NYBG

Georeferencing Specimen Localities

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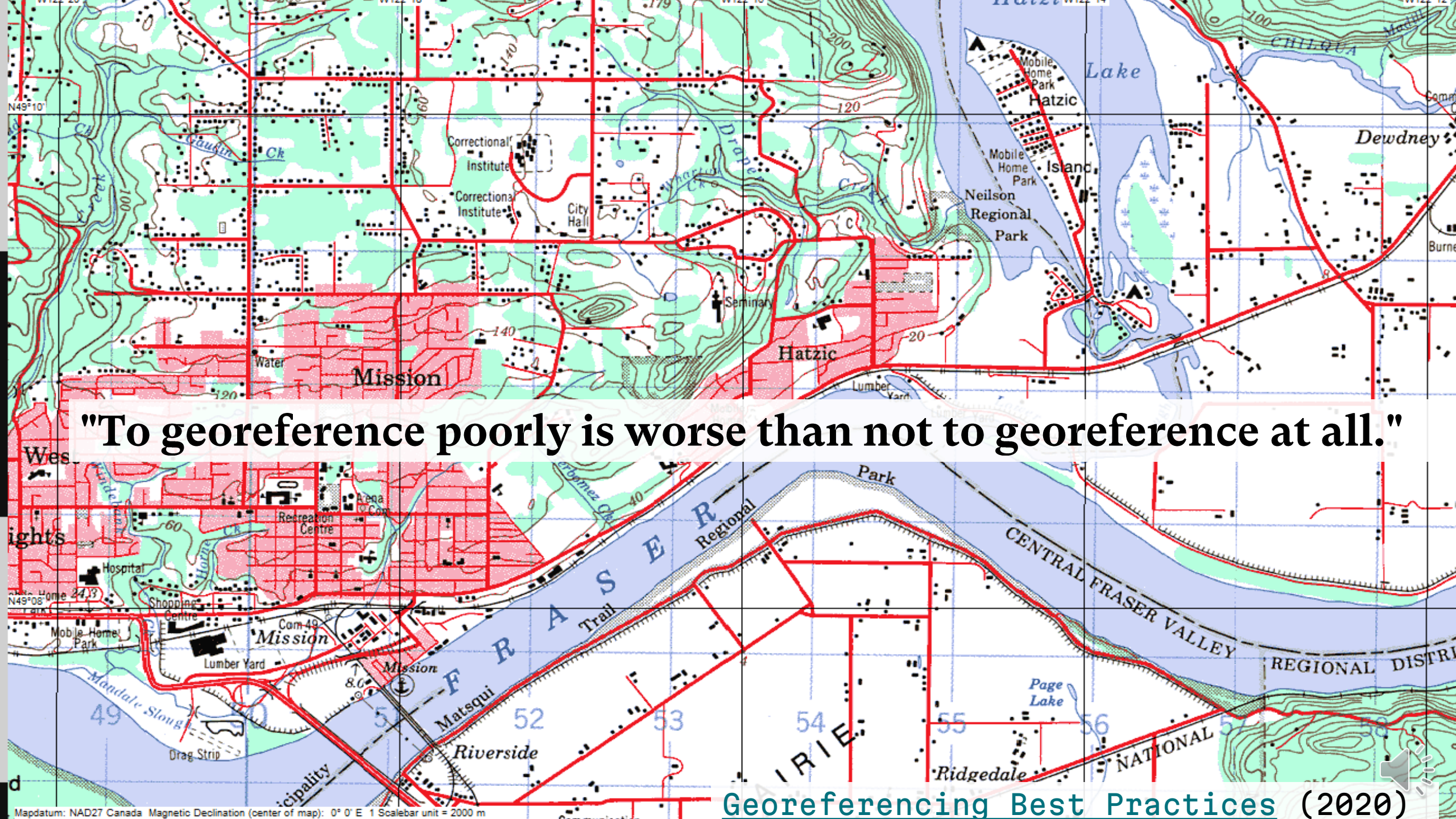
PART 2: METHODS & PROTOCOLS



"To georeference poorly is worse than not to georeference at all."

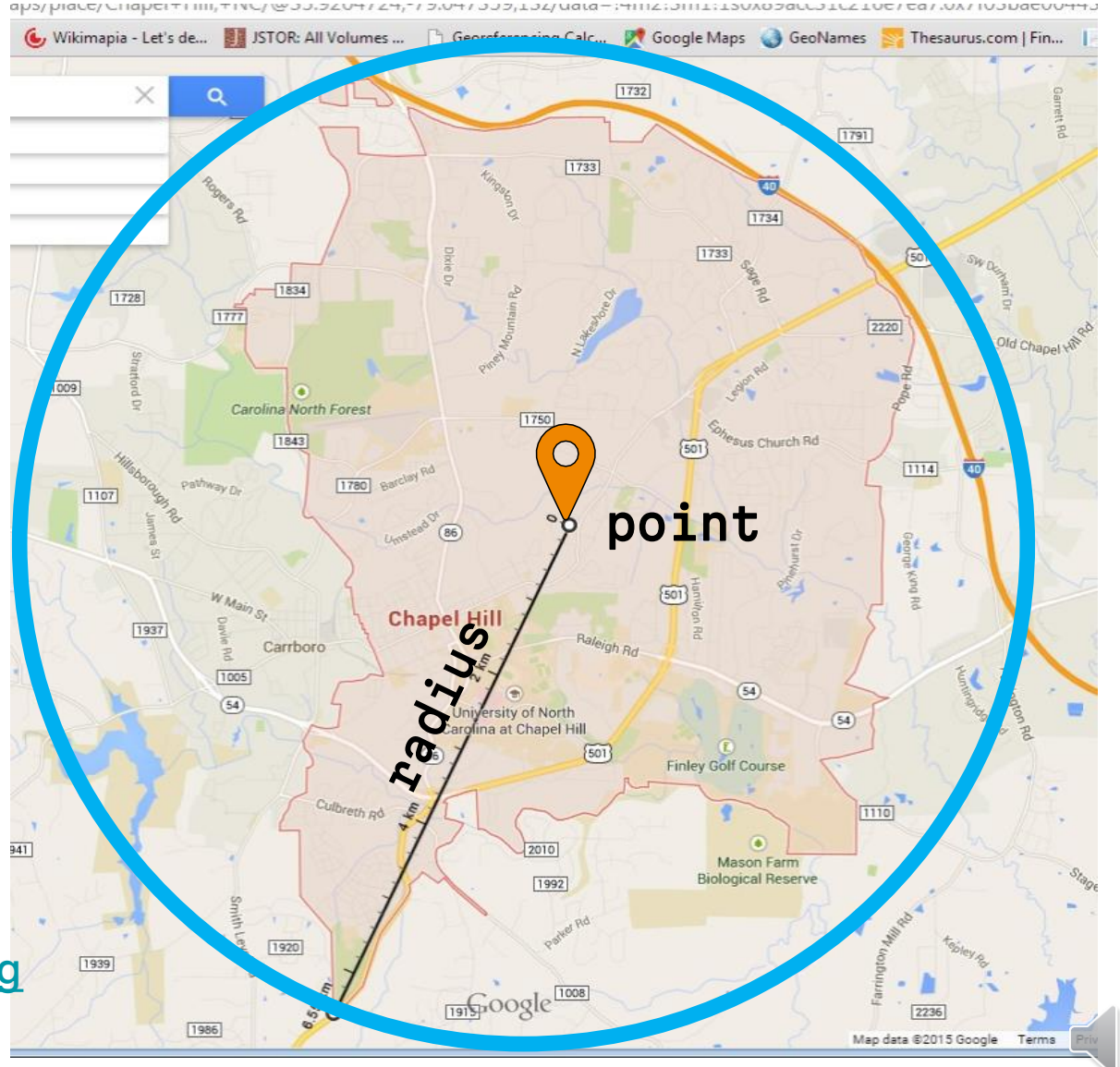
Georeferencing Best Practices (2020)

POINT-RADIUS METHOD

Objective: Locate a point (lat/long coordinates) that best represents the collection location, along with a radius that covers the potential area of the collection, factoring in all possible sources of error.

Adhere to the best practices guide to stay consistent in your methods and assumptions

Document your process, tools used, and rationale so that it is repeatable

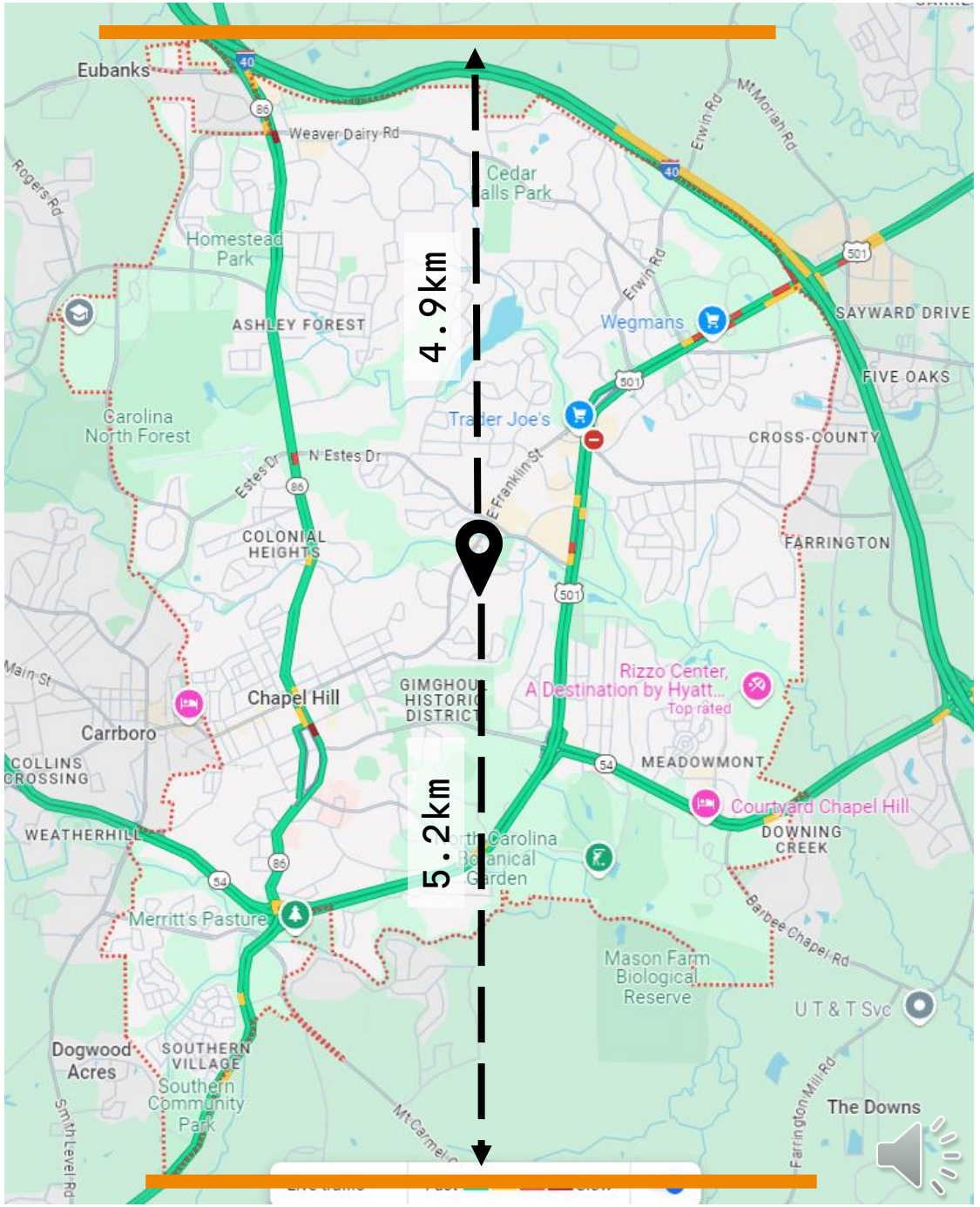


[The Point-Radius method for georeferencing locality descriptions and calculating associated uncertainty]

CORRECTED CENTER

- In Google Maps, roughly estimate a center point
- Use Distance Measurement Tool to mark your place
- From the center, measure due north to an area that matches the most northernmost part of the locality and due south to an area that matches the most southernmost. Ensure these measurements are roughly equal, adjusting the center point as needed.
- Repeat this step for east and west

Note: GEOLocate automatically visualizes the radius and can adjust the radius to fit a polygon, so these steps are not required.

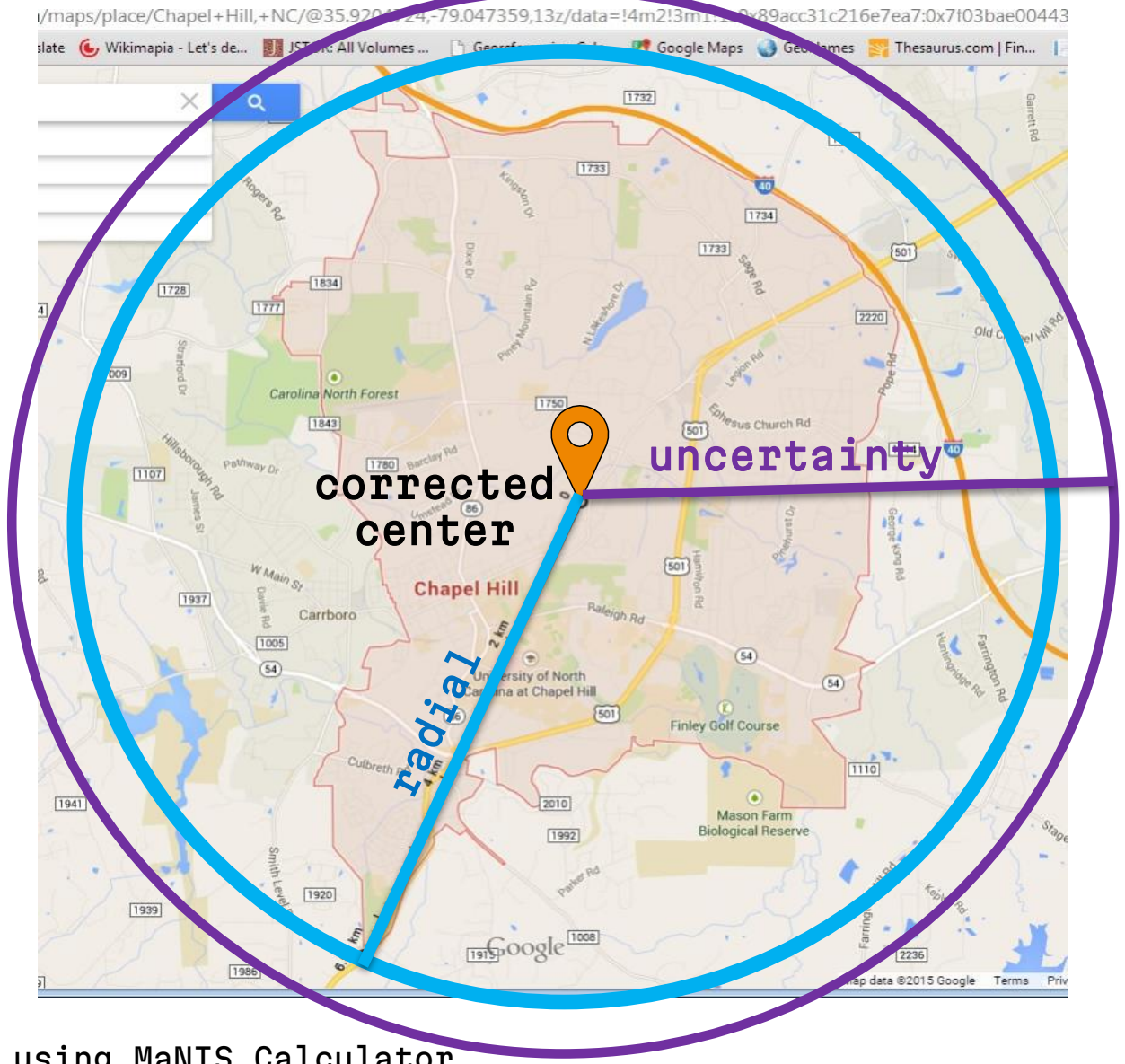


UNCERTAINTY

Uncertainty value encapsulates the total area from which the collection may have occurred

Sources:

- Radial of the locality (majority)
- Unknown datum
- Imprecision in distance measurement (user error)
- Imprecision in coordinate measurement (user error)
- Imprecision in direction measurement (from description)



Google Maps method: uncertainty radius found using MaNIS Calculator
GEOLocate method: **provided radial = uncertainty radius** (Calc. not needed)

GENERAL WORKFLOW

Classify Locality Description

↓

Determine Coordinates and Extent

↓

Calculate Uncertainty

↓

Document Georeferencing Process

BioGeomancer Guide To Best Practices for Georeferencing (2006)

CATEGORIZING LOCALITY

- Locality descriptions fall into a few categories, which determine the best approach for finding coordinates and a radial
- Crucial first step in attempting to georeference
- Identifying most specific part of the locality description can be challenging

Example: “Bridge over the St. Croix River, 4km N of Somerset”

Approach: Georeference based on the **bridge** (Feature – with Obvious Spatial Extent) if able to definitively determine which bridge rather than 4km N of Somerset (Offset – Distance at a Heading)

FEATURE – OBVIOUS SPATIAL EXTENT

Previously: Named Place: Bounded Area (2012)

LOCALITY TYPE

Named Place

Bounded Area: Locality refers to a geographic feature with discernible spatial boundaries

Examples: "Las Vegas", "Puerto Madryn", "San Fernando", "Verónica"

Feature categories include:

- ❑ city, town, county, suburb, populated place, or homestead
- ❑ spring, bore, tank, well, or waterhole
- ❑ island, reef, or cay
- ❑ port, bay, gulf, or harbor
- ❑ airport, buoy, dock, or jetty
- ❑ point, cape, or peninsula
- ❑ dam
- ❑ hill, peak, pass, or mountain
- ❑ park, reserve, or forestry zone
- ❑ junction of two paths (roads, rivers, contour lines, boundaries, etc.)

LOCALITY TYPE

Named Place

Bounded Area: Locality refers to a geographic feature with discernible spatial boundaries

Examples: "Las Vegas", "Puerto Madryn", "San Fernando", "Verónica"

FEATURE – OBVIOUS SPATIAL EXTENT

Previously called: Named Place: Bounded Area (2012)

Examples:

1. "Bakersfield, Kern Co., CA"
2. "Point Lookout, Nassau, NY"
3. "Bennetts Waterhole, Australia"
4. "Uruçuca, Bahia, Brazil"
5. "Isla Tiburon, Mexico"
6. "Lorne Reef"
7. "Yosemite National Park"
8. "Mt Hypipamee"
9. "34th Street & 5th Ave & , NY, NY"
10. "State Forest Reserve 607, Queensland"
11. "confluence of Labarge Creek and South Labarge Creek, […]"
12. "At 100 m contour line on Black street, […]"

If the locality description doesn't clarify the level of geography (e.g., a city and county with the same name), choose the larger entity to be more inclusive.

FEATURE – OBVIOUS SPATIAL EXTENT

Georeferencing Procedure:

Coordinates: Find the **corrected center**, or the point within a location that minimizes the geographic radial, obtained by finding the smallest enclosing circle that contains the entire feature and then locating the center of that circle.

Radial: Measure the distance from the selected coordinates to the farthest point within the named place.

Isla Tiburon, Mexico

COORDINATE PROTOCOL

Georeferencing Procedure:

Coordinates: Approximate the location of the **corrected center**

Tip: Visualize a box around the feature by identifying its northern, southern, western, and eastern limits to help determine the center's region.

Isla Tiburon, Mexico

RADIAL PROTOCOL

Georeferencing Procedure:

Radial: Measure the distance from the selected coordinates to the farthest point within the named place

Tip: selecting the largest radial ensures the entire feature is included.

Isla Tiburon, Mexico

FEATURE – OBVIOUS SPATIAL EXTENT (ODD SHAPE)

Georeferencing Procedure:

Issue with coordinates of the geographic center of the island is that they plot in the ocean.

If the geographic center does not fall inside the shape of the feature, then ***choose the nearest point to the center that lies within the shape.***

Radial: Measure the distance from the selected coordinates to the farthest point within the named place

Nantucket, Massachusetts

COORDINATE PROTOCOL

Georeferencing Procedure:

Coordinates: corrected center is found by slightly adjusting placement to shore of the island.

Nantucket, Massachusetts

RADIAL PROTOCOL

Georeferencing Procedure:

Radial: Measure the distance from the adjusted center coordinates to the farthest point within the named place.

Tip: If you're unsure of a locality's boundaries, include any extra areas that might be part of it, especially for islands where tidal or sandy regions may be left out of the polygon presented on Google Maps.

Nantucket, Massachusetts

LOCALITY TYPE

Named place

Undefined Area: Locality refers to a geographic feature that does not have a clear spatial boundary

Example: "Pampa Grande" (the extent is 4.7 km given that the center of the nearest named place, "Colonia Mariano Sarratea" is 9.4 km distant)

FEATURE – WITHOUT OBVIOUS SPATIAL EXTENT

Previously: Named Place: Undefined Area (2012)

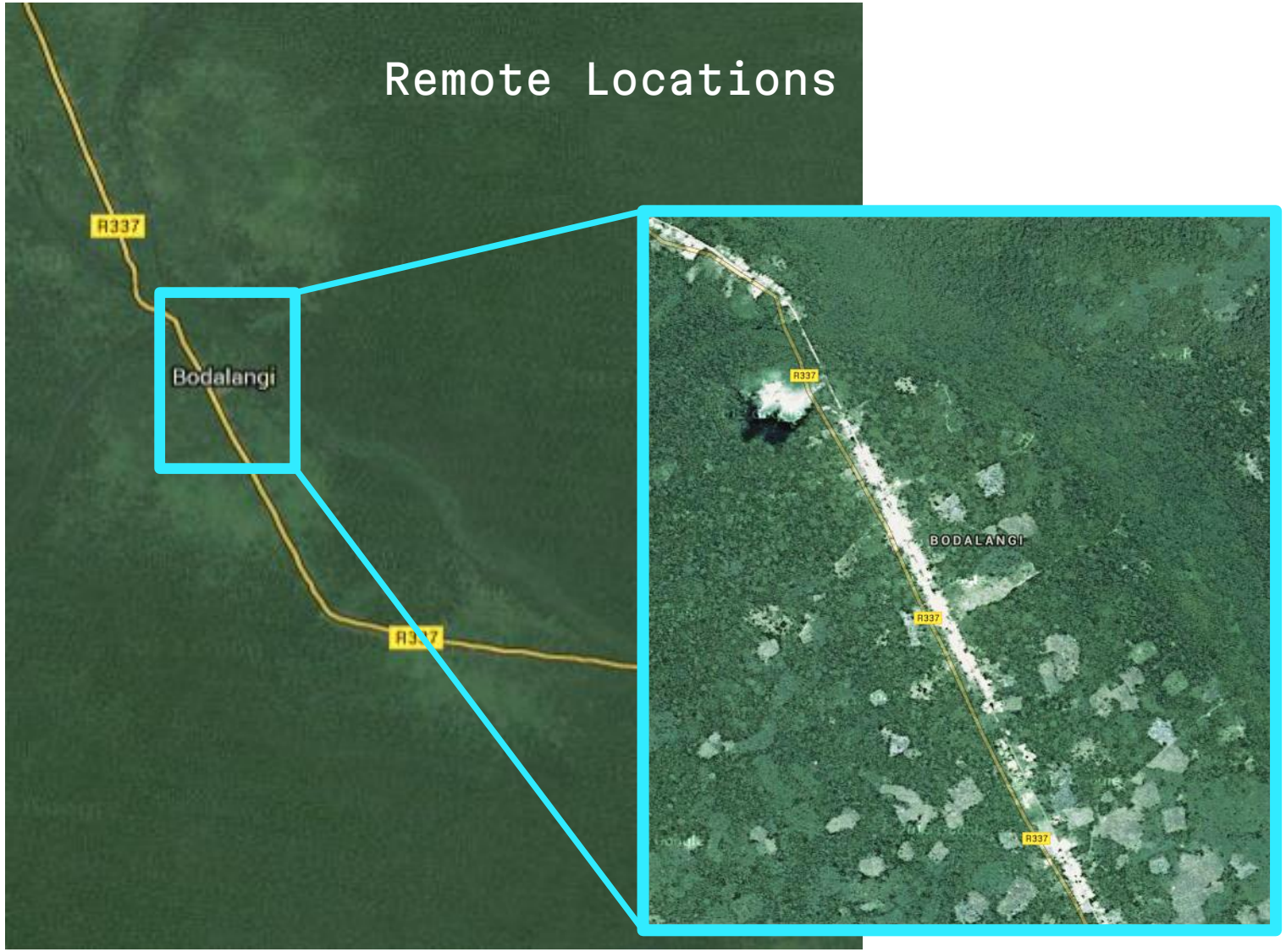
Feature categories include:

- ❑ Populated places without polygon when searched for in Google Maps with boundaries that cannot be reliably delineated from other sources or using visual cues
- ❑ Complex or amorphous landscape features with boundaries that are difficult to discern
- ❑ Features which are contiguous with other nearby or subsidiary named places
- ❑ Features which appear when searched on Google Maps, but no clearly defined settlement is visible nearby
- ❑ Names given to small and/or remote settlements which can be assumed to reflect larger, and more poorly defined territories

COORDINATE PROTOCOL

Georeferencing Procedure:

<u>Coordinates:</u> Find coordinates of the approximate center of the locality based on where Google Maps or a gazetteer places the name



Bodalangi, Democratic Republic of the Congo

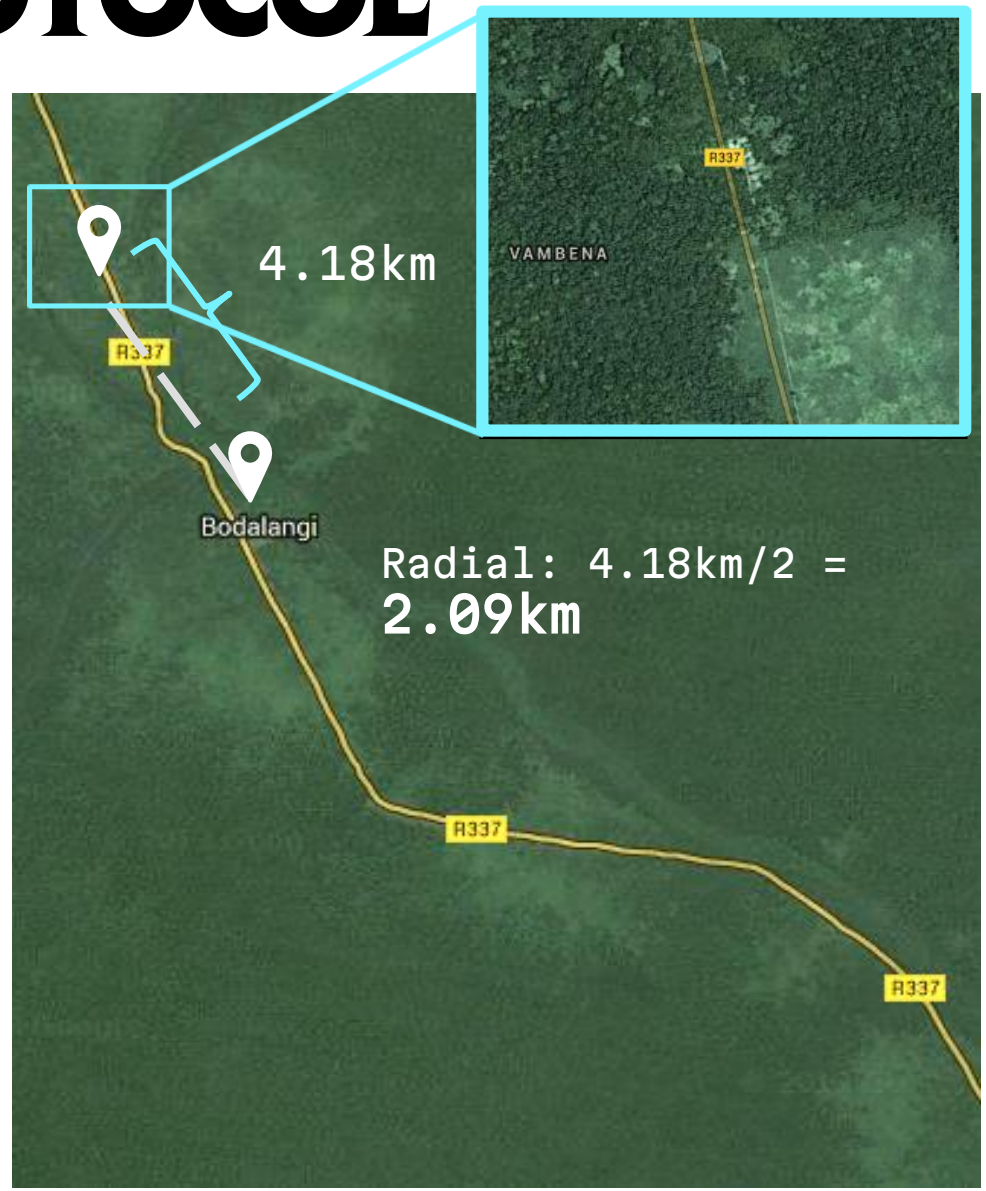
RADIAL PROTOCOL

Georeferencing Procedure:

<u>Radial:</u> Measure distance from the selected coordinates to the center of the nearest named feature of similar locality type and divide in half. **We use the halved distance as our estimated radial.**

Updated Quick Reference Guide (Zermoglio 2020) suggests to approximate boundary based on visible clues, and document rationale. This is ***not straight forward*** and is ***not easily repeatable***.

The halved distance protocol is from the previous version of the guide (Wieczorek 2012) but is in agreement with the updated guide (Zermoglio 2020)



Bodalangi, Democratic Republic of the Congo

MOUNTAINS

Boundaries of mountains are often difficult to discern. If unable to delineate mountain's extent, treat as a **Feature – without Obvious Spatial Extent**, and approximate area by using halved distance to nearest mountain (if possible)

If mountain's boundaries are apparent, treat as a **Feature – with Obvious Spatial Extent**

Incorporate elevation information if provided; locate coordinates at the elevation specified nearest to corrected center of mountain

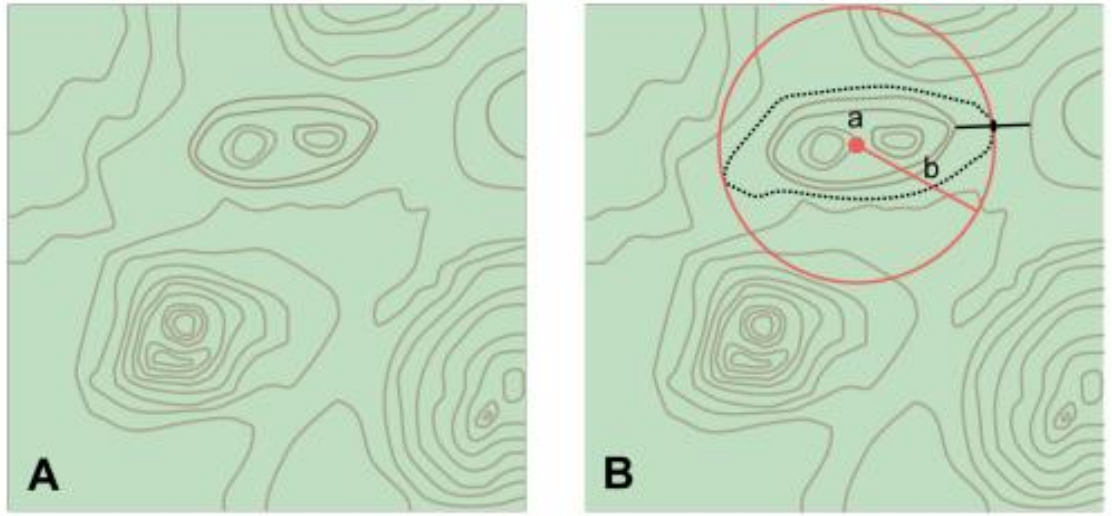


Figure 5. A. Topographic contours of a group of nearby mountains. B. Rough boundary, corrected center **a** *and geographic radial* **b** *of a mountain determined by the surrounding valleys, saddles, and plains.*

Feature – without Obvious Spatial Extent

LOCALITY TYPE

Named Place

Near a Named Place

Examples: "vicinity of General Conesa", "before Ceibas", "near Dina Huapi"

FEATURE – NEAR A FEATURE

Previously: Named Place: Near a Named Place (2012)

A locality given without an exact position, but with “near”, “in the vicinity of”, “adjacent to”, or some similar relation to a feature cited. These locality descriptions imply an offset from a named place without definitive directions or distances.

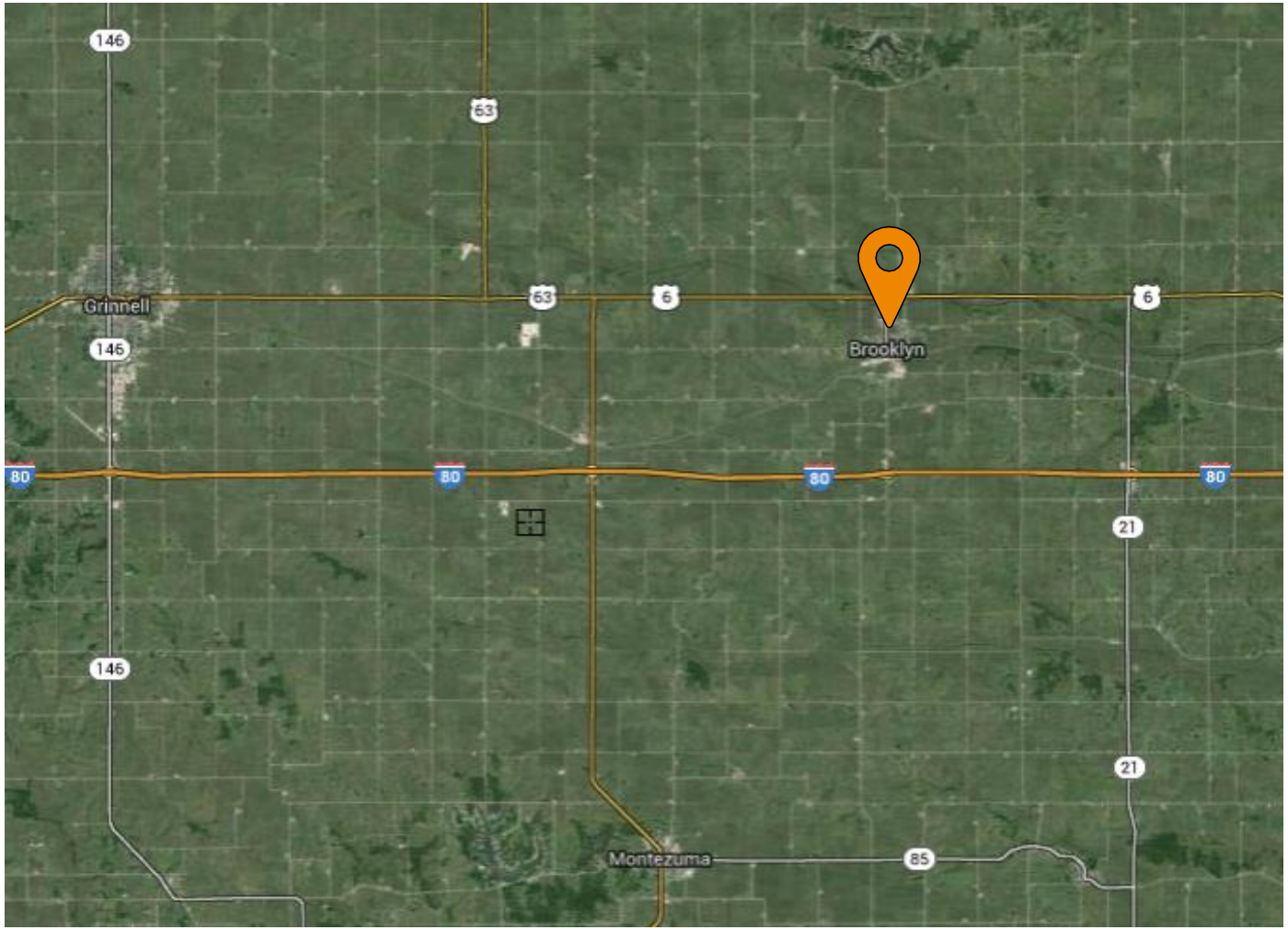
Examples:

1. “Near Las Vegas, NV”
2. “In the vicinity of Brooklyn, IA”
3. “General area of confluence of Black and Oshetna Rivers”
4. “Near bridge over Condamine River”

COORDINATE PROTOCOL

Georeferencing Procedure:

<u>Coordinates:</u> Find coordinates of the approximate center of the locality based on where Google Maps or a gazetteer places the name



In the vicinity of Brooklyn, Iowa

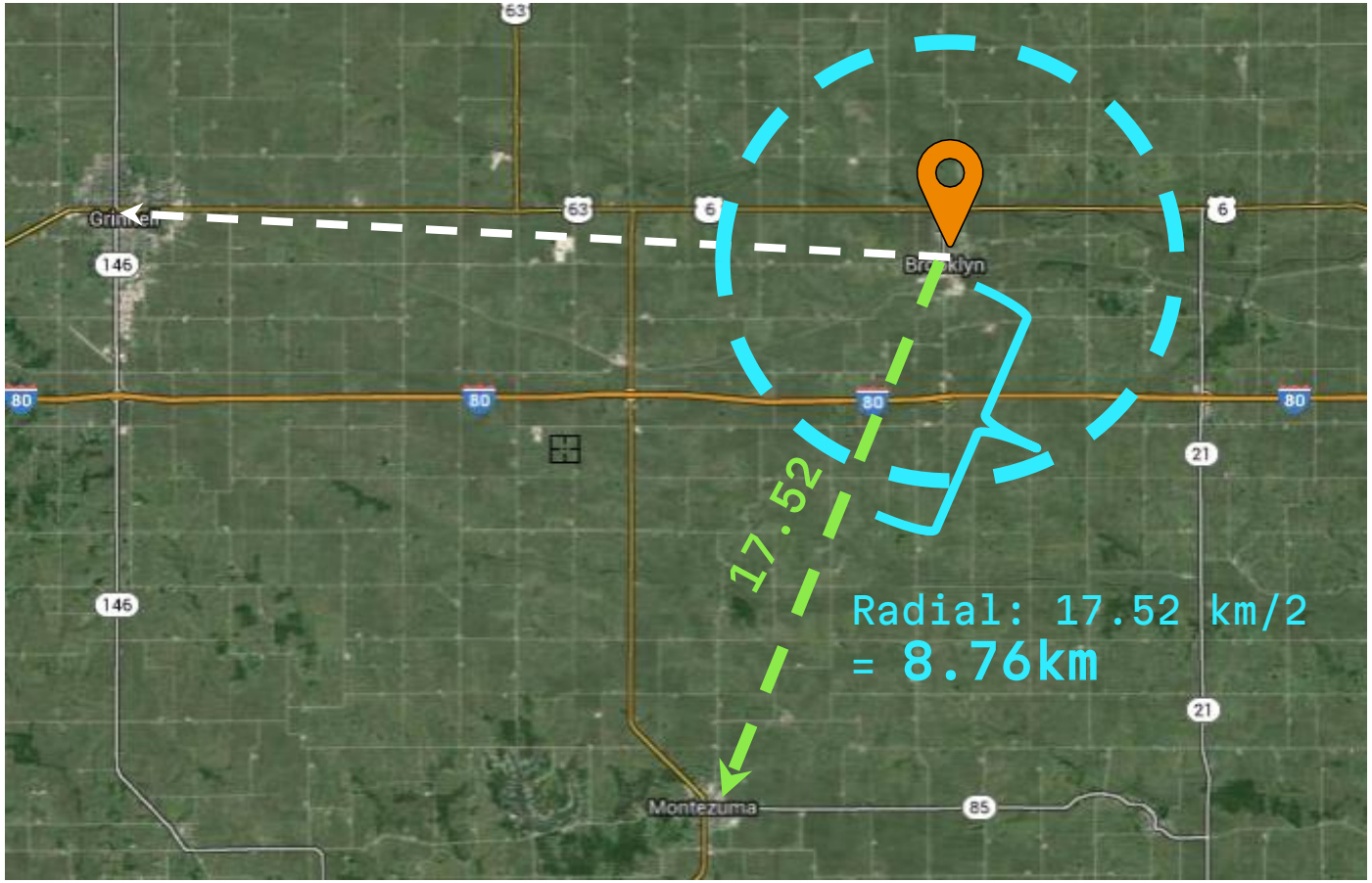
RADIAL PROTOCOL

Georeferencing Procedure:

Radial: Measure the distance from the coordinates to the center of the nearest named feature and divide in half. **We use the halved distance as our estimated radial.**

Note: We follow protocol from the Georeferencing Quick Reference Guide, 2012. The updated Quick Reference Guide (Zermoglio 2020) suggests to extend the boundary for the feature for a "fixed distance" in all directions from the feature to account for the mention of proximity. "Make a judgement and imagine what the person who recorded the locality meant."

This is ***not straight forward*** and is ***not easily repeatable.***



In the vicinity of Brooklyn, Iowa

SPECIAL SITUATIONS

Geological/natural and unevenly spaced features

Follow the [BioGeomancer Guide for Best Practices for Georeferencing (2006)] – Near a Feature guidelines

Georeferencing Procedure:

Coordinates: Find coordinates of the approximate center of the locality based on where Google Maps or a gazetteer places the name

Radial: Use whatever value is greater, 2km or 2x (200%) of the radial of the feature itself.

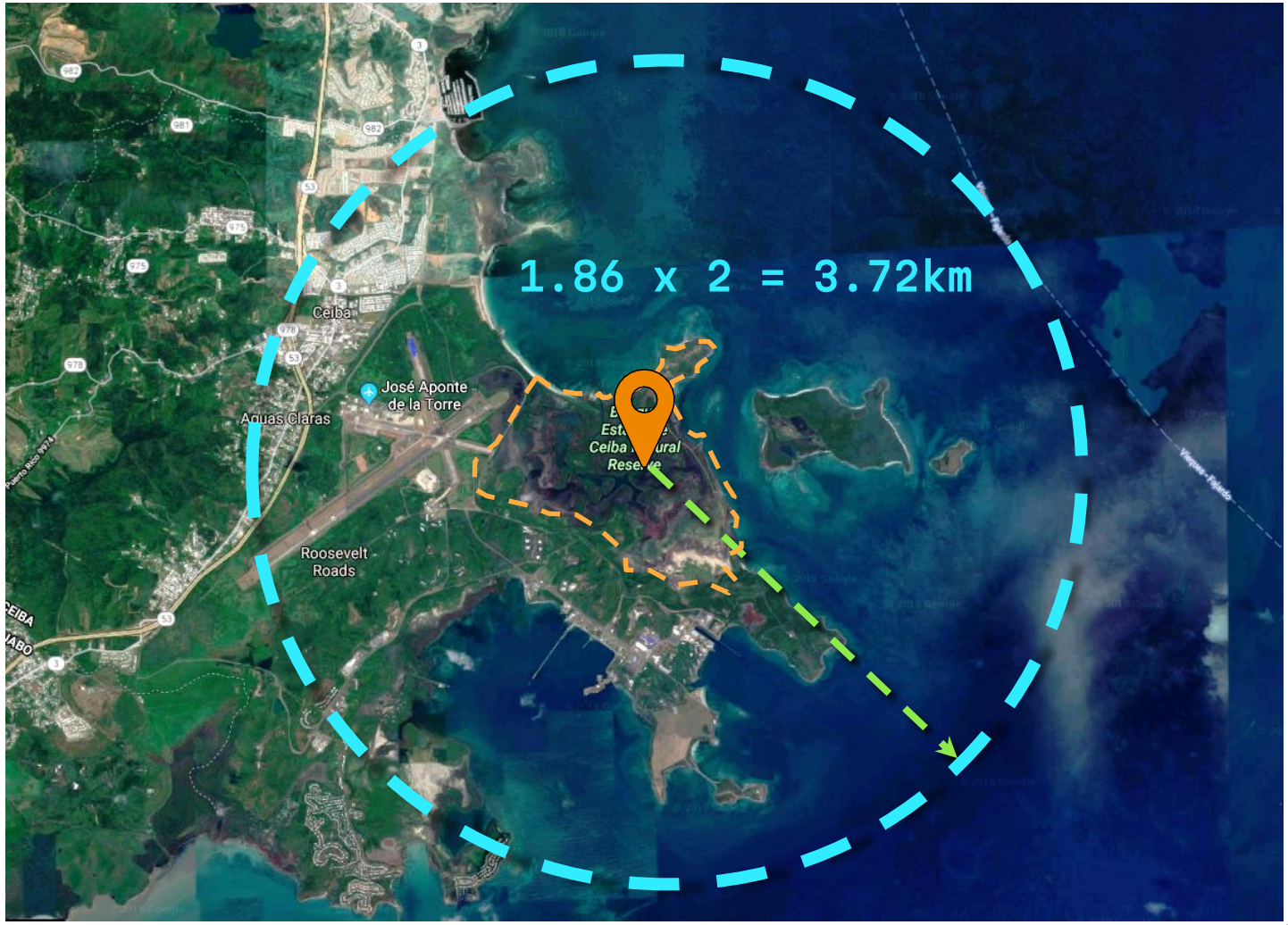
Near Bosque Estatal de Ceiba Natural Reserve, Puerto Rico

RADIAL PROTOCOL

Georeferencing Procedure:

<u>Radial:</u> Use whatever value is greater, 2km or 2x (200%) of the radial of the feature itself.

In this case, we would use 200% of the radial of the feature, as 3.72km is larger than 2km



Near Bosque Estatal de Ceiba Natural Reserve, Puerto Rico

FEATURE – BETWEEN TWO FEATURES

Previously: Named Place: Between Two Named Places (2012)

LOCALITY TYPE

Named Place

Between two Places

Examples: "between Missoula and Florence, Montana", "Entre Pampa Blanca y Pampa Vieja, Jujuy"

A locality cited as between two named places/features

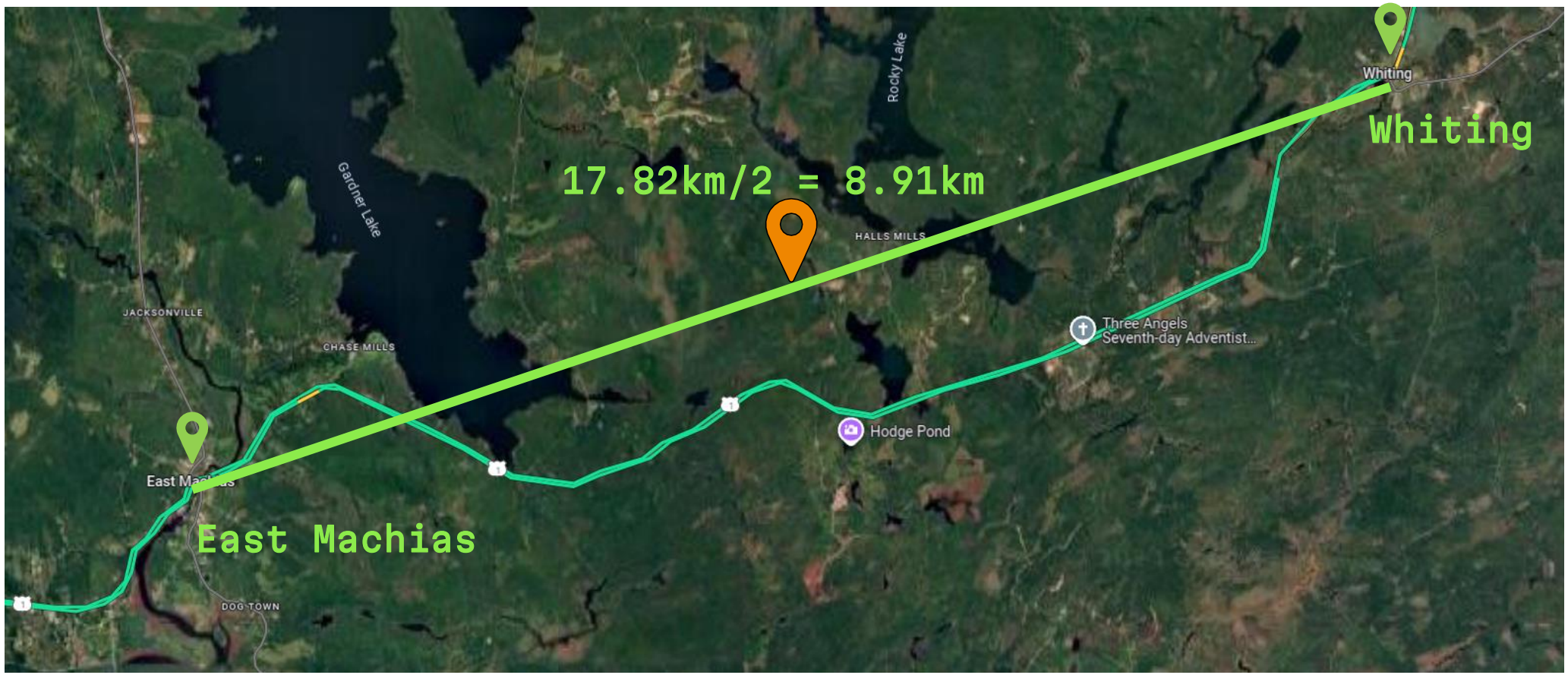
Georeferencing Procedure:

1. Find coordinates for the approximate corrected centers of the named places or features that the locality is said to be located between
2. Measure a straight line between the two sets of coordinates
3. Determine the midpoint of this line to find your midpoint coordinates
4. Use the distance from the midpoint to either feature's center (should be equivalent) as the radial

COORDINATE PROTOCOL

Georeferencing Procedure:

Coordinates: Roughly estimate centers of both localities, measure a straight line between the two and half this distance to locate the midpoint coordinates

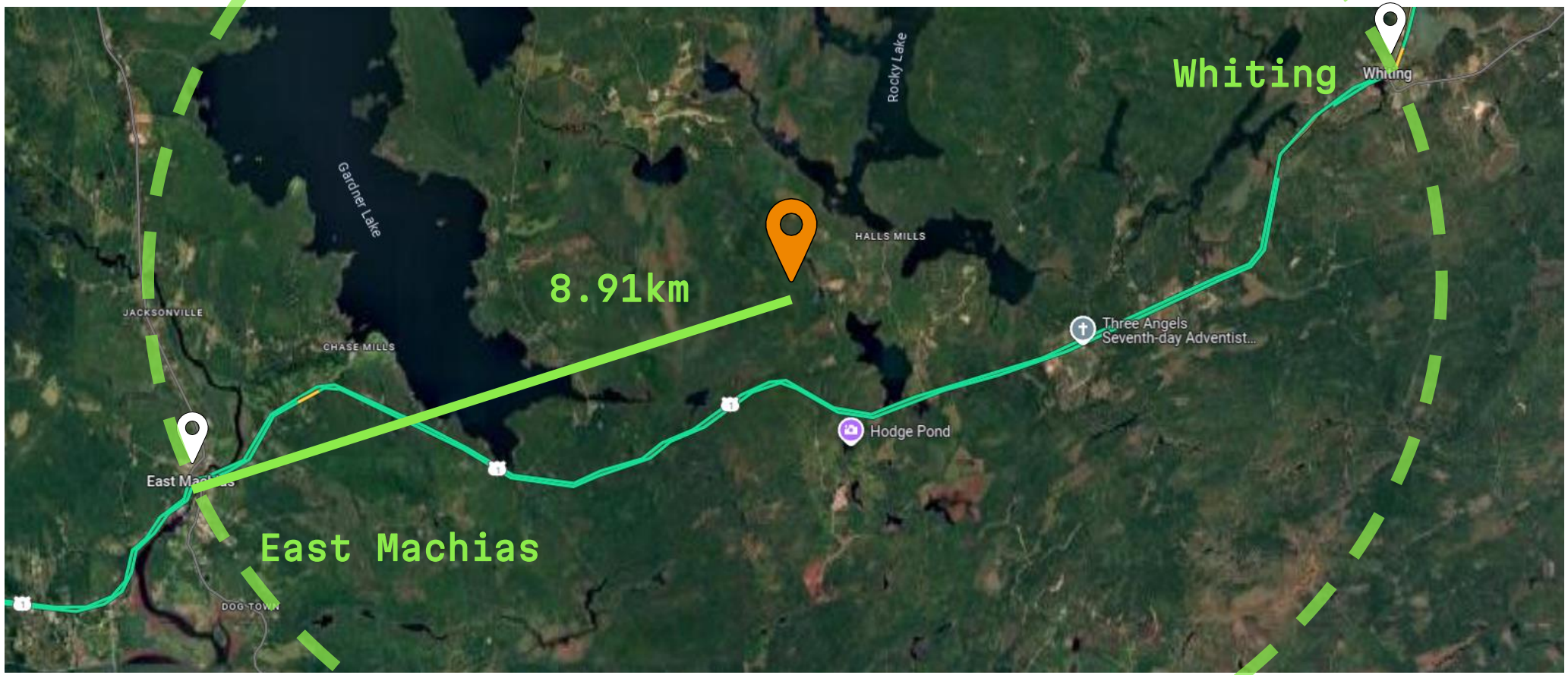


Between East Machias and Whiting, Maine

RADIAL PROTOCOL

Georeferencing Procedure:

Radial: Use the measurement from the midpoint coordinates to the center of either named place (should be equidistant)



Between East Machias and Whiting, Maine

LOCALITY TYPE

Named Place

River, stream, road, path

Examples: "Sacramento River", "Jones Road", "Río Paraná", "Arroyo Urugua-í"

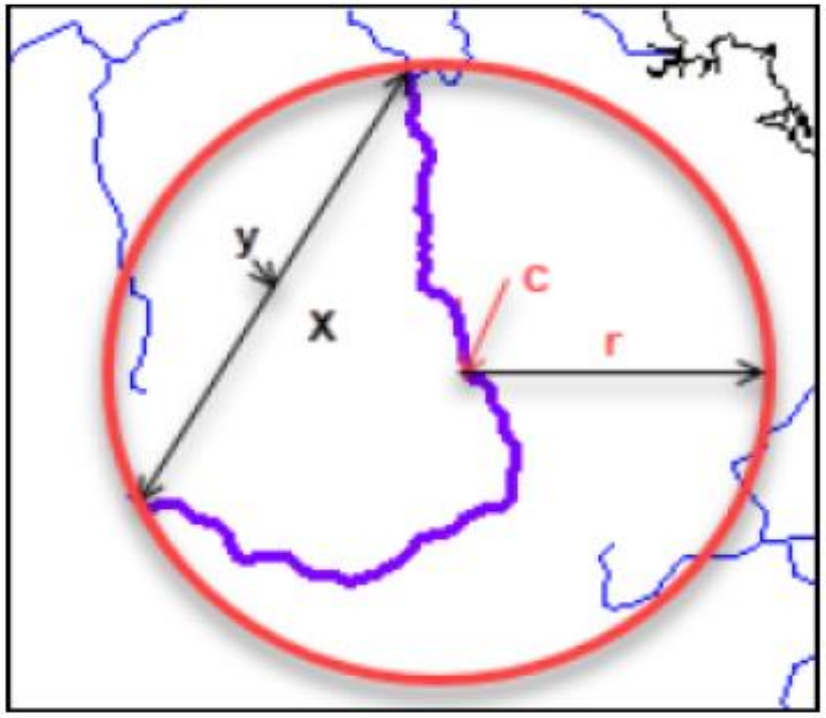
FEATURE – PATH

Previously: Named Place: River, stream, road, path (2012)

The locality is a linear feature such as a road, trail, river, or contour line; or a specific subdivision of a linear feature that is bounded by other named places or features.

Georeferencing Procedure:

1. Find coordinates for the endpoints of the linear feature
2. Measure a straight line between the two sets of coordinates
3. Determine the midpoint of this this line
4. Find the closest point along the linear feature to this midpoint to find the coordinates
5. Measure the distance from these coordinates to the farther of the two endpoints to find the radial



A path (river) showing the center of the smallest enclosing circle, ‘x’, the mid point between the ends of the river ‘y’, the corrected center ‘c’ and the radial ‘r’

COORDINATE PROTOCOL

Georeferencing Procedure:

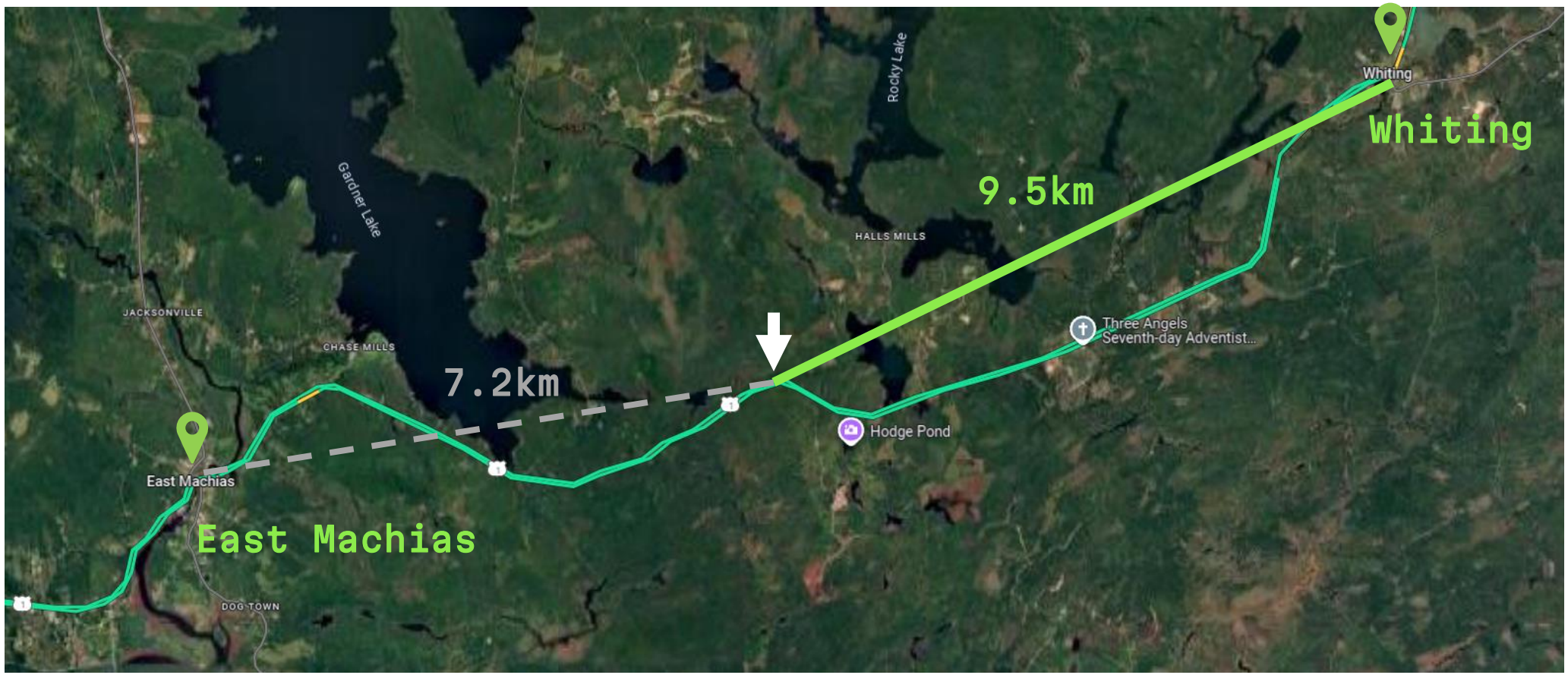
Coordinates: Roughly estimate centers of both localities, measure a straight line between the two and half this distance to locate the midpoint, move midpoint to road

Between East Machias and Whiting along Rural Route 1, Maine

RADIAL PROTOCOL

Georeferencing Procedure:

Radial: Re-measure the distance between the coordinates along the road and where the road comes nearest to the centers of both localities. Use the larger distance of the two.



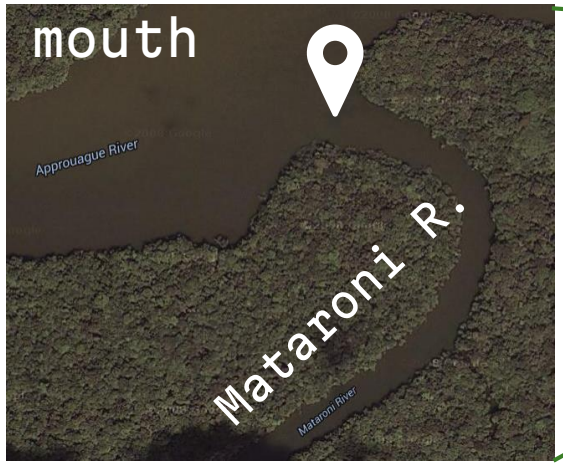
Between East Machias and Whiting along Rural Route 1, Maine

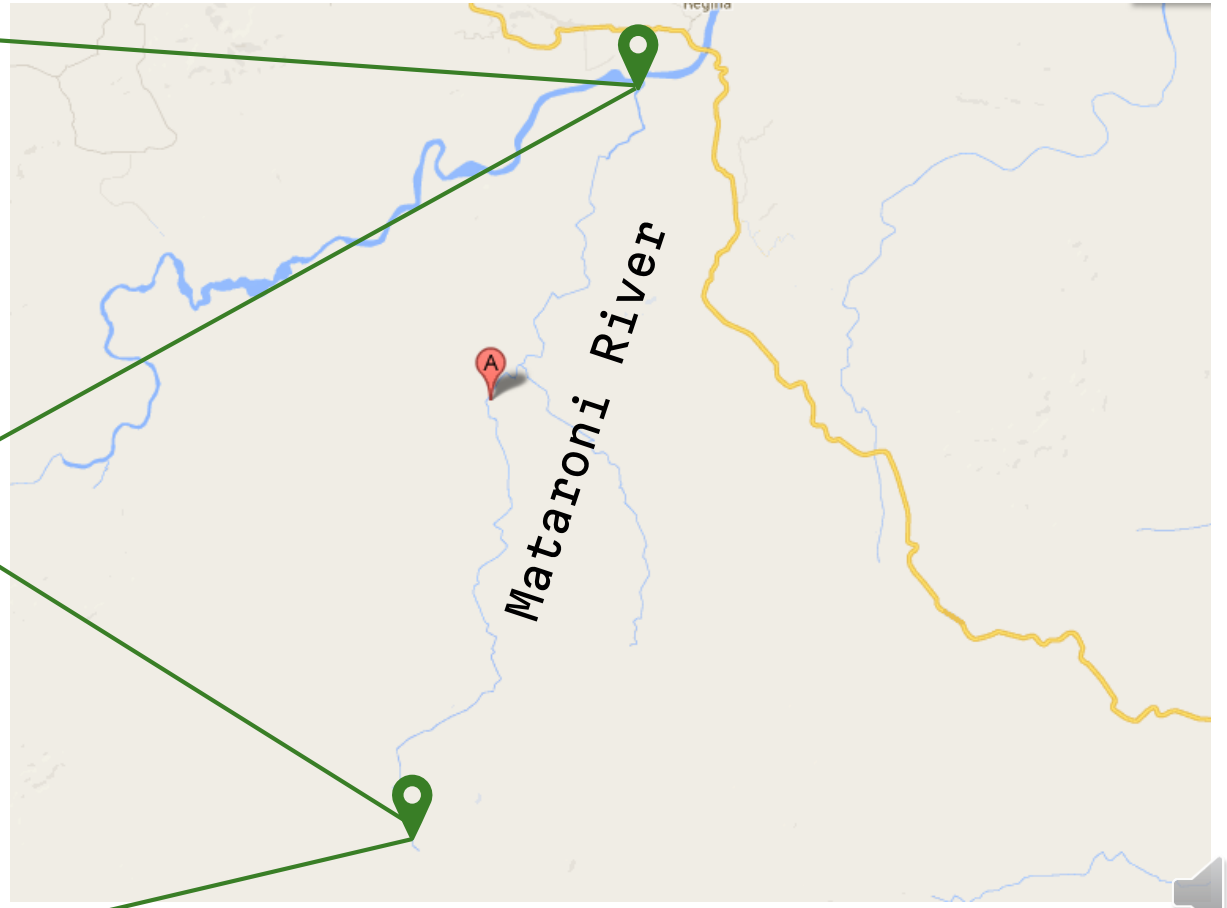
RIVERS WHEN BOUNDS NOT SPECIFIED

Georeferencing Procedure:

Coordinates: Locate midpoint between mouth (confluence with larger water body) and rough area of headwaters by measuring a straight line between the two and halving this distance.

If there are no specified boundaries, georeference the entire linear feature





Mataroni River, Cayenne, French Guiana

OFFSETS

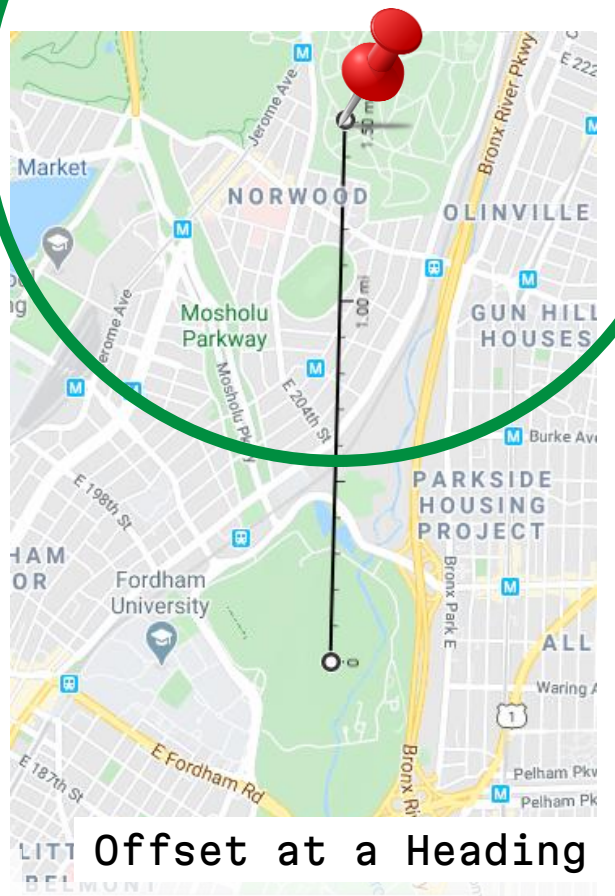
An offset is a displacement from a reference point, usually with a specified direction.

Some locality descriptions specify the route of the offset ("by road" or "by river"). Follow the designated path as closely as possible.

If the offset path is unclear, assume the offset to be “as the crow flies” (Offset at a Heading), which includes more uncertainty

Offset Along a Path

1.5 miles N of NYBG along the Bronx River Parkway



Offset at a Heading

1.5 miles N of NYBG

Example of the same offset distance and direction, with and without a route

OFFSET – DISTANCE ALONG A PATH

Previously: Offset: Offset along a path (2012)

LOCALITY TYPE

Offset

Offset along a path

Examples: "7.9 mi N Beatty, on US 95", "3 km en el Rio Jimenez arriba de Anita Grande", "left bank of the Mississippi River, 16 mi downstream from St. Louis", "Ruta Nacional 81, 8 km W de Ingeniero Guillermo Nicasio Juárez"

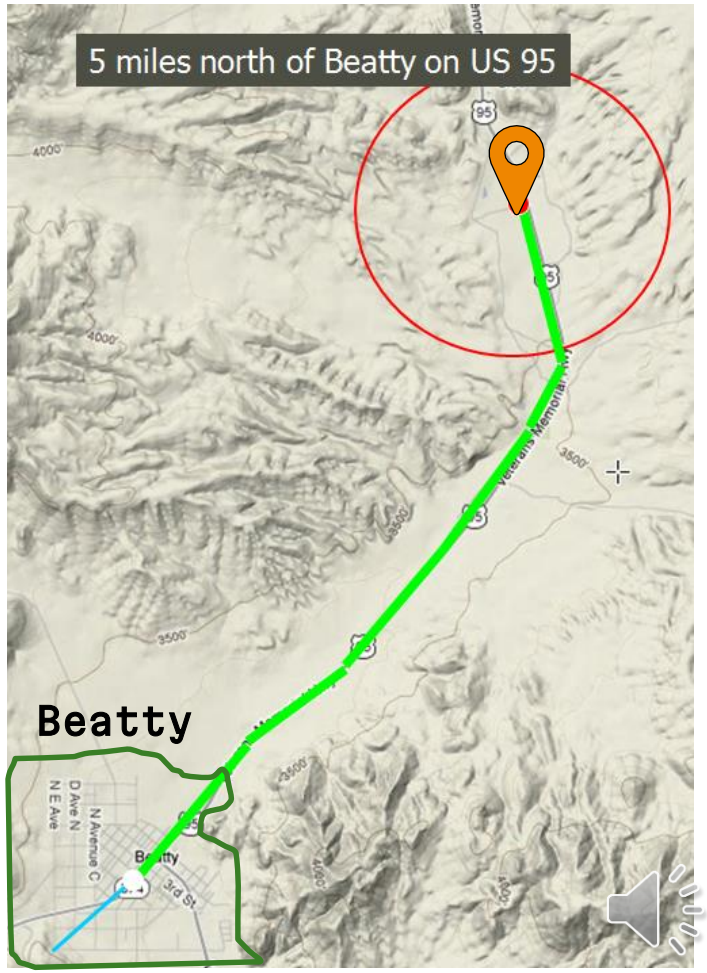
The locality consists of a specified distance and a specified route from a single named place, for example a distance and direction along a road, river, or path.

Georeferencing Procedure:

1. Determine the starting point for the offset (typically where linear feature comes nearest to center of named place) and begin measurement from this location

2. Manually measure distance along the route from the starting point using Google Maps Measure Distance Tool; find coordinates at offset location

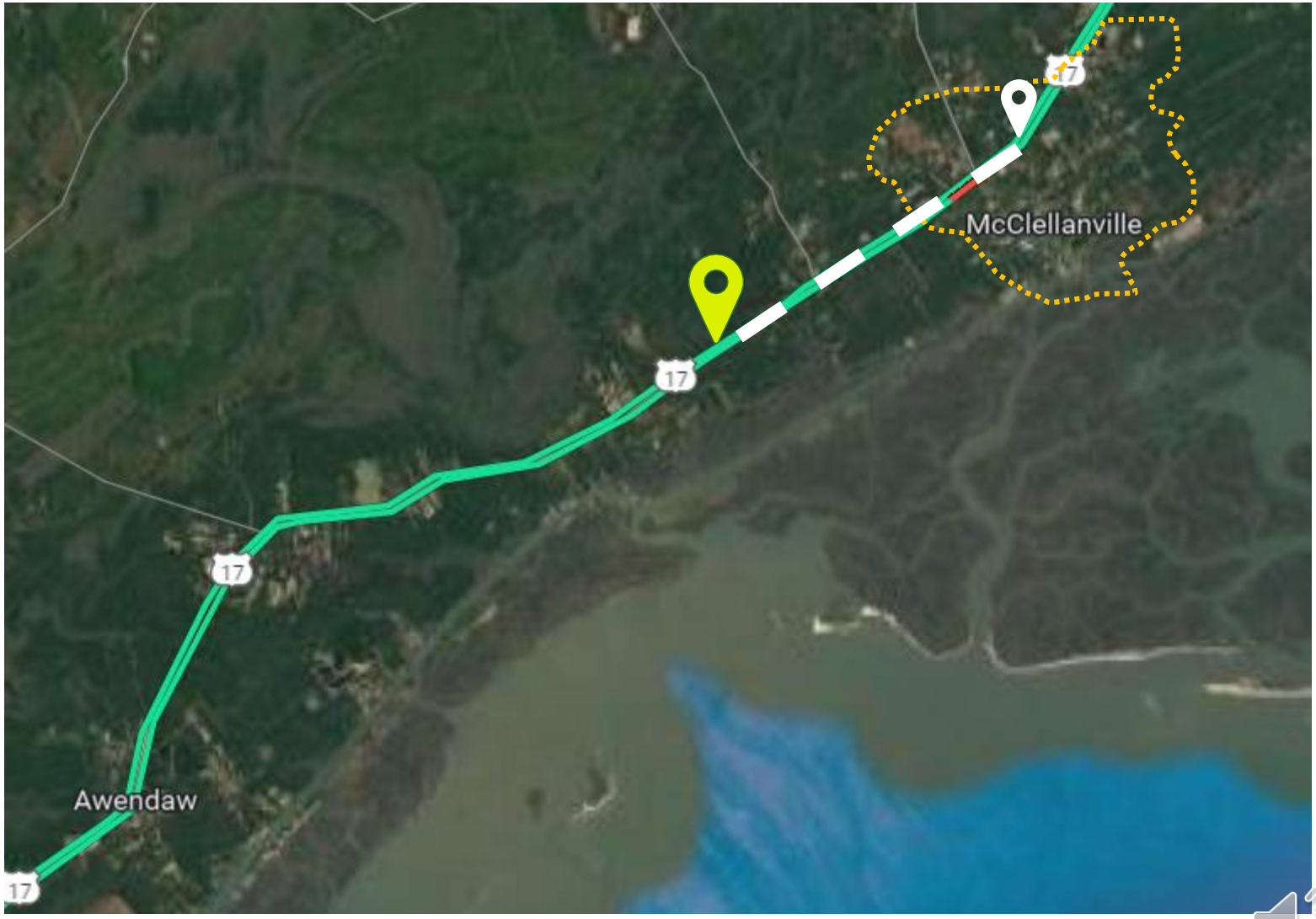
3. Return to starting location and determine radial for the starting location, (typically the bounds of the road within the starting city, or starting intersection/junction)



COORDINATE PROTOCOL

Georeferencing Procedure:

Coordinates: Starting where the road comes nearest to center of McClellanville, measure 2km SW along road (toward Awendaw). Record the offset coordinates.



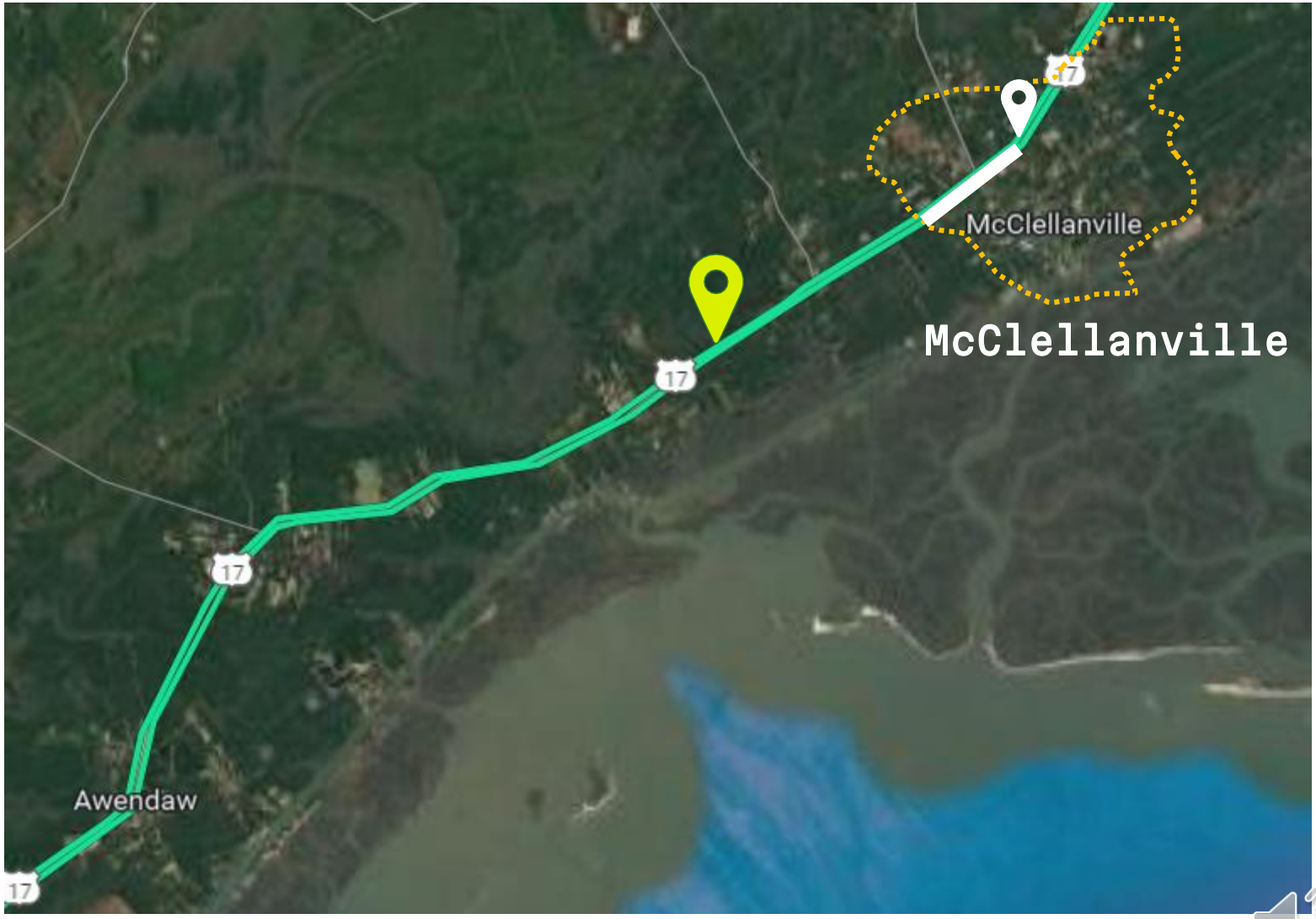
2 miles SW of McClellanville, SC on Route 17

RADIAL PROTOCOL

Georeferencing Procedure:

<u>Radial:</u>
If the starting location is a road or path within a town: measure from the offset's starting point to the farthest point of the feature within the town's boundaries.

If the starting location is an intersection: measure the entire area of the intersection, including all possible areas where the offset could have started.



2 miles SW of McClellanville, SC on Route 17

LOCALITY TYPE

Offset

Offset at a heading

Examples: "50 miles W of Las Vegas", "10 km E de Amamá"

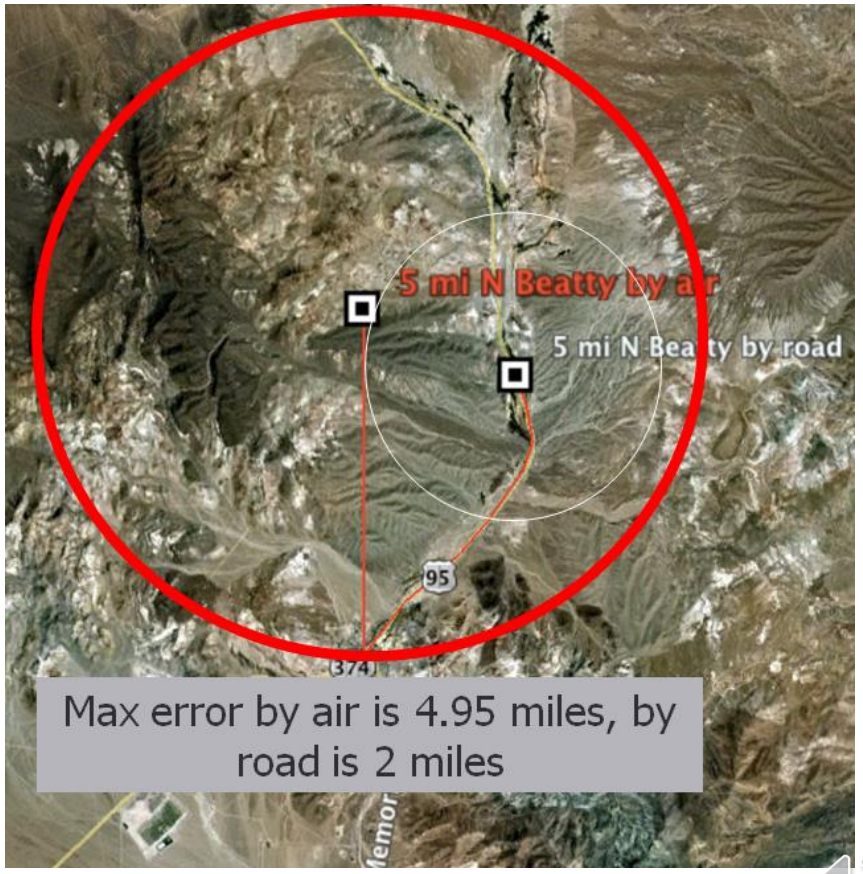
OFFSET – DISTANCE AT A HEADING

Previously: Offset: Offset at a heading (2012)

The locality consists of a specified distance, and a specified direction (Ex. “N”, “east”, “SW”, etc.) from a single named place.

Georeferencing Procedure:

1. Determine the starting point for the offset and find coordinates for the center
2. Determine the radial for the starting point as you would for a bounded or unbounded feature
3. Use the MaNIS Georeferencing Calculator to find the offset coordinates and uncertainty radius

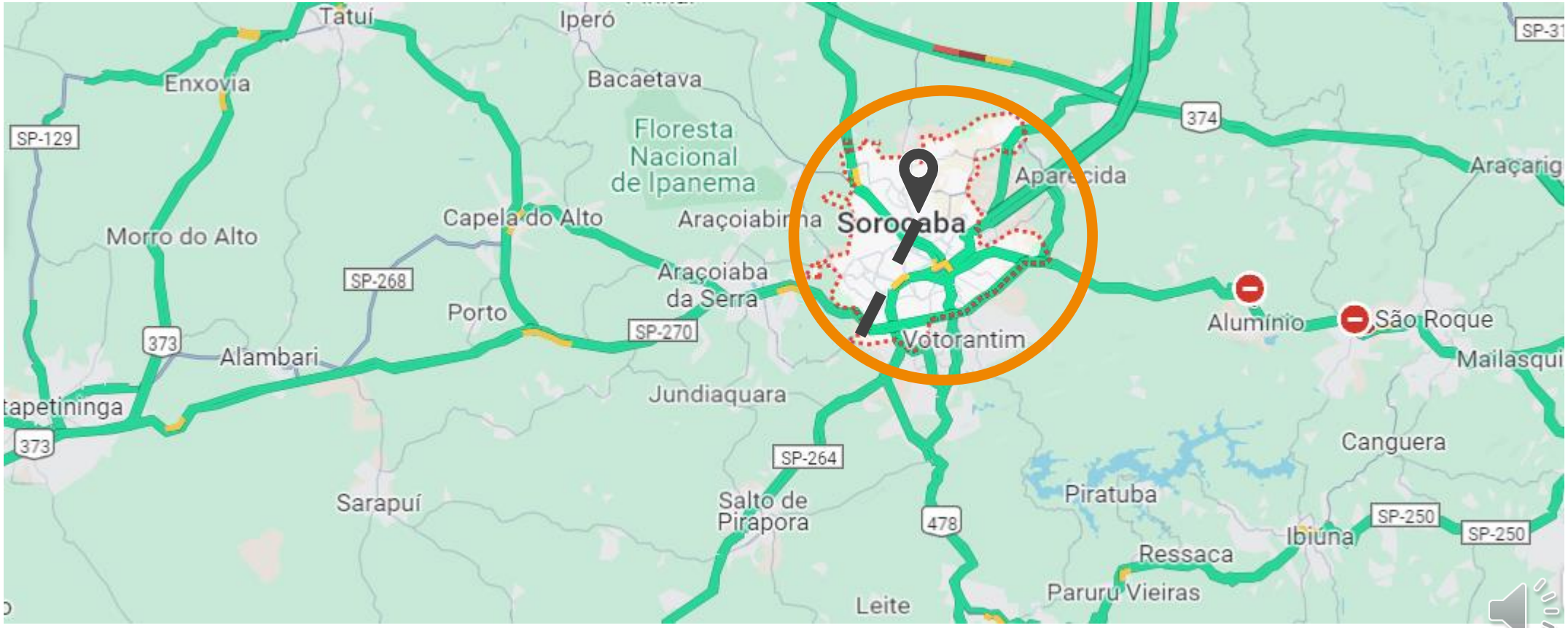


Can be automated by using GEOLocate (for U.S., Canada, and Europe)

COORDINATE & RADIAL PROTOCOL

Georeferencing Procedure:

Coordinates: Approximate center of starting location
Radial: Measure from coordinates to farthest extent of city to find radial

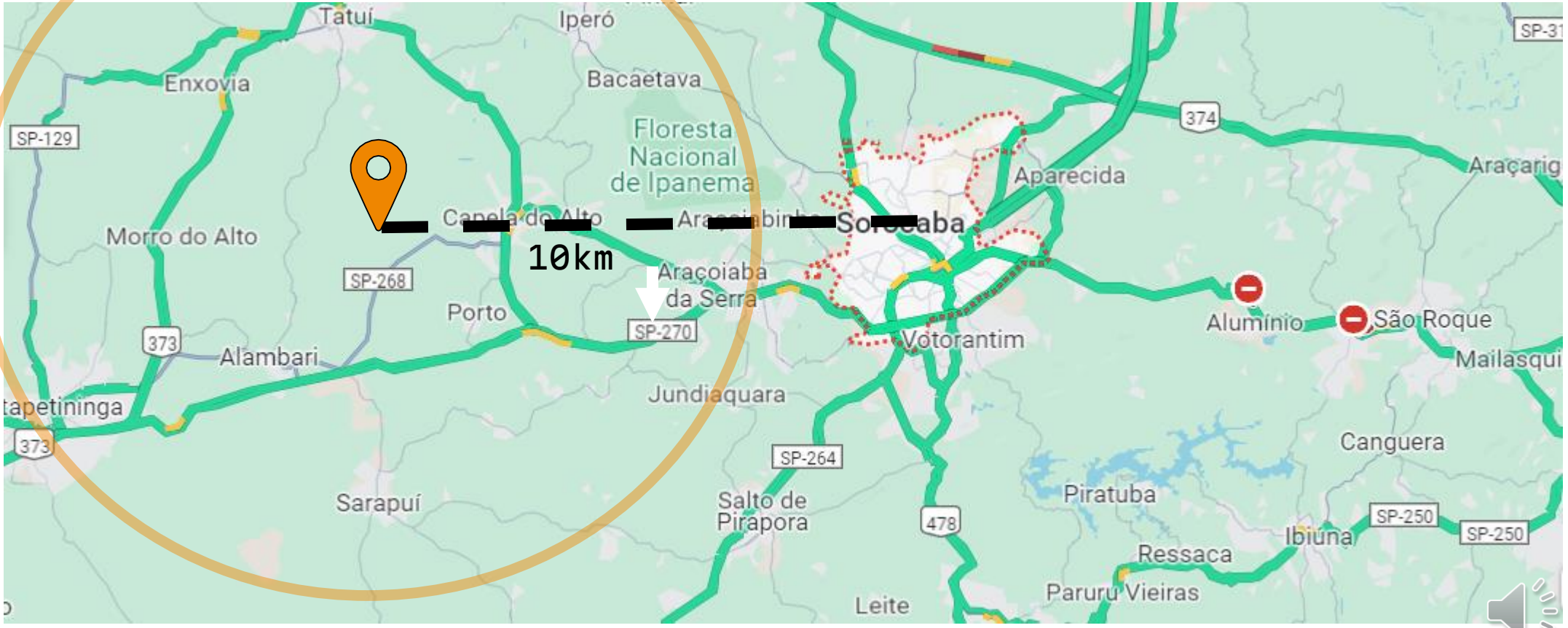


10km west of city of Sorocaba, S.P., Brazil

CALCULATOR PROTOCOL

Georeferencing Procedure:

Calculator: Enter coordinates and radial into the MaNIS Georeferencing Calculator to produce offset coordinates and uncertainty radius.



10km west of city of Sorocaba, S.P., Brazil

OFFSET – DISTANCE ALONG ORTHOGONAL DIRECTIONS

Previously: Offset: Offset in orthogonal directions (2012)

LOCALITY TYPE

Offset

Offset in orthogonal directions

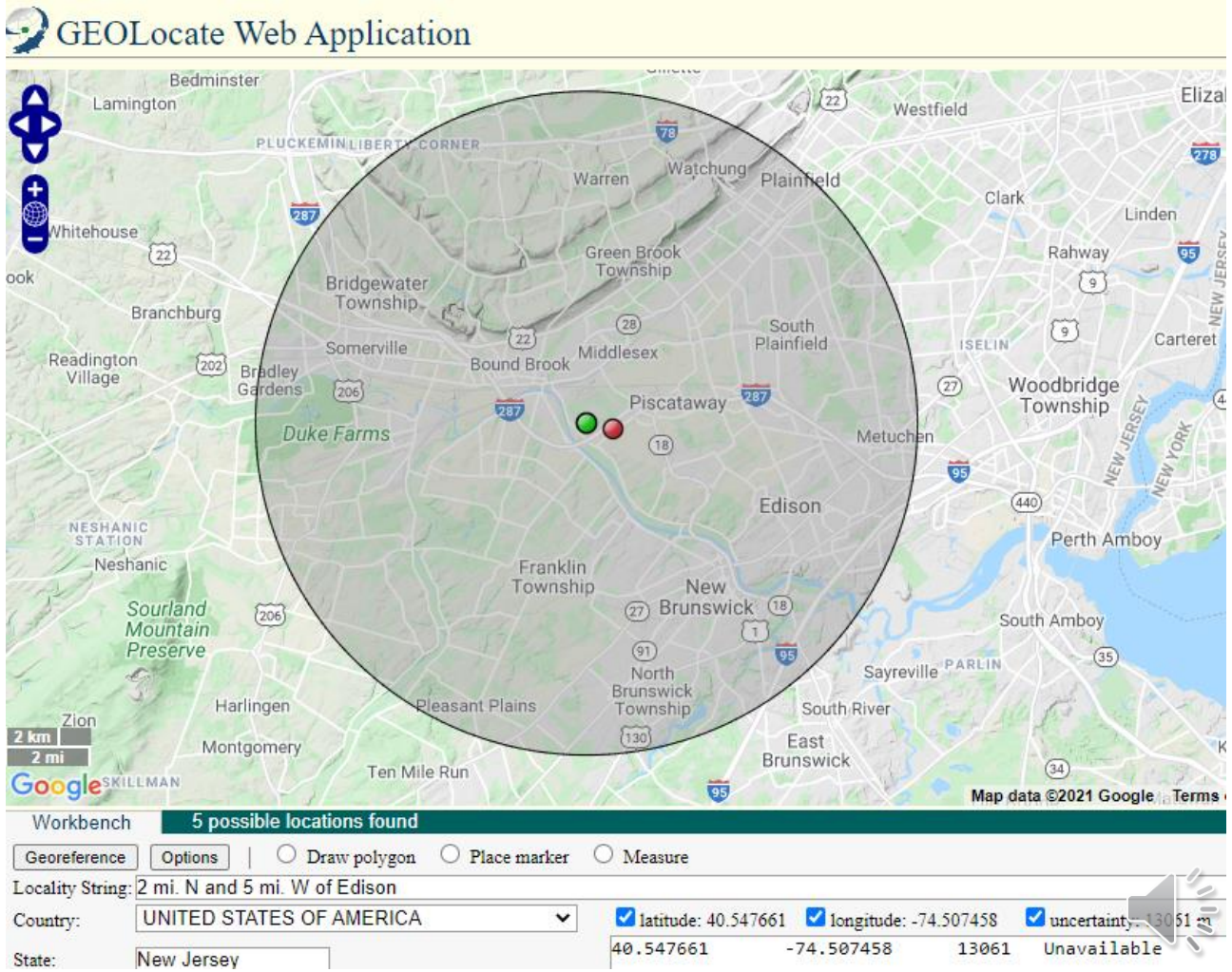
Examples: "6 km N and 4 km W of Welna"

The locality consists of a linear distance in two orthogonal directions from a feature

Georeferencing Procedure:

Best and easiest method to approach these localities (for U.S., Canada, and Europe) is by using GEOLocate

Otherwise consult the Georeferencing Quick Reference Guide



LOCALITY TYPE

Offset

Offset only, no direction

Examples: "5 km outside Calgary", "12 km fuera de Purmamarca"

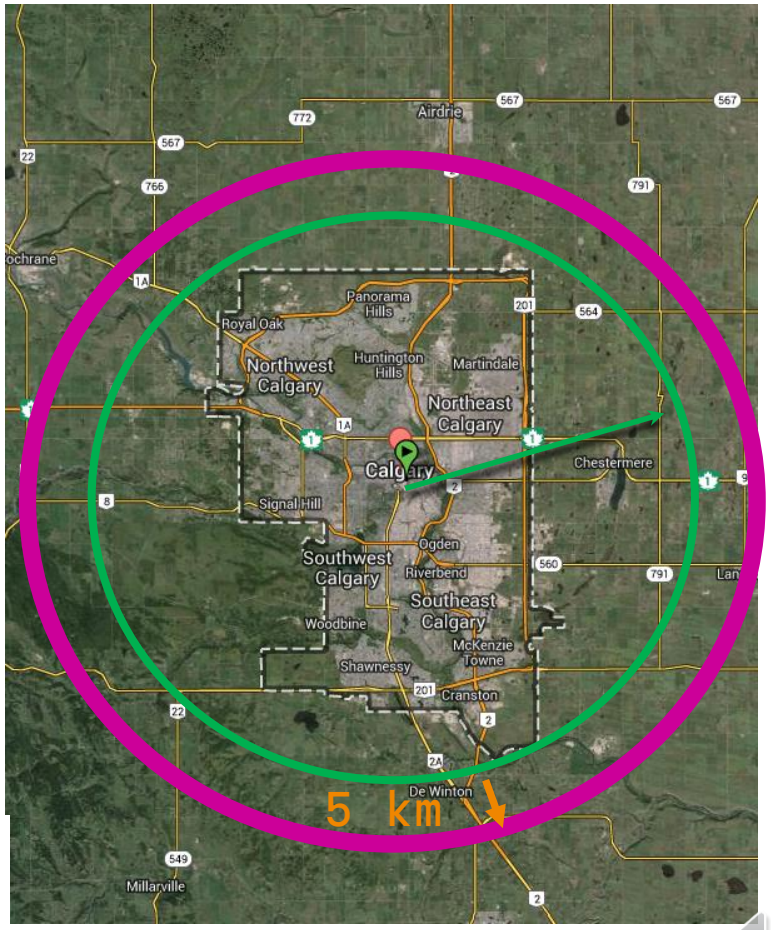
OFFSET – DISTANCE ONLY

Previously: Offset: Offset only, no direction (2012)

Locality consists of an offset from a feature without any direction specified.

Georeferencing Procedure:

1. Find coordinates for the approximate center of the locality.
2. Determine radial as you would for a bounded or unbounded feature, then add the offset distance to this value
3. Use the MaNIS Georeferencing Calculator to find the uncertainty radius.



Extent = 22 km
Offset = 5 km
Radial = 27 km

LOCALITY TYPE

Offset

Direction only, no distance

Examples: "N Palmetto", "N of Berkeley", "Saladillo N", "Al N de Saladillo"

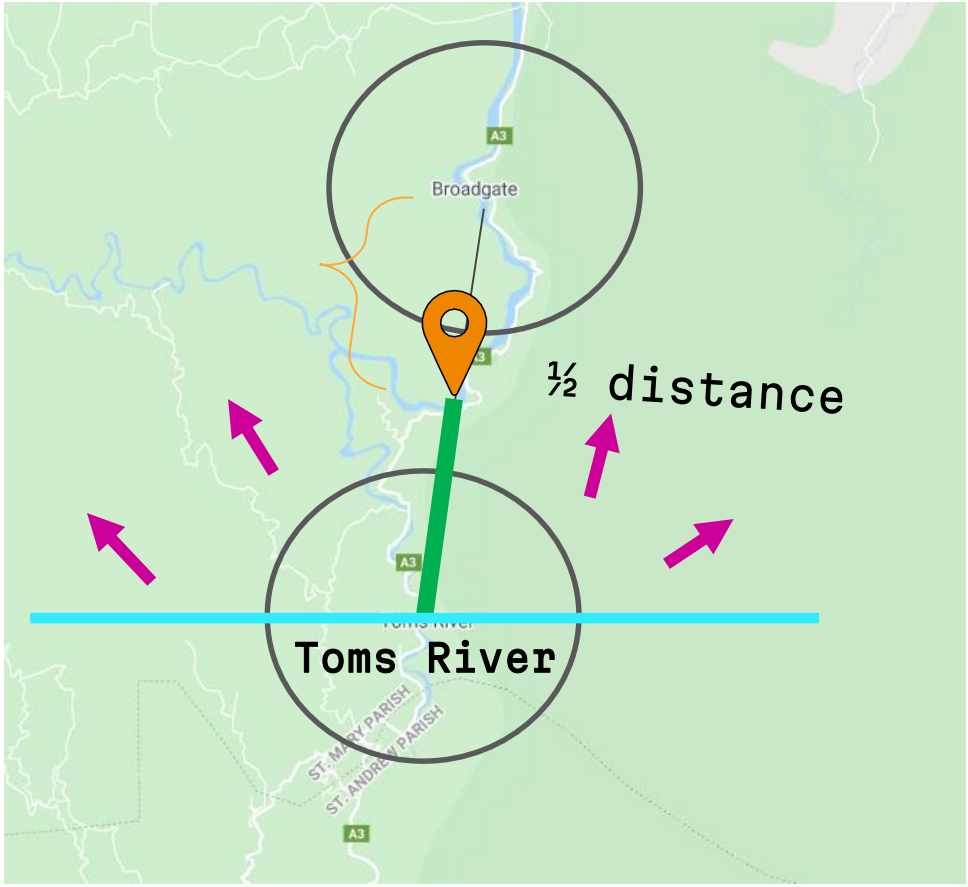
OFFSET – HEADING ONLY

Previously: Offset: Direction only, no distance (2012)

The locality consists of a direction from a feature without any distance specified.

Georeferencing Procedure:

1. **Determine coordinates for the approximate center of the named feature and the closest feature in the direction specified**
2. **Find the midpoint between the two centers. Record the midpoint coordinates**
3. **Use the distance from the coordinates to the center of either locality as the radial (should be equidistant)**



North of Toms River, Jamaica

WHAT SHOULD YOU NOT GEOREFERENCE?

CULTIVATED SPECIMENS

“in planting beds…”

cultivated/cult.

“growing in garden…”

“from nursery”

“Botanic Gardens from seed obtained from…”

UNABLE TO LOCATE

presumably central Chile

“San Jose, Mexico”

“Summit”

“locality not recorded”

“from São Paulo and Rio de Janeiro, Brazil”

INACCURATE/CONFLICTING DESCRIPTION

“20 mi S of Rockaway Beach, Queens” (plots in Ocean)

"Delano, Tulare Co." (incorrect county)

“10 mi W of Bakersfield, 6000 ft” (elevation mismatch)

LOCALITY TYPES

Simple Localities:

- Feature – With Obvious Spatial Extent (Defined Area)
- Feature – Without Obvious Spatial Extent (Undefined)
- Feature – Near a Feature
- Feature – Between Two Features
- Feature – Paths (River, stream, road, path)

Offsets:

- Offset – Distance only
- Offset – Heading only
- Offset – Distance along a path
- Offset – Distance along Orthogonal Directions
- Offset – Distance at a Heading

Google Maps

GEOLocate

Coordinates Exist:

- Lat /Long Coordinates (leave alone)
- TRS Coordinates
- UTM Coordinates

Do not georeference:

- Dubious
- Can not be located
- Demonstrably Inaccurate
- More than One Matching Feature
- Cultivated

Quick Guide: Appendix A - Key to Locality Types of the Georeferencing Quick Reference Guide

Zermoglio PF, et. al (2020) Georeferencing Quick Reference Guide. Copenhagen: GBIF Secretariat. https://doi.org/10.35035/e09p-h128

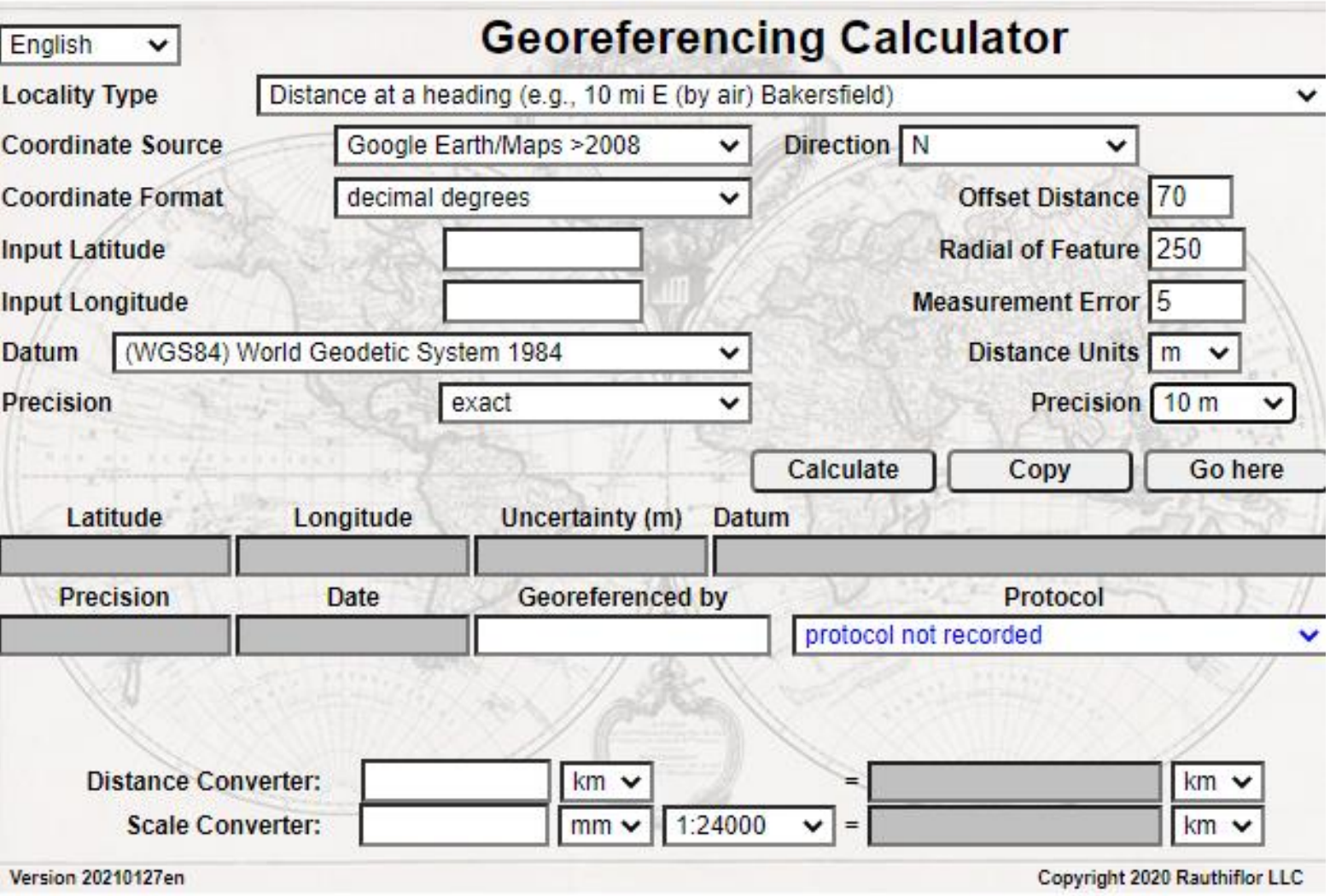
MANIS GEOREFERENCING CALCULATOR

Specialized calculator used in conjunction with Google Maps to determine the uncertainty radial and offset coordinates for georeferences (not used with GEOLocate). The tool incorporates measurement of locality's radial in addition to all other sources of error

Work Flow:

1. Select the appropriate Locality Type
2. Enter error parameters for calculation
3. Calculate the radius (output in meters)

PARAMETERS



Fields display depending on locality type:

Locality Type: Choose from 6 options provided
Coordinate Source: Google Maps > 2008
Coordinate Format: Decimal degrees
Datum: WGS84
Coordinate Precision: exact
Direction: (offset at a heading only) **North/South Offset & East/West Offset Distance:** (orthogonal directions only)
Offset Distance: As stated in locality description, in units provided
Radial of Feature: radial found
Measurement Error: Determine the smallest distance that you can reliably (reproducibly) measure on the map (10m)
Distance Units: Meters, automatically provided in this format
Precision: dependent on provided offset

GEOREFERENCING REMARKS

Notes or comments out of the ordinary about the georeference, explaining assumptions made in addition/opposition to the method referred to in the protocols followed. We aim to keep notes to **255 characters and under.**

Examples:

Dr. Davies Farm, Clarkstown, NY

Situation: Cannot find farm referenced. Moving up the geographical hierarchy.

Notes: *Unable to locate Dr. Davie's farm. Georeferenced to the corrected center of Clarkstown.*

6 miles South of McClouth, Jefferson Co., Kansas

Situation: Place name is a spelling variation or misspelled.

Notes: *Assumed McClouth is a misspelling of McLouth. Georeferenced to 6 mi S of McLouth.*

METADATA CAPTURE

The Darwin Core standard defines the fields recommended for capturing reproducible georeferences:

- **decimalLatitude, decimalLongitude, geodeticDatum (EMu: Latitude, Longitude, Datum)**: these fields specify the coordinates representing the center of the point-radius georeference.
- **coordinateUncertaintyInMeters (Radius (Numeric)):** the radius of the smallest enclosing circle around the coordinates that includes the entire location.
- **georeferencedBy, georeferencedDate (Determined By, Determination Date):** these fields identify the individual(s) who last modified the georeference and the date of this modification, marking the final authority on the georeference in its current state.
- **georeferenceProtocol (Determination Method):** refers to the methods used to determine the coordinates and the uncertainty of the georeference.
- **georeferenceSources (Determination Source):** a list (separated by commas) of maps, gazetteers, or other resources used to determine the georeference location.
- **georeferenceRemarks (Notes):** additional notes or comments about the georeference, explaining any assumptions or deviations from the formal guidelines followed.

BEST PRACTICES/GUIDES

Georeferencing Quick Reference Guide (2020)

Georeferencing Quick Reference Guide (2012)

Georeferencing Best Practices (2020)

Georeferencing Calculator Manual (2020)

BioGeomancer Guide to Best Practices in Georeferencing

MaNIS/HerpNET/ORNIS Georeferencing Guidelines