

# Linear Referencing in Boulder County, CO

Getting Started

# Authors

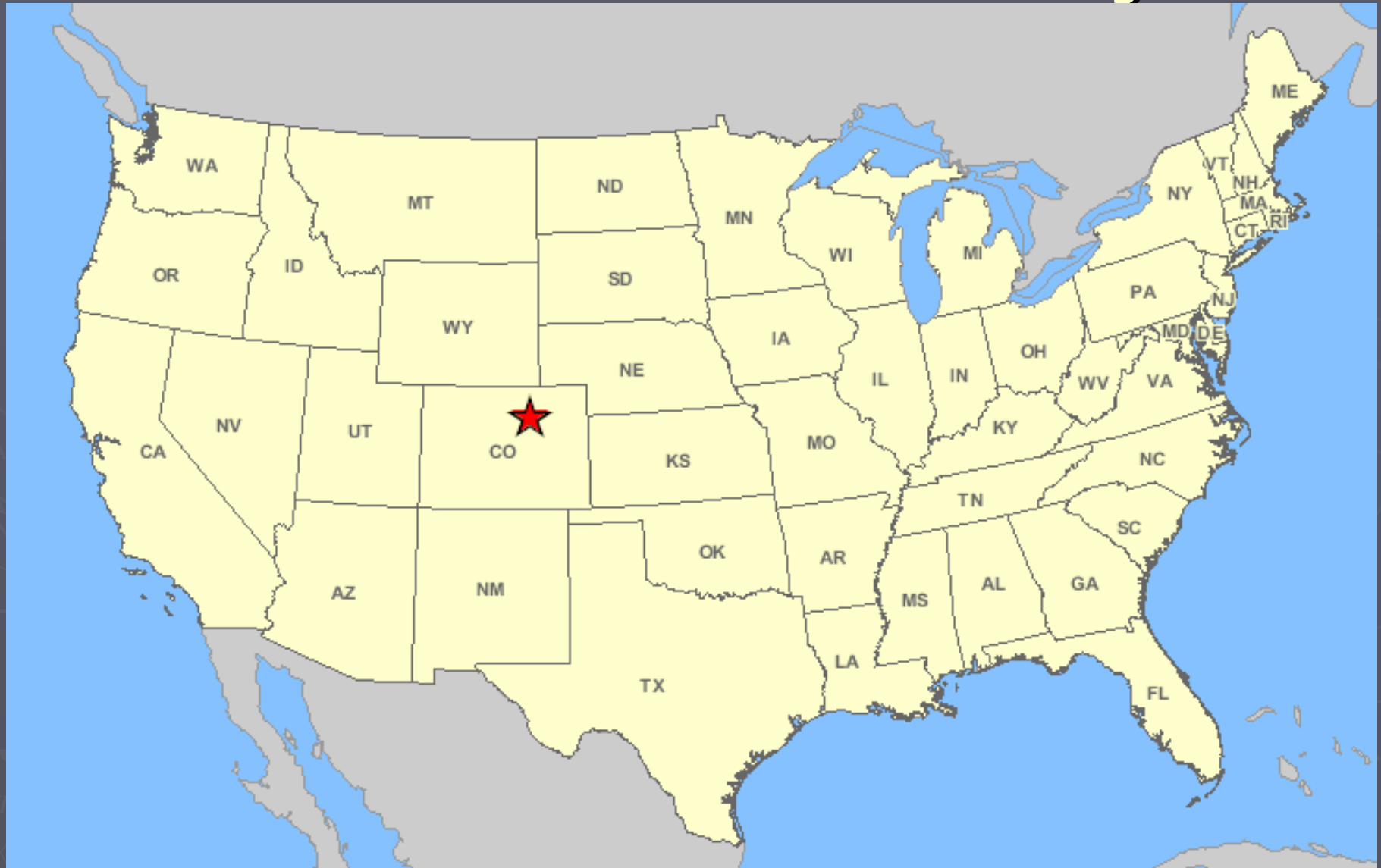
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  - County GIS coordinator
  - College GIS instructor

# Abstract

Boulder County, Colorado, is creating a countywide base-map of road centerline locations to be used for linear referencing. Data on road segments that relate to local road maintenance funding, asset management, pavement management, and the printed road map are the County Transportation Department's priorities. Other departments are interested in using a new base-map, too.

This paper discusses how we started our linear referencing database in 2005. Issues include planning for future uses, GIS modeling, editing geometry and topology, creating a geodatabase, and learning to use the ESRI linear referencing tools for creating routes and event tables. Critical "getting started" questions included "How long should our routes be?" and "What should we use as a route ID?" Funding, communication and collaboration are also discussed.

# Where is Boulder County?



# Geography = Mtns + Plains



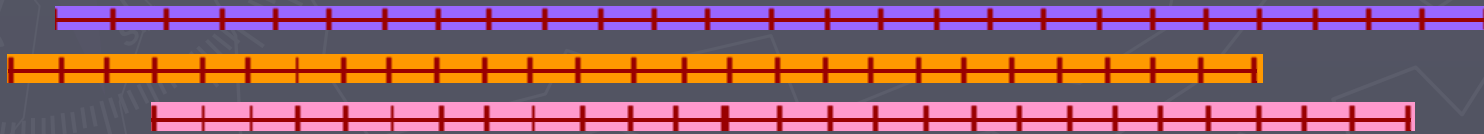
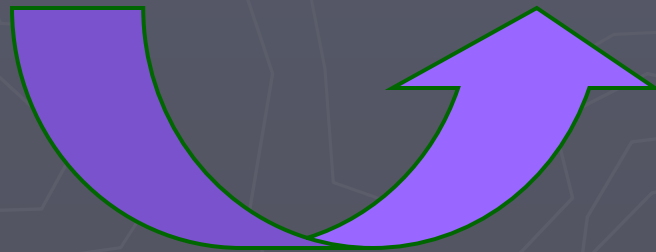
Boulder's Flatirons (City of Boulder homepage)

# Overview

1. What do we mean by linear referencing?
2. Why did we linear reference our road centerlines?
3. What tips and tricks did we learn along the way?
4. Costs: Was it expensive & time-consuming?
5. Benefits: How did it (or will it) help?

# What is linear referencing?

- ▶ Flexible measuring sticks.
- ▶ Beginning & ending points of road attributes.
- ▶ Multiple databases of road data.



# Overview

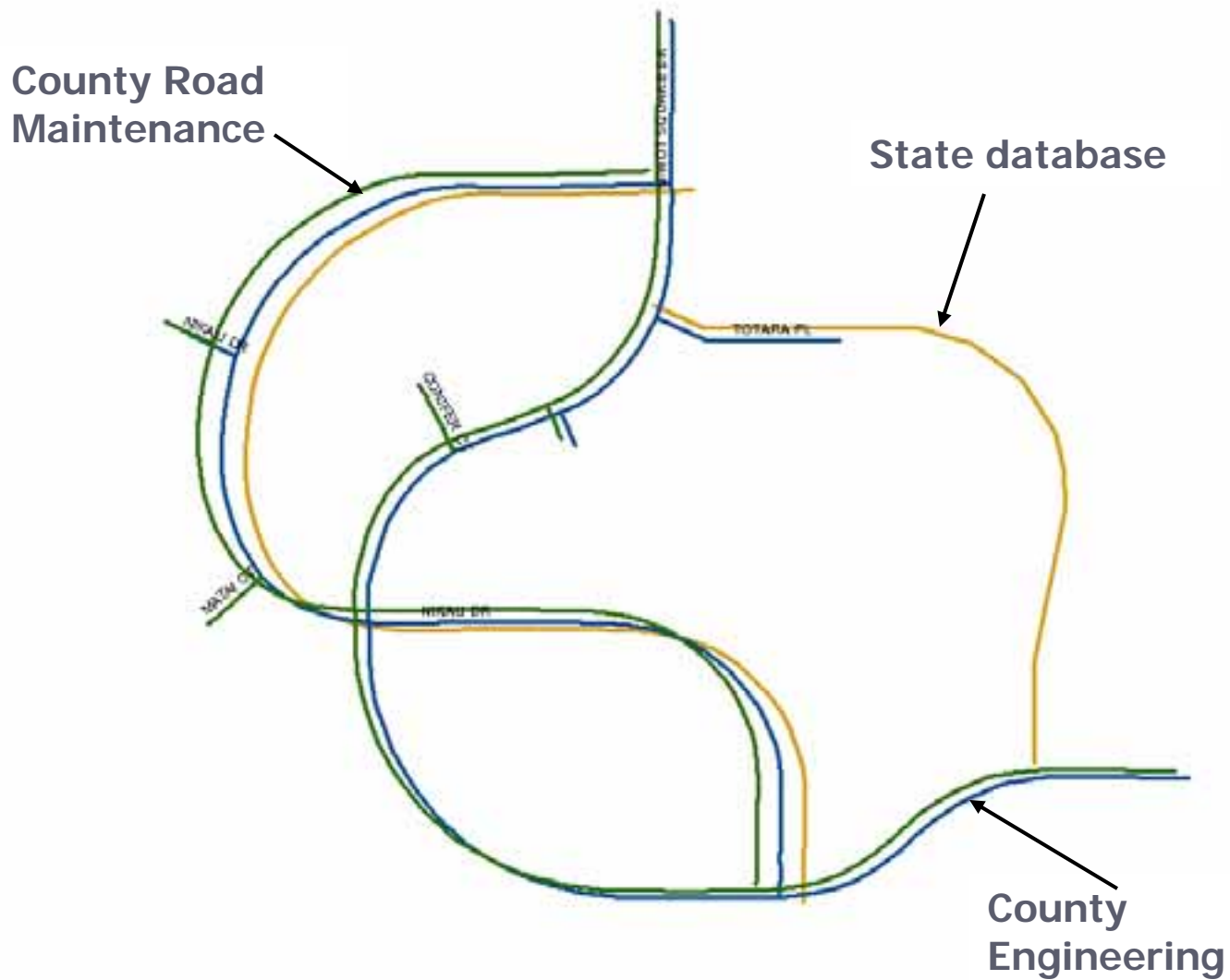
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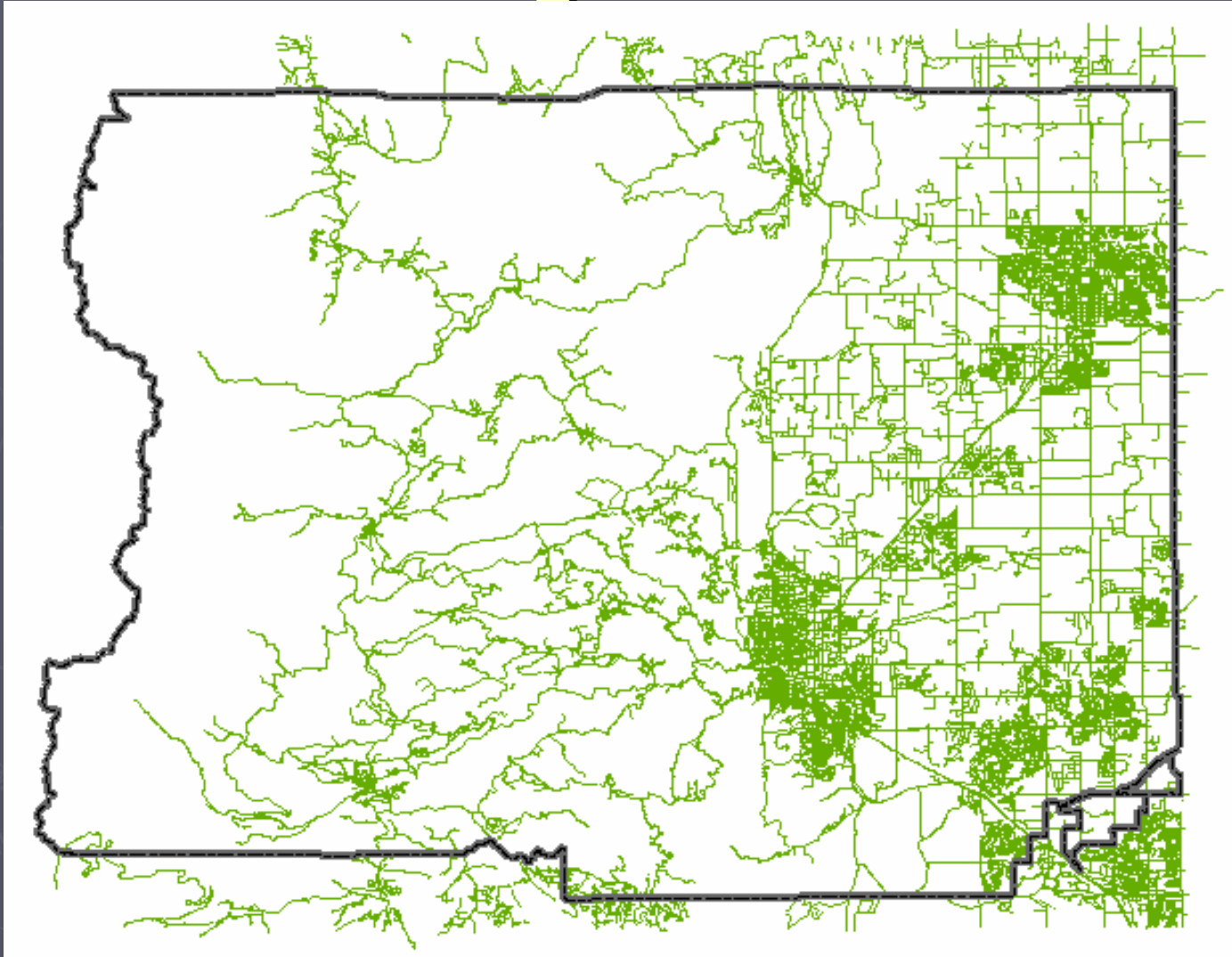
# Why LRS in Boulder County?

- ▶ One flexible road centerline layer
- ▶ Easy response to information requests
- ▶ Comprehensive
  - All county uses
  - Collaboration inside and outside the county

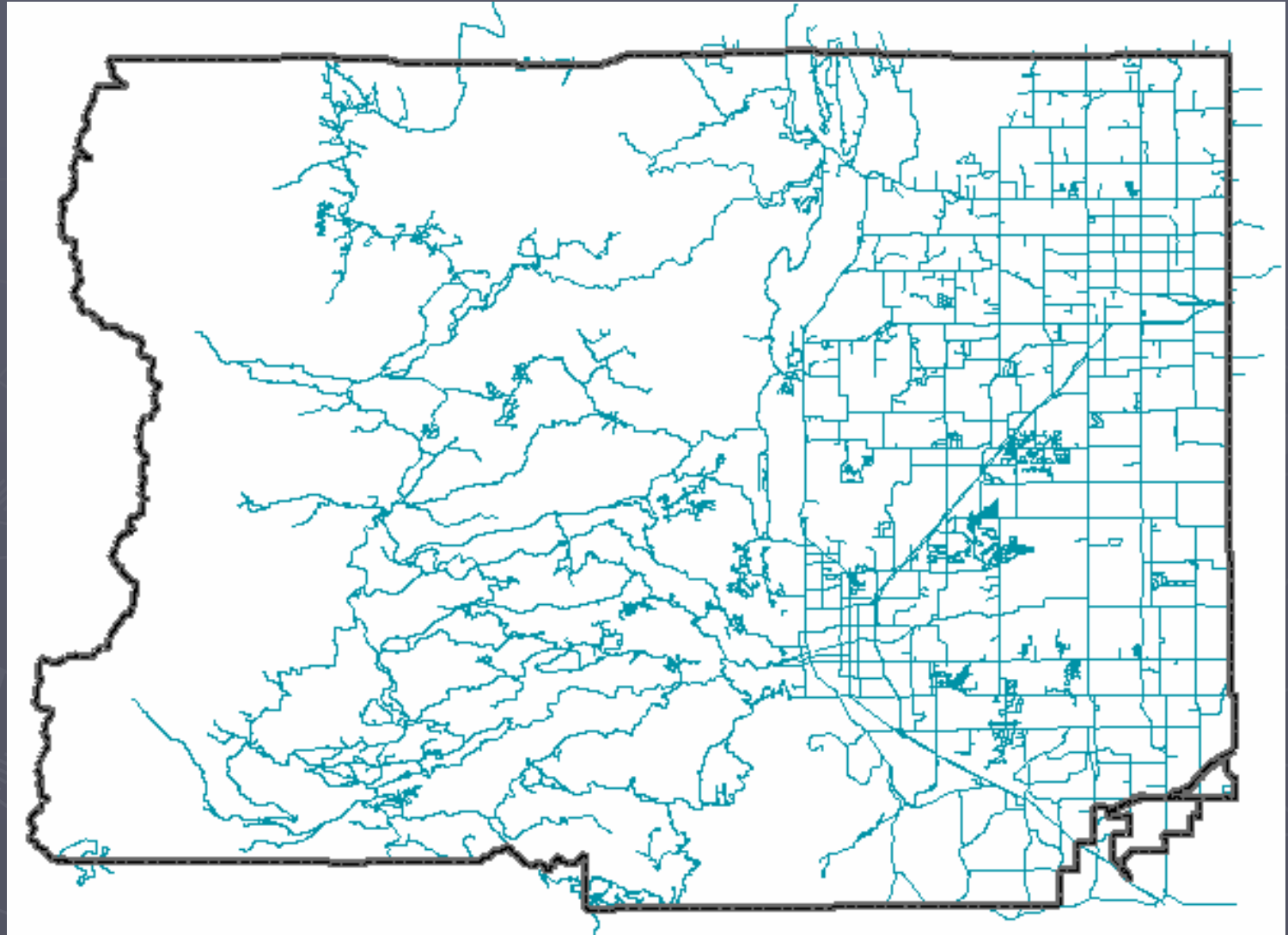
# 3 of our Hundreds of Road Layers



# County 911 Layer has 33,000 segments



# Compiled & Simplified Base-map



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# Base-map Issues



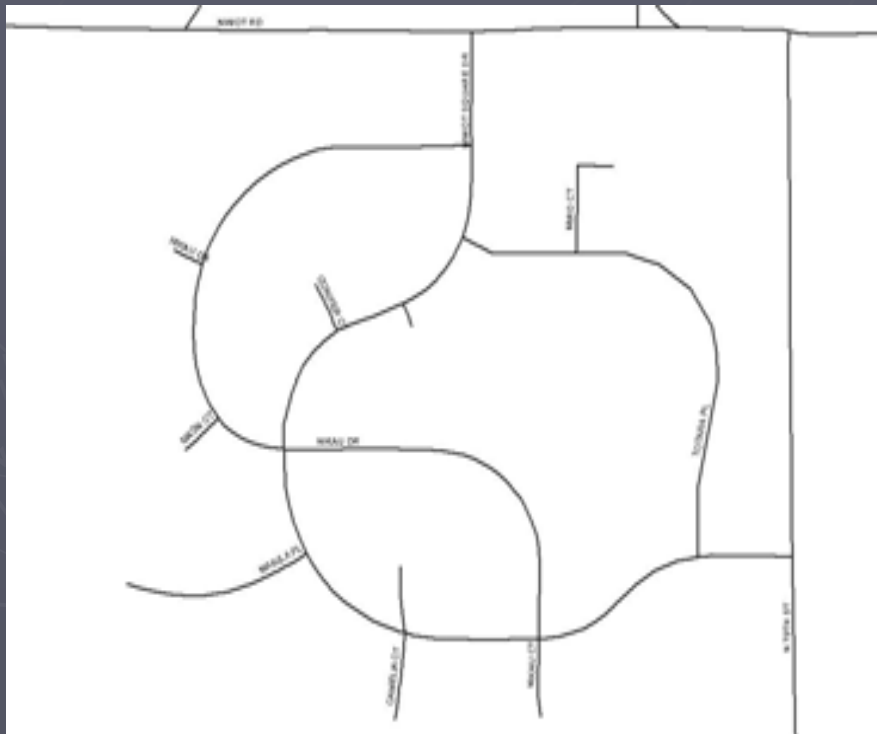
- ▶ Several (imperfect) base-maps.
  - Which one to begin with?
    - ▶ Mid-sized one created for printed map.
  - How comprehensive to make it?
    - ▶ Large enough to include county roads from state database.
- ▶ Combining disparate road segments.
  - Which attributes useful to copy such as grid location.
  - Streamline data compilation with intermediate file.

# More Base-map Issues

- ▶ Do we address topology problems at the base-map or LRS level?
  - Base-map level because LRS gets re-created



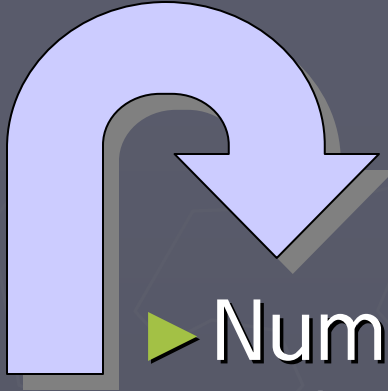
# Modeling Centerlines



- ▶ What is the best data model for representing islands, turn lanes, etc.?
  - Lines thru islands and cul de sacs unless 60' diameter;
  - extra segments for separated turn lanes.



# Detours to LRS Construction



- ▶ Number? Description? Existing or new ID?
  - We used a new number and assigned a unique description to a unique route number.
- ▶ Which road segments become a route?
  - Divided turn lanes, cul-de-sacs, connectors.

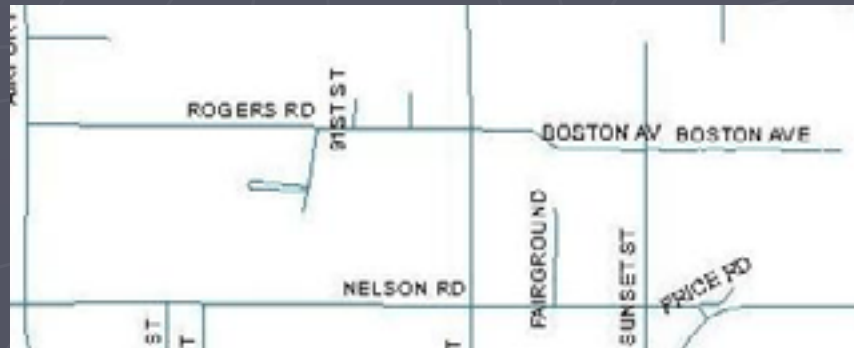
# Long or Short Routes

## ► Long routes.

- Fewer routes to maintain.
- More flexibility to divide routes into unique events.
- Easier to change city limits, road surface, etc.

## ► Short routes

- Contiguous (no gaps)
- Description similar to road name or previous data description
- Each within the same jurisdiction



# Linear Referencing Mistakes, page 1

1. Forgetting to set M value large enough in Environments (default was too short).
2. Forgetting to set extent & domain in Environments equal to the dataset you are working in.
3. Adding 44,000 segment records to about 2000 segments for purpose of deleting duplicates and expecting quick geoprocessing and selections.
4. Deleting duplicates or dissolving an outside database that will be updated regularly.
5. Dissolving on Road Name and expecting each to be unique.
6. Doing queries with Null. Populate fields with 1 or something first, then query values greater than 1. An empty cell is not the same as one with Null and Null doesn't come back if you start to type something in the cell by mistake.
7. Changing precision after changing output M domain. It will change the M domain.

## Linear Referencing Mistakes, p. 2

1. Saving map document after running tool to create routes from base-map. Go to ArcCatalog, delete LRS and change name of LRS1 to LRS. Then the map will point to the new routes.
2. Edit and run tools instead of open & run tools unless parameter is set for output.
3. Remember to snap vertices using topology edit tool; otherwise it's too easy to move whole line with the regular edit tool.
4. Remember to check all fields visible before loading or appending objects from that feature class. Even if using a tool.
5. Remember to save all output to same dataset not just same geodatabase. That way it will have the same extent and M domain.
6. Not copying and pasting date in exact format. It doesn't work to use calculate values using a copied value.

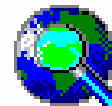
# ESRI's ArcGIS Software

- ▶ ArcGIS Desktop - ArcInfo license
- ▶ ArcMap - editing
- ▶ ArcCatalog - data management & topology
- ▶ Model Builder - creating custom tools
- ▶ ArcToolbox
  - Linear Referencing tools
  - Geo-processing

# Fun with GIS

ArcMap

**ArcMap has encountered a problem and needs to close. We are sorry for the inconvenience.**



If you were in the middle of something, the information you were working on might be lost.

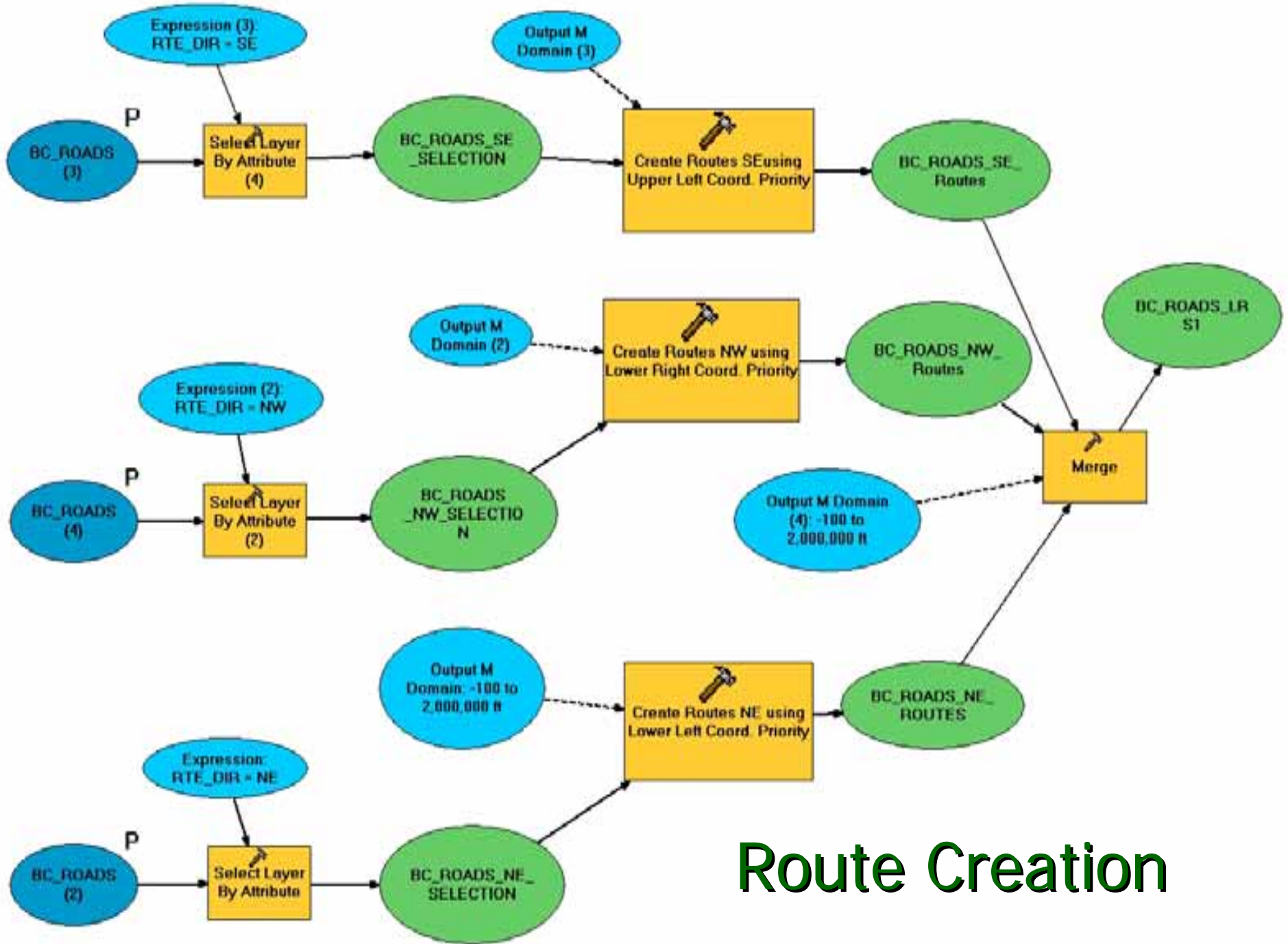
For more information about this error, [click here.](#)

Close

ArcMap message (ESRI)

# Favorite Buttons

- ▶ Create Route
- ▶ Zoom to selection
- ▶ Clear selection
- ▶ Save edits!



# Route Creation

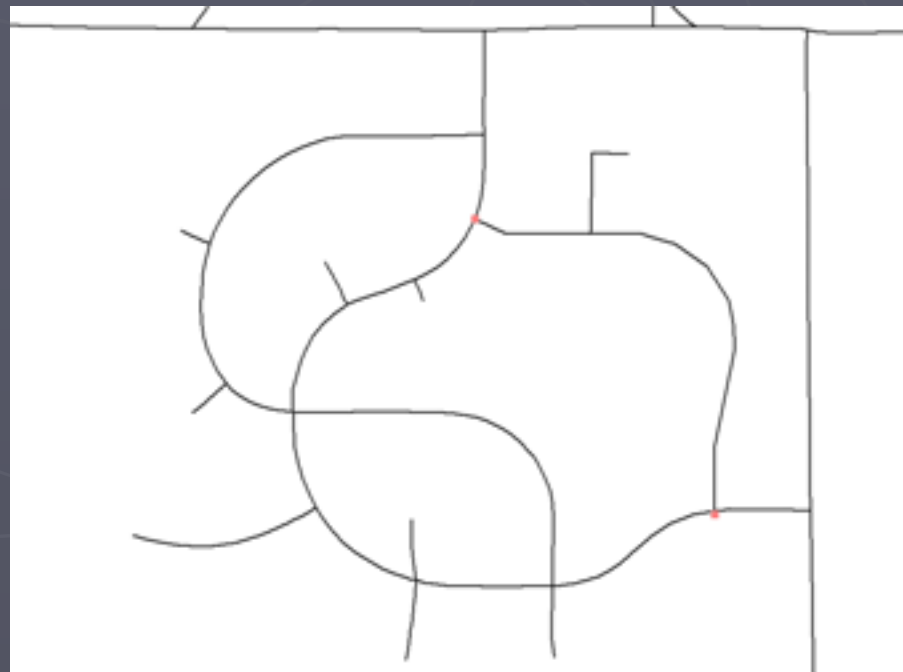


# Helpful Resources

- ▶ ESRI – on-line, in-person & e-mail
- ▶ Government agencies
- ▶ Technical papers
- ▶ GIS Colorado listserv

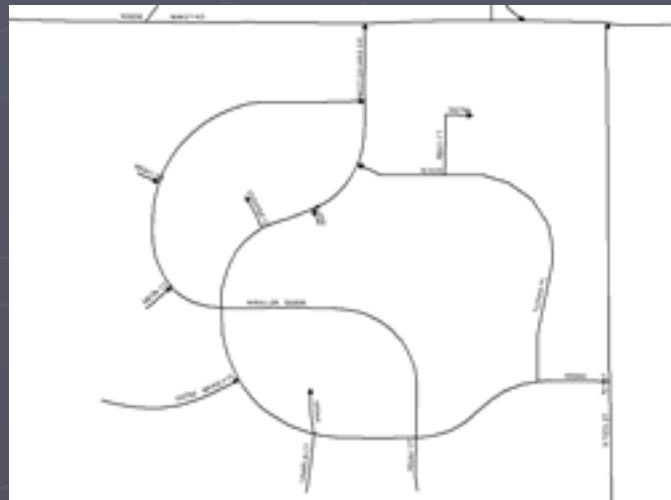
# Base-map Tips

- ▶ Base-map is key to a good LRS.
- ▶ Keep the data model simple.
- ▶ Use dual monitors.
- ▶ Add several fields.
  - Route number.
  - Route description.
  - Data source & date.



# LRS Tips

- ▶ Use arrow symbols on the LRS layer to show direction and to distinguish it from the base-map layer.
- ▶ Summarize table verifies Route IDs are unique



OID	RTT_ID	Count RTT_ID
0	100001	1
1	100002	1
2	100003	1
3	100004	1
4	100005	1
5	100006	1
6	100007	1
7	100008	1
8	100009	1
9	100010	1
10	100013	1
11	100014	1
12	100015	1
13	100016	1
14	100017	1
15	100021	1
16	100022	1

# Lessons Learned

- ▶ More experience with geodatabases necessary
- ▶ Confusing terms such as events and routes caused miscommunication
- ▶ Minimize the scope of work and order the tasks
- ▶ Use numbers and a description to uniquely ID routes on base-map but refer to numbers.
- ▶ Use a combination of long and short routes, depending on future needs.

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# Cost: How hard was the LRS?

- ▶ Depends on quality and scope of base-map.
- ▶ Depends on level of experience with linear referencing.
- ▶ Depends on level of funding and political support.
- ▶ Depends on geodatabase design.

# Costs

- ▶ Training and experimenting.
- ▶ Gathering and organizing data layers.
- ▶ Creating project flowcharts.
- ▶ Looking for grants or outside funding.

# Costs

- ▶ Distributing LRS user survey to staff.
- ▶ Developing customized tools.
- ▶ Estimated ROI time: unknown.
- ▶ Chocolate treats as motivation.



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# How will LRS help Boulder County?

- ▶ Attributes updated by measures not lines.
- ▶ Easier data sharing.
- ▶ Analyze and view funding income vs. road maintenance expenses by region, category or line segment.

# How will LRS help Boulder County?

- ▶ Centralized editing of centerline geometry saves departments time.
- ▶ Possible savings in software licensing needs.
- ▶ Interconnectedness of more attribute data.

# Status Report

- ▶ User survey July 2005.
- ▶ Testing started Oct. 2005.
- ▶ Communication continues Aug 2006.
- ▶ Base-map road layer mostly complete.
- ▶ LRS layer and several event tables created.
- ▶ Next: test and implement multi-user functionality.



# To Linear Reference or Not

## ► Why LRS:

- Fewer road centerline layers to manage.
- To avoid having to break line segments into even more segments.

## ► Why not LRS:

- Base-map is very outdated.
- Lack of funding and support.

# Summary

## ► Benefits.



- Cost effective in the long run.
  - Immediate benefits of cooperative effort to make one best map.
  - Interconnect tables and feature classes.
- Next steps: Create event tables from existing lines and points, get user input.

# Acknowledgments

- ▶ Thanks to Microsoft Clip Art for the smaller graphics.
- ▶ Thanks to ESRI for the images exported from ArcMap.

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