

Prepared in cooperation with the University of Maryland Center for Environmental Science

Geospatial Standard Operating Procedures of the Chesapeake Bay Program



Open-File Report 2023–1007

Cover. Photograph showing where the Susquehanna River empties into the upper Chesapeake Bay near Havre de Grace (left) and Perry Point, Maryland on November 9, 2021. Photograph by Will Parson of the Chesapeake Bay Program, with aerial support by Southwings. Used with permission.

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By John Wolf, Labeeb Ahmed, Peter Claggett, Andrew Fitch, Frederick Irani,
Sarah McDonald, David Strong, Renee Thompson, and Zhaoying Wei

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Abbreviations

AGOL	ArcGIS Online
CBP	Chesapeake Bay Program
CBPO	Chesapeake Bay Program Office
CBWA	Chesapeake Bay Watershed Agreement
CIMS	Chesapeake Information Management System
ELA	enterprise license agreement
EPA	U.S. Environmental Protection Agency
FGDC	Federal Geographic Data Committee
GIS	geographic information system
GIT	Goal Implementation Team
ISO	International Standards Organization
IT	information technology
NGDP	National Geospatial Data Policy
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
QA	quality assurance
QAPP	Quality Assurance Project Plan
REST/SOAP	Representational State Transfer/Simple Object Access Protocol
SDE	Spatial Database Engine
SQL	structured query language
SRS	Strategy Review System
STAR	Scientific, Technical Assessment, and Reporting Team
TMDL	total maximum daily load
URL	uniform resource locator
UMCES	University of Maryland Center for Environmental Science
USGS	U.S. Geological Survey
UTM	universal transverse mercator

Geospatial Standard Operating Procedures of the Chesapeake Bay Program

By John Wolf¹, Labeeb Ahmed¹, Peter Claggett¹, Andrew Fitch¹, Frederick Irani¹, Sarah McDonald¹, David Strong¹, Renee Thompson¹, and Zhaoying Wei²

Introduction

Purpose

The Chesapeake Bay Program (CBP) has operated a geographic information system (GIS) program since the early 1990s to address the established and growing need for and use of geospatial data, maps, and analysis within the CBP Partnership. This report is intended to detail the standard operating procedures of the CBP GIS program and address the quality assurance, quality control, and other technical activities that CBP will implement to ensure the commitment of the CBP GIS Team to performance standards (U.S. Environmental Protection Agency, 2003). The report is intended as an update to the 2011 Quality Assurance Project Plan (QAPP). For specialized tasks or analytical projects beyond the scope of this QAPP, a separate specialized QAPP with details on quality control, assurance procedures, and the geospatial methods associated with all aspects of the project may be required.

GIS Program Organization

The CBP GIS Team is composed of a GIS Team Leader, a Research Geographer who leads the Land Data Team, and seven Geographers/Geospatial Analysts. The GIS Team Leader is employed by the U.S. Geological Survey (USGS). The GIS Team Leader, Research Geographer, and Geospatial Analysts work under cooperative interagency agreements between the U.S. Environmental Protection Agency, USGS, and the University of Maryland Center for Environmental Science (UMCES). The team is primarily responsible for analyzing, mapping, and modeling geospatial data. Other than land cover data, the source of the geospatial data is almost exclusively from other organizations.

Other individuals responsible for implementing the geospatial QAPP include the U.S. Environmental Protection Agency (EPA) Data Center Manager and Deputy Data Center

Manager, who provide guidance and oversight for Data Center projects (including GIS), the quality assurance (QA) Officer, and the Branch Chief of the Science, Analysis, and Implementation Branch. The organization of the GIS Team and its relationship to the Chesapeake Bay Program Office (CBPO) Data Center is shown in [figure 1](#).

In addition, the GIS Team routinely coordinates and collaborates with geospatial leads in national and regional EPA and USGS offices, academic institutions, government contractors, and nongovernmental organizations that support Chesapeake Bay initiatives. At times, this broader geospatial community ([fig. 2](#)) develops products and projects in collaboration with the GIS Team and may also be subject to this QAPP on such projects.

Finally, the intended users of the geospatial products are not included in the organizational charts because of their high numbers. Users of geospatial analyses include environmental management agencies in the Bay watershed jurisdictions (Pennsylvania, Maryland, Virginia, West Virginia, New York, Delaware, and Washington, D.C.), members and participants of the Chesapeake Bay Program Goal Implementation Teams (GITs) and Workgroups, Federal agencies, state and Federal contractors, academic researchers, nonprofit environmental organizations, and the press.

Problem Definition/Background

Goal

The GIS Team provides geospatial research and support to the CBP Partnership, including the provision of effective and accurate geospatial data, analyses, web applications, and maps. These services are primarily conducted to address the commitments outlined in the Chesapeake Bay Watershed Agreement (CBWA), Chesapeake Bay total maximum daily load (TMDL) for nitrogen, phosphorus and sediment, USGS Chesapeake Science Priorities, and needs identified by Scientific, Technical Assessment, and Reporting (STAR) to support the Strategy Review System (SRS).

¹U.S. Geological Survey.

²University of Maryland Center for Environmental Science.

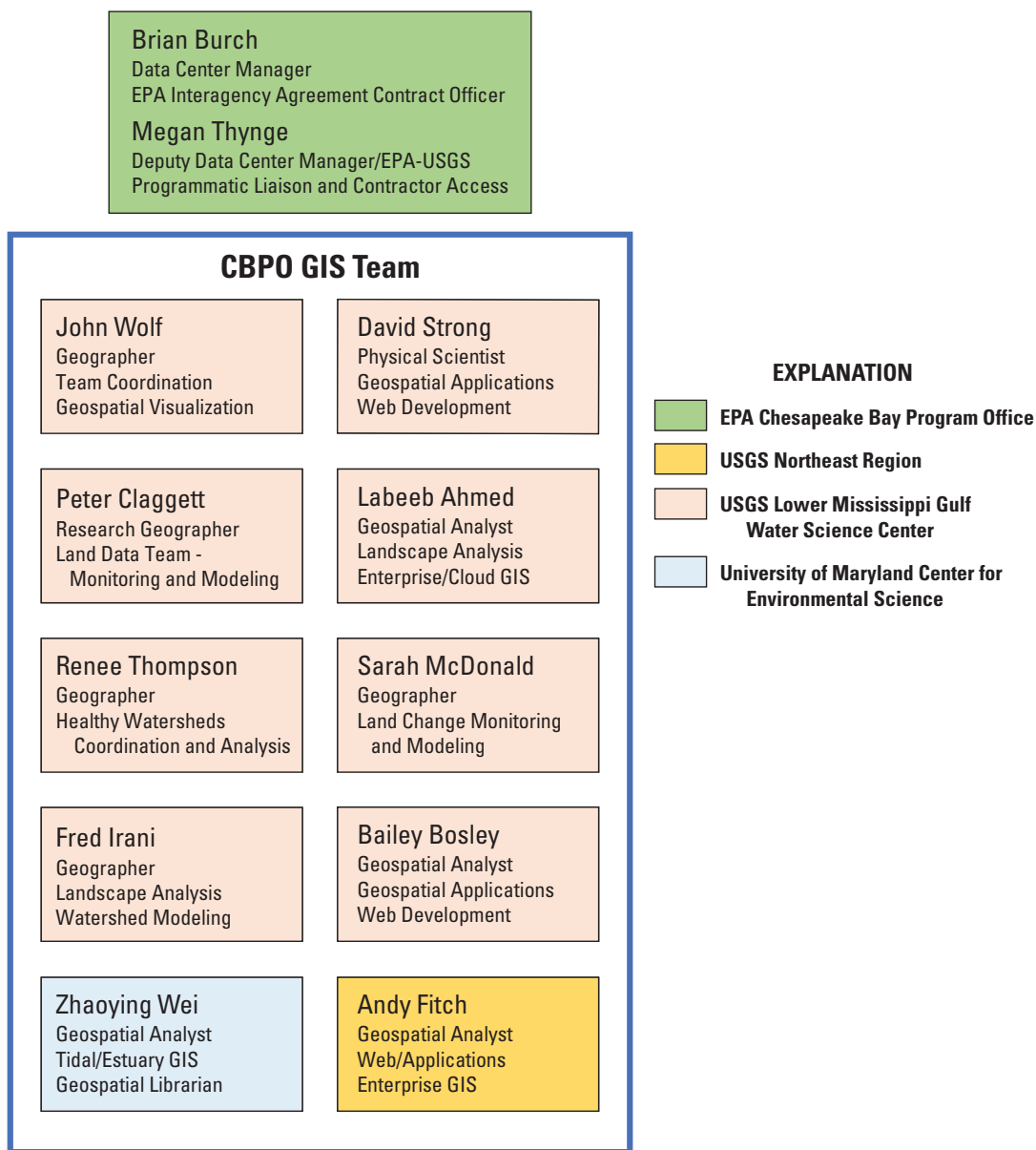


Figure 1. The Chesapeake Bay Program (CBP) geographic information system (GIS) Team and Data Center leadership organization chart. CBPO, Chesapeake Bay Program Office; EPA, U.S. Environmental Protection Agency; IAG, interagency agreement; GIS, geographic information system; NE, northeast; USGS, U.S. Geological Survey; LMG, Lower Mississippi-Gulf; UMCES, University of Maryland Center for Environmental Science.

Chesapeake Bay Program Geospatial Research and Support Ecosystem

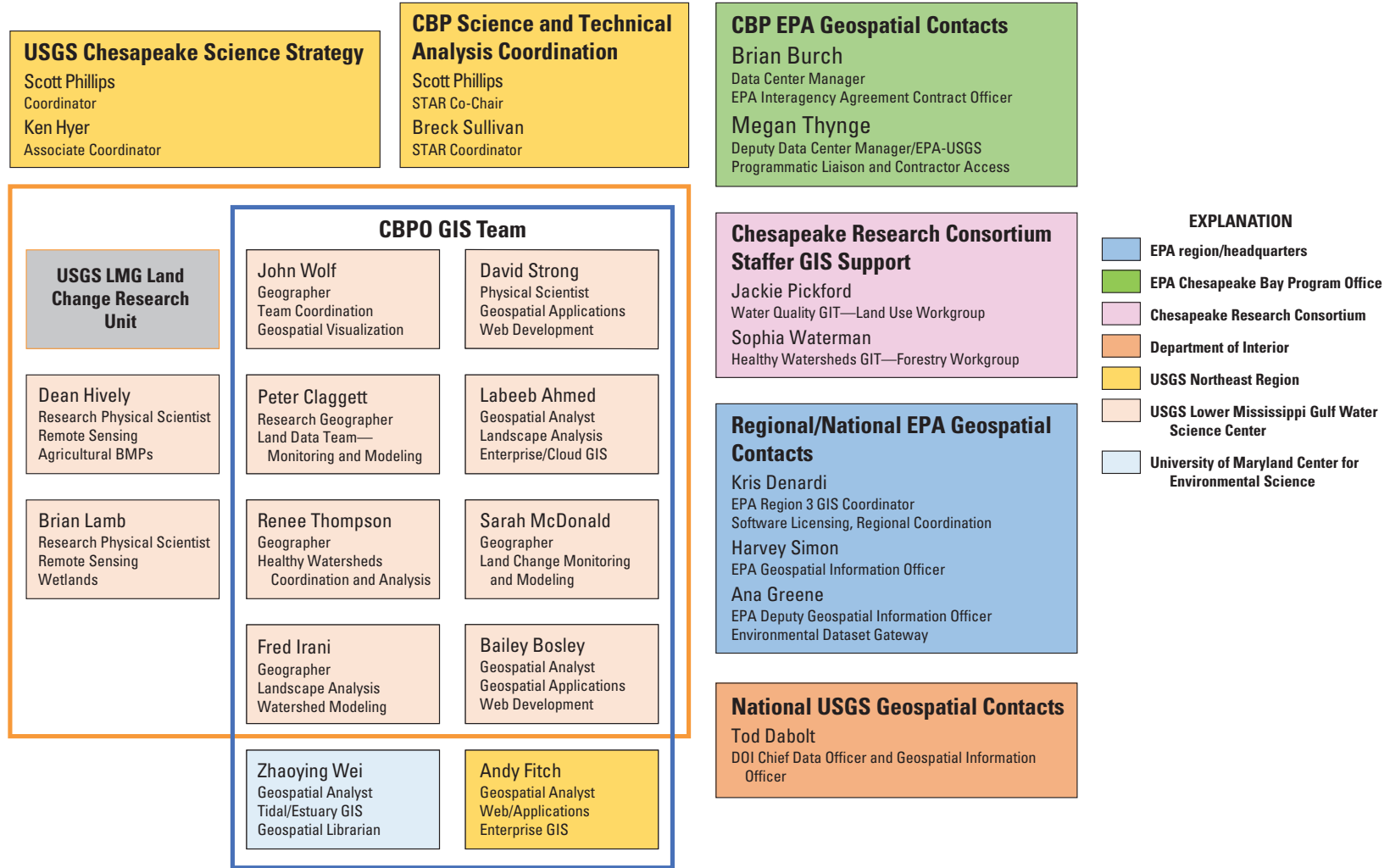


Figure 2. Chesapeake Bay Program geospatial research and support ecosystem chart. USGS, U.S. Geological Survey; CBP, Chesapeake Bay Program; STAR, Scientific, Technical Assessment, and Reporting Team; EPA, U.S. Environmental Protection Agency; IAG, interagency agreement; GIS, geographic information system; NE, northeast; LMG, Lower Mississippi-Gulf; GIT, Goal Implementation Team; DOI, Department of Interior; UMCES, University of Maryland Center for Environmental Science; CBPO, Chesapeake Bay Program Office; Hdqtr, headquarters; BMP, best management practice.

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Specifically, the GIS Team is charged with the following activities:

- **Geographic analysis**—Conduct integrated, multimedia analyses of geographical information used in regional land and watershed planning and modeling, and targeting nutrient, sediment, and chemical contaminant reduction and prevention programs in an optimal manner.
- **Spatial data development**—Coordinate with CBPO data managers, GIT leaders, and STAR members on the development of spatial databases needed to support CBP management and partner conservation and restoration efforts.
- **Spatial data access**—Develop the technical design and implementation of distributed, networked, spatial databases necessary for ensuring that the CBP partners and stakeholders have efficient, direct internet access to the environmental spatial data and information required to achieve the goals of the aforementioned agreements.
- **Geospatial application development**—In cooperation with the CBPO Data Center, develop programming solutions for integrating and automating spatial data analyses and associated results.
- **Land change modeling**—In cooperation with the CBP Land Use Workgroup and Healthy Watersheds Goal Implementation Team, develop, refine, and maintain the Chesapeake Bay Land-Change Model to support regional vulnerability and resource assessments and to inform land conservation and land-use planning decisions.
- **Web-based GIS and data visualization applications**—In collaboration with STAR, GITs, Workgroups, and the CBP Creative Team, develop, implement, and maintain internet-based GIS, mapping, and data visualization applications.
- **Indicator development**—In cooperation with the CBP Creative Team, develop multiscale geographic indicators that encompass environmental quality, implementation actions, and other related restoration and protection data and information.
- **Technical GIS support**—Provide expert GIS technical support to CBP partners and CBPO staff on the use of GIS to address Chesapeake Bay watershed conservation and restoration efforts.
- **Grant and project review**—Review grants and project deliverables for adherence to Chesapeake Bay Program guidance for GIS data management and related procedures.

GIS activities undertaken at the CBPO follow the directives outlined in the National Geospatial Data Policy (NGDP). The NGDP establishes the principles, responsibilities, and requirements for collecting and managing geospatial data used by Federal environmental programs and projects within the jurisdiction of the EPA. This policy also establishes the requirement of collecting and managing geospatial meta-data that describes the EPA's geospatial assets to underscore the agency's commitment to data sharing, promoting secondary data use, and supporting the National Spatial Data Infrastructure.

The NGDP addresses the geospatial data represented by points, lines, polygons, and rasters. Additionally, it encompasses original and interpreted geospatial data derived through remote sensing, including but not limited to images and raster datasets, aerial photographs, and other forms of geospatial data or datasets in both digitized and nondigitized forms. The NGDP addresses geospatial data operations in the context of data life cycle phases, consisting of (1) planning, (2) collection and acquisition, (3) processing and documentation, (4) storage and access, and (5) maintenance and retirement. It applies to all EPA organizations, grantees, agents working on behalf of the EPA, Tribes, localities and partner states of the EPA that design, develop directly or indirectly, compile, operate, or maintain EPA information collections developed for environmental program support.

Objectives

- Support the goals of the CBWA through geospatial analysis and science.
- Develop and maintain authoritative CBP geospatial datasets. (Note: authoritative datasets are datasets created and maintained by CBP for which only CBP has the authority to determine the geometry and attributes of those data. In other words, CBP is the authoritative source of these data.)
- Construct and maintain a current geospatial data library for cartography and spatial analyses.
- Provide analytical and cartographic support for CBP's partners.
- Provide analytical and cartographic support for presentations, publications, and meetings.
- Develop and maintain geospatial data, maps, applications, and data visualizations on CBP's suite of websites.
- Facilitate distribution of geospatial data and tools for the CBP.

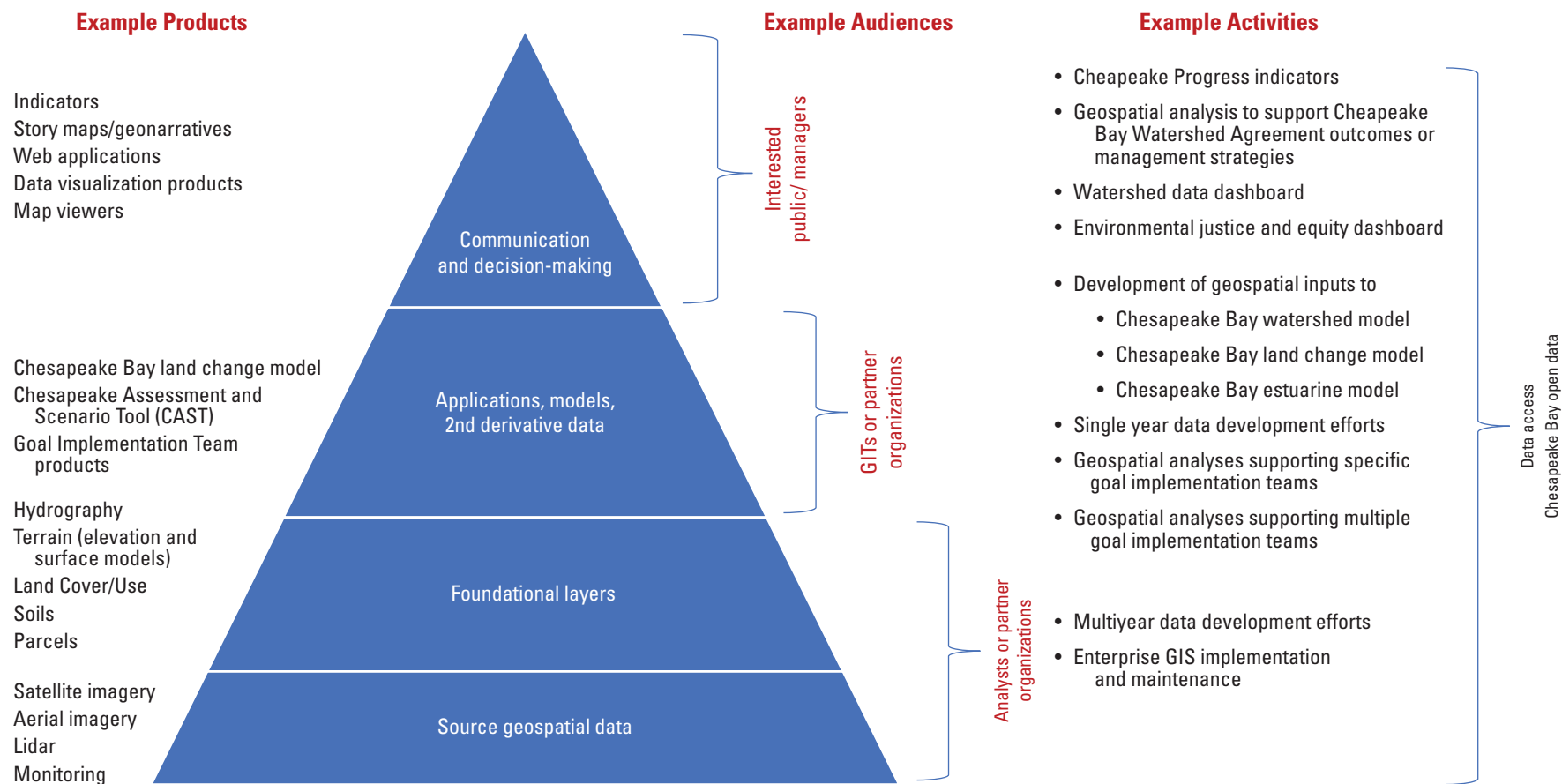


Figure 3. Hierarchy of geospatial data and data products used and produced by the Chesapeake Bay Program (CBP) geographic information system (GIS) Team. GIT, Goal Implementation Team; lidar, light detection and ranging.

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The GIS Team develops products for multiple audiences in the CBP Partnership. Examples of the types of products developed and used, and access to these products through the Open Data portal is illustrated in [figure 3](#).

Projects and Tasks

CBP's GIS program serves the needs of the CBP GITs and workgroups. The GIS Team is responsible for the following tasks:

1. Establish and maintain the CBP authoritative geospatial datasets for
 - A. Chesapeake Bay Monitoring Stations and Segments
 - B. Chesapeake Bay Modeling Segments
 - C. Protected Lands
 - D. Public Access Sites
 - E. Land Surface Data
 1. National Land Cover Database (NLCD)/Chesapeake Bay Land Cover Database
 2. Land Change Monitoring, Assessment, and Projection
 3. Hot-spot updates
 - a. Building height/volume
 - b. Vegetation height/age (above-ground biomass, stem density)
 - c. Topographic position (for example, ridges, bluffs, slopes, aspects, toe-slopes, plains)
 4. Future land use scenarios (2025–2100)
 - a. Planning and conservation best management practices
 - b. Habitat vulnerabilities
 - c. Healthy watershed vulnerabilities
 - F. Hydrographic data
 1. National Hydrography Dataset (NHD) + Medium Resolution (1:100,000)
 - a. Catchments
 2. NHD + High Resolution (1:24,000)
 - a. Streams and coarse stream characteristics
 3. Chesapeake Bay watershed hyper-resolution streams (1:2,000)

- a. Flow persistence
 - b. Channel characteristics (width, depth, bank angle, incision, burial, rating curves, bank-full boundaries)
 - c. Flow and thermal regime alteration
 4. Floodplains
 - a. 2-year, 10-year, 50-year, 100-year
 5. Riparian areas
 - a. 35-feet, 100-feet, and variable-width
 6. Ditches
 - a. Roadside
 - b. Agricultural tax
 - G. Other datasets as determined by the GIS and Land Data teams
2. Develop and maintain
 - A. Presentation maps, both hard copy and digital
 - B. Outreach material and publication maps
 - C. Web maps (including ArcGIS Online [AGOL])
 - D. Story maps
 - E. Web mapping and data visualization applications
 - F. Standardized map templates for
 1. Chesapeake Bay
 2. Chesapeake Bay watershed
 3. Chesapeake Progress and other CBP websites
3. Provide analytical and cartographic support for geospatial investigations, both internal and external
 - A. External projects must be applicable to the CBWA
4. Develop and maintain
 - A. Feature and map services stored on CBP's ArcGIS server
 - B. Data download and service links accessible to the CBP Partnership and the public through the Chesapeake Bay Program Open Data Portal
 - C. Maps, story maps/geonarratives, PDFs, and applications on the CBP AGOL system (Chesapeake Geoplatform)
5. Manage CBP's AGOL account

6. Manage geospatial data for Chesapeake Progress and other CBP websites
7. Coordinate operations with the CBP Data Center Manager and Deputy Data Center Manager
8. Participate in CBPO's information technology (IT) Data Center activities
9. Participate in EPA and USGS geospatial and data visualization communities

This CBP GIS Program QAPP does not address specialized spatial analyses undertaken by CBP Partnership collaborators. These projects are documented in individual QAPPs associated with the specific projects or agreements. As jurisdictions are, in part, funded by the CBP through grants and cooperative agreements, they are subject to QA requirements as established in the "Chesapeake Bay Program Quality Assurance Guidelines and Requirements" section of the CBP Grant and Cooperative Agreement Guidance (U.S. Environmental Protection Agency, 2022). This section is relevant to projects involving the collection of environmental data.

The CBP Quality Assurance Program ensures that projects include sufficient upfront planning for the development of well-defined project goals and data quality objectives. These objectives need to be supported by the implementation of sampling design, collection, and analysis protocols such that the resultant data completely and accurately addresses the project's goals. In order for the data to be useful to efforts to restore and protect the Chesapeake Bay, they must be of known and documented quality, having sufficient supporting documentation such that subsequent data users can evaluate if the data meets their needs. Additionally, data submission requirements for all grant or cooperative agreement funding are documented in the section "Chesapeake Bay Program Guidance and Policies for Data, Information and document Deliverables Submission" of the CBP Grant and Cooperative Agreement Guidance (U.S. Environmental Protection Agency, 2022).

Project Prioritization

GIS projects undertaken by the CBP GIS Team vary in complexity and the associated level of effort required to complete the project. The portfolio of the most complex projects (greatest level of effort) undertaken by the CBP GIS Team is planned for on an annual basis and is based on the relevance to the goals and outcomes of the CBWA. Recurrent or long-term projects are based on activities identified in (1) annual scopes-of-work between the EPA and USGS Lower Mississippi-Gulf and Virginia and West Virginia Water Science Centers, (2) the USGS Multi-Year Work Plan for Chesapeake Bay Studies, and (3) science needs identified through the STAR SRS planning process.

Shorter term, medium complexity projects are considered on a time-available basis and are based on the following criteria associated with CBP business processes, with projects meeting multiple criteria given greater priority:

- Does the project support one or more goals and outcomes of the CBWA?
- Is the project in support of the Chesapeake Bay TMDL, including Watershed Implementation Plans?
- Is the project multijurisdictional/multistate in geographic scope?
- Does the project support a Chesapeake Bay Data Center priority?
- Does the project support multiple GITs or Workgroups?
- Does the project support a CBP indicator or communication need?

Minimum complexity projects are typically completed in less than a day. These may include preparing a single map or graphic for a collaborator, generating simple geospatial statistics for a dataset, or developing metadata for an ArcGIS online map service.

Coordination

The GIS Team Leader coordinates GIS support activities within the CBPO Data Center with the EPA Data Center Manager and Deputy Data Center Manager. In addition, the GIS and Land Data Teams coordinate with a variety of internal and external CBP and related committees and workgroups including, but not limited to the following:

STAR

The GIS Team Leader serves as a member of STAR and participates in the planning and review of CBP initiatives requiring geospatial support. This includes coordination with the Modeling Workgroup, Nontidal Network Team, Status and Trends Workgroup, and other STAR Workgroups as necessary.

Land Use Workgroup

The Land Data Team Leader coordinates the activities of the CBP Land Use Workgroup. This includes the identification of geospatial data needs and plans to address those needs.

Healthy Watersheds Goal Implementation Team (GIT)

The Healthy Watersheds GIT is coordinated by a Geographer on the USGS Team, who identifies opportunities to leverage geospatial technologies and analyses to support the identification and protection of healthy watersheds in the Chesapeake Bay Basin. This includes analyses required to identify vulnerabilities associated with climate change and population growth and development.

USGS Science Team

Members of the GIS and Land Data Teams serve in leadership roles in the USGS Science Strategy, including coordinating Theme 3: Characterize land use and change to assess the vulnerability and resiliency of vital lands and healthy watersheds and parts of Theme 4: Enhanced data and information sharing. The GIS and Land Data Teams contribute to multiple research elements contained in the Chesapeake Studies Multi-Year Work Plan and collaborate with scientists working on all four science themes (Hyer and Phillips, 2021).

Chesapeake Conservation Partnership

The GIS Team coordinates with the Chesapeake Conservation Partnership to assist with the development of core datasets that support land conservation objectives in the region. This includes the identification of important farmlands, forest lands, water-quality areas, habitats, cultural lands, and lands important for recreation or public access.

Chesapeake Conservancy

The GIS and Land Data Teams coordinate with the EPA contract administrator and serve as technical leads on the multiyear EPA geospatial agreement for geospatial support. The Land Data and GIS Teams serve as the technical leads for the land use/land cover, hydrology mapping, and the geospatial and web mapping support activities of the agreement.

Quality Objective and Criteria

The work completed by the GIS Team follows the guidelines set forth by the Chesapeake Bay Program Office Grant and Cooperative Agreement Guidance (U.S. Environmental Protection Agency, 2022), the National Geospatial Data Policy (U.S. Environmental Protection Agency, 2008), and the Content Standard for Digital Geospatial Metadata (Federal Geographic Data Committee, 1998). The objectives of quality assurance and quality control are

1. Ensure that CBP projects and products are high-quality and credible data that can be confidently used by staff, CBP Partnership, and the public.
2. Design, document, and implement standard quality control and assurance procedures that minimize or eliminate errors.

Quality assurance and control procedures pertain to the acquisition, creation, editing, and geoprocessing of geospatial data and the construction of maps for any purpose. Preferred source data include Federal (for example, National Hydrography Dataset, USGS SPARROW model) and state agency authoritative datasets.

The Federal Geographic Data Committee has identified six components of data quality (Federal Geographic Data Committee, 1998) that are applied to all geospatial data generated, manipulated, or acquired by CBP:

- Accuracy—positional
- Accuracy—attribute
- Completeness
- Logical consistency
- Precision
- Lineage

In addition to the six components above, all geospatial data generated and acquired are reviewed for

- Best availability
- Appropriateness
 - Scale
 - Accuracy
 - Resolution
 - Time period
 - Format
 - Content
- Topology errors
 - Overlap
 - Gaps
 - Sliver polygons/segments
- Attribute errors
- Geometry errors
 - Empty geometry

Training

The GIS Team members are required to have extensive experience and knowledge of geospatial mapping and analysis techniques. This collective experience is the first step in assuring quality for products generated by the Team. Team members regularly participate in professional development and continuing education opportunities to keep abreast of the latest technology and software capabilities. Opportunities for both training and certification are available at

- Esri (www.esri.com)
- Virtual classroom
- Technical certification
- Workshops at conferences

- Local/Federal and International conference attendance
- GIS Certification Institute (www.GISCI.org)
- Online or in-person institution of higher education

Geospatial Skills

The collective skills and software proficiencies typically expected of GIS and Land Data Team members are listed in [table 1](#), although specific positions vary in terms of duties and job assignments. These skills and proficiencies are associated with the use of proprietary and (or) open-source GIS software, programming languages, database software, web-based programming, graphic design, and data visualization software.

Documents and Records

The following documents or documentation are developed and maintained by CBP:

1. CBP GIS program standards
2. Federal Geographic Data Committee (FGDC)/International Standards Organization (ISO) metadata for all CBP authoritative datasets
3. Existing documentation for secondary data sources if data are made accessible by CBP through the Open Data portal.

Metadata

The Chesapeake Bay Program adopted the FGDC-STD-001-1998 Content Standard for Digital Geospatial Metadata as the standard to follow when documenting CBP geospatial datasets. Subsequent to the adoption of the FGDC standards, the ISO developed ISO 19115: Geographic information—Metadata “to harmonize FGDC standards with other formal metadata standards.” Authoritative datasets published and distributed by CBP shall conform to these standards.

Authoritative Data

All authoritative datasets generated by CBP will comply with the CBP GIS program standards. In addition to dataset metadata, all CBP authoritative elements published on ArcGIS Online (Chesapeake Geoplatform) require summary metadata as detailed by the CBP GIS Open Data protocols.

Secondary Data

Data obtained from secondary sources will have existing metadata that will not be altered. This metadata will be maintained in the GIS folders with the original source data.

Operational Data

A majority of the operational datasets will not have updated metadata owing to the temporary nature of the data, interim purpose, or the secondary source for a majority of these data. Examples include the creation of new datasets for maps such as the selection of Chesapeake Bay watershed polygons from the National Hydrography dataset or extraction of NLCD land use land cover for a particular county. Both newly created datasets in the example have existing metadata from the authoritative source agency, are not distributed by CBP, and are processed only for cartographic effects required to develop the map.

AGOL Metadata

The CBP GIS Program provides guidance on metadata requirements for data, services, maps, and documents accessible through the CBP AGOL Open Data Portal. CBP will provide all metadata required. Metadata is limited by Esri to the following elements:

- Title
- Description
- Layers (within service)
- Terms of use
- Owner
- Tags
- Credits
- External uniform resource locator (URL) (where applicable)

Metadata Keywords and Tags

CBP products will include the appropriate metadata keywords and tags prior to publishing online or distribution. The tags will be selected from a list created by CBP to standardize the naming conventions. The list is currently under development as products are still being identified. At a minimum, all maps, datasets, and distributed items will include the following metadata tags/keywords:

- Chesapeake Bay Program
- CBP
- Title
- Subject of the data

Table 1. Geospatial skills expected of the geographic information system (GIS) Team.

[GIS, geographic information system; QGIS, Quantum GIS; GDAL, Geospatial Data Abstraction Library; OGR, Open GIS Simple Features Library; 3D, three dimensional; AGOL, ArcGIS Online; CBP, Chesapeake Bay Program; SQL, structured query language; API, Application Programming Interface; REST, Representational State Transfer; SOAP, Simple Object Access Protocol; FGDC, Federal Geographic Data Committee; GPS, Global Positioning System]

Skill	Skill level
Software proficiency	
Open-source geospatial applications	Proficient in use of QGIS and GDAL/OGR
ArcGIS Advanced (ArcInfo) and extensions, ArcGIS Pro	Proficient in Spatial Analyst, Geostatistical Analyst, and 3D Analyst extensions
ArcGIS Online	Proficient in development/publication of feature services, map services, map applications, story maps,
Geospatial programming	Proficient in C++, R, and Python
SQL server and queries	Proficient in SQL and database queries and manipulation
Microsoft Office Suite	Proficient in Excel (advanced features), Word, PowerPoint
Web development	Proficient in JavaScript and web development APIs
Data management	
Organization, structure, and maintenance of data	Proficient in best practices for hard drive and network folder management
Geodatabases	Proficient in establishing geodatabase structure, building and managing single user databases, converting data
Back-up and archiving data	Familiar with CBP data back-up and archiving procedures as they relate to geospatial data and project management
Horizontal coordinate systems and datums	Familiar with horizontal coordinate systems and datums and proficient in conversion between systems and datums
Vertical datums	Familiar with vertical datums and their implications for topographic, bathymetric, or other elevation-based data
Dissemination	Familiar with REST/SOAP services, data download, AGOL, Open Data
Cartography	
Principles	Familiar with cartographic design, including choice of appropriate map scale, resolution, and coordinate system selection
Map composition	Proficient in selection of appropriate map elements and marginalia
Data generation, acquisition, geoprocessing, and analyses	
Project management	Familiar with best practices in the management of projects, including budgets, timelines, resources, dependencies, and deliverables
Quality control and assessment	Familiar with standardized methods for quality assurance and control, including topology checks
Familiar with geographic coordinates	Proficient in the use and selection of geographic coordinate systems
Metadata	Proficient in the development and editing of metadata using FGDC standards
Geoprocessing	Proficient in the selection and use of standard geoprocessing tools, including buffer, extract, overlay, generalization, summaries, feature conversion, project
Analytical	Proficient in spatial analytical techniques including pattern analyses, suitability modeling, and geostatistical analysis
Familiar with spatial data collection methods	Familiar with GPS, remote sensing, aerial photography, field collection methods

Data Generation and Acquisition

The CBP does not collect field measurements for spatial data generation. The GIS program is primarily responsible for maintaining CBP's authoritative datasets, providing cartographic and spatial analytical products to CBPO staff and partners, as well as CBP outreach publications, presentations, and websites. This requires the development and maintenance of CBP's authoritative data, and the acquisition and geoprocessing of secondary data. Secondary use of data is the use of environmental and socioeconomic data collected for other purposes or from other sources.

Data Generation

This section will address data generation of the authoritative datasets developed or maintained by the CBP GIS Team. To maintain consistent edge-matching for boundaries and spatial analyses of the authoritative CBP datasets, the spatial extent of Chesapeake Bay watershed data products will, where applicable, default to

- the Chesapeake Bay watershed boundary as defined by the National Watershed Boundary Dataset,
- the boundary of counties that intersect the Chesapeake Bay watershed boundary as defined by U.S. Census Bureau data products, or
- the boundary of states that intersect the Chesapeake Bay watershed boundary as defined by U.S. Census Bureau data products.

In addition to authoritative spatial datasets, CBP generates spatial data to represent progress in tracking goals and outcomes of the CBWA, as portrayed on the Chesapeake Progress website (www.ChesapeakeProgress.com). Examples include

- point locations of certified sustainable schools in the Chesapeake Bay watershed,
- line segments representing streams opened to migratory fish species as a result of fish passage projects, and
- polygon boundaries of Chesapeake Bay segments impaired by toxic contaminants.

For these data, the spatial accuracy of the geospatial data is the responsibility of the source providing the coordinates. The CBP reviews the geospatial data for location integrity in the general vicinity, but CBP does not assess the accuracy of the point, polyline, polygons, or raster data provided by partners when CBP is providing GIS support to them.

Data Acquisition

A majority of CBP's GIS projects will use authoritative spatial data from partner agencies, which is referred to as "secondary data." CBP geospatial datasets are sometimes composed of collected datasets from jurisdictional and government partners. Every effort is made to collect data directly from authoritative data sources to inform CBP outcomes and models. Although CBP will assume that the partner agency has diligently upheld state and Federal standards for data quality, the GIS Team will review the data according to Chesapeake Bay Program grant guidance criteria (U.S. Environmental Protection Agency, 2022). The CBP will acquire and manage these data according to the specifications of this document.

The following datasets are the preferred standard for mapping and spatial analyses and are maintained in CBP's GIS library:

1. National Hydrography Dataset (hydrography)
2. National Hydrography Dataset Plus (hydrography)
3. National Elevation Dataset (elevation)
4. U.S. Census Bureau Tiger files (political boundaries)
5. National Watershed Boundary Dataset (hydrologic boundaries)
6. CBP high resolution and medium resolution shorelines
7. Esri basemaps (map services)
8. USGS topographic maps (map service)
9. National Agricultural Imagery Program aerial imagery (map service)
10. National Land Cover Database (NLCD)
11. EPA Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) database (impaired waters)
12. Latitude and longitude coordinates for point projects

The following criteria are applied to acquired data:

1. Geodatabase, GeoTIF, or Mr.Sid format
 - A. If data are distributed as shapefiles, the data are converted to a geodatabase format and reviewed with the original.
2. Distributed by the source of the data
 - A. Tertiary sources are discouraged except in the case of the National Hydrography Dataset Plus
3. Most current available or most appropriate for the project

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4. Latitude and longitude coordinates are provided as
 - A. An Excel spreadsheet
 - B. Five-digit precision, if appropriate
 - C. Decimal degrees format
5. Reviewed with comparative datasets, such as aerial imagery, for consistency and accuracy.

Chesapeake Progress

Spatial data collection for Chesapeake Progress updates is coordinated by the CBP Indicators Coordinator and CBP's partner agencies that serve as the Status and Trends Workgroup members. Data are provided to the GIS Team and used for cartography in the condition it is delivered.

Data Management

Data management is integrated into all aspects of the CBP GIS Team activities. This section describes the geospatial data life cycle phases, which consist of (1) design and planning for the program, (2) collection and acquisition, (3) processing and documentation, (4) storage and access, and (5) maintenance and retirement.

Program Data Management Activities

CBP's GIS Program has several key activities that it is responsible for:

1. Creating, updating, maintaining, and disseminating CBP's authoritative datasets
2. Providing summary data and analytical data for staff and partners
3. Conducting geospatial analyses to support CBP initiatives
4. Generating maps for staff and partners

These tasks are accomplished successfully through sufficient technical infrastructure, a standardized methodology for managing and processing data, and effective quality assurance and control methods.

Technical Infrastructure

Software

CBP's geospatial technical infrastructure consists of

1. ArcGIS Advanced 10.x. for desktop GIS processing, including Spatial Analyst, 3D Analyst, and related extensions (EPA Enterprise Licensing Agreement [ELA] with Esri)
2. ArcGIS Pro (EPA ELA with Esri)
3. ArcGIS Server 10.x, for storing and distributing data, maps, and services. (EPA ELA with Esri)
4. ArcGIS Enterprise 10.x (EPA ELA with Esri)
5. ArcGIS Online (AGOL) for creating and sharing data, PDFs, applications, and interactive web maps.
 - A. Chesapeake Geoplatfrom (ChesBay) account—used for publishing web maps, services, and discovering Chesapeake Bay data
 - B. EPA Geoplatfrom—used for authenticating ArcGIS Pro and collaboration with the EPA GIS community
 - C. USGS AGOL—used for publishing content to USGS online locations and collaboration with USGS GIS community
6. ArcGIS Insights
7. QGIS (previously known as Quantum GIS)
8. Tableau

Desktop software installation and updates, laptop hardware, and local data backup maintenance are the responsibility of the CBP Data Center. Server backups and server software are maintained by the CBP IT Network Team.

Storage and Backup

Data backup is performed on a daily basis to CBP's shared cloud drive, and automatically transfers from the cloud drive to an offsite location. System security and network backup is maintained by the IT Network Team according to CBP Data Center standards and policies.

Geospatial Data Types and Formats

Data Types

The CBP acquires and maintains four types of data as outlined in [table 2](#). Data update and distribution protocols are based on the type of data.

Dataset Format (Local)

The standard formats of all data managed by CBP are

- file geodatabase for all vector data (feature datasets for collections of related features)

Table 2. Geospatial data types.

[CBP, Chesapeake Bay Program; --, no data]

Dataset	Source	Purpose	Publicly distributed	Update frequency by CBP	Lifespan
Authoritative	Created and maintained by CBP or obtained from a trusted source	CBP core business responsibilities	Yes	As needed	Indefinite
Operational	Geoprocessed data	Cartography and analysis	No, limited audience	Frequent	Very short, depends on purpose
Analytical	Geospatial analyses, simple or complex	Analysis, reporting, and cartography	Potentially	As needed	Long
Basemap as a service	Esri (usually)	--	No	None	Indefinite

- file geodatabase or .img for raster data
- .csv or .dbf for tabular data
- PDF, JPG, or PNG for maps

Coordinate Systems

Unless otherwise specified, CBP adheres to the following two coordinate systems:

1. Albers Equal Area (for desktop GIS applications requiring the preservation of area measurements; [table 3](#)), and
2. Web Mercator Auxiliary Sphere (for web mapping applications and web-based decision-support tools; [table 4](#))

Exceptions may apply when another coordinate system may benefit the end user or audience (for example, cartography or spatial analyses) and provide improved visual display (for example, Universal Transverse Mercator) and accuracy of products.

Feature services and map services are distributed to the public for online consumption in ArcGIS Online and ArcGIS Enterprise. Because the established projection for ArcGIS Online is Web Mercator Auxiliary Sphere, CBP feature and map services are distributed in that projection. Datasets provided as layer packages for download through AGOL, ArcGIS Enterprise Portal, or Microsoft OneDrive may be in other coordinate systems depending on the needs of the project.

Storage Structure and Procedures

Local Storage and Structure

The organization of data storage is dependent on the size and scale of the project, as well as the usage of the data. In general, for high- and moderate-complexity projects, there is

an individual folder for source data that contains the original downloaded data. There is an additional data folder that contains the versions of the data being used (for example, clipped data). This folder contains the working data. The data within these folders is organized based on scale and (or) version. For example, if there is county level data for all counties in the watershed for both 2011 and 2017, folders for each year/version are appropriate. Within the version folders may be folders for each state, each containing folders for each county. The same structure is used for each version of the data. Where possible, the overall directory organization of GIS Projects conforms to the following topical structure. These topics should exist in the Spatial Database Engine (SDE), ArcGIS Server, map document folder, and Portal/AGOL, along with some application-specific folders.

- Boundaries
- Elevation
- Hydrography
- Land cover
- Water quality
- ChesapeakeProgress
- Infrastructure
- Shoreline

These topic categories are used to organize the spatial data downloads and operational data. The ISO metadata standard (ISO 19115) is the basis for the topic categories with a few additions and modifications established for CBP purposes. The purpose of the standardized topic categories is to facilitate easy data discovery within the library for projects and cartography.

Table 3. Albers Equal Area projection specifications.

[USGS, U.S. Geological Survey; GCS, Geographic Coordinate System; WKID, Well Known ID; EPSG, European Petroleum Survey Group]

Projected coordinate system	USA Contiguous Albers Equal Area Conic USGS version
Projection	Albers
WKID	102039
Authority	EPSG
Linear unit	Meters (1.0)
False Easting	0.0
False Northing	0.0
Central meridian	−96.0
Standard parallel 1	29.5
Standard parallel 2	45.5
Latitude of origin	23.0
Geographic coordinate system	GCS North American 1983
WKID	4269
Authority	EPSG
Angular unit	Degree (0.0174532925199433)
Prime meridian	Greenwich (0.0)
Datum	D North American 1983
Spheroid	GRS 1980
Semimajor axis	6378137.0
Semiminor axis	6356752.314140356
Inverse flattening	298.257222101

Table 4. Web Mercator Auxiliary Sphere projection specifications.

[WGS, World Geodetic System; WKID, Well Known ID; EPSG, European Petroleum Survey Group]

Projected coordinate system	WGS 1984 Web Mercator Auxiliary Sphere
Projection	Mercator Auxiliary Sphere
WKID	3857
Previous WKID	102100
Authority	EPSG
Linear unit	Meters (1.0)
False Easting	0.0
False Northing	0.0
Central meridian	0.0
Standard parallel 1	0.0
Auxiliary sphere type	0.0
Geographic coordinate system	GCS WGS 1984
WKID	4326
Authority	EPSG
Angular unit	Degree (0.0174532925199433)
Prime meridian	Greenwich (0.0)
Datum	D WGS 1984
Spheroid	WGS 1984
Semimajor axis	6378137.0
Semiminor axis	6356752.314245179
Inverse flattening	298.257223563

Naming Conventions

Nonsecondary geodatabases, tables, map files (.mxd), project files (.aprx), and map documents (.png) are named according to the subject of the data. Geodatabase feature datasets also include the coordinate system if the data are not projected in one of the standard projections. Naming conventions do not apply to the original data downloaded from secondary sources located in the source data folder; the original data names are retained. Operational data based on secondary data names may be modified once they are processed and relocated to CBP's GIS data library.

ArcGIS Enterprise Server Structure

CBP's SDE datasets and published feature and map services reside on ArcGIS Enterprise and structured query language (SQL) servers. Access to the ArcGIS Enterprise server as a user or publisher is provided by the GIS Team Web Geospatial Analyst. Server data are backed-up and managed by the CBP Data Center IT Network team.

Data and services are organized in a single-layer folder structure. The CBP uses the following folder organization as established by the GIS Team for feature classes and services:

- SDE datasets reside at the root level of the server as feature classes.
- Feature and map services reside in a folder described in the Local Storage and Structure section.

ArcGIS services are created using the following steps:

1. Prepare data

- Project to Web Mercator Auxiliary Sphere
- Remove unnecessary fields
- Hide fields that may be helpful to keep, but aren't immediately needed
- Rename or provide aliases for cryptically named fields

2. Copy data to servers (including FGDB data and MXD/APRX files). Contact the web geospatial analyst for specific sever locations.
3. Service settings (unless otherwise warranted):
 - Enable query
 - Allow per request modification of layer order and symbology
 - Enable copying for copy feature/copy raster geoprocessing tools
 - Implement intuitive symbology
 - Enable feature access only when required by the application
 - Set minimum instances for pooling to 0 unless it is anticipated to be a heavily used service
 - Consider enabling other capabilities as appropriate

Steps for publishing with ArcGIS Desktop:

1. Create GIS server connection in ArcCatalog
2. Sign in with Chesapeake Information Management System (CIMS) credentials username@CIMS or CIMS\username (case-sensitive), or use cbpageadmin credentials
3. Go to File / Share As / Service
4. After publishing, log into the Portal to set permissions (share with everyone) and transfer ownership of the service item to cbpageadmin, if necessary.

Steps for publishing with ArcGIS Pro:

1. Add CBP GIS Portal to the Portals list in the ArcGIS Pro settings
2. Sign in with CIMS credentials username@CIMS or CIMS\username (case-sensitive!), or use cbpageadmin credentials
3. Right click it in the Portals list, and choose Set as Active Portal
4. Click the Web Layer button on the Share ribbon, and select Publish Web Layer (or Overwrite Web Layer, if applicable)
5. Select Reference registered data
6. Choose a Portal folder (default will be user's root folder), and ArcGIS Server folder
7. Choose applicable sharing settings
8. If necessary, transfer ownership to cbpageadmin account.

Additional information on publishing services is contained in the Chesapeake Bay Program GIS Confluence site (<https://confluence.chesapeakebay.net>). Feature classes and services published to the CBP servers abide by the CBP GIS program standards for metadata, keywords, thumbnails, and naming conventions.

ArcGIS Online Structure and Procedures

The CBP maintains an ArcGIS Online Organizational account (ChesBay) that is administratively managed by UMCES. The ChesBay AGOL organizational membership is managed by the CBP GIS Team Leader in conjunction with the CBP EPA Deputy Data Center Manager. ChesBay data, maps, and map application content may be private (for internal use) or public. Content intended for widespread/public distribution is owned by the ChesapeakeBayProgram member account. Within the ChesapeakeBayProgram member account, content intended for distribution through the Chesapeake Bay Program Open Data site is added to the Open Data group within AGOL. All CBP services are provided in the Esri web map coordinate system of WGS84 Web Mercator Auxiliary Sphere.

CBP uses the ArcGIS Enterprise portal to

1. Publish Representational State Transfer/Simple Object Access Protocol (REST/SOAP) map and feature services for authoritative datasets for public access.
 - These services are a member of the Open Data group.
 - All services are provided in the web map coordinate system (WGS 84 Web Mercator Auxiliary Sphere).
2. Publish REST/SOAP map services for operational datasets used in mapping applications.
 - These services are not a member of Open Data groups.
 - All services are provided in the web map coordinate system (WGS 84 Web Mercator Auxiliary Sphere).

CBP uses AGOL to

1. Create and publish web maps and mapping applications.
 - These applications may be included within Open Data if applicable
2. Create and share layer packages of authoritative data for CBP partner download.

ArcGIS Open Data Structure and Procedures

Chesapeake Open Data is the primary mechanism for providing access to authoritative CBP geospatial data and frequently requested (and documented) analytical data products.

In addition, Chesapeake Open Data serves as a pointer to frequently requested data, maps, decision support tools, and other scientific data products maintained by the Chesapeake Bay Program and partner institutions. For data and information products housed within other data portals and websites, the Chesapeake Open Data record is limited to an AGOL metadata light record with a reference to the external resource. For CBP data products made accessible through Open Data, see the specific recommended workflow in the Chesapeake Confluence site (<https://confluence.chesapeakebay.net>). Data products associated with USGS scientific research are reviewed through the USGS Information Product Data System and published through ScienceBase. Once published, a record in Open Data should be created to point to the ScienceBase resource.

Processing Data

Overall Standards

Spatial datasets are often manipulated for cartographic and analytical purposes through geoprocessing and data management processes. The output typically includes multiple intermittent and final geospatial datasets that may be similar to the original or completely different. The following standards are applied for all geoprocessing tools:

- If a new vector or raster dataset is generated, the new dataset is tested for positional consistency with the original dataset, when applicable.
- All analyses are completed (input and output) in the file geodatabase environment for both vector and raster datasets.
- The use of shapefiles is discouraged.
- Source data that originates from a shapefile is converted to a file geodatabase feature class, reviewed for positional accuracy in ArcMap or ArcGIS Pro with basemaps, and topology is validated for inappropriate overlaps and gaps (polygons).
- Geoprocessing of data should be limited, and repeated procedures should be initiated on copies of the original source dataset.

Generating Official Datasets

Spatial Analyses Standards/Best Practices

The CBP GIS Team may conduct simple spatial analyses (such as using ArcToolbox Tools) to summarize spatial data by geographic areas, calculate the areas of polygons, and so forth. These analyses are often straightforward and completed in one to two steps. The tool parameters may vary depending on the product desired. Environment settings should be inspected prior to conducting analyses.

Reporting

Each project requiring a geospatial analysis or reporting requires project documentation. The documentation details the methods, assumptions, and rationale that were required to complete the project. This documentation will be stored within the project directory. The project directory will reside on a common, shared network drive that allows full access to the GIS Team. An index file will reside in the project directory that provides an overview of the data and documentation files. The GIS Analyst is responsible for the creation and maintenance of the project documentation. If requested, the GIS Analyst will provide project documentation to the project lead.

Documentation of the geoprocessing steps as a report, memo, or metadata is stored with, and provided with, all distributed datasets that have been processed by the CBP. If the data or the process encountered limitations or errors, these are also to be provided in the documentation. An example limitation may be the use of watersheds to summarize the NLCD where a subset of the watersheds are not sufficient in area to accurately summarize the 30-meter NLCD data. The metadata and the summary table must note this limitation.

Projecting Data

One of the more common and critical geoprocessing techniques is the projection of data from one coordinate system to another, or defining the projection of geospatial data that lack a projection file. Regardless of the format of the data, all newly projected data will be compared in ArcGIS Pro with the original data to ensure the projection was successful and features are aligned within an acceptable tolerance.

Defining a Projection

Data lacking a defined spatial coordinate system are projected, but steps must be taken to decipher what coordinate system the data are using. This may occur if the projection file is lost or not provided by the source. The steps to determine the projection are

1. Identify the number of digits to the right of the decimal of the coordinates to isolate the system as universal transverse mercator (UTM), State Plane, or Geographic.
2. Systematically display the data with the unknown coordinate system in ArcGIS Pro with datasets of known coordinates to find a coordinate system match.
 - A. Clear the display coordinate system to disable Projection-on-the-fly in ArcGIS Pro.
3. Once the projection has been identified, use the Define Projection tool in the Data Management Toolset, Project and Transformations tools to define the projection.

Vector Data

- Projecting vector data will use the appropriate transformation if required.
- Distance tolerance of geometry when comparing the new and the original datasets: zero feature units.

Categorical Raster Data

The projection of categorical raster data, such as land use or land cover data, will have the following settings:

- Resampling Technique set to NEAREST neighbor
- Output Cell Size equal or proportional to source data
- Snap Raster set to original raster dataset
- Distance tolerance of grid cells when comparing the new and the original datasets vary with the coordinate systems

Continuous Raster Data

The projection of continuous raster data, such as digital elevation models, will have the following settings:

- Resampling Technique set to BILINEAR interpolation
- Output Cell Size equal or proportional to source data
- Snap Raster set to original raster dataset
- Distance tolerance of grid cells when comparing the new and the original datasets vary with the coordinate systems

Cartography

Where appropriate, the CBP will follow National Map Accuracy Standards for hardcopy, standalone, and published maps. However, web maps and graphics developed for presentations shall consider audience needs in conjunction with map accuracy standards to identify a reasonable presentation given the specific context of the map or application.

Map Elements

A list of map elements and marginalia typically included in CBP cartographic products is shown in [table 5](#). Consideration should be given to the audience and intended use when evaluating the need to include individual items.

Source Citations

All maps will include appropriate citations to external data sources when those sources appear in hardcopy or digital static maps. Citations must identify the source and year of the data, (for example, aerial photography from the U.S. Geological Survey [2007] or USGS aerial imagery, 2007).

AGOL Resource Citations

ArcGIS Online (AGOL) services offer interactive maps, story maps, and applications through the ChesBay, EPA Geoplatform, and USGS organizational accounts. The CBP uses these resources for short-term and long-term projects. Short-term projects include interactive maps to support meetings and discussions and have a life cycle of less than one month. Longer-term projects include interaction maps, story maps, and applications that reside in the Chesapeake Geoplatform and may be embedded in one or more of the CBP Program websites. Appropriate source citations for basemaps and other non-CBP map layers should accompany CBP static and interactive web mapping products.

Operational Maps

For decision-making maps, which typically have a lifespan of a single meeting or day, the procedure includes

1. Preserving the data source and original format of the data received in a project folder file on the server.
2. Converting latitude and longitude coordinates to decimal degrees (5-digit precision), if required.
3. Developing geospatial data in a file geodatabase as points, polylines, or polygons.
 - A. Polyline and polygons may be generated from points or heads-up digitizing
 - B. Heads-up digitizing—National mapping standards with highest level of horizontal accuracy possible or acceptable
4. Displaying data and review for accuracy.

Coordinates and datum will vary with the map medium. The CBP generally defaults to either Albers Equal Area or Web Mercator Auxiliary Sphere coordinate systems and the North American Datum of 1983 (NAD 83) High Accuracy Reference Network as a horizontal datum. The exceptions to these defaults are when another coordinate system may benefit the user—for example, cartography, spatial analyses, and web maps—and provide improved visual display and accuracy of products.

Table 5. Chesapeake Bay Program map elements.

[URL, uniform resource locator]

Item	Required	Notes and examples
Title	Yes	Example: Chesapeake Bay Watershed Land Cover
Legend or key	Yes	Explanation of the symbology of the map data
Date of data	Yes	Maps intended to show status or progress of ecosystem recovery must include a date associated with the data
Map author's initials and date	Yes	The agency's URL may also be used. Example: Chesapeake Bay Program (jcw), www.chesapeakebay.net , November 12, 2019
Originating program	No	Example: Software – Esri ArcGIS Pro (ver. 10.x)
Source files	No	Example: Source file(s) – G:\GIS\WORKING\landcovermaps\landcover.mxd
Data source citation	No; except when using external data	Example: Aerial photography from the U.S. Geological Survey (2007).
Additional descriptive text	No	Dependent on map status, use, or content
Graphical scale	Yes	Include at least one scale bar
Numeric scale	No	An optional representative ratio (1:24,000)
Originating agency and (or) logo	Yes	Follow agency guidelines. Use logos from other agencies, as appropriate, when they are contributors to the development of the map
Geographic reference or locator map	Yes	Use depends on the scale of the map and the size of the area depicted. This may include latitude/longitude graticule or a common theme (for example, counties) as a backdrop, and highlight the area being mapped
North arrow	Yes	
Coordinate system including projection and datum	No	

Publications

The GIS Team periodically provides standardized maps for CBP publications. GIS Team Members collaborate with the CBP Communications Team to design standardized map templates used within each publication. In addition, the CBP GIS Team maintains standard map templates for the Chesapeake Bay watershed and the Chesapeake Bay (estuary) geographic extents.

Quality Control and Assessment

Data Development

Geospatial data and nongeospatial data are reviewed according to the specifications detailed in the Data Management section. Additional data quality control measures include

- Creation of data in a file geodatabase
- Enforcement of topology rules, if applicable

Digitizing

Where possible, polygons and polylines should share identical geometry and accuracy with existing CBP or other agency authoritative data, such that

- Threshold is zero meters or feet from the authoritative datasets.
- Heads-up digitizing (data capture) of authoritative datasets is used to generate the feature geometry.

When geospatial data are generated using heads-up digitizing techniques, the following is a quality control checklist:

- Source data are authoritative and appropriate in scale, accuracy, resolution, time period, format, and content
- Source data are generated according to National Map Accuracy Standards
- Source data are projected in the same coordinate system and datum as the dataset being generated
- ArcMap or ArcGIS Pro coordinate system is consistent with the source material and the dataset to be generated
- Map scale is appropriate for digitizing effort accuracy and precision

- The following methods are used to copy existing features from another dataset
 - Copy and paste
 - Trace tool on the Feature Construction toolbar
 - Replace Sketch
- Feature templates are used, if applicable
- Save often
- Review dataset according to specifications in the Data Management section

If the data fail to meet the criteria, the data are either edited to correct the error, or archived and the process of generating the data repeated according to a modified methodology to ensure meeting quality assessment criteria.

Imagery Geoprocessing

In many cases, the default parameters and environment of the ArcToolBox tools are sufficient for the CBP's geoprocessing needs. However, processing of imagery requires the implementation of the following standards:

- All raster and vector datasets involved in a process must be in the same coordinate system.
- Snap Raster (Processing Extent in Environment Settings) is set to match the original raster dataset if a new raster dataset or subset of the data is being generated.
- Output coordinate system is the same as the input.
- Raster resampling of cell size is equivalent or proportional to the original raster dataset.
- Raster resampling uses BILINEAR interpolation for digital elevation data.

Latitude and Longitude Coordinates

Partners may provide secondary data to CBP as latitude and longitude coordinates of projects for mapping purposes. The CBP depends upon the source agency or project manager to guarantee the accuracy of the data provided. In this case, five-digit precision is required. The CBP will then assess

- The relative positional accuracy through comparative visual inspection using base data/maps or ancillary data, if possible
- Data completeness
- Number of features
- Attribute table content

Maintenance and Retirement

Authoritative Datasets

The CBP's authoritative datasets are updated as needed by the GIS Team at the request of the responsible program/subject matter experts. Changes include boundary adjustments using the standards mentioned in the Quality Control and Assessment section and attribute updates.

Updates occur when the managing program/subject matter experts request an update or there is a change in managing personnel that results in a change in the boundary file's attributes. Datasets and metadata are updated using the follow steps:

1. A new file geodatabase is created.
2. The previous version is copied to the new geodatabase.
3. The geometry or attributes are updated in the new geodatabase.
4. Metadata are updated in the new geodatabase.
5. The previous version is retired to an Archive folder within the same folder.
6. A map is created to review the dataset by the appropriate program lead, if needed.
7. The ArcGIS Server and services are updated by archiving the existing service and updating to the new version.

Secondary Datasets

Secondary datasets require the most maintenance for the GIS Team. All downloaded secondary data must include metadata so that GIS Team members can verify currency with the source data download website. In addition, when the data are downloaded to the appropriate folder, the download file name will include the date of the download (for example, NHD_V2_11_23_2013.zip) for easy reference. Secondary data are retired if a more current version exists from the source. Retirement of secondary data follows the same standards for Operational Datasets (see section below) except for legacy/historical data. Legacy/historical data such as land use land cover from previous years are NOT retired since these data are of use for specific analyses. Determination of legacy/historical data is at the discretion of the GIS Team Leader or CBP GIS staff.

Operational Datasets

Operational datasets are data that have been manipulated, edited, or projected for a limited purposed, typically a specific cartographic request. These data usually have a short life cycle predominantly spanning one day, and less frequently one year (for example, streams for a Congressional Districts reference

map). To clarify the purpose of the data, the names of the spatial feature classes and rasters should include, if appropriate, the purpose of the manipulated data.

If the data are no longer relevant to CBP or its partners as determined by the GIS Team member, these data and associated documents (tables, maps) will be retired in one of the following two ways:

- Relocated to an Archive folder in the topic folder if there is a potential future need
- Deleted if
 - Data are erroneous or not what was requested/needed for a map
 - More up-to-date data or analyses would replace the data (predominately the case)
 - Redundant with existing data
 - No future use is identified

Analytical Datasets

Analytical datasets are managed and maintained using the same procedures as operational datasets. These are datasets derived from spatial analysis in a specific project but, unlike authoritative datasets, may not have general utility beyond the context of that project or deliverable.

Dissemination of Spatial Data and Maps

Authoritative Datasets

The CBP distributes authoritative datasets using the ArcGIS Enterprise Portal server, ArcGIS Online through the Chesapeake Bay Open Data site (<https://data-chesbay.opendata.arcgis.com/>), and the organizational ArcGIS Online license (<https://chesbay.maps.arcgis.com>). The CBP follows the ArcGIS Online best practices and guidelines provided by Esri and the EPA Geospatial Platform. These data are available as feature and map services and available for download by the public.

Operational Datasets

The CBP hosts operational datasets using the same methods as the authoritative datasets with the exception that these data are often limited in use and audience (for example, a specific meeting that required an interactive map for one day). Therefore, operational data are generally not available for public download.

Analytical Datasets

Datasets derived from spatial analyses or specific projects may be disseminated using the same methods and maintenance as the authoritative datasets. These may include data from high level spatial analyses projects that are not addressed in this QAPP; these datasets will have their own QAPP.

Basemaps

The CBP does not download, manage, or disseminate basemaps. These are provided by the authoritative source (typically Esri) as a service for consumption by the CBP in maps.

Project Management

GIS project ideas originate from a variety of sources. Where possible, potential projects are evaluated and incorporated into annual planning documents, such as the

- Annual Workplan and Scope of Work associated with Interagency Agreements among EPA and USGS Grantees
- Annual and Multi-Year Workplans associated with the USGS Chesapeake Science Strategy (Hyer and Phillips, 2021)
- CBP Science Needs cataloged by STAR to support the SRS
- Annual Workplan with Chesapeake Conservancy covering geospatial support deliverables

Other potential projects are evaluated on a case-by-case basis after an initial discussion with the GIS Team Leader. The GIS Team Leader will first ascertain if the project meets the business needs of the CBP, if the project is feasible within the existing timeline provided, and if data are available to accomplish the project. If the project is feasible and consistent with CBP's business needs, the project is scheduled according to the GIS Team's workload and existing priorities.

The following information is obtained from the requester of a GIS project:

- Who is the project proponent/customer?
- What is the proposed schedule for the project?
- Who is the audience for the project?
- What is the project's purpose?
- What data will be provided for the project?
- What documentation needs to accompany the project?
- What contextual information is necessary to execute the project?

- What is the format of deliverables requested for the project?
- Who will review the project deliverables for accuracy?

Project Workflow

1. Identify project objectives and requirements.
2. Identify feasible timeline.
3. Identify if a project specific QAPP is required or needed.
4. Identify datasets and spatial analyses needed.
5. Specify spatial representation (point, polyline, polygon, raster) or products.
6. Specify medium of product and intended audience:
 - A. Publication
 - B. Dataset
 - C. Hardcopy map
 - D. Interactive online map or application
 - E. Geonarrative
 - F. Presentation
7. Establish necessary folders with a standardized naming convention for all products.
8. Inventory existing data.
9. Determine data collection needs and potential sources.
10. Acquire available data.
11. Project spatial data to necessary coordinate system.
12. Geoprocess spatial data if necessary.
13. Identify or design attribute fields.
14. Specify valid attribute values and relations.
15. Validate data and QA checks:
 - A. Completeness of data
 - B. Attribute accuracy
 - C. Logical consistency
 - D. Physical consistency
 - E. Positional accuracy
 - F. Precision of data
16. Generate product (for example, map, spatial dataset, reporting data).
17. Generate metadata and tags; validate metadata.
18. Publish product (online, if applicable).
19. Generate and publish QAPP with data.
20. Maintain or archive product.
21. Review and optimize procedure used to generate product.

Publishing Feature and Map Services

1. Project datasets to Web Mercator Auxiliary Sphere (ArcGIS Online standard), if needed
2. Migrate required datasets to the ArcGIS Enterprise or SDE server, if needed
3. Ensure datasets have minimum metadata if it is an operational dataset, full metadata if authoritative dataset
4. Develop .aprx or .mxd file with appropriate feature datasets from ArcGIS Enterprise or SDE server
5. Publish using Share as Service or Share as Web Layer.
6. Check Publish as Service
7. Select the existing folder on the development or production server at the CBP
8. Using the Service Editor, use the following settings
 - A. Capabilities set to features and mapping
 - B. Feature Access set to
 1. Create NO
 2. Delete NO
 3. Query YES
 4. Update NO
 5. Do NOT check the Allow Geometry Updates
 - C. Complete the Item Description
9. Analyze the data and address errors and warnings
10. Publish
11. Review data or map online for errors or issues

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