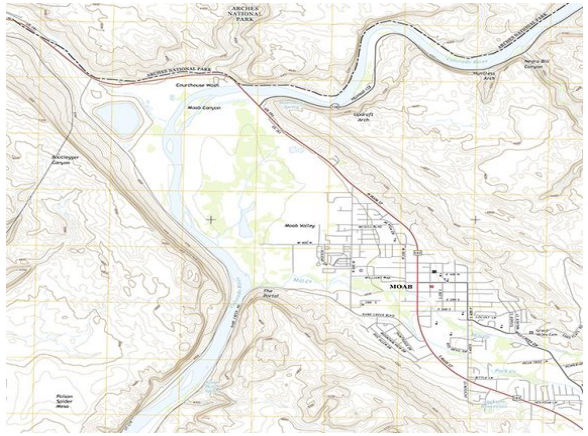
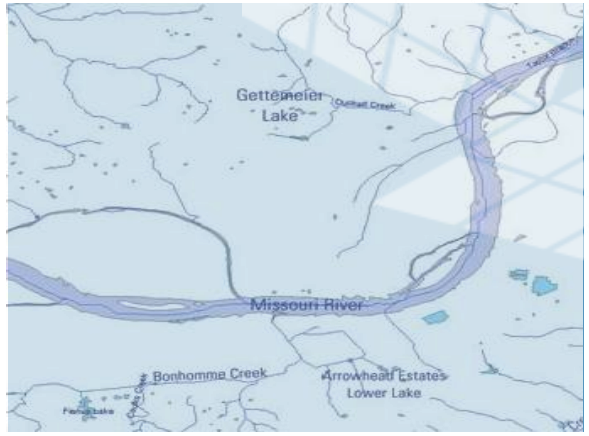
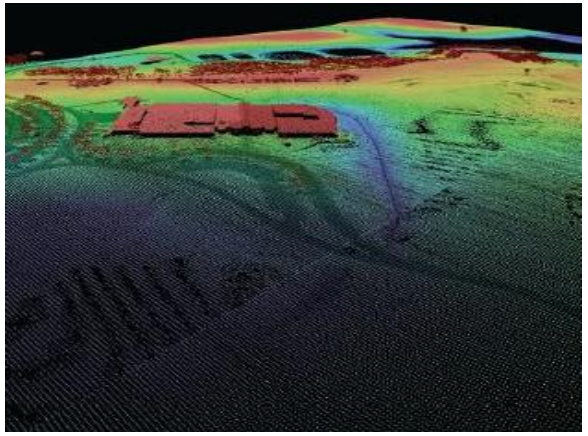
The USGS 3D Hydrography Program







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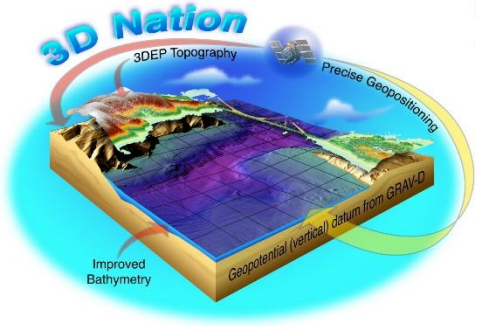
3D National Topography Model (3DNTM)

Integrates elevation and hydrography datasets to model the Nation's topography in 3D



3D Hydrography Program (3DHP)

- Hydrography derived from/integrated with 3D Elevation Program data
- Connections to groundwater, wetlands, and engineered hydrography
- 3DHP Infostructure for data sharing as part of the Internet of Water

Next Gen 3D Elevation Program (3DEP)

- New quality levels and refresh cycles
- Integration of inland bathymetry
- 3DEP Ecosystem for data and resource sharing
- Continual improvement with new technologies and approaches

Future Integrated 3D Model

- *Research and develop a 3D data model to fully integrate 3DHP and next gen 3DEP*
- *Integrate other data from The National Map*

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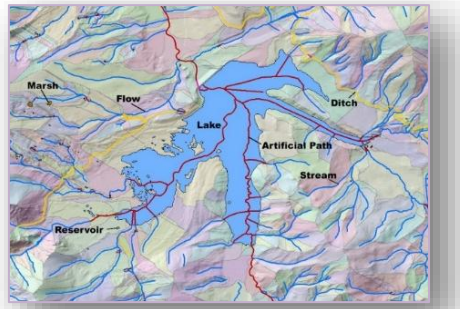
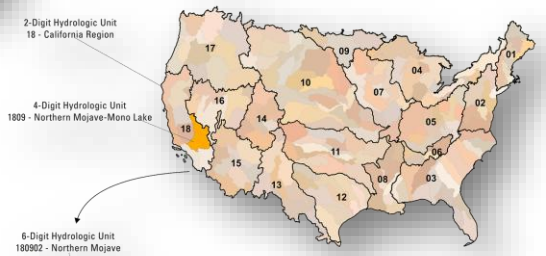
Previous Approach to National Hydrography Datasets

- For the past two decades, the National Hydrography Dataset (NHD) portfolio of datasets was the most comprehensive and current data of the Nation's surface waters
  - 9.4 million miles stream of network, including 8 million waterbodies and over 130,000 nested hydrologic units
  - Based on 1:24,000-scale maps
- NHD and Watershed Boundary Dataset (WBD) leveraged local knowledge and updates through a stewardship program with participants from 41 states and Washington DC
- Updates were not uniform
  - Some areas have been updated; others untouched and based on older information – sometimes 40+ years old
  - National consistency of data quality has decreased over time
  - NHD surface water features don't align well with highly accurate 3D Elevation Program data



National Hydrography Dataset



Watershed Boundary Dataset

NHDPlus High Resolution

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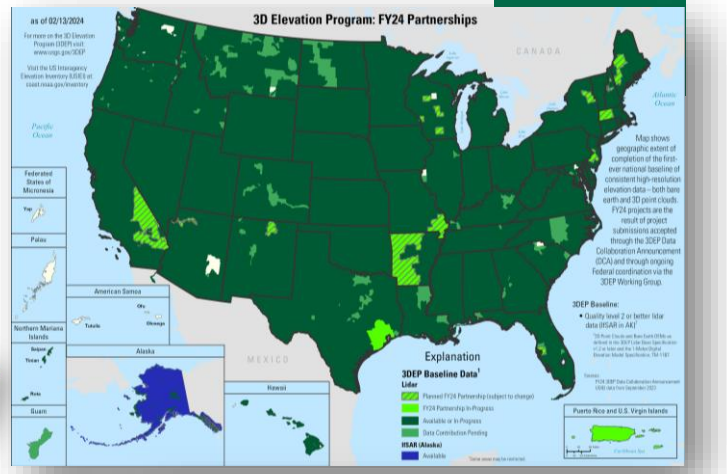
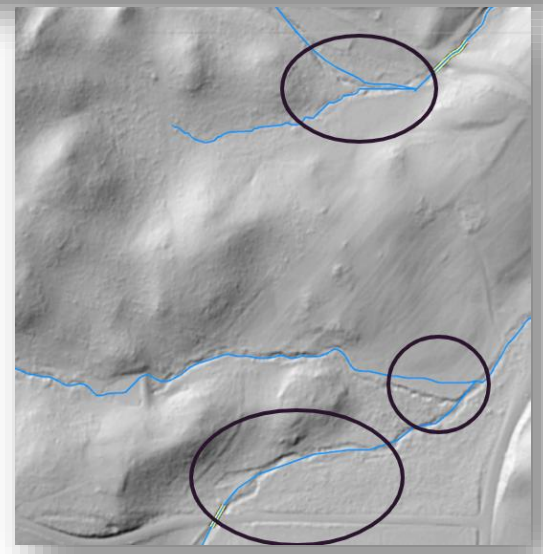
3D Hydrography Program Goals

Align vertically, horizontally, and temporally with 3DEP data

- Replace existing older, inconsistent data with higher accuracy hydrography standardized to align vertically, horizontally, and temporally with 3DEP data
- **Data and systems built for hydrologic applications**
- Follow 3DEP best practices
  - Governance
  - **Collaborative acquisition**
  - Leverage expertise of private sector mapping firms by contracting data acquisition through the USGS Geospatial Products and Services Contracts (GPSC)
  - Co-operative data acquisition
  - **Specifications and data validation**
- Building on decades of work and concepts from current hydrography products





Example of misalignment between older hydrography data and elevation data

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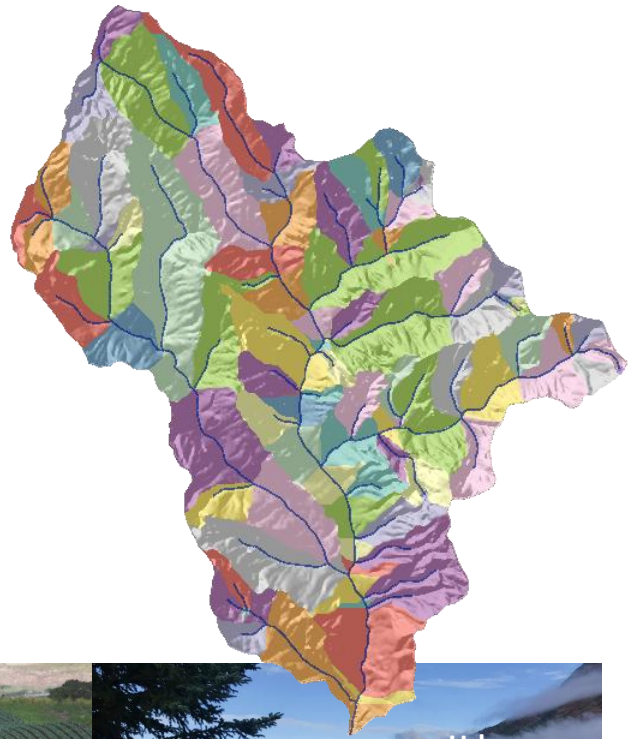
Benefits to updating National Hydrography Datasets

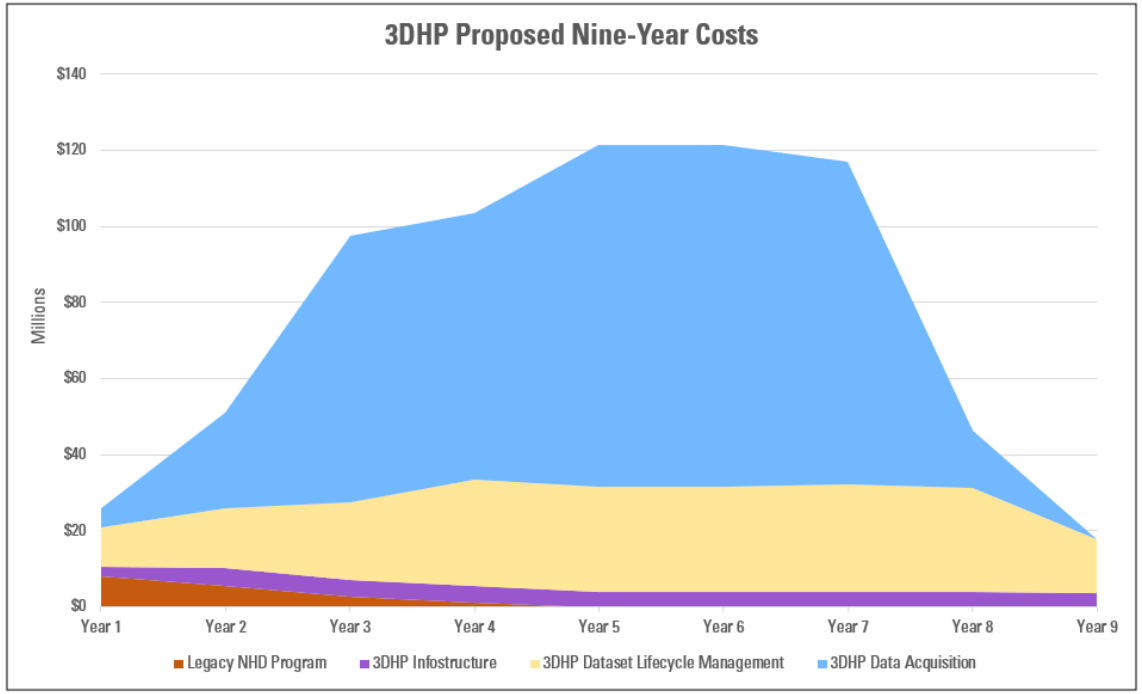
- **Hydrography Requirements and Benefits Study (HRBS; 2016)** documented 420 mission critical business uses with 23 Federal agencies, 50 states, 8 Tribal governments and 3 national associations
- HRBS found that hydrography data are essential to a broad range of critical applications and the current program provides $538M annual benefits
- A modernized 3D-enabled hydrography program could provide up to $1.14 billion annually in benefits if all user requirements are met



3DHP Call for Action

A community-wide effort of $685M over 9 years

- Follow a similar collaborative funding model as 3DEP that anticipates significant investments by partner organizations on shared data acquisition costs (64% of 3DEP was funded by partners)
- A $685 million investment across the community could support the effort for the first 9 years



The cost-share model is one potential model and is not intended to allocate cost shares to any organization or to individual government sectors; the actual funding model could evolve and change through the program operations plan

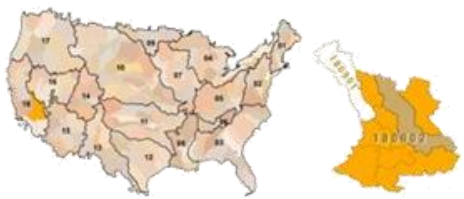
The 3DHP Data Lifecycle

Planning → **Acquisition** → **Validation** → **Publication** → **Access**

Planning

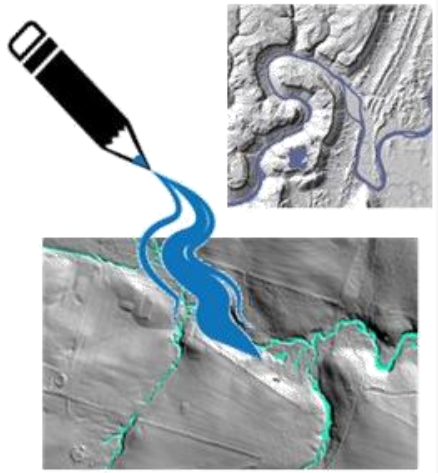
Federal, state, tribal, local or private entities partner on an area of interest

USGS and/or partners plan the project & award a task order



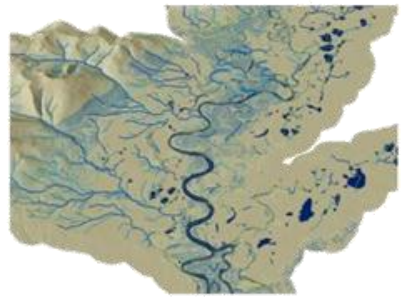
Acquisition

Contractors acquire and process data



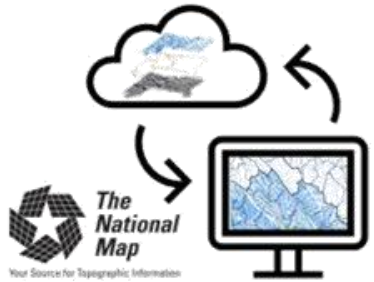
Validation

USGS validates data & produces standard 3DHP data products



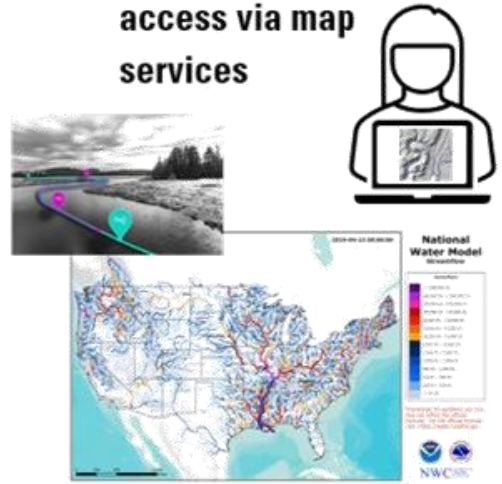
Publication

USGS makes 3DHP data publicly available on The National Map & via services in the Cloud



Access

Users can download analysis ready data or access via map services



Over $ 1B in annual benefits to the Nation if hydrography data needs are met (HRBS, 2016)

Annual Data Acquisition

Built on Partnerships

Working Groups (Federal)

- Federal partners identify mapping priorities
- Enter into Interagency Agreement (IA) with USGS
- IA funds can be used as matching funds on DCA applications or for direct acquisitions

3DNTM DCA*

- Process to collaborate on data acquisition and request matching funds from 3DHP or 3DEP
- Project submissions are assessed for overlap with federal priority areas and other criteria

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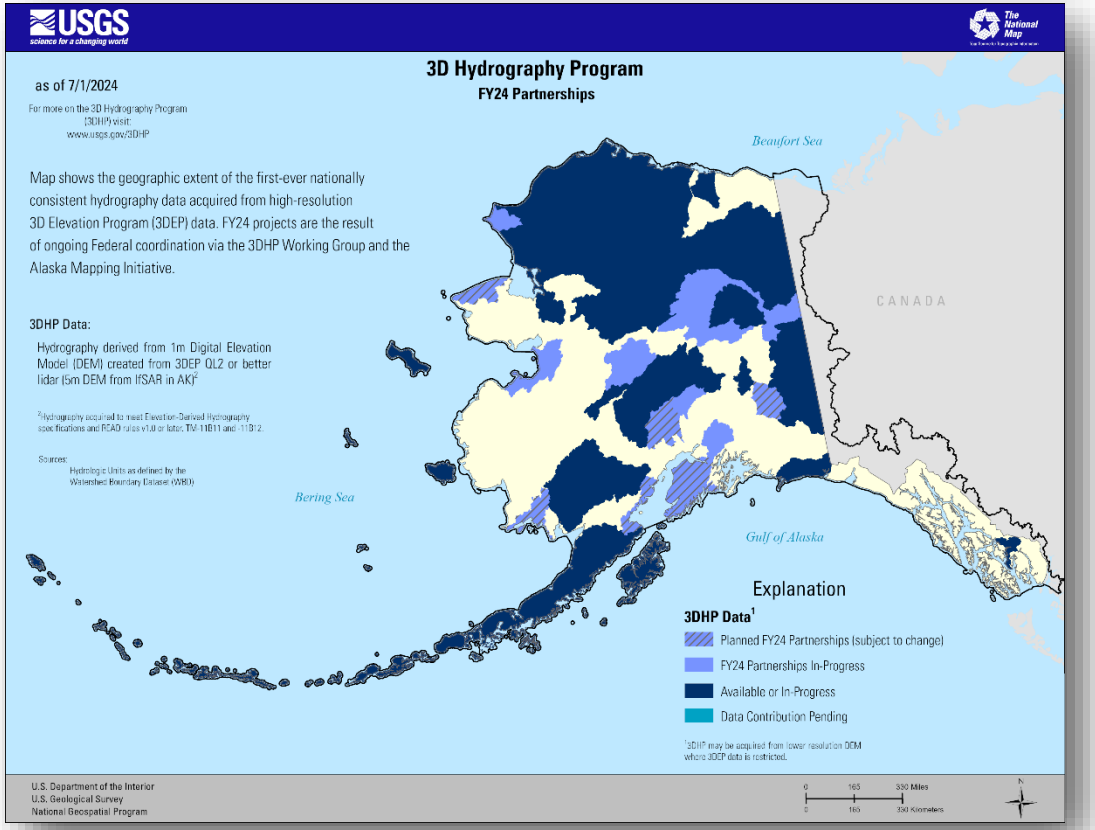
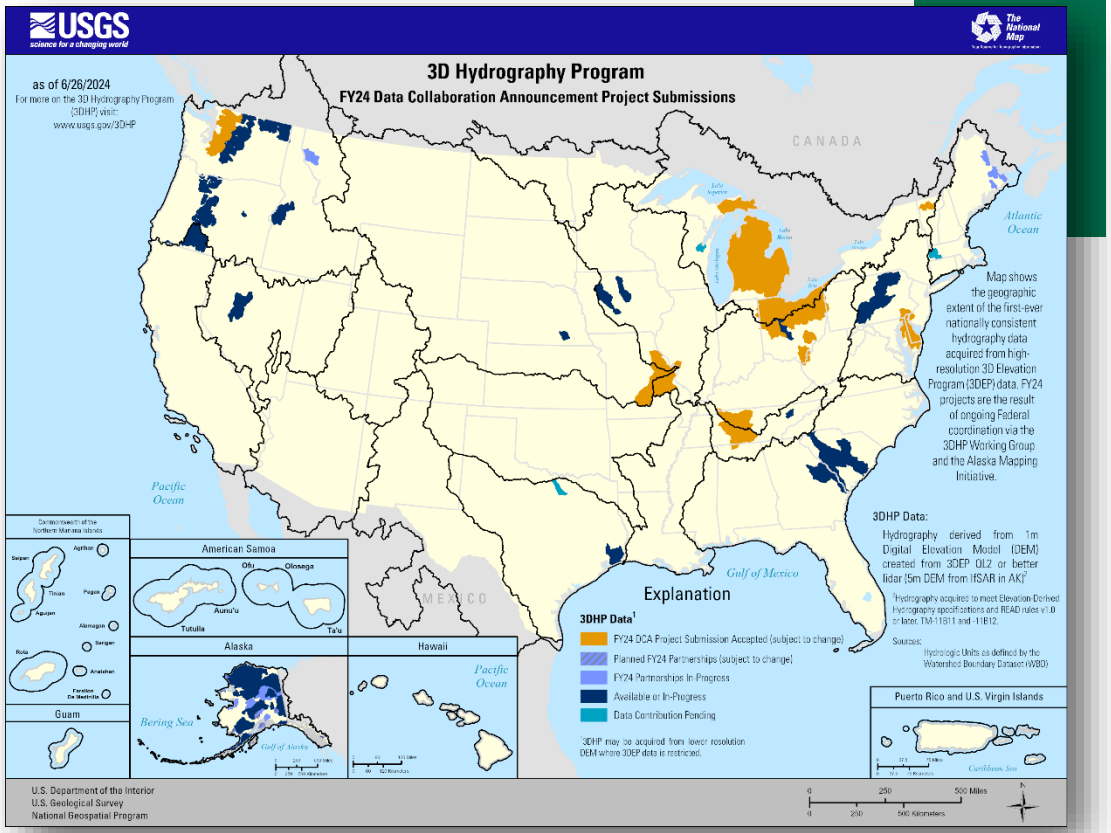
*3D National Topography Model (3DNTM) Data Collaboration Announcement (DCA) - usgs.gov/3DNTM/DCA

3DHP FY24 Data Acquisition

Alaska

- ~314K sq miles available or in progress at the end of FY23
- ~72K sq miles currently planned for FY24





CONUS+

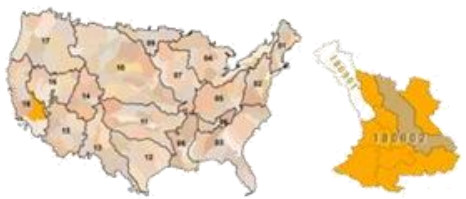
- ~60K sq miles available or in progress at the end of FY23
- ~103K sq miles currently planned in FY24
  - 3DNTM DCA projects in DE, MI, MO, OH, PA, TN, VT, and WA
  - Federal projects in ME and MT
  - Additional projects in development

The 3DHP Data Lifecycle

Planning

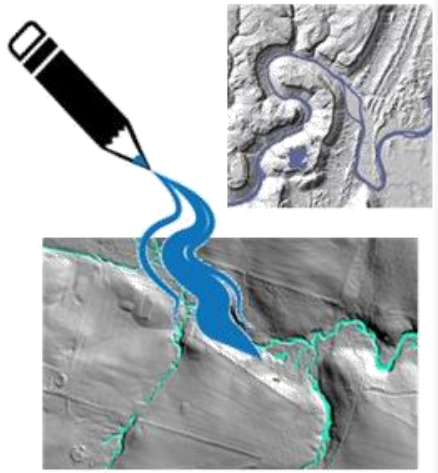
Federal, state, tribal, local or private entities partner on an area of interest

USGS and/or partners plan the project & award a task order



Acquisition

Contractors acquire and process data



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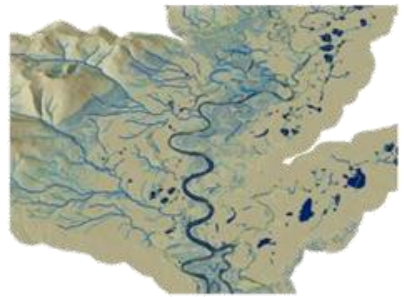

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Publication

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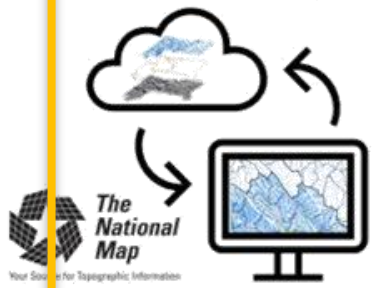

Access

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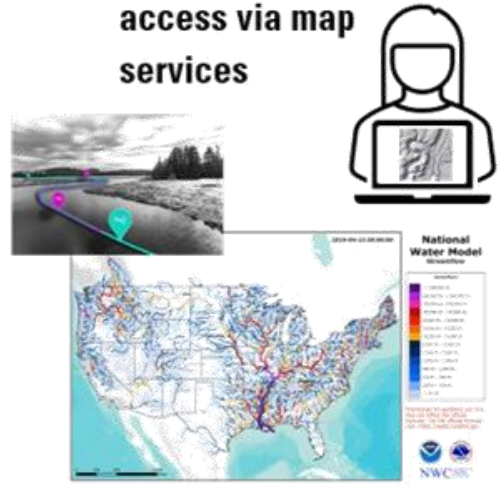
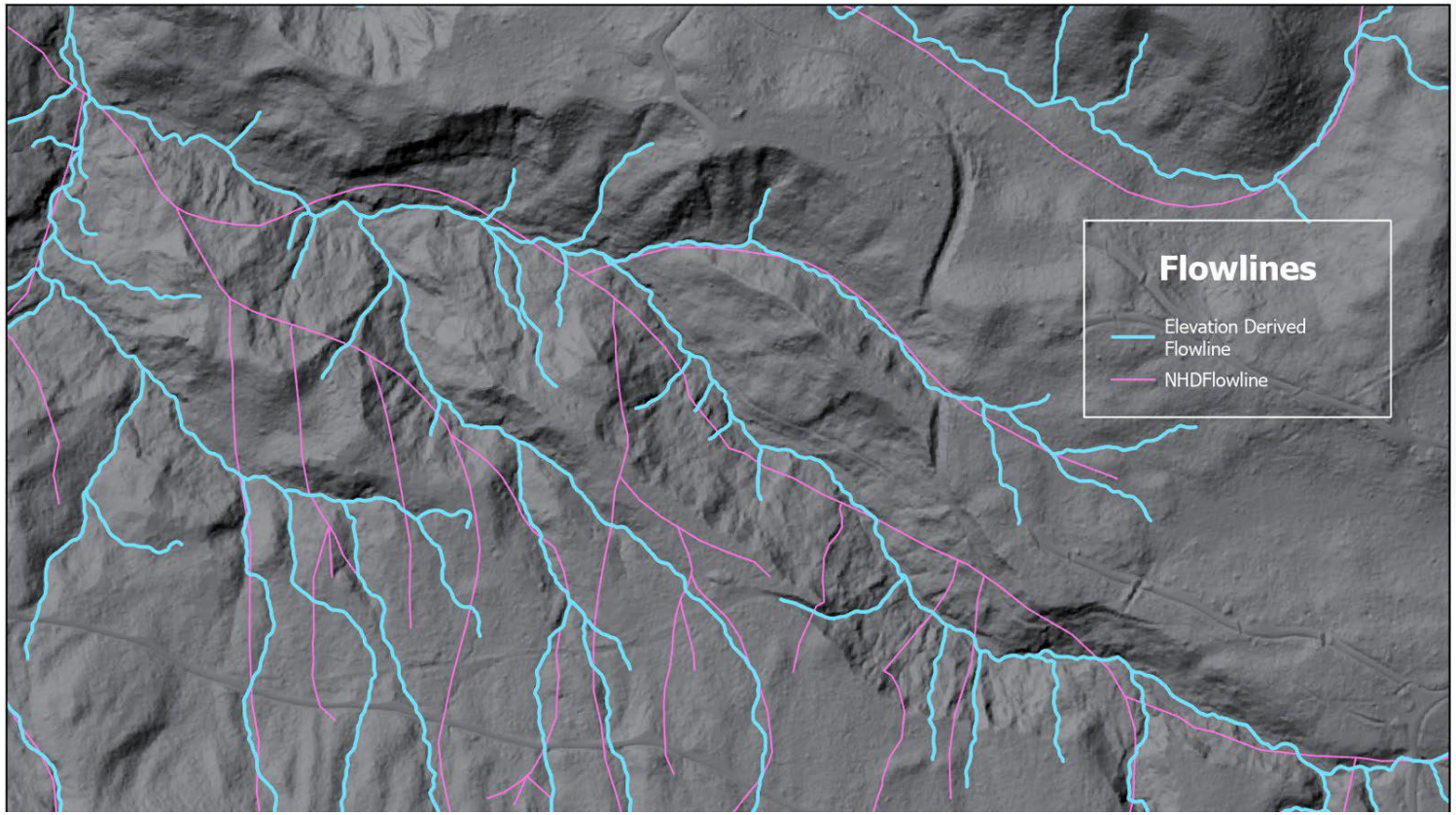


More accurate, more precise, more consistent

Data collected and validated to meet specifications



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usgs.gov/3DHP/EDHSpecs

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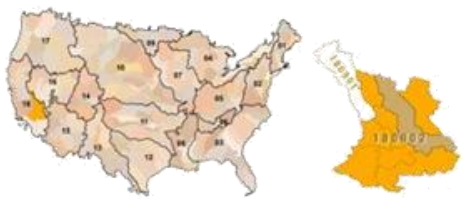

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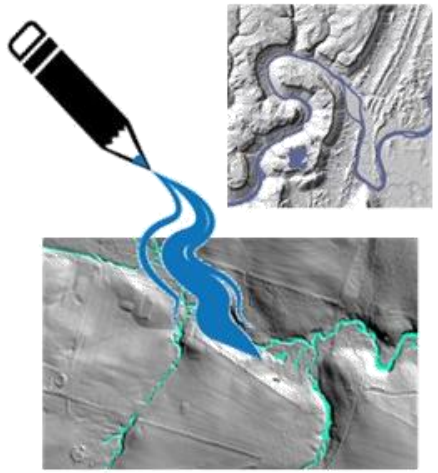

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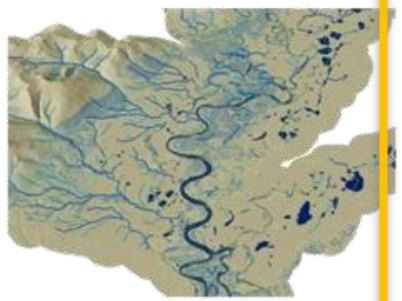

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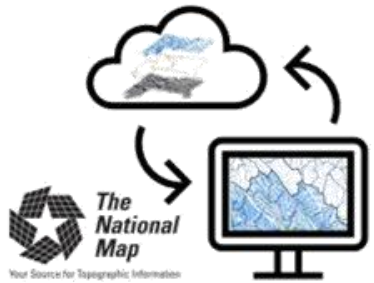


Access

Users can download analysis ready data or access via map services

3DHP Data Model

One time load to create a National coverage of data

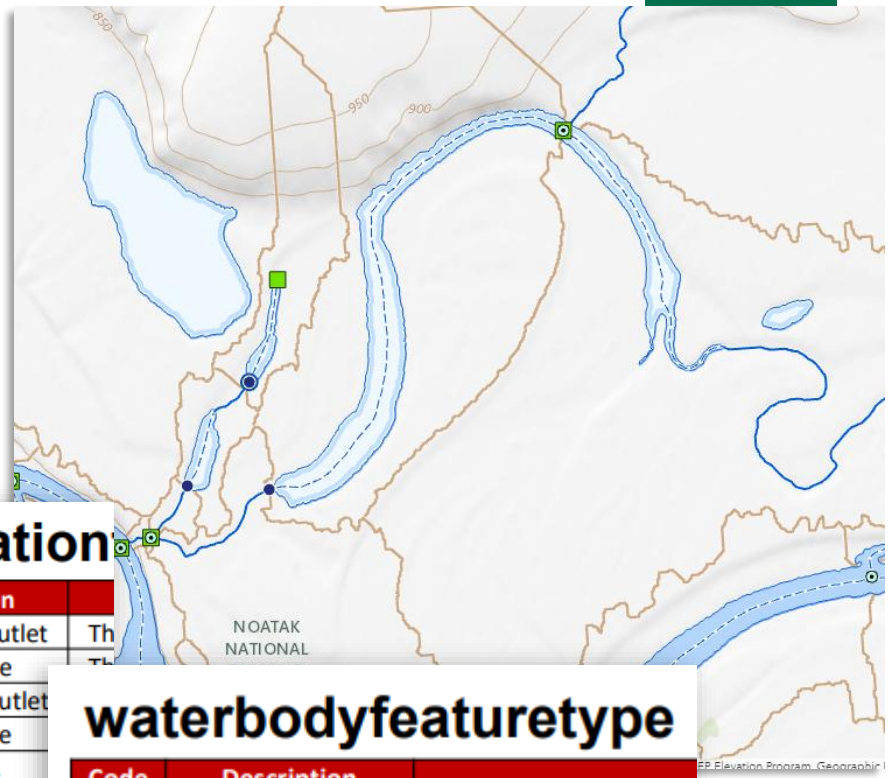
- Conflation of NHD to 3DHP data model
  - includes 95% of NHD features
  - 10% of feature types
- Feature type and GNIS name, Reachcode Start and End
- Features defined by representation on the elevation surface, not hydrologic characteristics
- Crosswalk of 107 feature types to:
  - 7 flowline (line) feature types
  - 11 hydrolocation (point) feature types
  - 4 waterbody (polygon)

flowlinefeaturetype

Code	Description	
1	River	Flowing body o from upstream
2	Canal	Flowing body o from upstream catchment.
3	Drainageway	Drainage pathw setting (headwa discernable cha
4	Surface Connector	Abstract surfac
5	Waterbody Connector	
6	Elevation Breaching Connector	
7	Hydro Unenforced Connector	

hydrolocation

Code	Description	
1	Catchment Outlet	Th
2	Confluence	
3	Waterbody Outlet	
4	Divergence	
5	Terminus	
6	Headwater	
7	Spring	
8	Sink	
9	External Connectio	
10	Reachcode Start	
11	Reachcode End	



waterbodyfeaturetype

Code	Description	
1	River	A body of flowing wate
2	Canal	A body of flowing wate catchment.
3	Lake	A body of standing wat ponds and reservoirs.
4	Ocean or Great Lake	A body of salt or fresh network features and a

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usgs.gov/3DHP/HydroProductSpecs

3DHP Data Model

Attribution – IDs

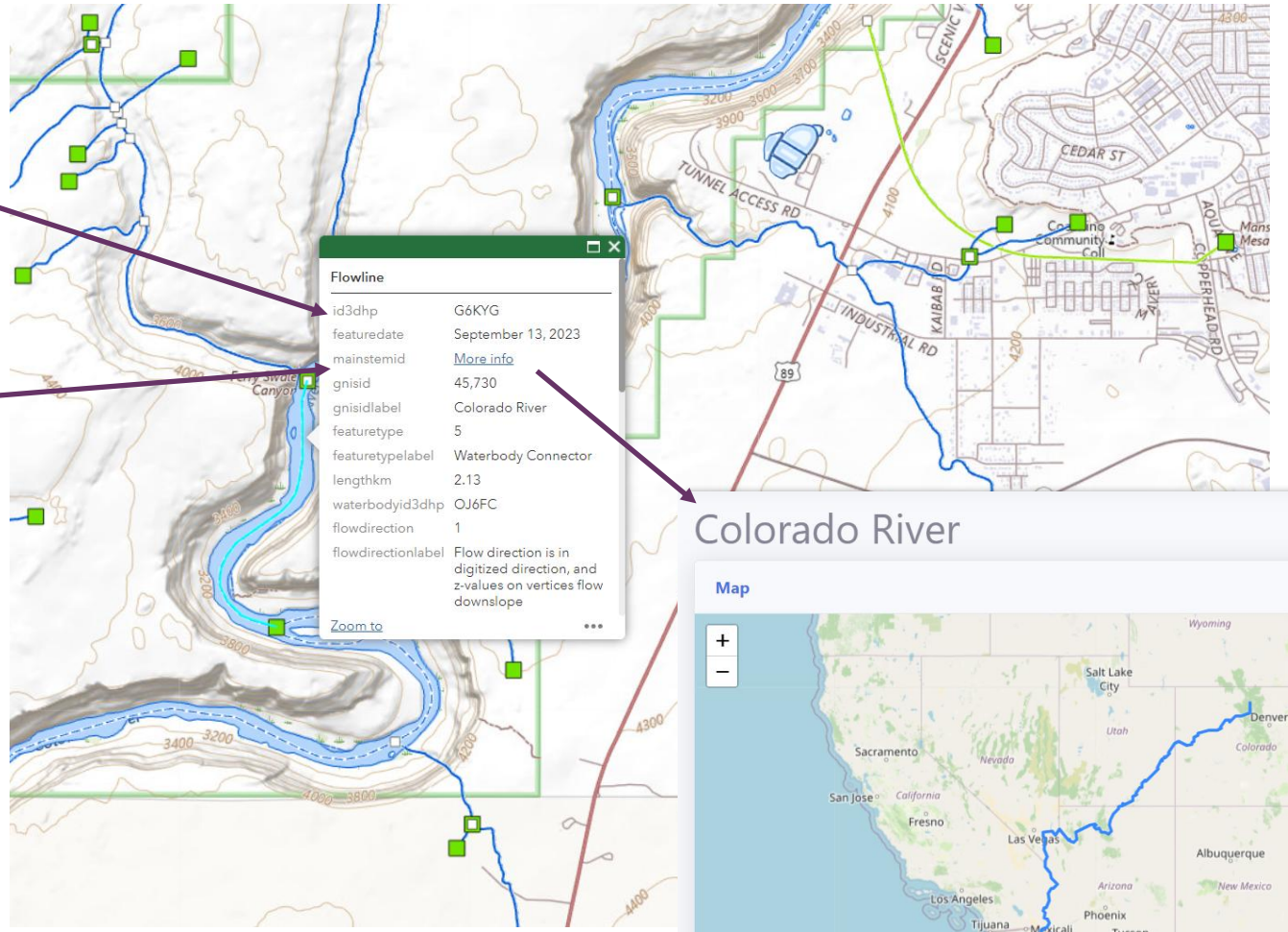
Id3dhp identifies an individual Segment:

- id3dhp identifies the individual flowline

Mainstem Identifier identifies entire river:

- Mainstemid identifies the entire length from headwater to confluence or outlet

- Provides connection to the Internet of Water



3DHP Data Model

Internet of water connection

- Through collaboration with the Internet of Water the 3DHP dataset follows and supports FAIR data principles
- **FAIR represents data that are Findable, Accessible, Interoperable, and Reusable**
- Geoconnex is a primary way that 3DHP is implementing a link to outside data sources

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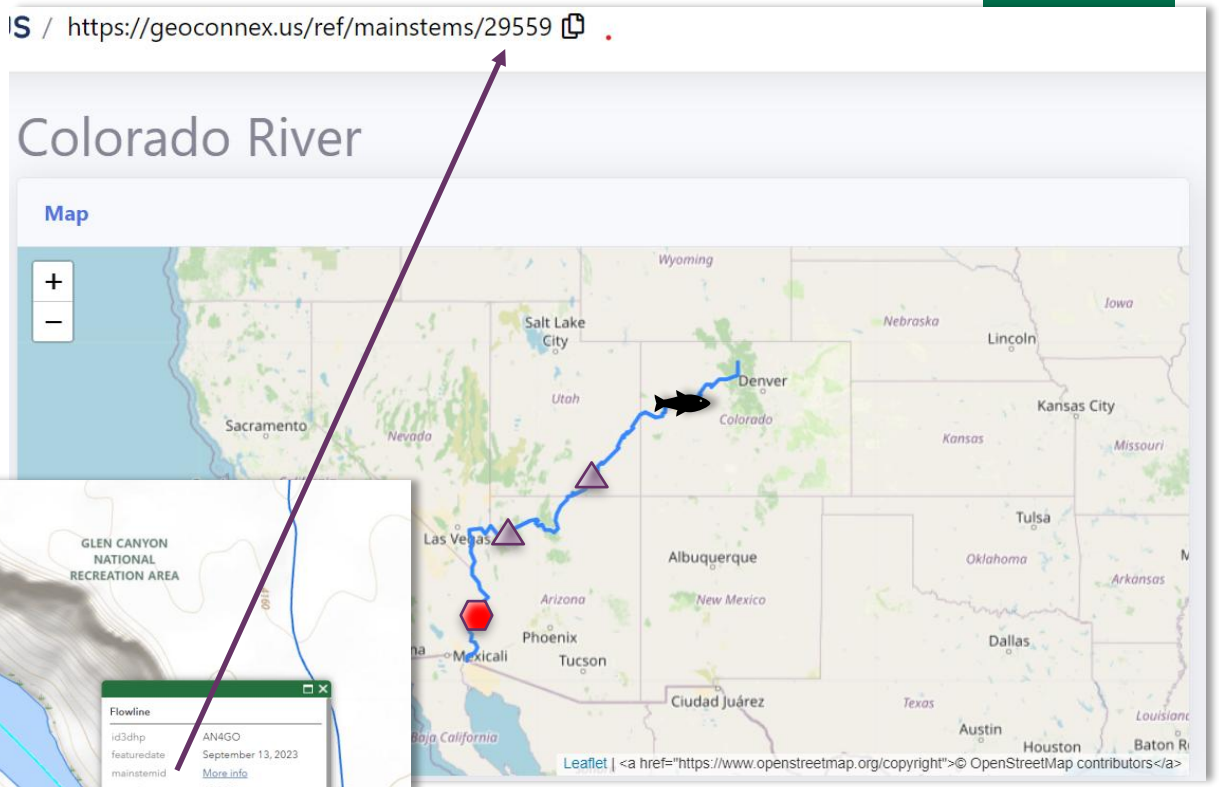
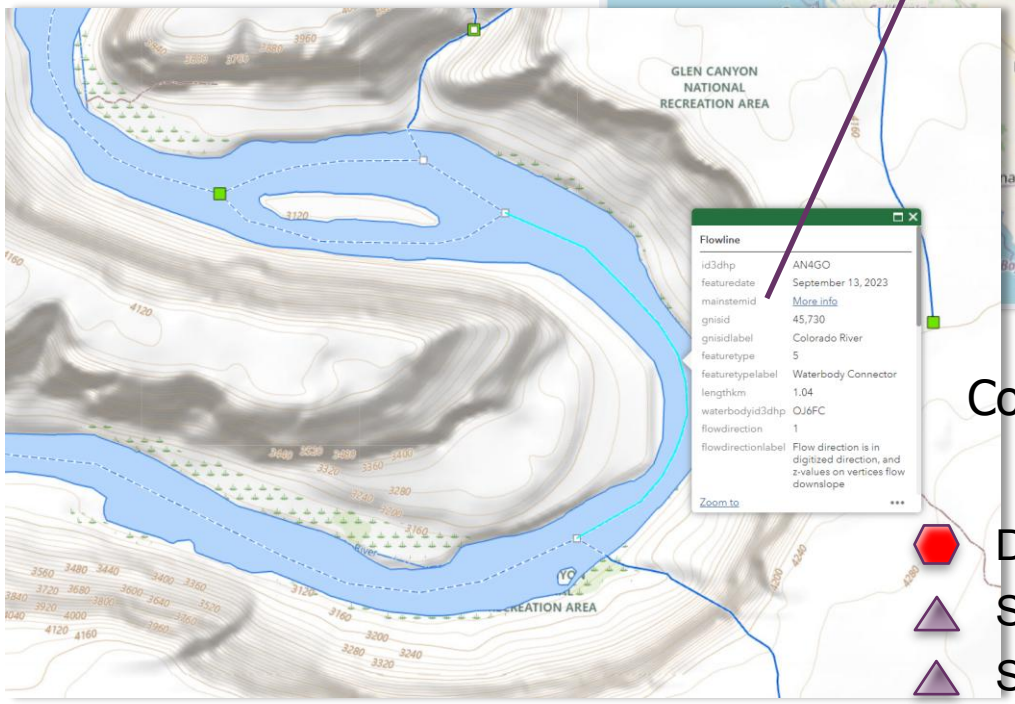
3DHP Products

Geoconnex, HydroAdd3d

Tools exist to:

- Permanently identify a river from headwater to outlet.
- Assign data points to a location on a mainstem
- Navigate and summarize features according the position on the network





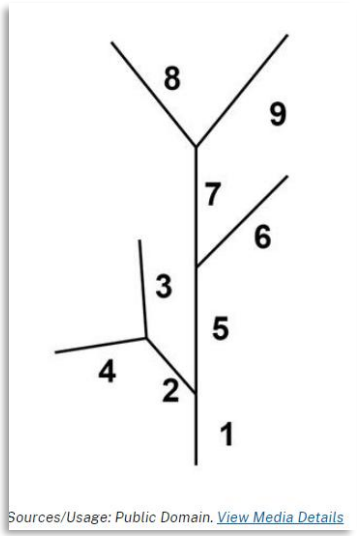
Colorado River: Mainstemid = 29559

- Discharge point, Mainstemid 29559, x, y, z
- Stream gage, Mainstemid 29559, x, y, z
- Stream gage, Mainstemid 29559, x, y, z
- Fish passage, Mainstemid 29559, x, y, z

3DHP Data Model

Attribution – Flowline Network Derivatives

flownetworkderivatives (table)- The flownetwork derivatives table contains information that relate flowlines to catchments and attributes that **support network navigation and flow analysis**.



Sources/Usage: Public Domain. View Media Details

streamlevel	StreamLevel is a numeric code that traces main pa water flow upstream through the drainage networ
startflag	Startflag is used to differentiate headwater feature non-headwater features.
terminalflag	Terminalflag is used to differentiate terminal flow from non-terminal flow features.
streamorder	Strahler stream order number for the flowline feat
streamcalculator	Further modification of streamorder created to ass tracking divergences and is computed with stream
hydrosequence	Nationally unique sequence number that places th hydrologic sequence.
dnhydrosequence	Downstream mainstem hydrologic sequence numb
uphydrosequence	Upstream mainstem hydrologic sequence number.
levelpath	Hydrologic sequence number of the most downstr feature that is on the same StreamLevel path as th feature according to the flownetwork table.

uplevelpath	Levelpath identifier of the feature on the main path immediately upstream.
dnlevelpath	Levelpath identifier of the feature on the main path immediately downstream.
pathlength	Distance to terminal flowline feature downstream along main path in kilometers using an equal area projection.
terminalpath	Hydrologic sequence number of terminal flowline of the basin the feature is in.
arbolatesum	The sum of the lengths of every upstream feature in the flownetwork, as well as the length of the current feature.
divergence	Indicates if a flowline feature is a diversion based on the divergencetype.
rtrndivergence	Indicates that one or more of the paths contributing to a given flowline originates in a divergence that recombines with its main path at the current flowline.

The 3DHP Data Lifecycle

Planning

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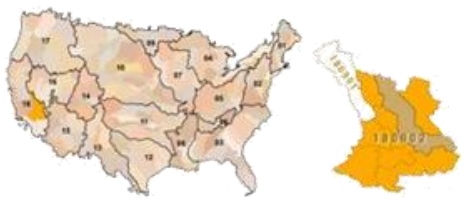
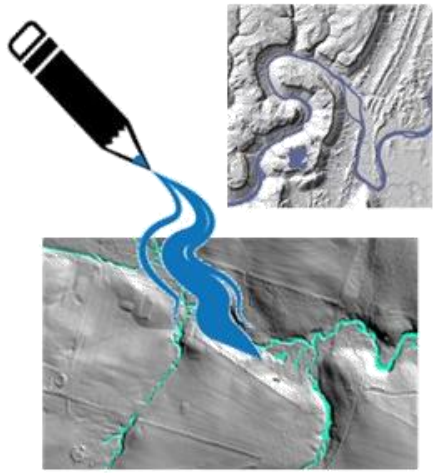


Acquisition

Contractors acquire and process data



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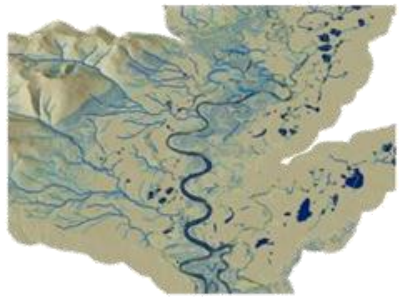

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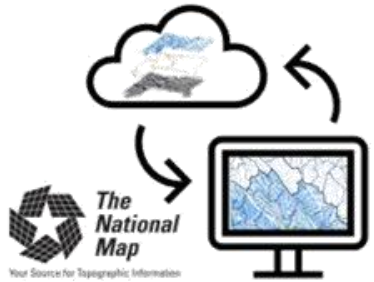

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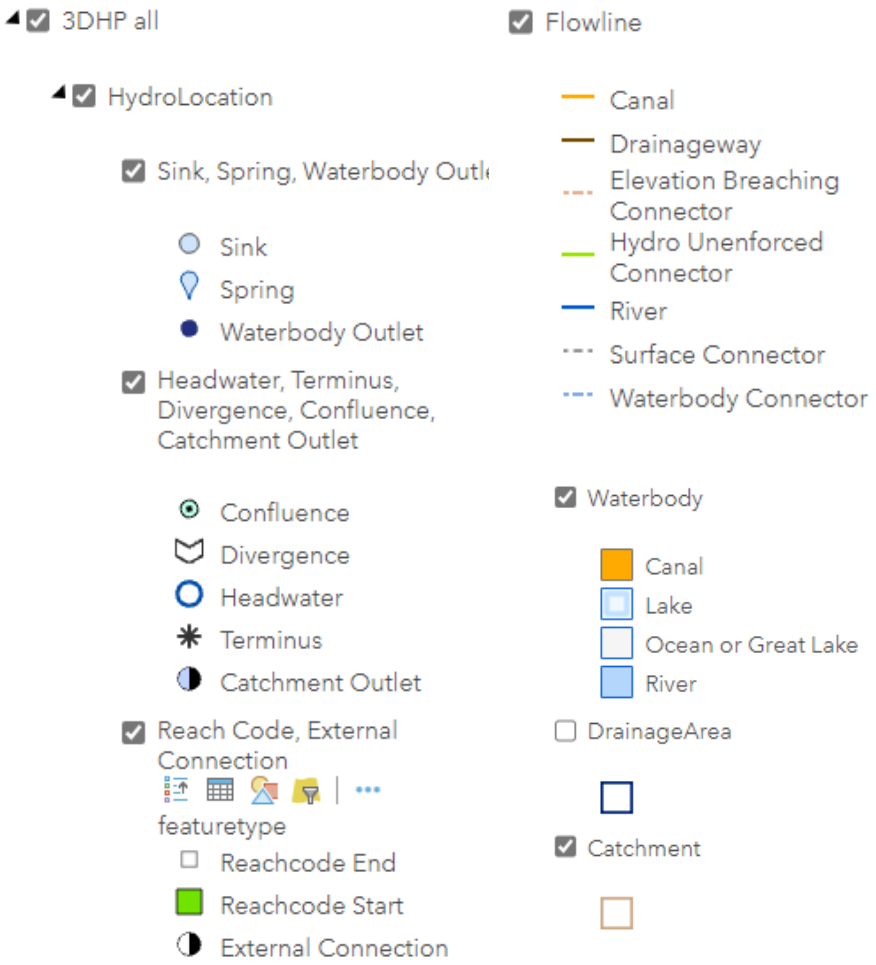
Access

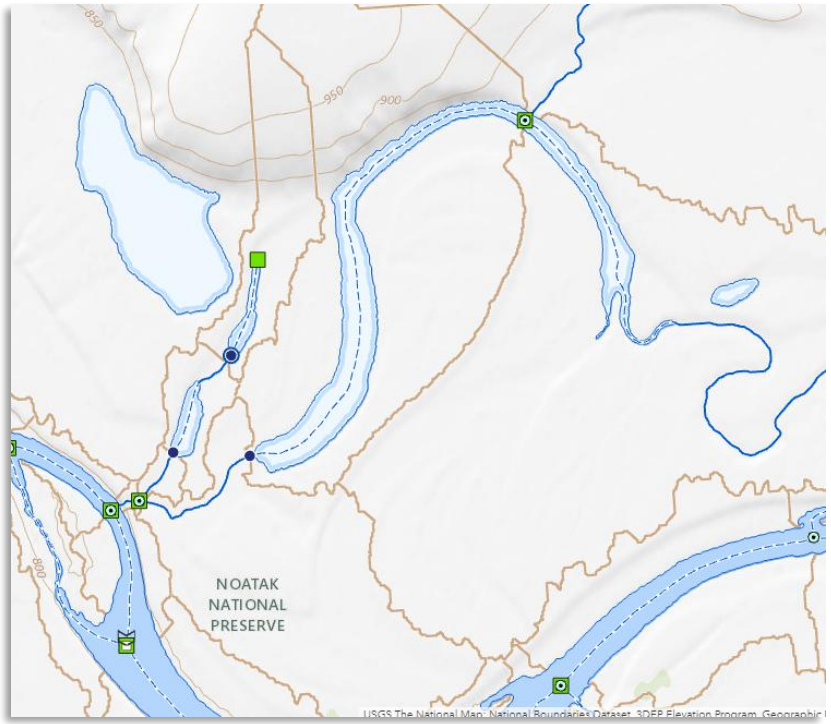
Users can download analysis ready data or access via map services

3DHP Products

Web services

- WMS (and soon a WFS) map service is available for visualizing and querying the 3DHP_all data.
- All data, NHD and Elevation-derived Hydrography sourced data provides National coverage





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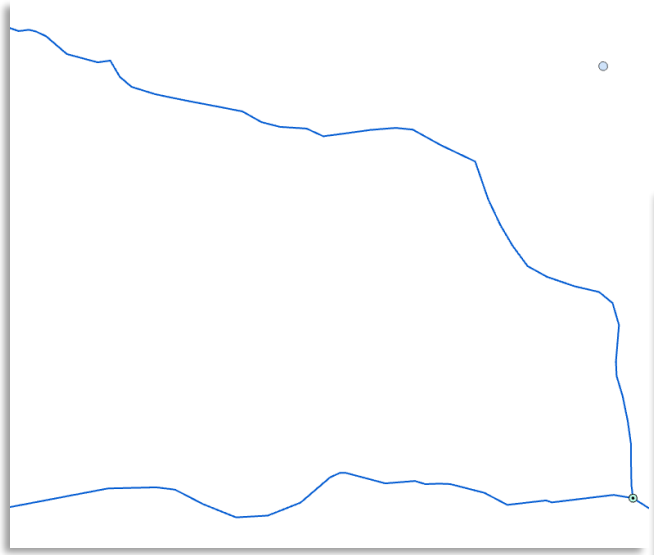
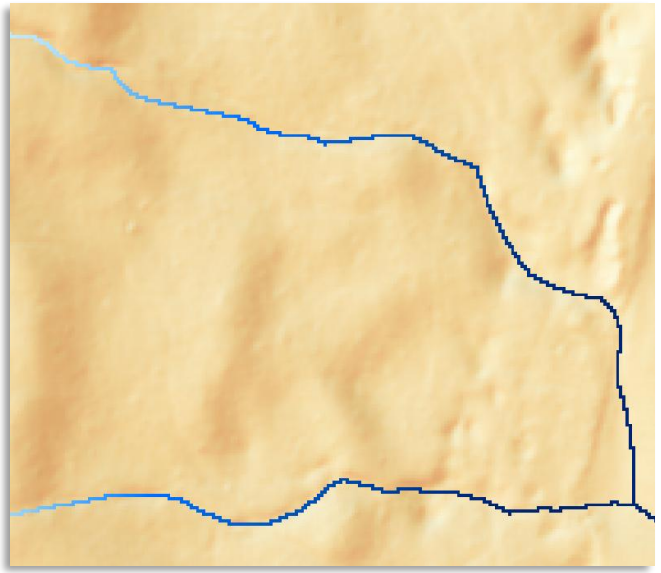
3DHP Products

Downloadable products – yearly snapshots

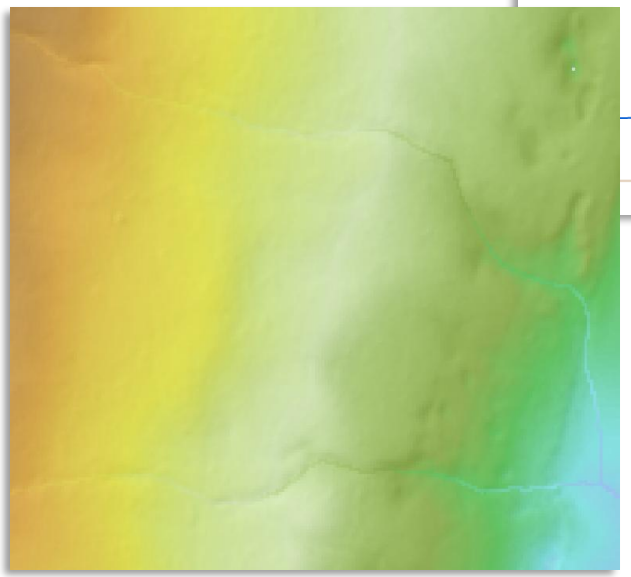
Annual release of products, identified with a digital object identifier (DOI) URL for reference and citation



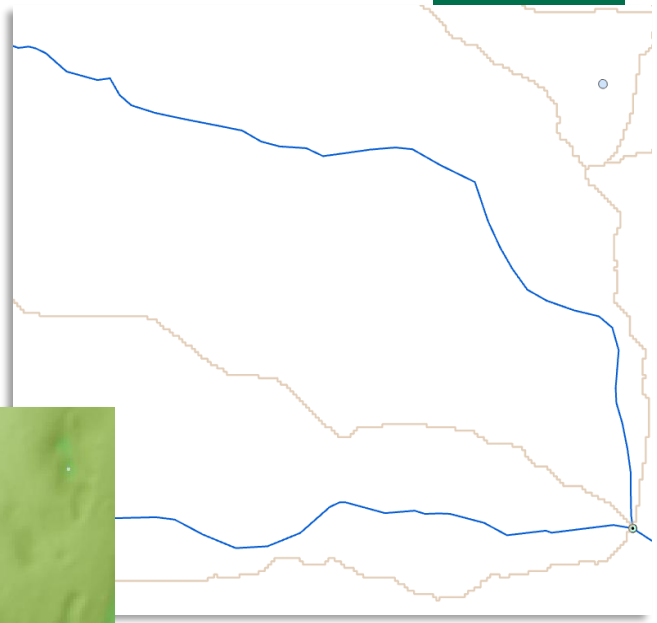
Hydrography features



Stream Raster with z-values



Hydro-enforced Elevation dataset

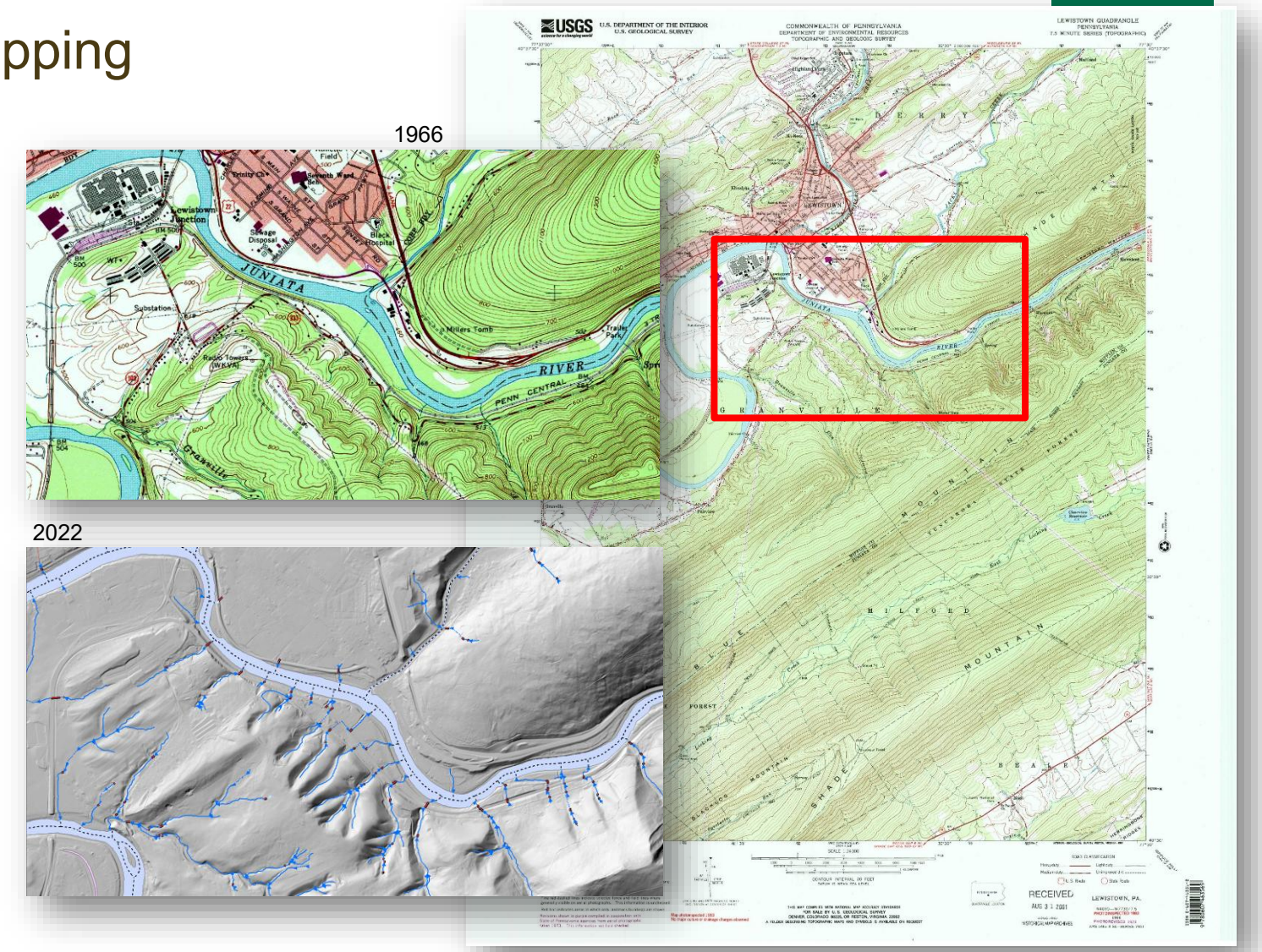


Catchments and Drainage areas

3D Hydrography Program

A new era for surface water mapping

3DHP is the first complete remapping of the Nation's hydrography since the original USGS 24K topographic mapping program was active between 1947 and 1992



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