information (ALI) datasets
 - Geospatial call routing readiness
 - The short term and long term NG9-1-1 GIS data maintenance workflow procedures
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Abbreviations, Acronyms & Definitions

For the purpose of this document the following applies:

Term	Meaning
9-1-1 Service Provider Database	The telephone service provider database(s) that stores the caller name, telephone number, address and location information, and sometimes supplemental emergency service information used to route the call to the appropriate PSAP. These databases include the Master Street Address Guide (MSAG) and Automatic Location Information (ALI).
Automatic Location Information (ALI) Database	A database of information queried during a 9-1-1 call. A data record from this database is delivered to the PSAP during a 9-1-1 call, and includes a call back number, the address/location of the caller and sometimes supplemental emergency service information.
Civic Address Layer	Features that represent physical street addresses and/or landmarks using GIS points, lines, or polygons.
Emergency Call Routing Function (ECRF)	A functional element in NG9-1-1 Core Services responsible for routing 9-1-1 calls to the proper PSAP based on a caller's location.
Emergency Service Number (ESN)	A 3-5 alphanumeric code that represents an emergency service zone identifying the emergency service agencies for a geographic area.
Emergency Service Zone (ESZ)	A geographical area that represents a unique combination of emergency service agencies within a specified 9-1-1 jurisdiction. An ESZ is assigned an Emergency Service Number (ESN) to identify the EMS, Fire, and Law Enforcement for a specific area.
GIS Data Provider	An individual or group who is responsible for maintaining authoritative GIS data for a given geographic area.
i3 Standard	Non-proprietary consensus-based standard, developed according to strict process requirements describing protocol, interfaces, and systems to locate users who contact 911 via voice, video, text, data, and other means, route their calls to the appropriate PSAP and allow for easy transfers, failovers, and multi-party calls.
Location Validation Function (LVF)	A functional element in NG9-1-1 Core Services where civic location information is validated against authoritative GIS data to provide a route for an emergency call and direct responders to the proper location.
Master Street Address Guide (MSAG) Database	A database of street names and house number ranges within an associated community used to define ESZs and its associated ESNs, to enable proper routing of E9-1-1 calls and may provide display of appropriate emergency response agencies to the PSAP call taker.
Next Generation 9-1-1 (NG9-1-1) Core Services (NGCS)	The base set of services needed to process a 9-1-1 call on an ESI-net.
Spatial Interface (SI)	A standardized data replication interface used to publish GIS data to the functional elements that consume GIS data such as the ECRF, LVF, etc.

Chapter 1: Purpose

This document is intended to provide guidance on the provisioning of GIS data to support Next Generation 911 (NG9-1-1) services in accordance with the standards defined in the *NENA Detailed Functional and Interface Standards for the NENA i3 Solution (NENA-STA-010.2-2016)*. The focus of this document will be on the GIS data required by the Location Validation Function (LVF) and the Emergency Call Routing Function (ECRF). GIS data is used by the LVF to validate address locations and by the ECRF to geospatially route 9-1-1 calls to the proper Public Safety Answering Point (PSAP).

This document is for informational purposes only and does not define additional data standards or requirements. It should be noted that references will be made to existing guidelines, standards and best practices available through the National Emergency Number Association (NENA) and through the Virginia Information Technology Agency (VITA) including the Virginia Geographic Information Network (VGIN). References to any applicable documents will be listed in the References section of this document.

Chapter 2: Overview

Legacy 9-1-1 systems rely on tabular service provider databases named the Master Street Address Guide (MSAG) and Automated Location Information (ALI) to route emergency calls to the proper PSAP. The full implementation of NG9-1-1 utilizes geospatial call routing which relies on GIS data to route calls to the proper PSAP by validating civic addresses associated with fixed caller locations and spatially querying that location against corresponding responder boundaries. For these spatial queries to work, it is critical to develop and maintain accurate GIS data to ensure that geospatial call routing produces the desired results.

Geospatial call routing is dependent upon multiple GIS data layers as depicted in the NENA Standard for NG9-1-1 GIS Data Model (NENA-STA-006.1-2018). While some layers, such as site/structure address point and road centerline data may be readily available by PSAPs and GIS data providers, other layers such as PSAP boundaries, emergency response zones, and provisioning boundaries may not, and will need to be developed and/or modified to meet NG9-1-1 requirements.

All NG9-1-1 data layers must go through a validation and synchronization process to ensure geospatial routing readiness. At a minimum, the site/structure address point and road centerline data, in conjunction with the boundary data, must be able to replicate the functionality of today's 9-1-1 service provider datasets. As a result, the GIS datasets must be analyzed against the MSAG and ALI datasets to ensure that they encompass the data stored in the MSAG and ALI tables. Discrepancies must be resolved, when appropriate, to attain synchronization at an agreed upon and acceptable level as set by the selected provider of next generation core services (NGCS) and in compliance with the NENA informational document *Synchronizing GIS with MSAG & ALI* (NENA 71-501 v1).

Validated and synchronized NG9-1-1 GIS data should be tested for ingest readiness by utilizing Spatial Interface validation tools to ensure that the GIS data conforms to the NGCS provider's specifications. Data providers should develop maintenance workflows to support NG9-1-1. The processes to maintain the required GIS datasets is iterative and the appropriate workflows and error reporting mechanisms should be in place to support continued NG9-1-1 GIS data maintenance and provisioning requirements.

Chapter 3: GIS Data Sources and Providers

The GIS data sources involved in GIS data creation and maintenance must collaborate with the associated PSAP to determine which data source is authoritative for the PSAP's service area and determine the workflow with which that data will be provisioned to the Spatial Interface (SI). A PSAP's service area may include one or more GIS data sources and/or GIS data providers. The GIS data source is the entity responsible for the maintenance of a specific GIS dataset for a given geographic area. The GIS data provider is the entity responsible for provisioning of GIS data to the SI. It is critical to understand the roles and responsibilities of the GIS data sources and GIS providers within the PSAP area.

The participating stakeholders including the PSAP(s), GIS data source(s), and GIS data provider(s) should collaborate to understand the required GIS datasets, the availability of those datasets, and the development and/or maintenance responsibilities of those datasets. When there are multiple GIS data sources and/or data providers for a PSAP's service area, coordination will be required to define data provisioning roles and responsibilities to ensure there is not an overlap or gap in coverage of the underlying GIS data.

GIS Data Source:

A GIS data source is the entity responsible for the day to day maintenance and content of a specific GIS dataset for a specific geographic area. Within a given GIS data source's geographic area, there may be more than one data source responsible for the development and maintenance of specific GIS data layers. For example, one agency may maintain the address point and road centerline layers, and another agency maintains the fire response boundary layer, and another agency maintains the law enforcement response boundary layer. In this case each agency is the data source for a specific GIS data layer.

GIS Data Provider:

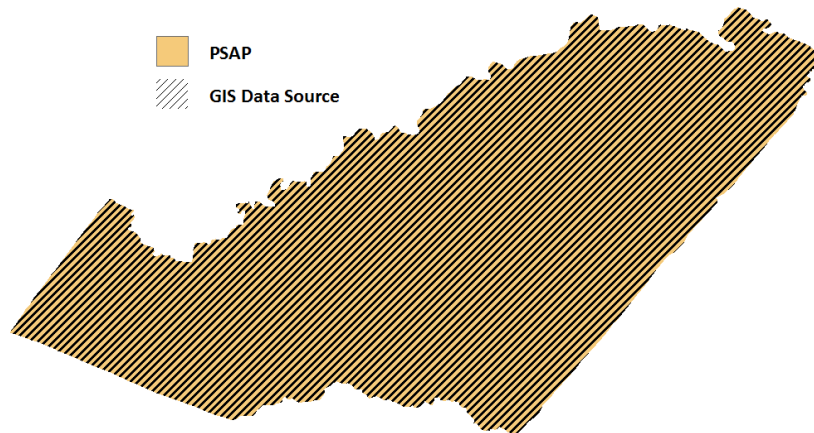
A GIS data provider is the entity responsible for the GIS dataset to be provisioned to the SI based on agreed upon policies as determined by the PSAP authority. A GIS data provider may be the original GIS data source or may aggregate multiple GIS datasets from more than one GIS data source. A GIS data provider is responsible for maintaining consistency between all datasets and performing quality control checks on the data within the provisioning area.

Third Party Role:

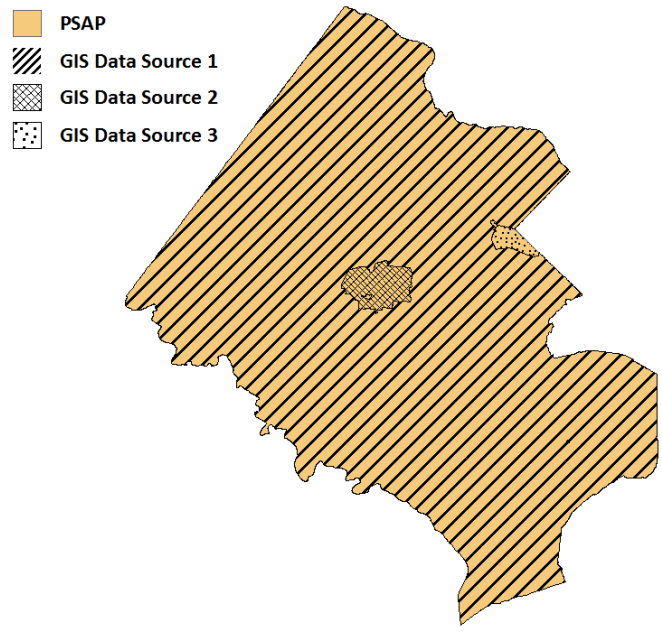
There may be situations where a third party, such as a commercial vendor, may serve the role of GIS data source and/or data provider and be responsible for the creation and maintenance of GIS data and/or provisioning the data for a PSAP service area.

To better understand the roles of the GIS data source and the GIS data provider, the following scenarios describe how each may play a role in an NG9-1-1 environment. Note that these scenarios are for illustrative purposes only and do not reflect actual conditions associated with the jurisdictions depicted in the examples. These examples have been simplified and are not limited to the following scenarios and variations may occur.

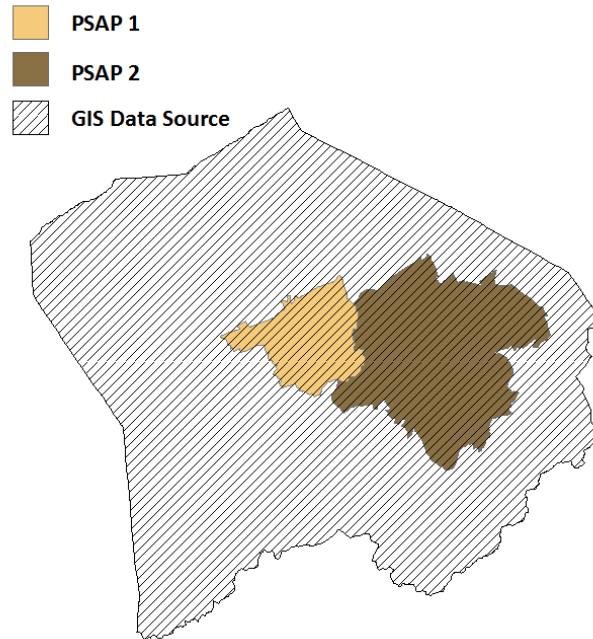
- PSAP service area below is equivalent to a single GIS data source coverage area
 - The GIS data source maintains the civic address and emergency service boundary datasets that covers the extent of the PSAPs service area. Because the GIS data source is the only responsible agency for the data within the PSAP, the GIS data source may also be the GIS data provider.



- PSAP service area below is equivalent to multiple GIS data source coverage areas
 - The PSAP service area includes more than one GIS data source who independently maintain GIS data. In this example, there are three separate GIS data sources within the PSAP service area. It should be determined if a single GIS data source will serve as the primary GIS data provider for each GIS data source and aggregate the data into a regional dataset or if each GIS data source will independently serve as a GIS data provider and provision data directly to the SI.



- PSAP service area below is not equivalent to the GIS data source coverage area
 - The consolidated PSAP service area includes one or more individual PSAPs service areas that are not coincident with the GIS data source's coverage area. The GIS data source will need to have processes in place to provision data that is limited to the service area of the participating PSAPs.



There is not a single preferred solution as this can vary from one location to another. This will ultimately be the decision of the participating PSAP and GIS data sources in determining the approach that fits the business and workflow requirements for their NG9-1-1 implementation.

Regardless of the local scenario, the GIS data source and provider will assume certain responsibilities that are required when provisioning data to support NGCS. For additional information and guidance, please refer to *NENA Standards for the Provisioning and Maintenance of GIS data to ECRFs and LVFs*. (NENA-STA-005.1.1-2017). These responsibilities include but are not limited to the following:

- Working with PSAPs to determine polices, responsibilities, and commitments.
- Create, maintain, and document GIS data in adherence to relevant NENA standards.
- Establish a GIS data maintenance process that keeps the data as accurate and current as possible.
- Supply GIS data to the Spatial Interface (SI) for use in an ECRF and LVF.
- Work with neighboring and associated GIS data sources and providers to resolve boundary discrepancies. Boundary polygons must meet the needs for 9-1-1 call routing, and are not legal or surveyed boundaries.

- Accept GIS error notifications from an ECRF and LVF via the SI and resolve errors as soon as possible.

Chapter 4: NG9-1-1 GIS Data Requirements

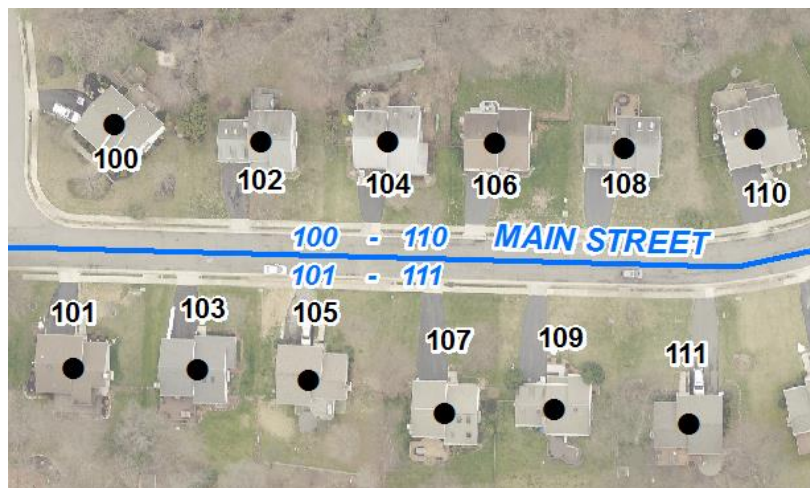
NG9-1-1 core services require specific GIS data layers. These layers are used in the validation, call routing, and location delivery within NG9-1-1 to replace the functionality of the MSAG, ALI, and selective router in E9-1-1. These layers can be divided into two general categories:

Civic Address Layers: Civic address layers are data that represents physical street addresses and/or landmarks and includes site/structure address points and road centerlines.

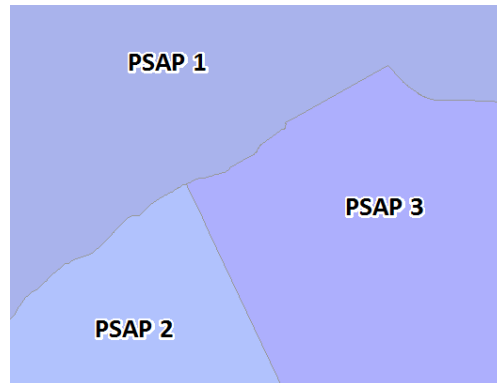
Site/Structure Address Point: Site/Structure address points are individual and unique address locations representing actual real world addresses. The placement of the point feature may vary depending upon business requirements as there are multiple approaches to point placement. Additional information on Site/Structure Address Points can be found in the *NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1 (NENA-INF-014)*.

Road Centerline: Road centerline data stores address information in a range format encompassing corresponding site/structure address point addresses. Road centerline address ranges are stored using a Left and Right, From and To format. It should be noted that as a result of the range format, it is possible for road centerlines to store address ranges that encompass more potential addresses than found in the real world addresses. This is done to include additional potential addresses to accommodate future development and/or to include full hundred block addresses.

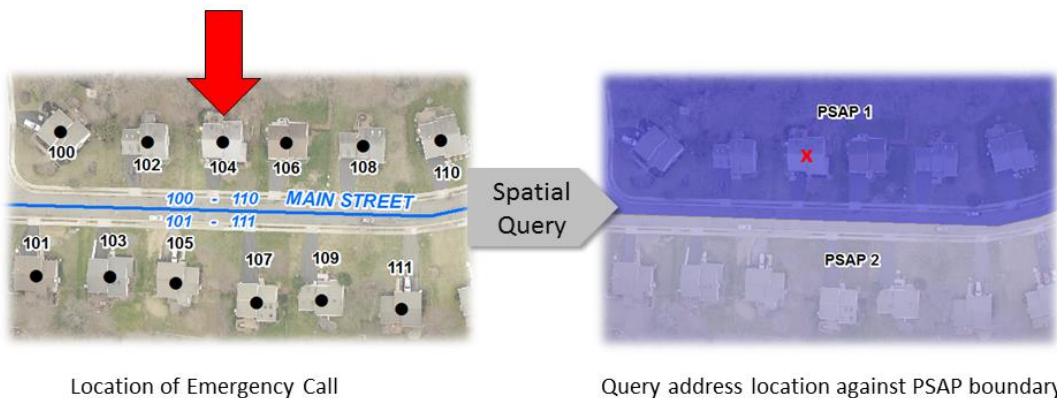
The example below shows point site/structure address point features and road centerline address ranges for Main Street.



Service Boundary Layers: Service boundary layers are data that represents the geographic extent of an area of coverage for a specific service such as a PSAP or a responder agency.



Civic address and service boundary layers are used by NG9-1-1 services to validate address locations, locate the emergency call, and spatially query the service boundary and route the call to the correct PSAP.



Location of Emergency Call

Query address location against PSAP boundary

NENA Standard:

The NENA Standard for NG9-1-1 GIS Data Model (NENA-STA-006.1-2018) defines the GIS Data Model standard to support the NG9-1-1 services. Adherence to this standard is required for interoperability with other 9-1-1 systems at both a regional and national scale. NENA document NENA-STA-006.1-201 should be referenced for specific guidance and specifications.

File Format: GIS data can reside in multiple formats depending on the data source and software in place and utilized by the data provider. At this time, there is not a NENA standard for GIS file format. In many cases, this will be vendor driven and GIS file format will be dictated by specific vendor requirements.

Spatial Reference: NG9-1-1 systems require GIS data to reside in the World Geodetic System of 1984 (WGS84). It should be noted that local GIS data can reside in any spatial reference system but conversion to WGS84 will be required and data providers should work with their vendor to incorporate this process into the data provisioning workflow.

GIS Data Layers:

Required: These layers must be provided to support NG9-1-1 services. It should be noted that layers that do not exist will need to be developed to support NG9-1-1.

- Site/Structure Address Points
- Road Centerlines
- PSAP Boundary
- Provisioning Boundary
- Emergency Service Boundary (separate layer by agency)
 - Fire
 - Law
 - Emergency Medical Service (EMS)
 -

Strongly Recommended: These layers may be beneficial to support NG9-1-1 services but are not required. Data providers should determine the suitability of these layers to support their PSAP operations.

- Street Name Alias Table
- Landmark Name Part Table
- Complete Landmark Name Alias Table
- States or Equivalent
- Counties or Equivalent
- Incorporated Municipality Boundary
- Unincorporated Municipality Boundary
- Neighborhood Community Boundary
- Other Emergency Service Boundaries such as Poison Control, Animal Control, etc.

Recommended: These layers may be beneficial to support NG9-1-1 but are not required. Data providers should determine the suitability of these layers to support their PSAP operations.

- Railroad Centerlines
- Hydrology Line
- Hydrology Polygon
- Cell Site Location
- Mile Marker Location

For further guidance on the specific attribute requirements for each layer, refer to the NENA GIS Data Model which defines the attributes for each GIS layer using a Descriptive Name, Field Name, Attribute Category, Field Type, and Field Width.

Descriptive Name: The description of the attribute field to define the field content.

Field Name: The database field name that must be used in the GIS database schema.

Attribute Category: The specific attributes for each layer are categorized as Mandatory, Conditional, or Optional where:

- Mandatory: An attribute value must be provided for each record within the attribute field. The attribute field cannot be blank.
- Conditional: If an attribute value exists, it must be provided. If an attribute value does not exist, it can be blank.
- Optional: An attribute value may or may not be provided for the attribute field.

Field Width: The length of the attribute field.

Field Type: The data type of the attribute field.

This table illustrates the documentation of the attribute requirements in the NENA GIS Data Model:

Descriptive Name	Field Name	M/C/O	Type	Field Width
Street Name	St_Name	M	E	60

Virginia Standard:

The Virginia Information Technologies Agency (VITA) and the VITA Integrated Services Program (VITA-ISP) including the Virginia Geographic Information Network (VGIN), and Public Safety Communications (PSC) Division have developed recommendations and state standards compatible with NENA standards to support GIS data maintenance and NG9-1-1 data provisioning throughout the State. The Virginia standards follow state *Information Technology Resource Management (ITRM) Policy (GOV 102-02)*.

Guidelines have been developed to support the development and maintenance of road centerlines, address points, and PSAP and emergency service boundary datasets.

These standards include the components of the NENA GIS Data Model but includes additional attribute fields to assist in the migration from current 9-1-1 to NG9-1-1.

For further guidance and specifications, please refer to *PSAP and Emergency Service Boundaries Geospatial Data Standard (OTH 705-00)*, *Road Centerline Data Standard (OTH 703-00)*, and *Address Point Data Standard (OTH 704-00)*.

Chapter 5: Meeting the NG9-1-1 GIS Data Requirements

The NENA NG9-1-1 GIS Data Model requires higher levels of standardized data and attributes than today's existing 9-1-1 systems may have in place. As a result, GIS data may need to be developed and/or existing data may need to be modified to meet the minimum requirements to support NG9-1-1 services. Data providers should be aware of the potential impact of this on both local and regional workflow processes.

Variations will exist across data providers in the approach to meeting the NG9-1-1 GIS data requirements. There will not be a universal solution for each data provider because the decision to migrate data or adopt components of the NG9-1-1 schema will be dependent upon multiple factors including but not limited to the following considerations.

- The availability of required data in data provider GIS databases
 - Does existing data contain what is required to support NG9-1-1?
- The ability to migrate data from local data provider GIS database schemas to the NG9-1-1 schema
 - Can existing data be transformed to support NG9-1-1 requirements?
 - Do resources exist to develop tools to migrate the data provider data to a schema to support NG9-1-1?
- The flexibility to modify data provider GIS database schemas
 - Are there any business process requirements that will not allow the modification of existing GIS database schemas?
 - Is the data provider the data source?

Chapter 6: Data Validation and Synchronization

The process of data validation and synchronization is one of the most important steps in the preparation of data for NG9-1-1. This process will ensure that the GIS data is synchronized with the MSAG and ALI datasets and serve as a bridge between the databases used for E911 and NG9-1-1. NENA Information document "*NENA Information Document for Synchronizing Geographic Information System databases with MSAG & ALI, NENA 71-501*" should be referenced for additional guidance.

The GIS data should spatially represent the MSAG and ALI by storing the corresponding data which will ensure that the GIS data is replicating the functionality of the MSAG and ALI databases. In simpler terms, the addresses found in the MSAG and ALI databases must match the addresses in the GIS database. Addresses associated with ALI records must have a corresponding address record in the GIS address point file. Additionally, address ranges in the MSAG must have corresponding ranges in the GIS road centerline file. The intent of this task is to compare the MSAG and ALI to the GIS datasets to identify discrepancies that will require review and resolution in order to synchronize the datasets. NENA guidance suggests a 98% match rate as the minimum threshold that a data provider must achieve in order to deploy NG9-1-1. If this match rate is not achieved, additional GIS development and/or modification must be completed

until a minimum of 98% is attained. It should be noted that local 911 and GIS authorities may choose to implement a higher match rate if desired.

The initial discrepancy review and resolution process has the potential to be both resource and time intensive depending on dataset size and discrepancy numbers. It is not expected that such substantial effort be required at latter phases after the desired level of accuracy has been attained. However, validation and synchronization is an iterative process and will need to be integrated as part of the local maintenance workflow as an ongoing data provisioning task to support NG9-1-1 services. It is important to note that the discrepancy review process may result in the modification of either or both the service provider and/or GIS data to achieve synchronization between the datasets.

Types of Validation Checks:

The purpose of the validation checks is to compare the various address components between the service provider and the GIS datasets to identify any discrepancies. Discrepancies should be reviewed and resolved accordingly to synchronize the GIS to the service provider datasets. In most instances the comparison should occur using each dataset as the source and target so that the MSAG and ALI are compared to the GIS and the GIS is compared to the MSAG and ALI. This will ensure that any discrepancies that may potentially reside uniquely in one of the datasets are detected during the validation process. While the intent of this process is to identify and resolve any inconsistencies between the datasets, it should be noted that false or incorrect data should not be introduced for the purposes of attaining synchronization and achieving the match rate as there may be exceptions. There may be instances where a discrepancy is identified but cannot be resolved due to dependencies on other business process requirements and as a result will be flagged as an exception. Exceptions should be stored in a manner that allows the exceptions to persist in future validation checks such that those same valid discrepancies are not repeatedly identified as discrepancies for review.

The types of validation checks that should occur include comparisons of the following:

- Street Name Components
- Community Designations
- ESN Assignments
- Address/Address Ranges

It is important to note that while these validation checks are listed and discussed separately in this document for the purposes of clarity, it will be necessary to perform these checks on both an individual basis at the data component level and in conjunction with the other data components.

Street Name Components

The comparison of the street name components will identify inconsistencies in street names between the GIS and service provider datasets. Discrepancies identified during this check may be resolved multiple ways depending on the nature of the underlying inconsistency resulting in modification of either or both datasets to synchronize them.

While this is not a comprehensive list, the types of street name discrepancies may include the following:

GIS Street Name not in MSAG/ALI Data:

The data validation process may identify street names that are stored in the GIS data and not in the service provider data. This is due to the underlying functionality of each dataset. The GIS dataset stores address points and road centerlines for the associated addresses and streets within a specific geographic area per the data provider's area of responsibility. The MSAG/ALI data stores the addresses associated with valid landline numbers within the PSAP's area of responsibility. This results in instances where the GIS data may store a street name without corresponding address information. As a result, the MSAG/ALI will not store a record for that street name. This would be considered a valid discrepancy and flagged as an exception. Examples of this include Interstates, Ramps, and other streets not typically assigned a civic address.

There may also be a temporal factor contributing to this type of discrepancy. Because GIS data supports multiple functional business areas, there may be instances when data is entered into GIS at a preliminary planning and development phase. If a request for service was not requested in parallel with the entry into GIS, this would yield a discrepancy with a street name residing in the GIS data and not in the MSAG/ALI data.

MSAG/ALI Street Name not in GIS Data:

The data validation process may identify street names that are stored in the MSAG/ALI data and not in the GIS data. These discrepancies may be the result of lapses in data maintenance. The GIS data is typically maintained on a regular basis to reflect real world conditions. However, the MSAG/ALI database is typically only updated with new records for service requests and the review and removal of outdated records may not be a routine process as the inclusion of those records may not necessarily impede current operations. As these discrepancies are identified during the validation process, these records should be reviewed to determine if they are valid and resolved accordingly.

Street Name Format Discrepancies:

The maintenance of the GIS and MSAG/ALI datasets have typically been independent from each other. As a result, the standardization of street name components across the datasets may not have been implemented during the data entry process. The data validation process may identify inconsistencies in the specific street name components which may include: numeric street names, special character usage and punctuation, street type, directional, and spelling variations.

- *Numeric Street Names:* Numeric street names can be represented multiple ways and there will be variations in how each dataset may represent numeric streets. Numeric streets may be stored as: 2 ST, 2ND ST, SECOND ST.
- *Special character usage and punctuation:* The use of punctuation in the street name may vary across each dataset. One dataset may store punctuation in the street name whereas the other may not: OBRIEN ST, O'BRIEN ST; VILLA-DEL-REY CT, VILLA DEL REY CT.
- *Street Type:* There can be multiple representations of street types. For the street type AVENUE, this can commonly be represented in one of the following ways: AV, AVE, AVEN, AVENUE, AVN, AVNUE. Discrepancies may be found with how street types are represented in each dataset or with the street type itself
- *Directionals:* Directionals reside in the street name as either a predirectional or a postdirectional as N, E, S, W, NE, NW, etc. Discrepancies may be found with the actual directional value itself where one dataset has one value and the other dataset has another. Or the discrepancy may be found in the actual placement of the directional where one dataset has the directional as a predirectional and the other as a postdirectional and vice versa.
- *Spelling:* A discrepancy may occur in how the two datasets represent the same street name, for example: street name in the MSAG - WHIPPOORWILL and street name in the GIS data – WHIPPORWILL.

Data standardization is a critical first step in the synchronization process. Discrepancies identified in street names should be reviewed at multiple levels to determine the validity of the discrepancy. Within a given geographic area, street names may be duplicated with slight variations. Therefore, when reviewing the discrepancy, additional data such as address ranges and community values associated with the street name should be also be reviewed to determine the appropriate resolution.

Community Designations

Community designations in the GIS and MSAG/ALI datasets represent a specific assignment of a known geographic entity to the addresses and streets within a given geographic area. These designations may represent postal community areas, municipal boundaries, unincorporated county areas or other known populated places. The community designation value distinguishes the specific address by adding an additional level of validation. Errors in the community values have the potential to validate an address in the incorrect community. Community designation discrepancies between the GIS and MSAG/ALI datasets should be reviewed, validated against existing data sources, and resolved accordingly in either or both datasets, where applicable.

Emergency Service Number (ESN) Assignments

Emergency Service Numbers (ESNs) are alphanumeric codes that identify the emergency service responsibility for a specific geographic area as depicted in the MSAG. The approach for discrepancy review, validation, and resolution for ESN values

is similar to Community designations. However, ESN values are independent of Community values and should be maintained as a separate entity.

Addresses

Address information is stored in both the GIS and MSAG/ALI datasets. Addresses can be represented as single unique house number representations or as ranges that define a lower and upper address for a given street. The GIS address point and ALI datasets store a single address per database record whereas the GIS road centerline and MSAG datasets store ranges per database record. The GIS and MSAG/ALI address information should be synchronized to ensure that the GIS data is inclusive of the addresses stored in the MSAG/ALI data. A discrepancy between the datasets has the potential for an address not being validated or incorrectly validated.

The validation process will identify the discrepancies between the GIS and MSAG/ALI datasets. These discrepancies will require review of associated datasets to determine the appropriate resolution. Not all discrepancies will be errors and there will be exceptions which should be flagged as such. The purpose of the validation is to ensure that the GIS datasets can replace the functionality of the MSAG/ALI in routing requests for service.

Due to differences in how addresses are stored, the validation process should be conducted using multiple approaches. Since the ALI and GIS address point datasets represent individual unique addresses, these datasets should be compared to ensure that the GIS address points are inclusive of ALI addresses. It should be noted that because the ALI dataset represents addresses associated with individual telephone numbers, it is common for the ALI dataset to store a greater number of records to account for addresses that are inclusive of apartment units, suites, etc. which may or may not be represented in the GIS address points depending on the business process requirements of the local address authority and the data provider. At a minimum, the GIS address points should be inclusive of the primary house number on the ALI address.

The validation process will compare identify discrepancies between the GIS and MSAG/ALI datasets to detect the following:

- ALI to Address Point:
 - There should be an address point for each ALI record using the primary house number.

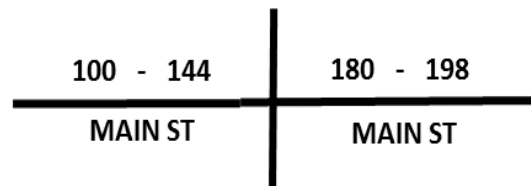
Phone Number	Address
XXX-XXX-XXXX	123 MAIN ST, APT. A
YYY-YYY-YYYY	123 MAIN ST, APT. B
ZZZ-ZZZ-ZZZZ	123 MAIN ST, APT. C



- MSAG to Road Centerline:
 - *Address Range Gap:* A gap occurs when the road centerline address range is not inclusive of the corresponding addresses within the MSAG. A gap in the address range could indicate missing addresses and has the potential to not validate an address. It should be noted that not all gaps are errors. There will be legitimate address range gaps where streets end at an impasse and resume elsewhere (e.g. either side of parks, industrial areas, major thoroughfares, etc.). The appropriate modifications should be made to synchronize gaps between the two datasets.

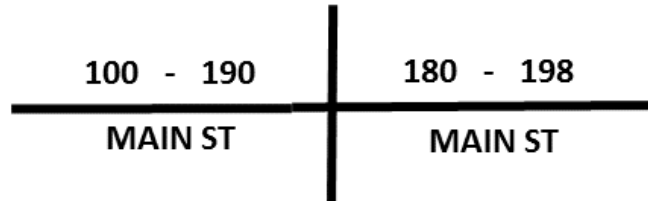
The following example shows an MSAG record of 100-198 Main St. The GIS road centerline range shows two centerlines with a range of 100-144 and 180-198 Main St. There is a gap where addresses between 144 and 180 Main St are not represented which would result in those addresses not being located in the GIS data.

From	To	Street Name
100	198	MAIN ST



- *Address Range Overlap:* An overlap occurs when address ranges are duplicated between one or more road centerlines where all other values are equivalent. An overlap in the address range has the potential to locate an address in more than one location.

The following example shows a GIS road centerline with ranges of 100-190 and 180-198 Main St. There is an overlap where addresses of 180-190 Main St are duplicated which would result in those addresses being located in two locations in the GIS data.



Address Range Exceptions

The MSAG and GIS road centerline address validation process may identify inconsistencies that do not require a resolution because of external system dependencies or the production of false errors as a result of the software or methodology used during the validation process itself. Because the road centerline and MSAG may contain records that serve multiple functions, these discrepancies may be considered exceptions during the data validation process. Thorough review of these discrepancies should be conducted to further validate that these are exceptions and not errors.

Address ranges may exist in the GIS road centerline but do not exist in the MSAG due to the following conditions:

- *Pseudo Address Ranges*: Pseudo address ranges in the road centerline are ranges created specifically to support other business functions to provide a means to addressing typically non-addressable roadways such as private roads, non-paved roads, access roads, etc. and do not reflect actual valid addresses. As a result, they will reside only in the GIS road centerline.
- *Mile Marker Address Ranges*: Mile marker address ranges in the road centerline are ranges that are based on mile marker distances on roadways to provide a means to address typically non-addressable roadways such as Interstate highways and other limited access roadways. They do not reflect actual valid addresses but do serve the purposes of geocoding functionality. As a result, they will reside only in the GIS road centerline.
- *Planned (Paper) Streets*: Planned streets in the GIS road centerline represent those roads and associated address ranges that have been entered into the GIS road centerline at the site plan stage but do not exist in the real world pending construction. As a result, a request for service may not have been received by the provider and they will reside only in the GIS road centerline.

Address ranges may exist in the MSAG but do not exist in the GIS road centerline due to the following conditions:

- *Historic Address Ranges:* Address ranges in the MSAG may be present due to stale data. Variations in the frequency of maintenance and updates may leave outdated records in the MSAG. If there are no ALI records associated with outdated MSAG records, efforts should be made to remove them.
- *Time Lapses in Updates:* The data validation process represents a snapshot in time of each dataset at the time the validation occurs. If the MSAG is not updated in parallel to the road centerline, it is possible that one dataset is updated prior to the other.
- *Shell Records:* These records are required in the MSAG for the purposes of routing for various classes of service such as FOREIGN EXCHANGE, VOIP, WP1 (WIRELESS PHASE I), TEST, etc. These records will reside in the MSAG only.

Maintenance

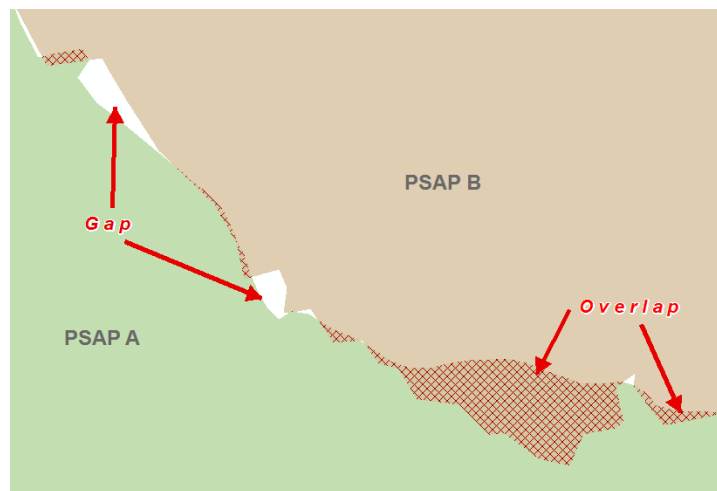
The data validation and synchronization is an iterative process and should be integrated into the local maintenance workflow. While a match rate of 98% is the initial goal, the remaining 2% should be addressed in the long term. Depending upon dataset sizes, a 2% unmatched rate can potentially represent a significant number of records resulting in a significant number of potential errors. These unmatched records should be reviewed, validated, and resolved where applicable.

Chapter 7: PSAP Boundary Development & Refinement

The process of data validation and synchronization is one of the most important steps in the preparation of data for NG9-1-1. Upon completion of this task and a minimum of 98% has been attained, the GIS data will be further validated against the emergency service boundaries. The GIS data in conjunction with the PSAP boundary will replace the functionality of the MSAG in E911 in routing calls to the correct PSAP.

Most localities do not have a dedicated PSAP boundary and those that do may not have developed and/or maintained it in coordination with neighboring PSAPs. For this reason, aggregating from multiple localities may yield a potentially high number of geometry issues such as topology errors with gaps and overlaps between and across individual PSAP service areas. To avoid devoting significant time and resources into resolving topology errors, general guidance suggests starting with an approximation of the PSAP boundary and refining it based on results from the data validation process. Per *PSAP and Emergency Service Boundaries Geospatial Data Standard (OTH 705-00)*, the PSAP boundary data source can be developed from the Virginia Administrative Boundary dataset. This will offer a preliminary dataset that can be further refined using emergency service response area boundaries, data validation discrepancy reports, and other relevant sources of information.

Data discrepancies located near the border of the PSAP boundary should be reviewed against existing GIS and MSAG/ALI datasets in collaboration with neighboring PSAPs to determine a mutual resolution of their shared boundary. The PSAP boundary should be refined to a mutually agreed upon location that is based on review of address point, road centerline data, and other relevant GIS data to determine the appropriate modification to the boundary to be inclusive of the addresses associated with each PSAPs area of responsibility. It is essential that this task be done in collaboration with neighboring PSAPs to ensure that the PSAP boundary is seamless and topology errors such as gaps and overlaps are not introduced in the refinement phase. A gap would result in an area of no coverage and an overlap would result in an area of duplicate coverage. Such errors may cause incorrect routing of the emergency request to the proper PSAP and potentially delay emergency response.



For additional guidance and specifications, please refer to *PSAP and Emergency Service Boundaries Geospatial Data Standard (OTH 705-00)*.

Chapter 8: Provisioning Boundary

The provisioning boundary is a polygon layer that defines the area of GIS data provisioning responsibility. The geographic extent of the provisioning boundary must be agreed to by neighboring data providers and should be a seamless coverage with no intentional gaps or overlaps. The purpose of the provisioning boundary is to delineate the spatial extent within which a single data provider will provision the civic address and emergency service boundary data. The data provider must ensure that they are including seamless GIS data for the entire geographic area within their provisioning boundary extent.

The provisioning boundary will be used during additional data validation and QC processes to verify that a single data provider's GIS data is completely contained within that provider's provisioning boundary. Any GIS features extending past or outside of that boundary is considered an error as data outside that boundary would be considered

the responsibility of the neighboring PSAP and data provider. As a result, much like the PSAP boundary, the development and refinement of the provisioning boundary should be completed in coordination with neighboring PSAPs and data providers to ensure seamless coverage across borders.

Because the provisioning boundary is delineating the spatial extent of GIS data, data providers should note the following considerations:

- Road centerlines that cross the boundary
- Road centerlines that are coincident or near coincident with the boundary
- Address point placement for parcels near and/or split by the boundary
- Use of snap points at the border
- Coordination with neighboring data providers to reduce data duplication at borders
- Updates and/or changes to the provisioning boundary must be done in coordination with neighboring data providers

For additional guidance and specifications, please refer to *NENA Standard for NG9-1-1 GIS Data Model (NENA-STA-006.1-2018)*.

Chapter 9: Spatial Interface

The Spatial Interface (SI) is a data replication service that publishes data to the ECRF and LVF. The SI is the last stop before GIS data is placed into service to support NGCS. Additionally, the SI provides data updates to the ECRF and LVF. It is critical that the proper data validation and synchronization tasks have been completed prior to the provisioning of GIS data to the SI as improper provisioning of GIS data to the ECRF and LVF systems can ultimately result in misrouted 911 calls.

PSAPs may choose to operate their own SIs or choose to utilize SI services provided by the SI provider. At a minimum, the SI should include the following:

- Provide the GIS data provision interface for the ECRF and LVF
 - Minimum NG9-1-1 required datasets
 - Data provider input and configuration interface
- Perform additional QA/QC validation checks to enable:
 - Error reporting to the data provider
 - Discrepancy reporting and resolution support
 - Method for receiving and sending of reports
 - Method to support error resolution
 - Standardization of data to the ECRF and LVF
 - Boundary polygon gap and overlap detection

For additional information and guidance, please refer to *NENA Standards for the Provisioning and Maintenance of GIS data to ECRFs and LVFs. (NENA-STA-005.1.1-2017)*.

GIS Data Provisioning

While data providers must provide GIS data that, at a minimum, supports the NG9-1-1 GIS Data Model, it should be noted that the Spatial Interface Provider may have additional data requirements. Data providers should work with their NG9-1-1 provider to understand any additional required data elements of their specific SI implementation.

Transitional Phase

The timeframe within which a NG9-1-1 deployment may occur could impact any additional legacy data needs required by the SI provider. While the NG9-1-1 GIS data model fulfills the requirements for a fully i3 compliant system, it is intended for an end state where all applicable services, interfaces, and systems are fully i3 compliant. There will be a transitional phase where both legacy and i3 components will be implemented in a hybrid environment. For example, the NG9-1-1 GIS Data Model requires fully spelled out street name components (North vs N, Avenue vs Ave, etc.) whereas today's service provider MSAG and ALI databases utilize abbreviated versions of the street name components. Consequently, the SI provider may require the provisioning of legacy data in addition to the i3 compliant NG9-1-1 GIS data. Both GIS data sources and data providers should coordinate with their SI provider to ensure that the required data is being provisioned to the SI.

Data Submission

During the initial data submission to the SI, data providers will need to provide each of the required layers and configure their data following the specification and file format of the specific SI requirements. Often, this process involves a field mapping approach to input source data attribute fields and configuring them to crosswalk to the corresponding data model attribute fields utilized by the ECRF and LVF. This approach gives the data provider flexibility in that it allows the data provider to provision their local schema or variation of local schema, as is, and map it to the target SI schema. Data providers should be aware of the following considerations when provisioning GIS to the SI:

- Field type discrepancies
 - Can the SI accept attribute field type differences or does the data provider need to modify field types prior to submission?
- Relational data models
 - If the data provider stores GIS data in a relational data model, will a provisioning model need to be developed that flattens the data model for the purposes of submission?
- Required attribute fields
 - Are there additional SI provider attribute field requirements beyond the NG9-1-1 data model requirements?
- Legacy fields
 - Will the SI require legacy fields?
- Topology error threshold
 - What is the target threshold that determines the topology errors between input boundary polygons?

GIS Data Validation and Error Correction

Upon completion of the GIS data configuration and submission to the SI, additional validation checks will be performed on the address point, road centerline, and boundary polygon files. It is important to understand that this stage of data validation performs additional validation checks on the provisioned GIS data only and does not perform validation of GIS data to the service provider MSAG and ALI databases. It is assumed that these validation checks have been completed prior to provisioning of GIS data to the SI.

The validation checks performed in the SI will identify errors that will prevent the ECRF and LVF to accurately function. These checks will be performed on each GIS data layer individually and across all layers in conjunction with each other. Discrepancy and error reports will be submitted to the data provider in the format utilized by the SI provider which may include report documents and/or GIS data files that identifies the feature(s) with the error and the associated error type. Identified errors must be corrected and the associated data resubmitted to the SI for further validation. At this time, there is no requirement in place for the timeframe within which errors should be corrected and GIS data resubmitted. The Data Provider should coordinate with their associated PSAP(s) to determine the appropriate error resolution timeframe that meets the business requirements of the PSAP.

Examples of the types of validation checks and errors include but are not limited to the following:

- Features outside of the provisioning boundary
- Boundary gaps/overlaps
- Attribute field constraints
- Duplicates
 - Attribute
 - Geometry
- Address range overlaps
- Required fields missing
- Geometry errors

Data Updates

As part of a persistent long term GIS data maintenance and provisioning workflow, GIS data updates will need to be provisioned to the ECRF and LVF through the SI. Data providers and PSAPs will need to coordinate to determine the appropriate timeframe(s) for the frequency of updates as this may vary by data provider depending on the frequency of GIS updates occurring within the data authority's area of responsibility. In addition, some GIS layers may be more dynamic and updated more frequently than others and as a result will need to be provisioned to the SI on a more frequent basis. For example, in geographic areas where there is rapid development, address points and road centerlines may be updated often to reflect the newly constructed structures and streets and associated addresses. It is anticipated that these GIS datasets may require a more frequent provisioning schedule to the SI than other more stable GIS datasets.

Data Aggregation

GIS data from multiple data providers will be coalesced into a single GIS dataset that is published to the ECRF and LVF through the SI. The aggregation of data from different data providers may produce validation discrepancies and/or errors that were not detected in each standalone dataset when validated independently. While neighboring PSAPs and GIS data providers may have collaborated during the data review and modification process, some errors may be the result of the data aggregation process itself.

SI providers should have a mechanism in place that allows for the distribution of discrepancy reports to the originating data provider for resolution. It is critical for data providers to resolve these errors as soon as possible and in coordination with neighboring data providers to ensure that the aggregation of each dataset produces a seamless dataset across the geographic area of interest and that there are no gaps and/or overlaps between neighboring PSAP GIS datasets.

Chapter 10: Conclusion

GIS data is at the core of NG9-1-1. The transition from legacy 911 to NG9-1-1 is dependent upon the successful collaboration and integration between GIS data providers, GIS data sources, and PSAPs as the traditional service provider MSAG and ALI datasets are replaced by ECRF and LVF systems that are provisioned with GIS data.

It is critical that participating agencies understand the level of effort associated with the various GIS preparation and readiness tasks required for the transition to NG9-1-1 so that expectations can be managed to ensure adequate coordination and collaboration between both internal and external agencies and stakeholders. While the initial data readiness preparation and readiness tasks may be a significant effort initially, it is expected that in a long term maintenance environment, this effort is reduced since the GIS and MSAG/ALI datasets have already attained the acceptable match rate. However, it is important to note that this process is an iterative one and one that must be integrated into the NG9-1-1 GIS workflow environment.

This document in conjunction with the NENA and VITA documents listed in Appendix A of this document should be referenced for additional guidance during the transition to NG9-1-1 to ensure that GIS data will meet the requirements to support NGCS within the PSAPs area of responsibility.

Appendix A: References:

“NENA Detailed Functional and Interface Standards for the NENA i3 Solution”. (NENA-STA-010.2-2016 (originally 08-2003)). NENA.

“NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1”. (NENA-INF-014). NENA.

“NENA Information Document for Synchronizing Geographic Information System Databases with MSAG & ALI”. (NENA 71-501). NENA.

“NENA Standard for NG9-1-1 GIS Data Model”. (NENA-STA-006.1-2018). NENA.

“NENA Standards for the Provisioning and Maintenance of GIS data to ECRFs and LVFs”. (NENA-STA-005.1.1-2017). NENA

“Public Safety Answering Point (PSAP) And Emergency Service Boundaries Geospatial Data Standard”. (OTH 705-00). Virginia Information Technologies Agency (VITA). Virginia Geographic Information Network (VGIN).