

# Geoconnex.us: a standards-based framework to discover water data

Benjamin Webb  
Software Developer  
Internet of Water Project



LINCOLN INSTITUTE  
OF LAND POLICY



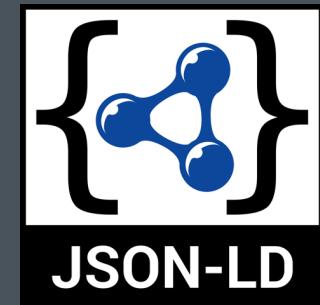
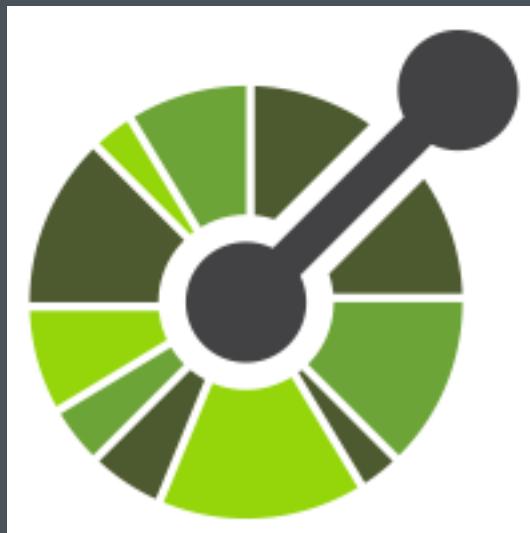
Internet  
of Water  
COALITION



CENTER FOR  
GEOSPATIAL  
SOLUTIONS

# Setting the stage: Standards, Interoperability, FOSS/4G

- W3C Spatial Data on the Web
- OpenAPI and Swagger
- OGC API



# What is geoconnex.us?

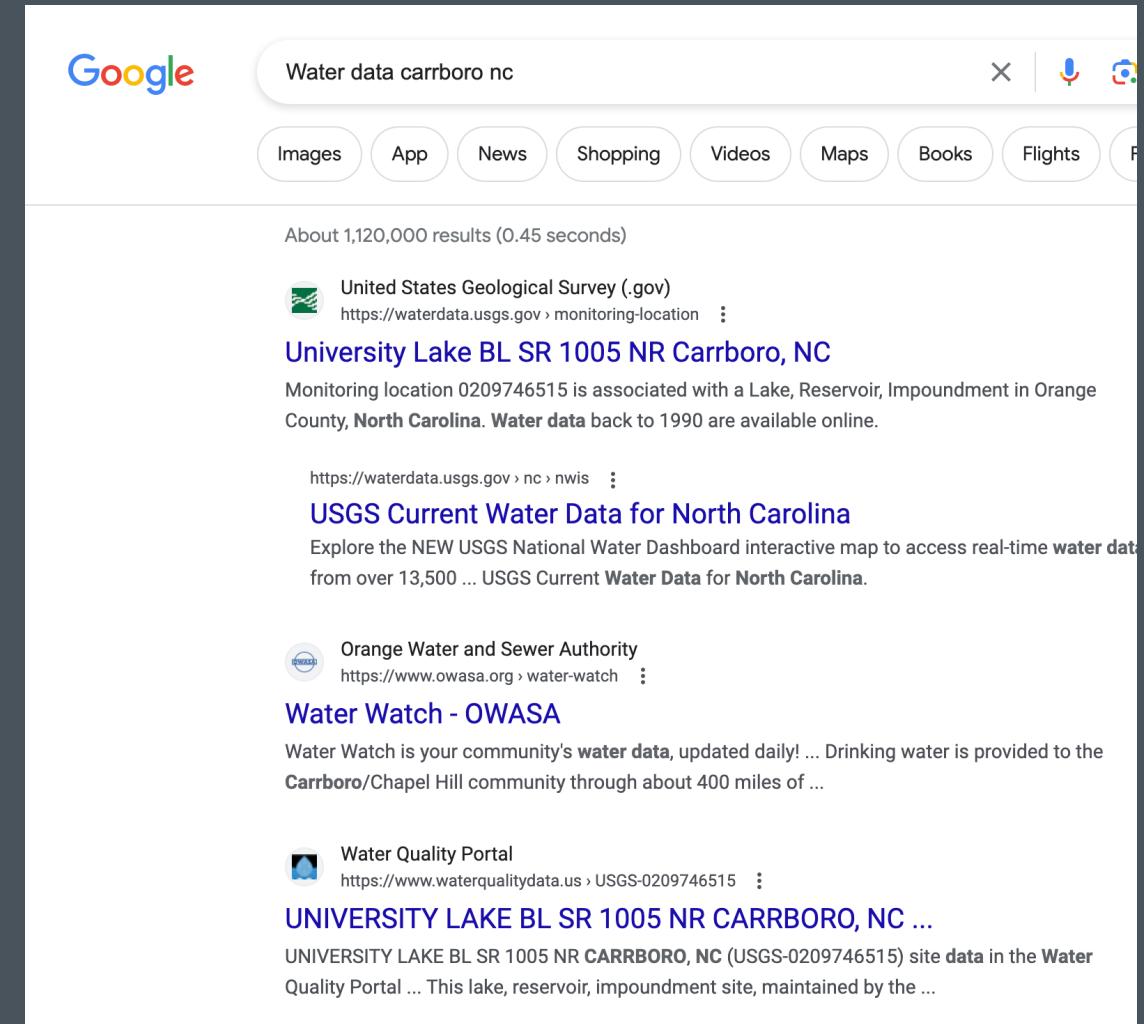
- A project providing guidance and best practices to make water data as easily discoverable, accessible, and as usable as possible
- A knowledge graph linking hydrologic features in the United States
- A community of practice made up of public agencies, academic institutions, community scientists, and the private sector



Image credit: Australian Research Data Commons

# Why geoconnex.us?

- An increasing number of web applications are providing open data
- A mix of structured and unstructured data, missing important topics and data providers



A screenshot of a Google search results page. The search query is "Water data carlboro nc". The results include:

- United States Geological Survey (.gov)**  
<https://waterdata.usgs.gov> › monitoring-location
- University Lake BL SR 1005 NR Carboro, NC**  
Monitoring location 0209746515 is associated with a Lake, Reservoir, Impoundment in Orange County, North Carolina. Water data back to 1990 are available online.
- USGS Current Water Data for North Carolina**  
Explore the NEW USGS National Water Dashboard interactive map to access real-time water data from over 13,500 ... USGS Current Water Data for North Carolina.
- Orange Water and Sewer Authority**  
<https://www.owasa.org> › water-watch
- Water Watch - OWASA**  
Water Watch is your community's water data, updated daily! ... Drinking water is provided to the Carrboro/Chapel Hill community through about 400 miles of ...
- Water Quality Portal**  
<https://www.waterqualitydata.us> › USGS-0209746515
- UNIVERSITY LAKE BL SR 1005 NR CARRBORO, NC ...**  
UNIVERSITY LAKE BL SR 1005 NR CARRBORO, NC (USGS-0209746515) site data in the Water Quality Portal ... This lake, reservoir, impoundment site, maintained by the ...

## The Present

# Why geoconnex.us?

Google movies carboro nc

Images Best Maps News Shopping Videos Books Flights Finance

Results for Carrboro, NC · Choose area :

### Movies playing

Movie Title	Rating	Runtime	Genre	Description
The Flash	(PG-13 (USA))	2...	Action/Advent...	
Indiana Jones and the Dial o...	(PG-13 (USA))	2...	Adventure/Ac...	
Elemental	(PG)	1h 49m	Animation/Ad...	
Spider-Man: Across the S...	(PG)	2h 20m	Action/Advent...	
No Hard Feelings	(R)	1h 43m	Comedy/Origi...	
Transformers: Rise of the B...	(PG-13 (USA))	2...	Action/Sci-fi	

Cinema Clock  
<https://www.cinemaclock.com> nc > carboro > theatres

### Movie Theatres in Carrboro, NC - Cinemas

Varsity Theatre Cha... Lumina Theater Cha... Silverspot Chapel Hill Regal Timberlyne C...

Google weather data carboro nc

Images News Shopping Videos Maps Books Flights Finance

About 1,480,000 results (0.55 seconds)

Results for Carrboro, NC · Choose area :

72 °F | °C Precipitation: 15%  
Humidity: 91% Wind: 4 mph

Temperature | Precipitation | Wind

Time	Temp (°F)	Precipitation	Wind (mph)
10 AM Fri	79°	65%	
1 PM Fri	84°	65%	
4 PM Fri	89°	67%	
7 PM Fri	89°	65%	
10 PM Fri	86°	65%	
1 AM Sat	83°	63%	
4 AM Sat	84°	65%	
7 AM Sat	86°	68%	
10 AM Sat	75°	65%	
1 PM Sat	78°	65%	
4 PM Sat	77°	65%	
7 PM Sat	72°	65%	
10 PM Sat	69°	65%	
1 AM Sun	67°	65%	
4 AM Sun	66°	65%	

[weather.com](http://weather.com) · Feedback

### Carrollton, NC Weather History

10-51 AM 72° F 60° F 07° W 01W 6° mph 0° mph 00.74 in. 0.0 in. Cloudy 1-51 AM 72

# ... also The Present

# Why geoconnex.us?

Data that...

- is structured and interlinked with other relevant data
- is spatially indexed and topically organized
- does not require knowledge of water data providers

The screenshot shows a Google search results page with the query "Water data carrboro nc" in the search bar. The results are organized into several sections:

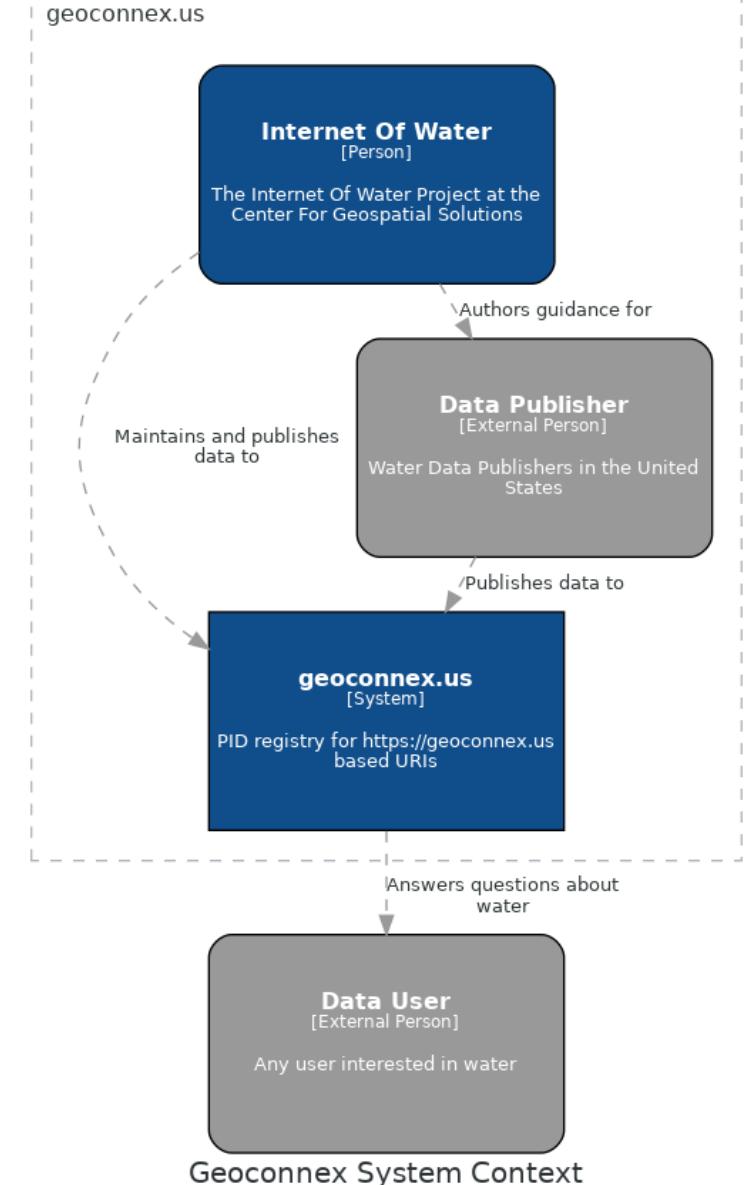
- Water data relevant to Carrboro, NC, 27510. Morgan Creek Watershed**: This section contains five cards: Stream-flow, Precipitation, Water Quality, Drinking Water Quality, and Water Use.
- Streamflow near Carrboro NC**: This section lists three data sources:
  - USGS Gages**: Includes links to [Morgan Creek](#) and [Booker Creek](#).
  - NC Department of Emergency Mgmt Gages**: Includes links to [Station 1234B](#) and [Station 45x](#).
  - Orange Water and Sewer Authority Gages**: Includes a link to [OWASA University Lake](#).

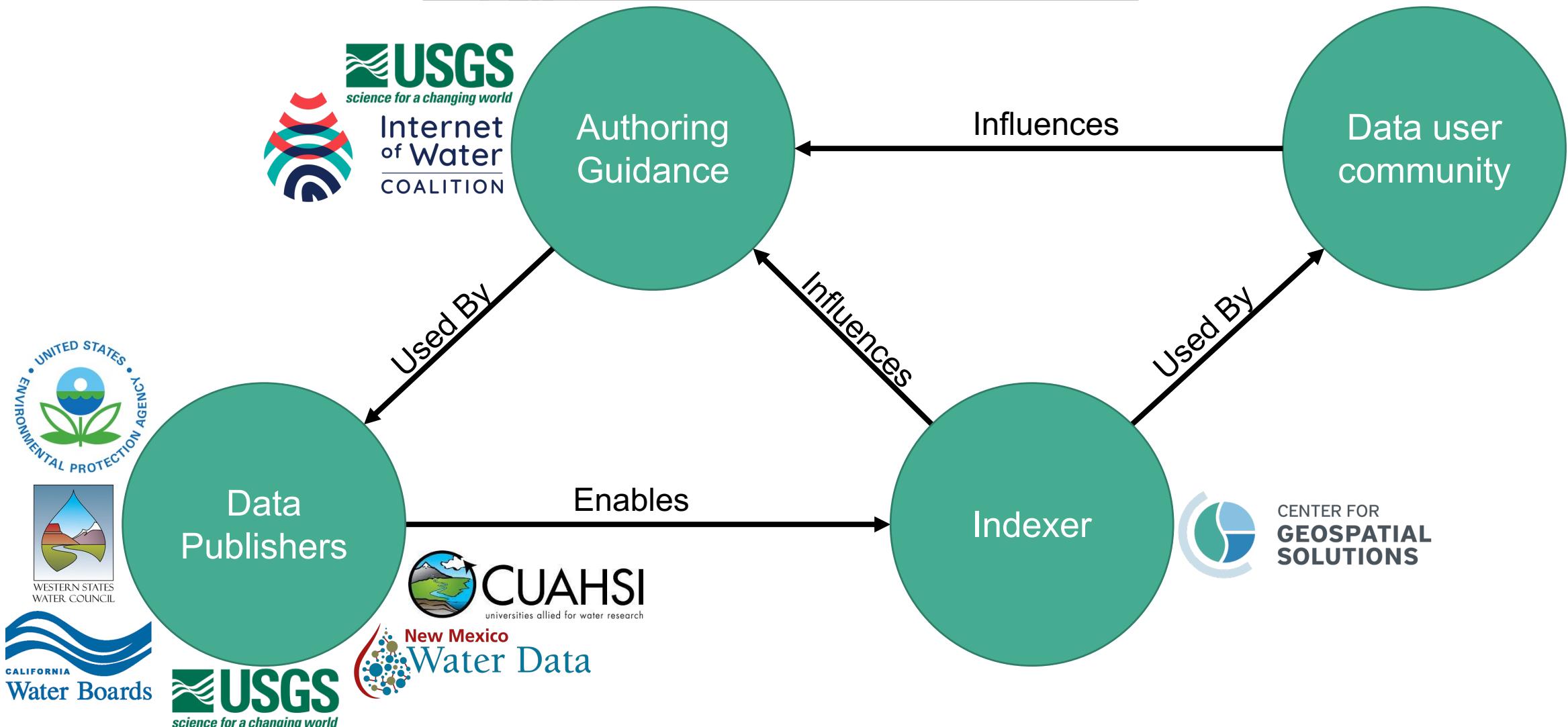
## The Vision

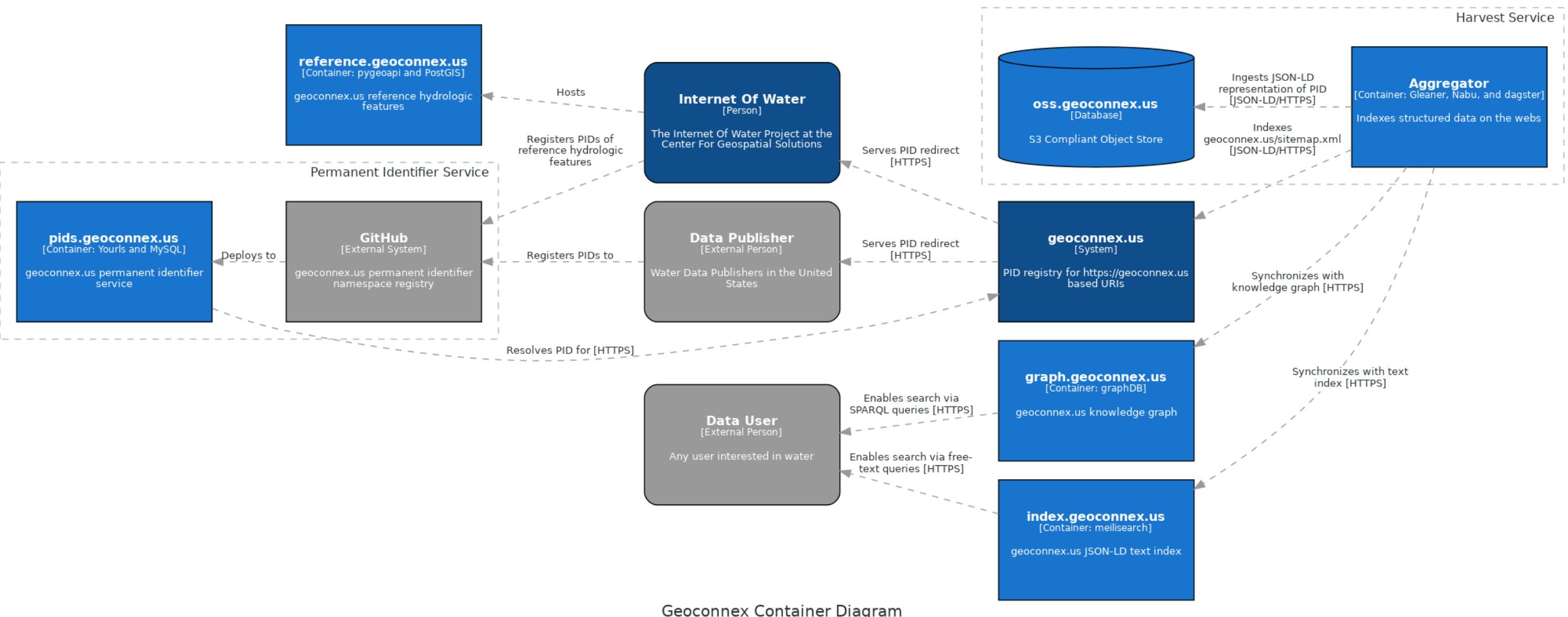
# The Big Picture

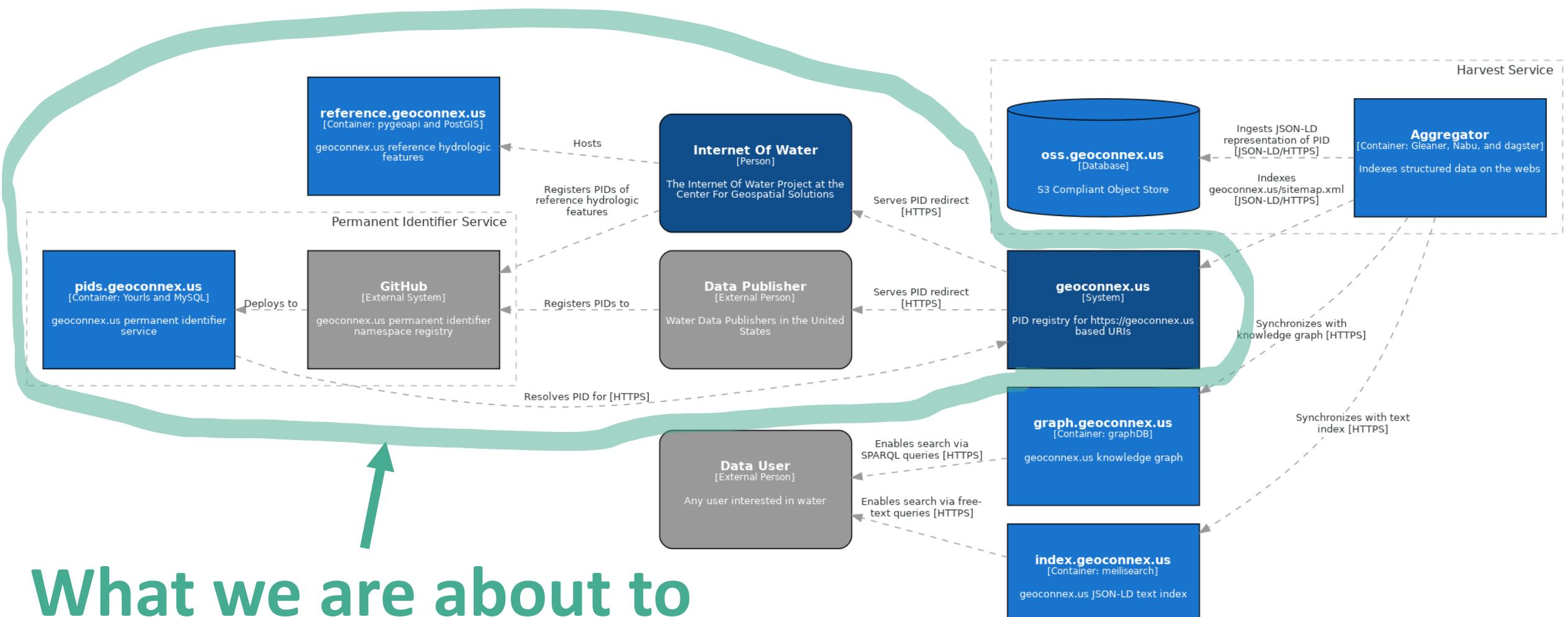
The **Internet of Water Coalition** is a network of organizations building foundational water data infrastructure across the US to support better water data for better water decisions

- IoW supports geoconnex.us by hosting services, creating reference hydrologic features, and authoring guidance to data publishers
- External publishers include data providers, such as federal, state, and local water agencies, who contribute hydrologic data to the system
- Data consumers, including scientists, researchers, and application developers, can access and retrieve relevant water data from geoconnex.us









# What we are about to cover

Geoconnex Container Diagram

# Implementation: Persistently Identified Real World Objects

Persistently identifiable community *reference features* (e.g. watersheds, mainstems, dams, bridges, etc.) which many organizations may collect and publish data about

GEOCONNEX.US Home / Collections / Reference Mainstems / Items / Item 29559

JSON JSON-LD

Home

RESOURCES

Collections

DOCUMENTATION

API Definition

Conformance

## Item 29559

Map

The map displays a blue line representing the mainstem, starting from the headwaters in Wyoming and flowing south through Colorado, Arizona, and California, ending near San Diego. Major cities like Denver, Phoenix, and Los Angeles are labeled along the river. The map also shows state boundaries and other geographical features.

Property	Value
id	29559
fid	25439
outlet_nhdpv2huc12	150301070200
outlet_2020huc12	150301070200
featuretype	[{"https://www.opengis.net/def/schema/hydrography#Mainstem"}]
uri	<a href="https://geoconnex.us/ref/mainstems/29559">https://geoconnex.us/ref/mainstems/29559</a>
downstream_mainstem_id	
lengthkm	2137.5
superseded	False
encompassing_mainstem_basin	

Previous Next

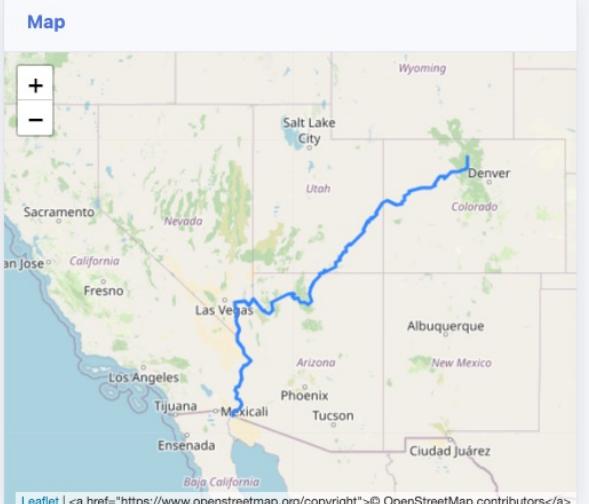
<https://reference.geoconnex.us/>  
via pygeoapi

# Implementation: Persistently Identified Locations including Structured Data

Home / Collections / Reference Mainstems / Items / Item 29559 JSON-LD

## Item 29559

**Map**



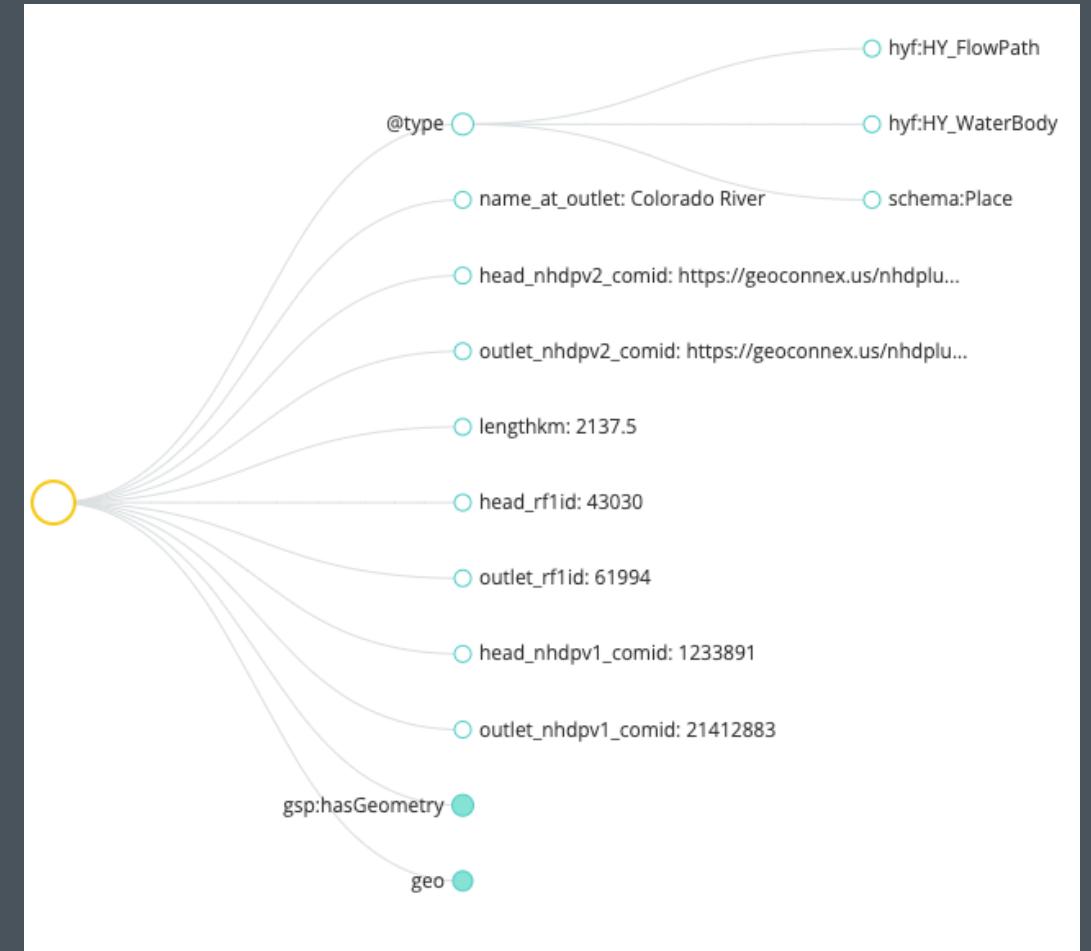
The map displays the Colorado River's course from its headwaters in the Rocky Mountains through states like Wyoming, Colorado, and Arizona, ending in the Gulf of California. Major cities like Salt Lake City, Denver, and Phoenix are labeled. The river is shown in blue, with its tributaries in green.

Leaflet | <a href="https://www.openstreetmap.org/copyright">© OpenStreetMap contributors</a>

Previous Next

**Service provided by:** Team geoconnex  
**Address:** 113 Brattle St, Cambridge, Massachusetts 02138 USA  
**Email:** konda@lincolninst.edu  
**Web:** https://internetofwater.org  
**Terms of service:** https://creativecommons.org/licenses/by/4.0/  
**License:** CC-BY 4.0 license  
**Powered by:** pygeoapi 0.15.dev0

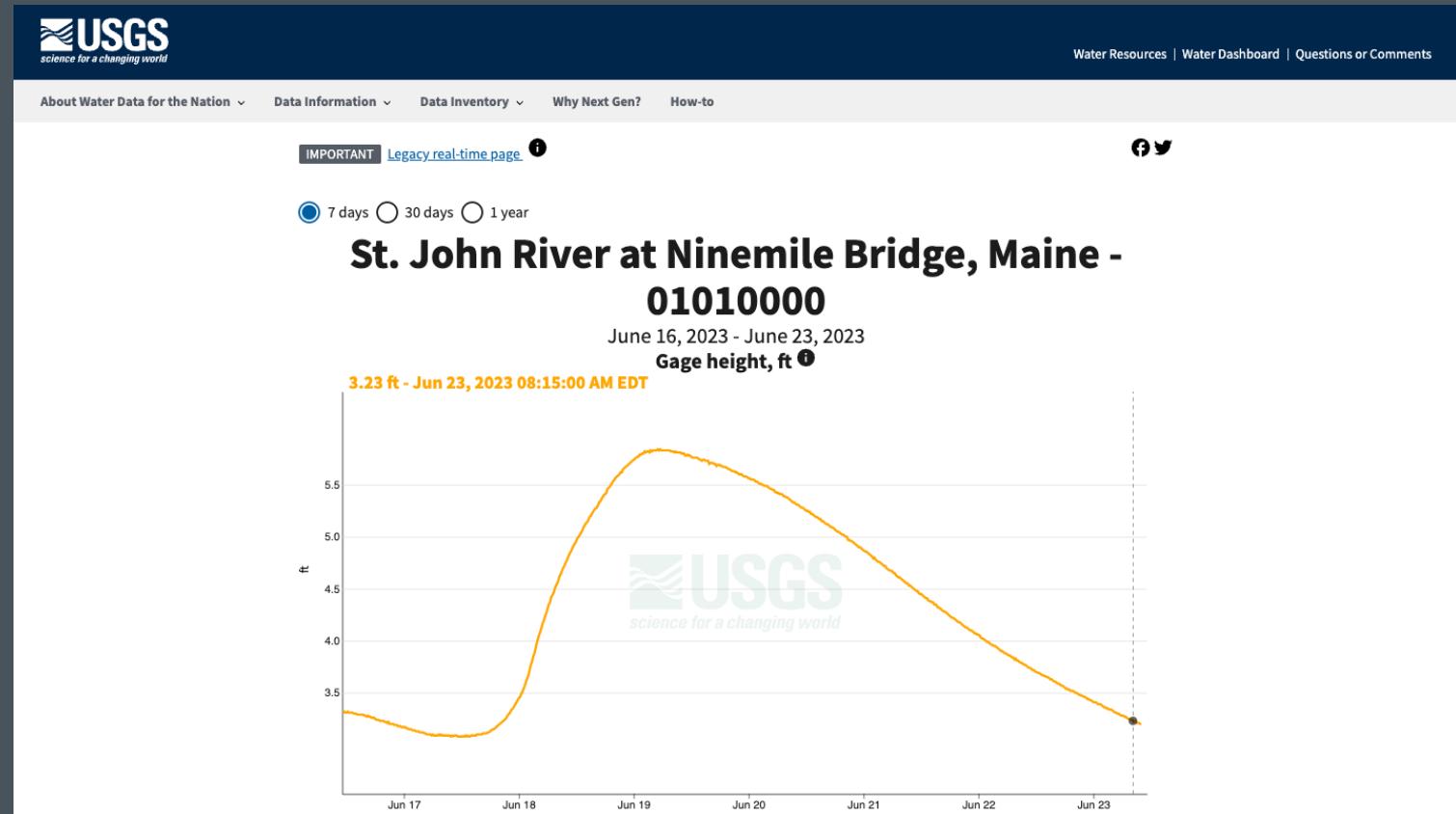
```
$>
<script src="https://unpkg.com/leaflet@1.3.1/dist/leaflet.js"></script>
<script type="application/ld+json">
{
  "@context": [
    {
      "schema": "https://schema.org/",
      "gsp": "http://www.opengis.net/ont/geosparql#",
      "wiki": "https://www.wikidata.org/wiki/",
      "hyf": "https://www.opengis.net/def/schema/hy_features/hyf"
    },
    {
      "name_at_outlet": "schema:name",
      "superseded_by_mainstem": {
        "@id": "schema:supersededBy",
        "@type": "id"
      },
      "head_nhdpv2_comid": {
        "@id": "wiki:Property:P885",
        "@type": "id"
      },
      "outlet_nhdpv2_comid": {
        "@id": "wiki:Property:P403",
        "@type": "id"
      },
      "head_nhdpv2huc12": {
        "@id": "wiki:Property:P885",
        "@type": "id"
      },
      "outlet_nhdpv2huc12": {
        "@id": "wiki:Property:P403",
        "@type": "id"
      },
      "lengthkm": "https://www.wikidata.org/wiki/Property:P2043",
      "outlet_drainagearea_sqkm": "https://www.wikidata.org/wiki/Property:P2053",
      "downstream_mainstem_id": {
        "@id": "hyf:downstreamWaterbody",
        "@type": "id"
      },
      "encompassing_mainstem_basin": {
        "@id": "hyf:encompassingCatchment",
        "@type": "id"
      },
      "geo": "schema:geo"
    }
  ],
  "@id": "https://geoconnex.us/ref/mainstems/29559",
  "@type": "schema:Place"
}
</script>
```



Viewed in JSON-LD Playground

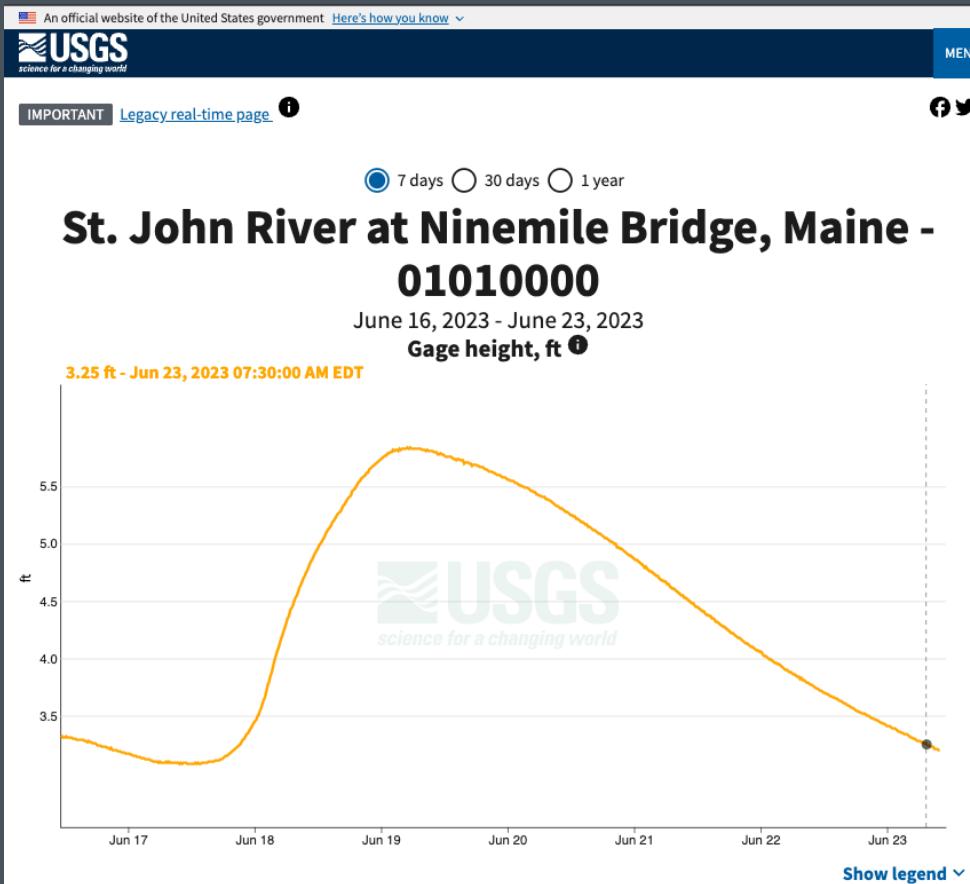
# Implementation: Persistently Identified Organizational Monitoring Locations

Persistently identifiable organizational *features* owned and published by a particular entity or from a specific dataset



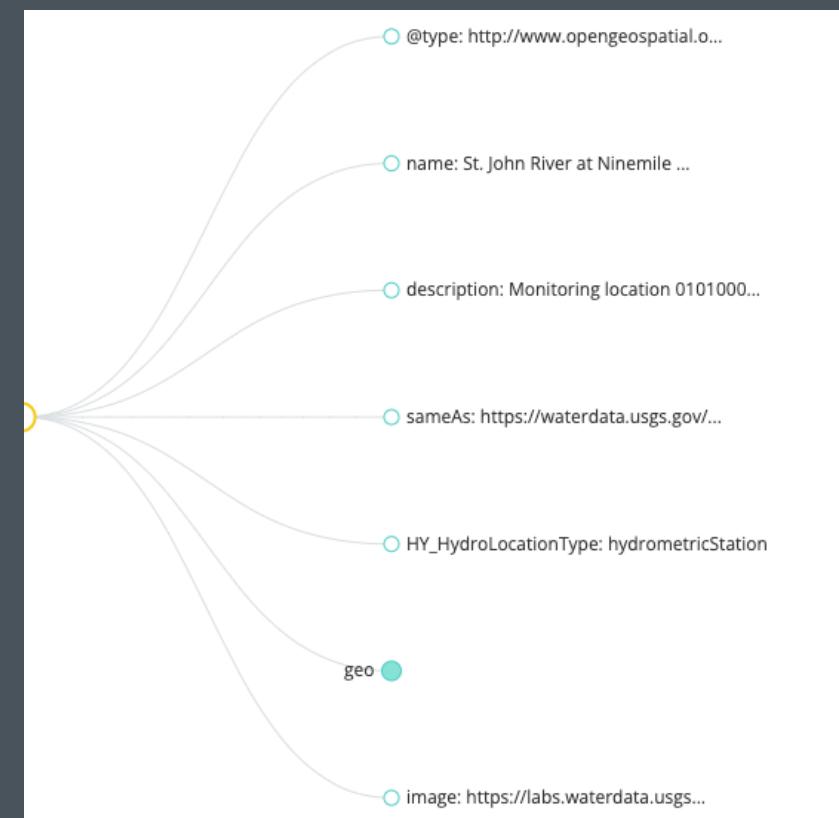
<https://geoconnex.us/usgs/monitoring-location/01010000>

# Implementation: Persistently Identified Locations including Structured Data



Elements >> 1 4 ⋮ X

```
<title>...</title>
<script src="/nwisweb/wsgi/static/scripts/uswds-init.js">
<link rel="stylesheet" href="/nwisweb/wsgi/static/initial.css">
<script type="application/javascript">...</script>
<script type="application/ld+json">
...
{
  "@context": ["https://opengeospatial.github.io/waterml2/context.jsonld"],
  "@id": "https://waterdata.usgs.gov/monitoring/location/01010000",
  "@type": "http://www.opengeospatial.org/standards/waterml2#HydroLocation",
  "name": "St. John River at Ninemile Bridge, Maine",
  "description": "Monitoring location 01010000 in Aroostook County, Maine. Current conditions of Discharge and Water Level are available. Water data back to 1950 are available.",
  "sameAs": "https://waterdata.usgs.gov/nwis/location/01010000",
  "HY_HydroLocationType": "hydrometricStation",
  "geo": {
    "@type": "schema:GeoCoordinates",
    "latitude": "46.70055556",
    "longitude": "-69.7155556"
  },
  "image": "https://labs.waterdata.usgs.gov/api/location/01010000/?parameterCode=00065"
} == $0
```



# Structured Data with pygeoapi

Out of the box, pygeoapi supports publishing structured data on a feature level – everything needed to publish structured data in the geoconnex.us ecosystem

The screenshot shows a web browser window displaying a pygeoapi item page. The URL is <https://demo.pygeoapi.io/master/collections/obs/items/371>. The page has a header with the pygeoapi logo and navigation links for Home, Collections, Observations, Items, and Item. Below the header is a map showing a green area with a blue location pin. To the right of the map is a table with columns 'Property' and 'Value'. The table contains the following data:

Property	Value
id	371
stn_id	35
datetime	2001-10-30T14:24:55Z
value	89.9

Below the table is a 'Links' section with the following items:

- [The landing page of this server as JSON \(application/json\)](#)
- [The landing page of this server as HTML \(text/html\)](#)
- [This document as GeoJSON \(application/geo+json\)](#)
- [This document as RDF \(JSON-LD\) \(application/ld+json\)](#)
- [This document as HTML \(text/html\)](#)
- [Observations \(application/json\)](#)

On the far right, the browser's developer tools are open, specifically the Elements tab. It shows the JSON-LD serialization of the data. The JSON-LD includes schema.org properties like 'id', 'stn\_id', 'datetime', and 'value', along with geo properties like 'geometry' (a point at -75.0, 45.0) and 'hasGeometry' (a wktLiteral POINT (-75 45)). It also includes links to the JSON and HTML versions of the document.

# Indexing data to CUASHI HydroShare

- Data stewards can annotate what reference features their datasets are about
- Future researchers can find what data already exists about a feature of interest

**Related Geospatial Features**

This HydroShare resource is linked to the following geospatial features [1](#)

**Geoconnex, through the Internet of Water:** This field allows you to relate this resource to overlapping geospatial features in order to increase the FAIRness and discoverability of your data. Below, collections of reference features within the United States are provided. Search these collections to find features that overlap with your data, or provide a URL that resolves to a geospatial feature not yet in the Geoconnex collections.

[Learn more about Related Geospatial Features](#)

1. Choose a collection to search... [Ten-digit Watersheds \(hu10\)](#)

Feature options for step #2 have been limited to the collection you selected here

2. Select related features to add to resource metadata

- B. Everett Jordan Dam - Saddle Dike 1 [dams/10983...]
- B. Everett Jordan Dam - Saddle Dike 3 [dams/10983...]
- B. Everett Jordan Dam - Saddle Dike 2 - B. Everett Jor...
- Governors Club Dam #3 [dams/1018562]
- North Carolina [states/37]
- Durham, NC [ua10/25228]
- B. Everett Jordan Dam - Saddle Dike 4 [dams/10983...]
- Piedmont and Blue Ridge crystalline-rock aquifers [pr...

- Hide Map [Q Search using visible map bounds](#)

Cane Creek-Haw River [hu10/0303000205]  
https://geoconnex.us/ref/hu10/0303000205

+ Add Feature

Select a feature for more information.

# Permanent Identifier Service

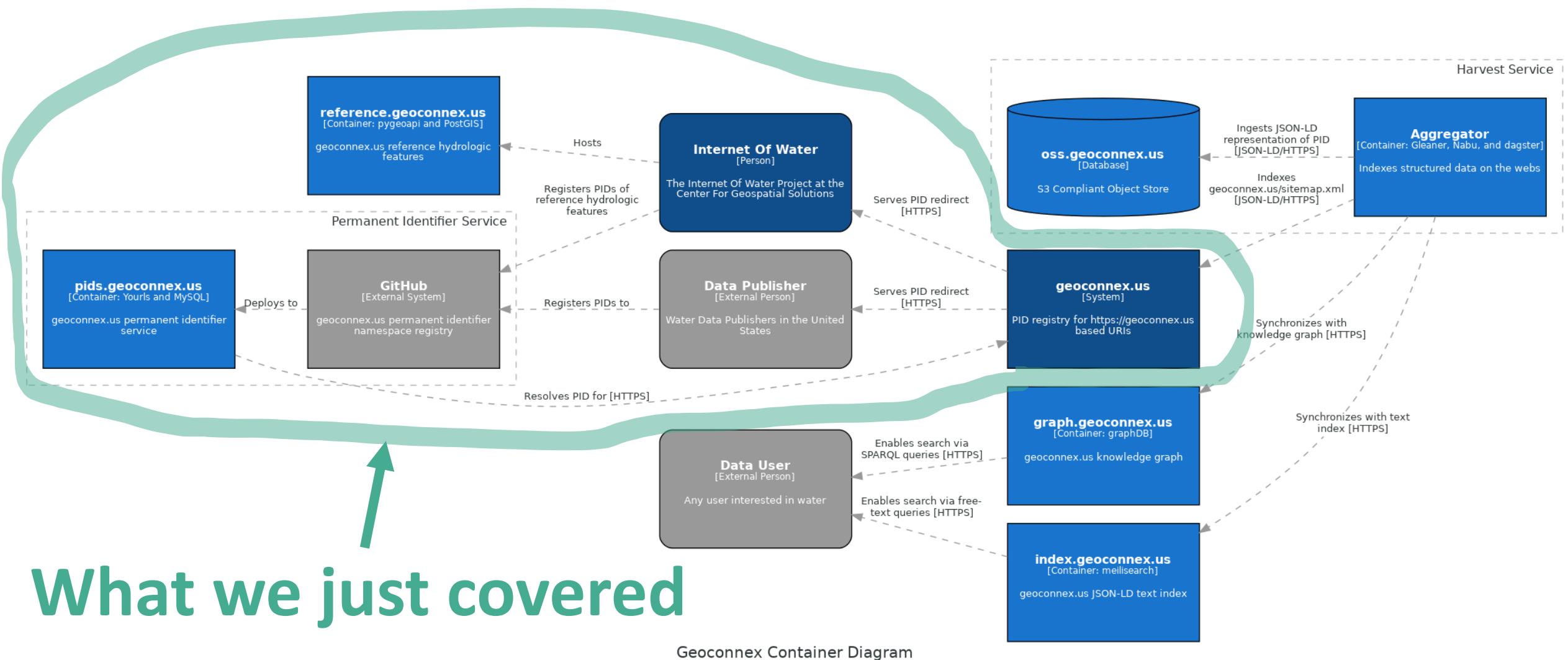
 GEOCONNEX.US

Target (URL) e.g. usgs.gov Persistent Identifier (URI) e.g. usgs Register PID

Target (URL)	Persistent Identifier (URI)	Date	Clicks	Actions
/wqp/([-a-zA-Z0-9_/.]+).*\$	WQP Sites https://www.waterqualitydata.us/provider/\$1	Jun 08, 2023 18:44	0.0.0.0	0
/wade/sites/([-a-zA-Z0-9_/.]+).*\$	WaDE Sites https://westdaatqa.westernstateswater.org/details/site/\$1	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21020002	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21020002	Jun 08, 2023 18:44	0.0.0.0	3
usgs/hydrologic-unit/21020001	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21020001	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/210200	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/210200	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/2102	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/2102	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21010006	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21010006	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21010005	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21010005	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21010004	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21010004	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21010003	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21010003	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21010002	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21010002	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/210100	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/210100	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/2101	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/2101	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/21	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/21	Jun 08, 2023 18:44	0.0.0.0	0
usgs/hydrologic-unit/20070000	hydrologic units in waterdata.usgs.gov https://waterdata.usgs.gov/hydrological-unit/20070000	Jun 08, 2023 18:44	0.0.0.0	0

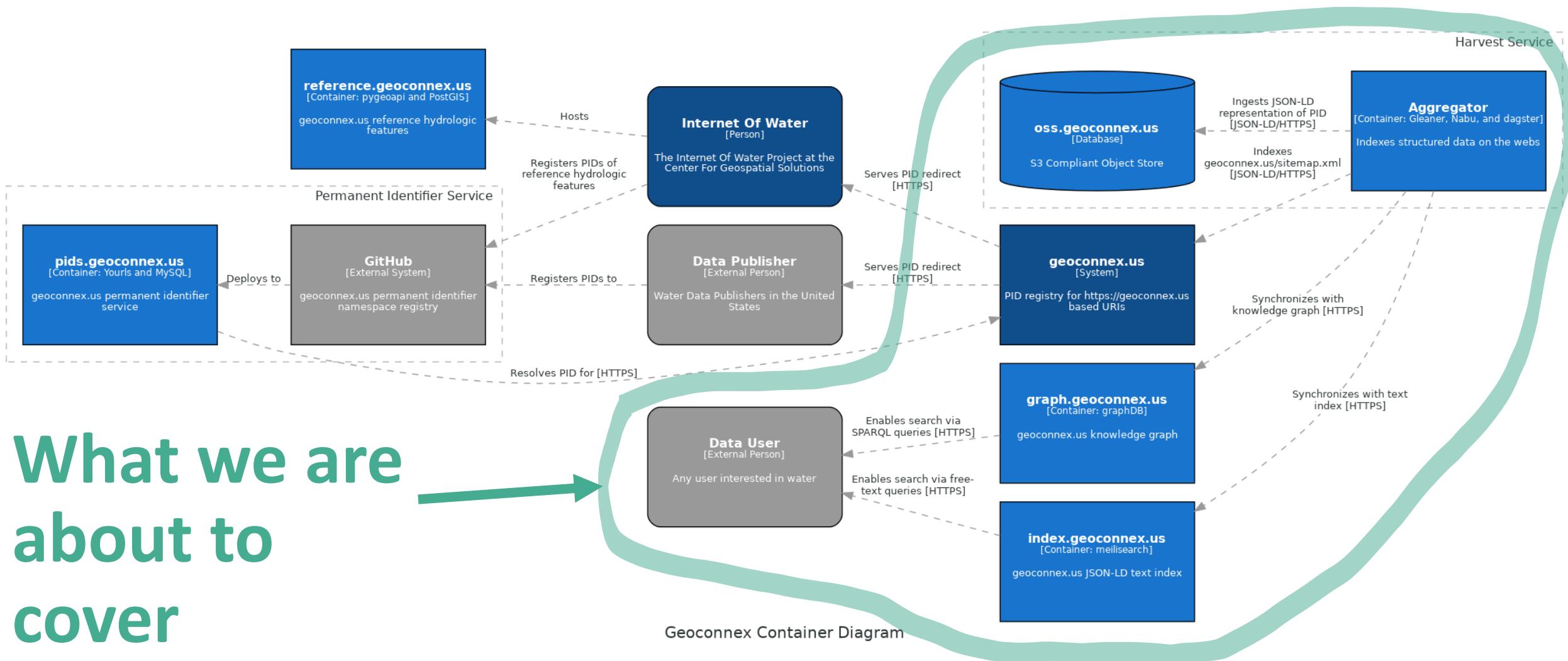
Search for  in All fields     15165 pages      ...

Running on YOURLS v 1.9.2 & Sleeky

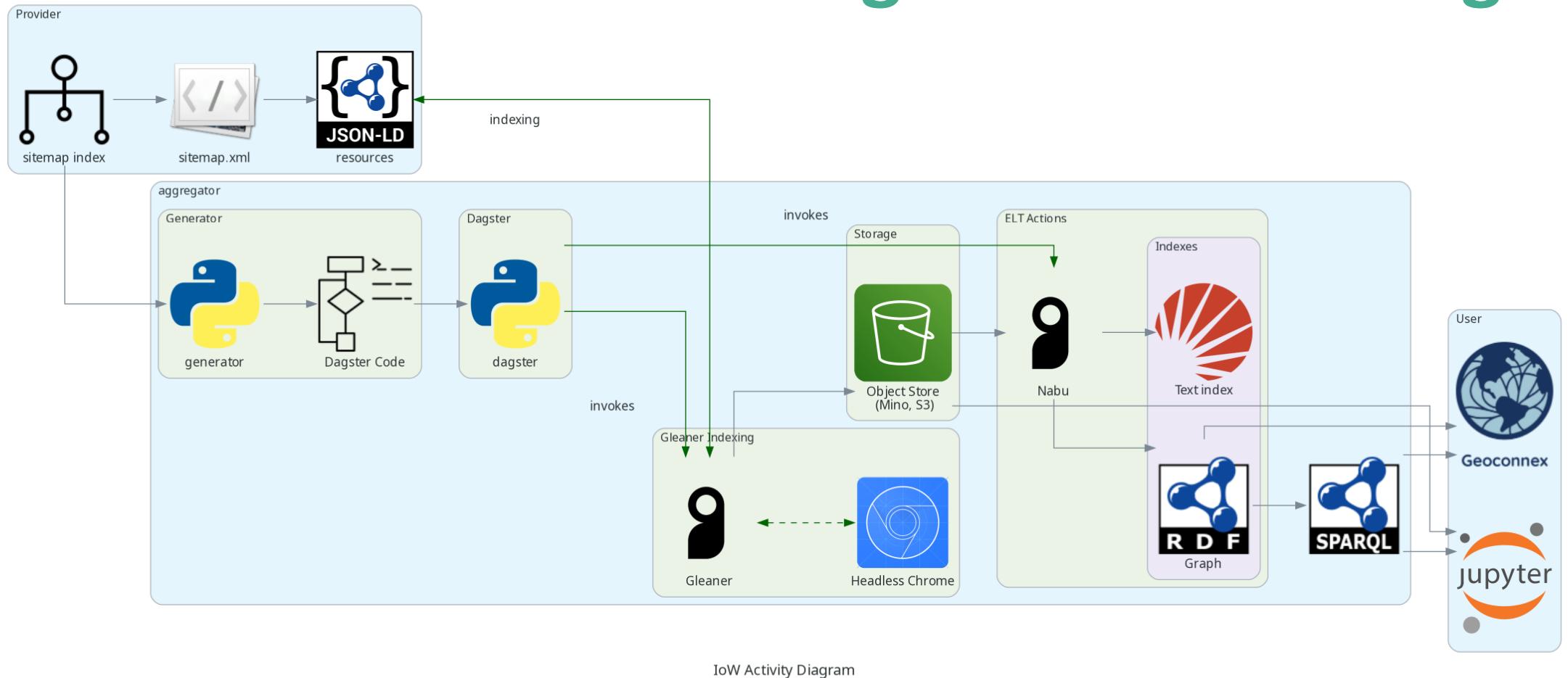


# What we just covered

# What we are about to cover

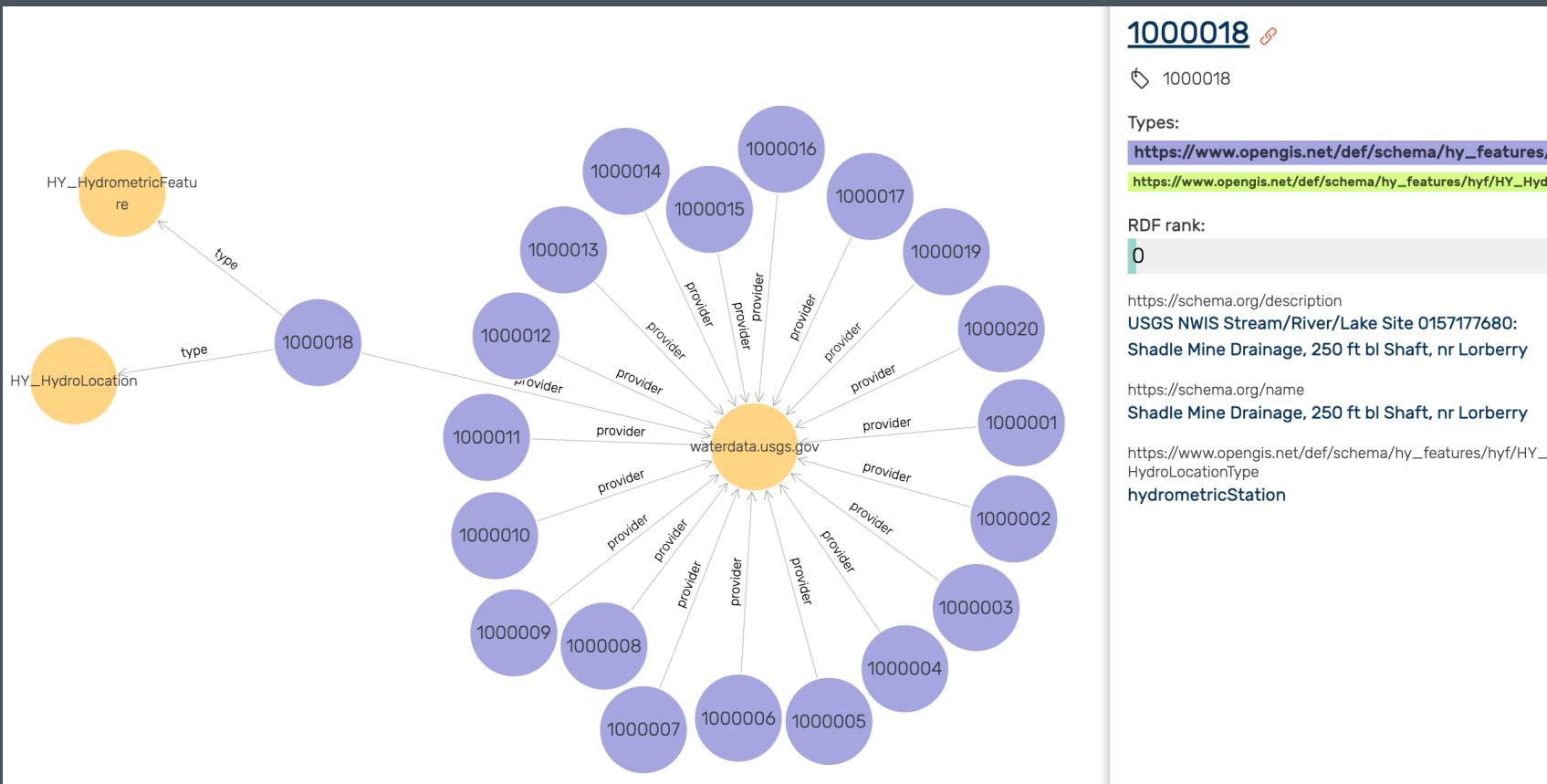


# Indexing like a search engine

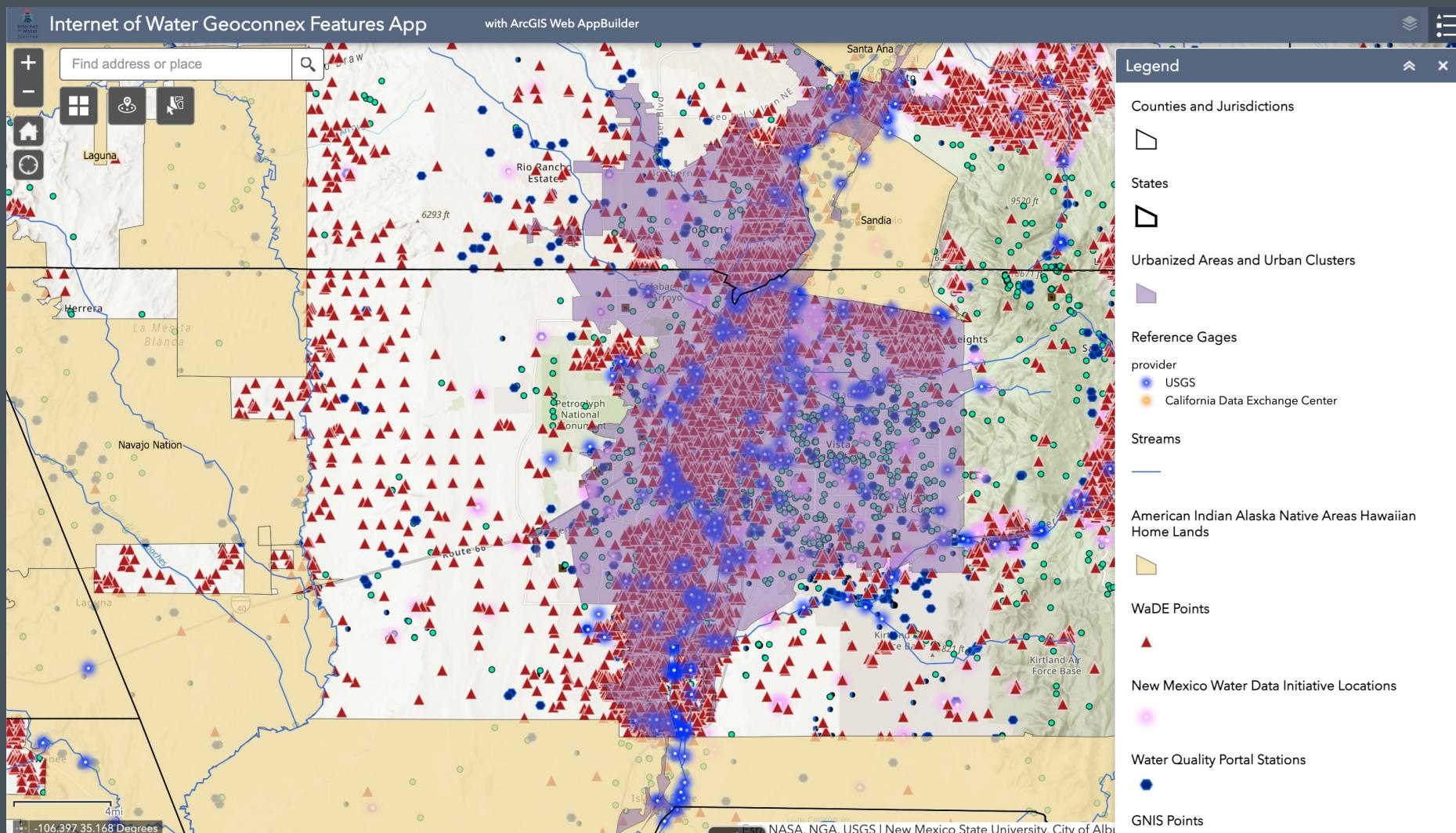


# Implementation: Knowledge Graph

- Ability to answer innumerable water-related questions
- Leveraging the Internet of Water principles and linked data semantics



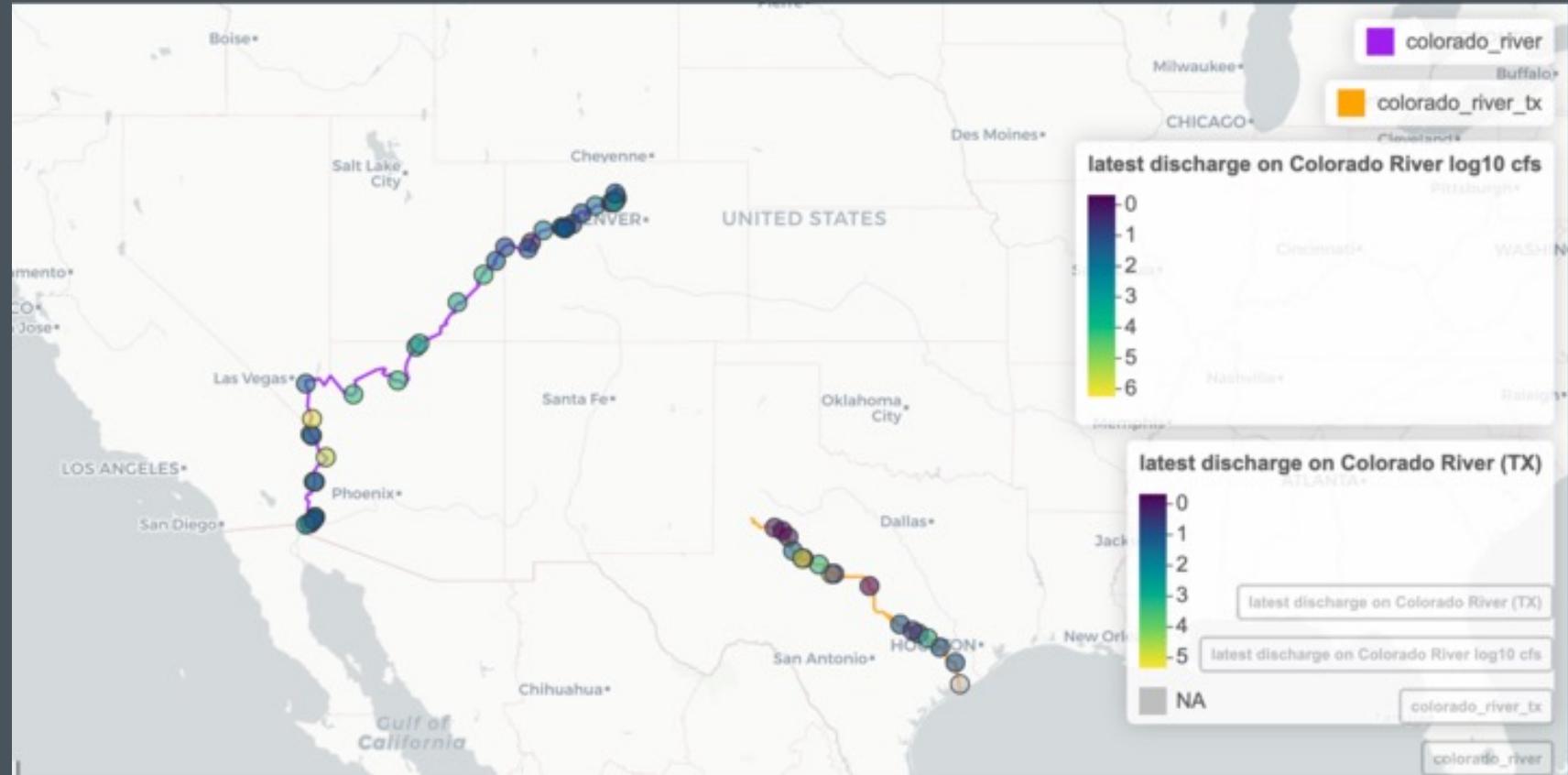
# Demonstration: Geoconnex.us at work



<https://geoconnex.us/iow/map>

# Identifiers that resolve to JSON-LD

This shows a query from USGS for current discharge along "Colorado River", specifically the [Colorado River](#) and another totally different [Colorado River](#).



Source: <https://t.ly/eX1x>  
<https://geoconnex.us/iow/cr-demo>

# Further Reading

- Internet Of Water History & Principles: <https://geoconnex.us/iow/principles>
- Geoconnex Identifier Registry evolution: <https://geoconnex.us/iow/tracker>
- Geoconnex.us docs [WIP]: <https://docs.geoconnex.us>
- SELFIE: <http://www.opengis.net/doc/PER/SELFIE-ER>
- HyRiver Geoconnex Python Package: <https://geoconnex.us/iow/hyriver>



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Twitter @CGS\_earth

Contact our team at  
[internetofwater@lincolninst.edu](mailto:internetofwater@lincolninst.edu)

# Please reach out!

Benjamin Webb

[bwebb@lincolninst.edu](mailto:bwebb@lincolninst.edu)

Tom Kralidis

[tomkralidis@gmail.com](mailto:tomkralidis@gmail.com)



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113 BRATTLE STREET

CAMBRIDGE MA 02138

[LINCOLNINST.EDU](http://LINCOLNINST.EDU)

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