Redneck's and Duct Tape

GIS/GPS Method of Efficient School Bus Routing

Will Davis, GISP

Lake County Schools

Wednesday, April 10th, 2013

The Big Yellow Bus

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Project Background

294 Buses

Transporting 21,860 Students

Twice Daily

30,670 Miles

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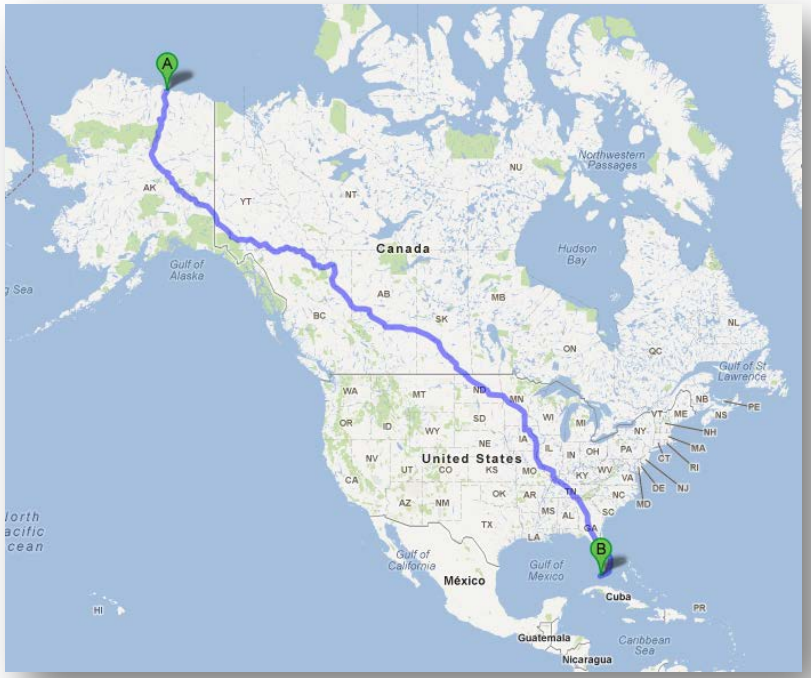
Project Background

Key West, FL to Deadhorse, AK
Distance of 5,482 -- 4 Days 15 Hours
30,670 Miles = 2.8 Round Trips
6.2 mpg = 4,950 gallons/day



Project Background

Annual Distance Traveled
5,523,740 Miles
(11.5 Round Trips)

238,900 Miles

Situation

- Revenue/Budget Shortfall
  - Total Cost = $16 Million
  - Cost to District = $7.65 Million
  - State Reimbursement = $8.35 Million
- Cost Cutting Measures
- State Statute & Board Policy

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Key Project Points

- Efficient Routing
  - Travel Time/Distance
  - Depot Stops
- Reduce Ridership
  - State Guidelines
  - Board Policy
- Student Safety
  - Local Govt. Coordination
  - Public Involvement

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Project Goals

- Reduce Cost to School District
  - Eliminate routes
  - Eliminate stops (initiate depot stops)
  - Reduce travel time/distance
  - Eliminate or reduce staff hours
  - Cut fuel consumption
  - Cut Maintenance

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Where Do We Start?

- Determine tasks & budget
- Data collections efforts
  - Students
  - Routes/Stops
  - Streets (networkable)
  - Cost
- Measuring success

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Analysis Constraints

- Determine operating cost
  - Minimize windshield time
    - Driver hours
  - Minimize travel distance
    - Fleet maintenance
    - Reduce fuel cost
- Load balancing of students
- Student travel time constraints
- Bell time constraints
- Stop allocation

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How to get there?

- Mapping what we KNOW
  - Geocoded students
  - Determine transportation
    - Routes
    - Stops
  - Networkable GIS layers
    - Walkability (Student)
    - Drivability (Bus)

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Locate Bus Routes

Hand Drawn Laminated Paper Maps

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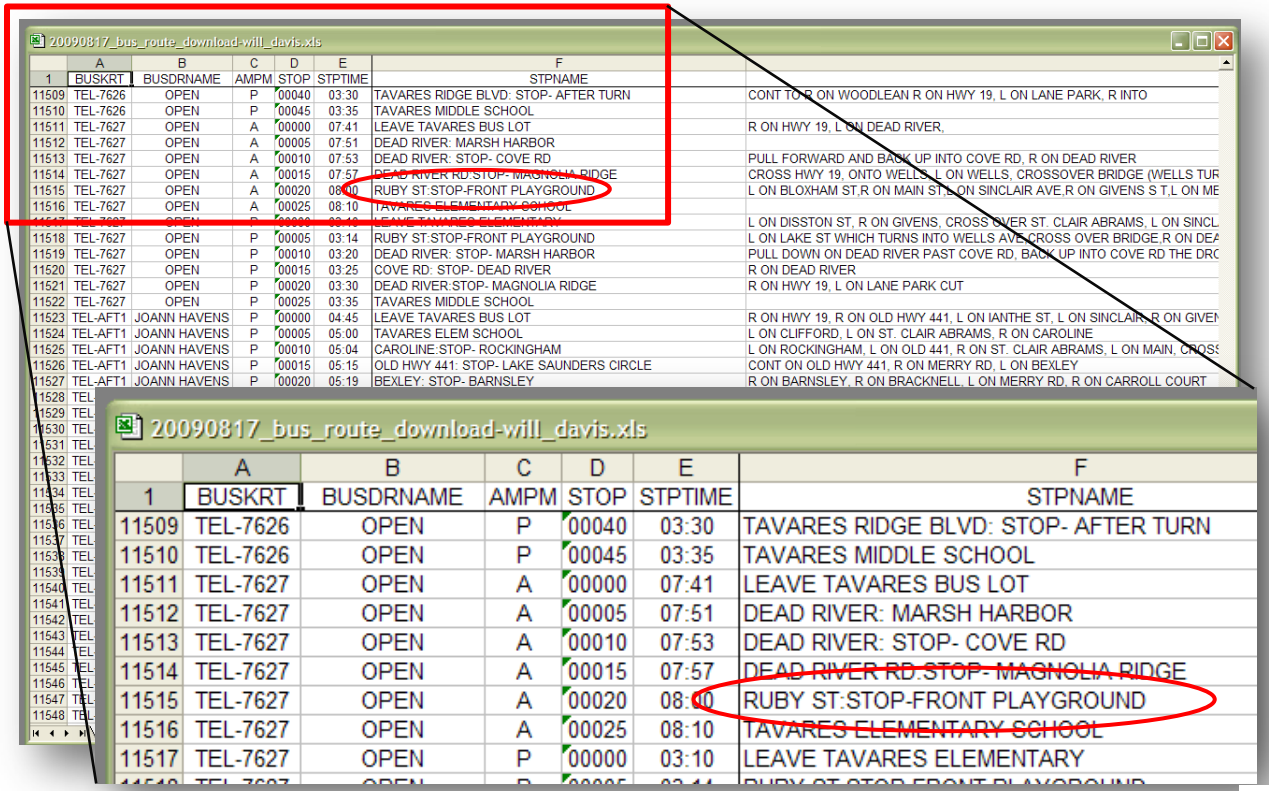
Locate Bus Stops

Bus Stop Tabular File from IT Dept.



	A	B	C	D	E	F
1	BUSKRT	BUSDRNAME	AMPM	STOP	STPTIME	STPNAME
11509	TEL-7626	OPEN	P	00040	03:30	TAVARES RIDGE BLVD: STOP- AFTER TURN
11510	TEL-7626	OPEN	P	00045	03:35	TAVARES MIDDLE SCHOOL
11511	TEL-7627	OPEN	A	00000	07:41	LEAVE TAVARES BUS LOT
11512	TEL-7627	OPEN	A	00005	07:51	DEAD RIVER: MARSH HARBOR
11513	TEL-7627	OPEN	A	00010	07:53	DEAD RIVER: STOP- COVE RD
11514	TEL-7627	OPEN	A	00015	07:57	DEAD RIVER RD:STOP- MAGNOLIA RIDGE
11515	TEL-7627	OPEN	A	00020	08:00	RUBY ST:STOP-FRONT PLAYGROUND
11516	TEL-7627	OPEN	A	00025	08:10	TAVARES ELEMENTARY SCHOOL
11517	TEL-7627	OPEN	P	00000	03:10	LEAVE TAVARES ELEMENTARY
11518	TEL-7627	OPEN	P	00005	03:14	RUBY ST:STOP-FRONT PLAYGROUND
11519	TEL-7627	OPEN	P	00010	03:20	DEAD RIVER: STOP- MARSH HARBOR
11520	TEL-7627	OPEN	P	00015	03:25	COVE RD: STOP- DEAD RIVER
11521	TEL-7627	OPEN	P	00020	03:30	DEAD RIVER:STOP- MAGNOLIA RIDGE
11522	TEL-7627	OPEN	P	00025	03:35	TAVARES MIDDLE SCHOOL
11523	TEL-AFT1	JOANN HAVENS	P	00000	04:45	LEAVE TAVARES BUS LOT
11524	TEL-AFT1	JOANN HAVENS	P	00005	05:00	TAVARES ELEM SCHOOL
11525	TEL-AFT1	JOANN HAVENS	P	00010	05:04	CAROLINE:STOP- ROCKINGHAM
11526	TEL-AFT1	JOANN HAVENS	P	00015	05:15	OLD HWY 441: STOP- LAKE SAUNDERS CIRCLE
11527	TEL-AFT1	JOANN HAVENS	P	00020	05:19	BEXLEY: STOP- BARNSLEY

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Modeling Methods

- Mapping existing details
  - AVL Tracking Systems
  - GPS "Geofence" detection
  - VRP – Vehicle Routing Problem
  - EMC – Ejection Chain Method
  - TSA – Tabu Search Algorithm
  - Heuristic Method

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Vendor Options

- Locating Bus Routes or Stops
  - Transfinder (*Routefinder Pro*)
  - Tyler Technologies (*Versatrans* ™)
  - Edulog (*Edulog.nt*)
  - Route Solutions (*StreetSync*™)
  - Trapeze Group (*Trapeze MapNet*)
  - Gecko Microsolutions, Inc. (*T.O.M.*)
  - Everday Solutions, Inc. (*GEOREF*)
  - Total Solutions Partners (*BusOnePro*)

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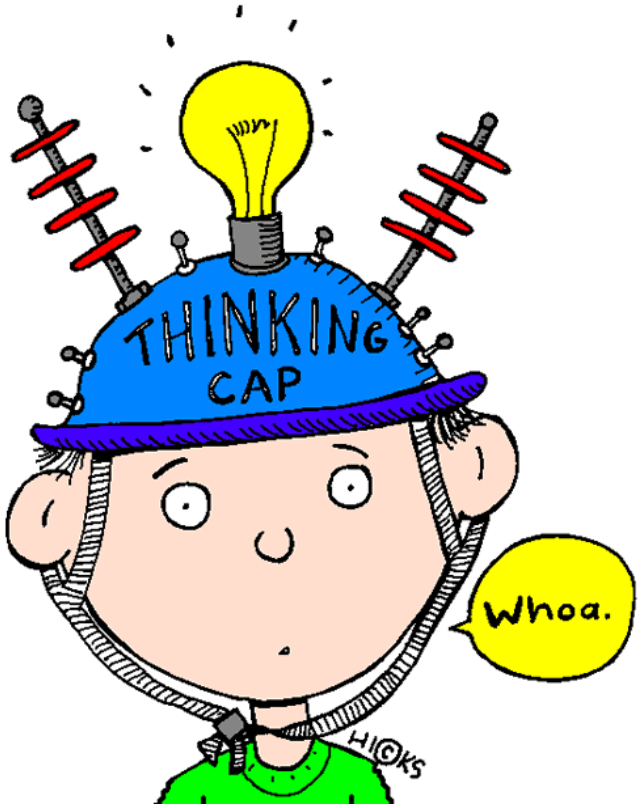
Options Overload

How to Obtain Useful GIS Data



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Low-cost Solution

- Ernest P. Worrell GIS Method
  - Affordable GPS Tracking Key
  - Scripts to extract
    - Routes
    - Stops
  - Create GIS Layers
    - Arcs
    - Points

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Low-cost Solution

GPS Tracking Key

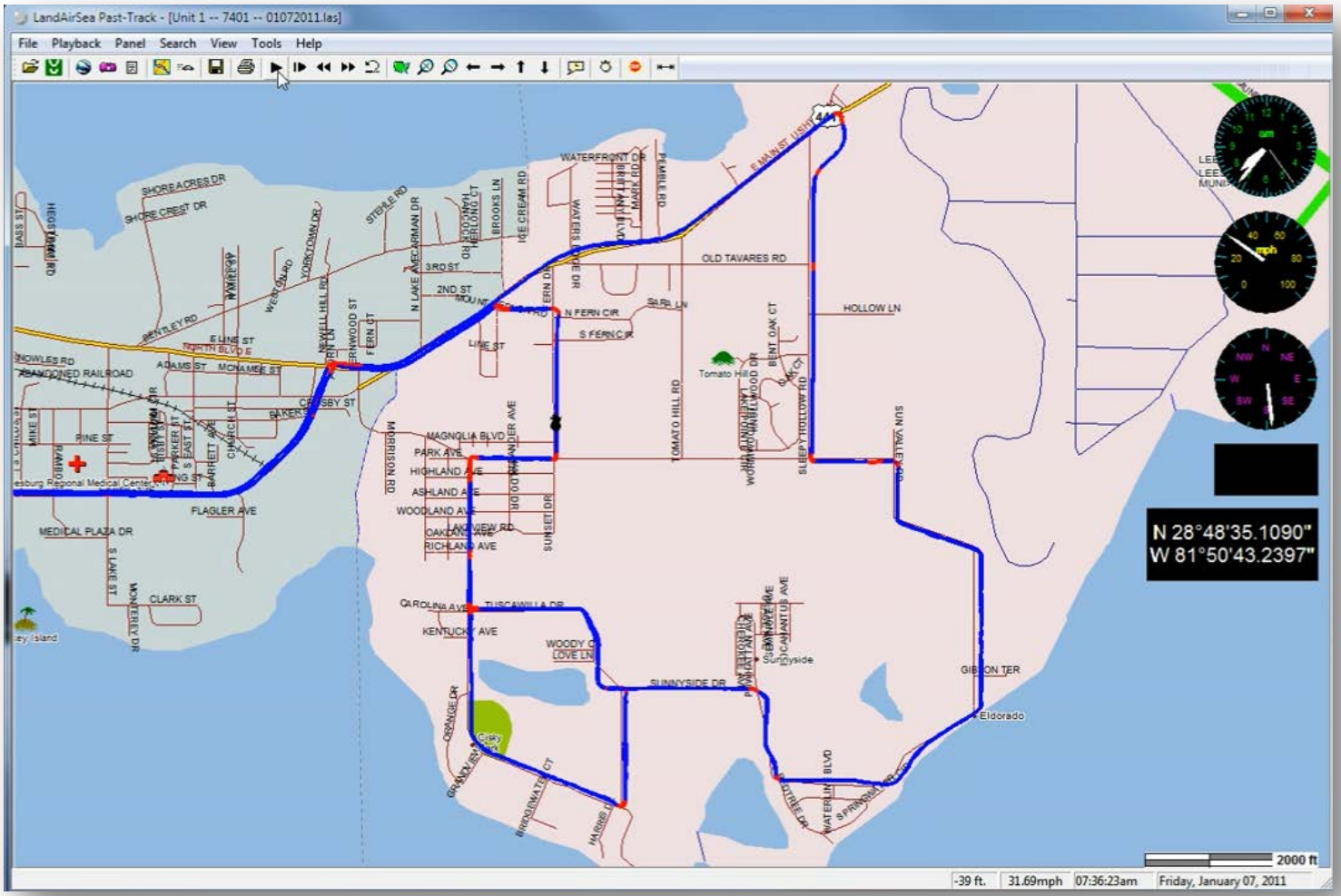
Collecting the Data

Preferred Bus Mounting Option

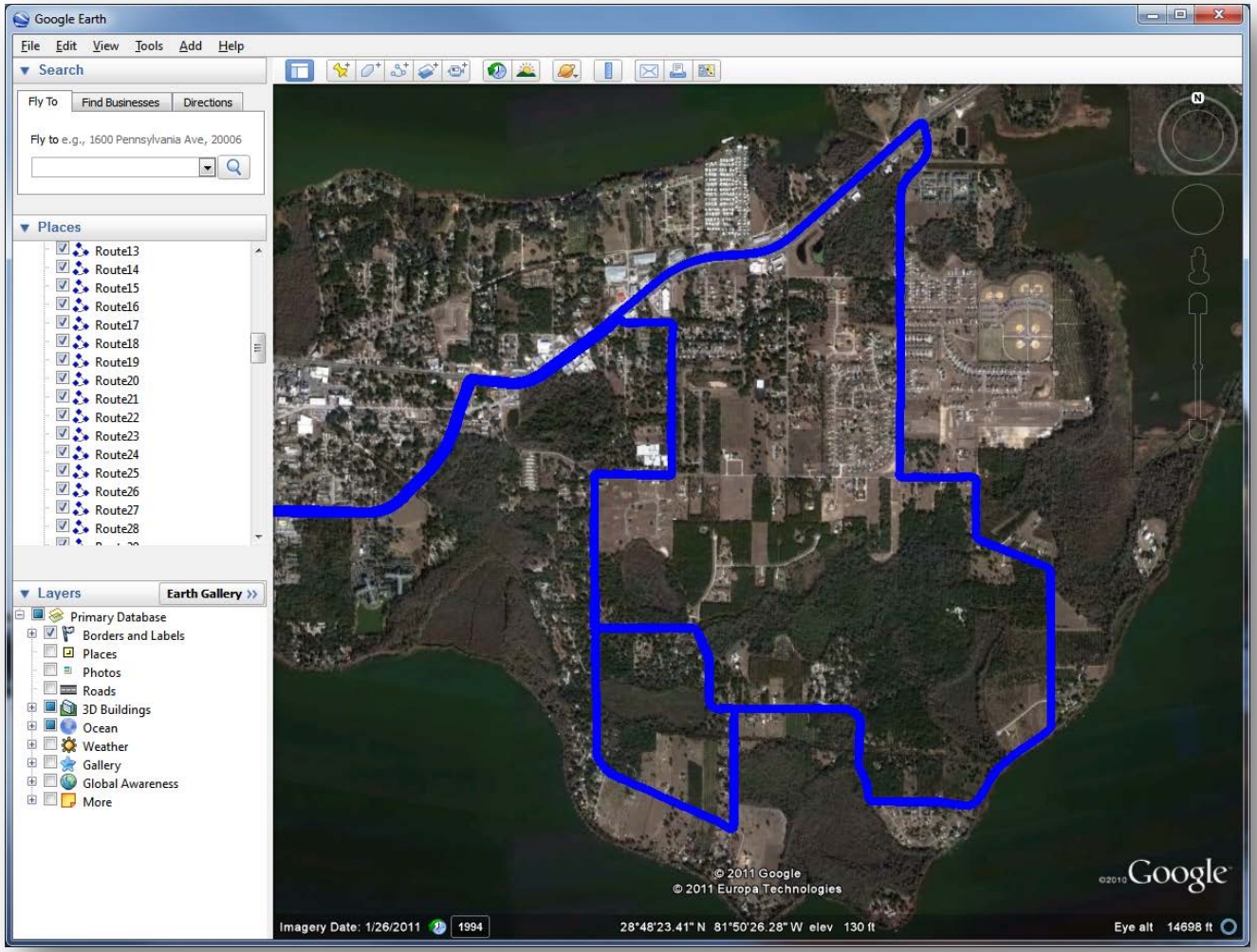
Collecting the Data

Non-preferred Bus Mounting Option

Data Reinforcement

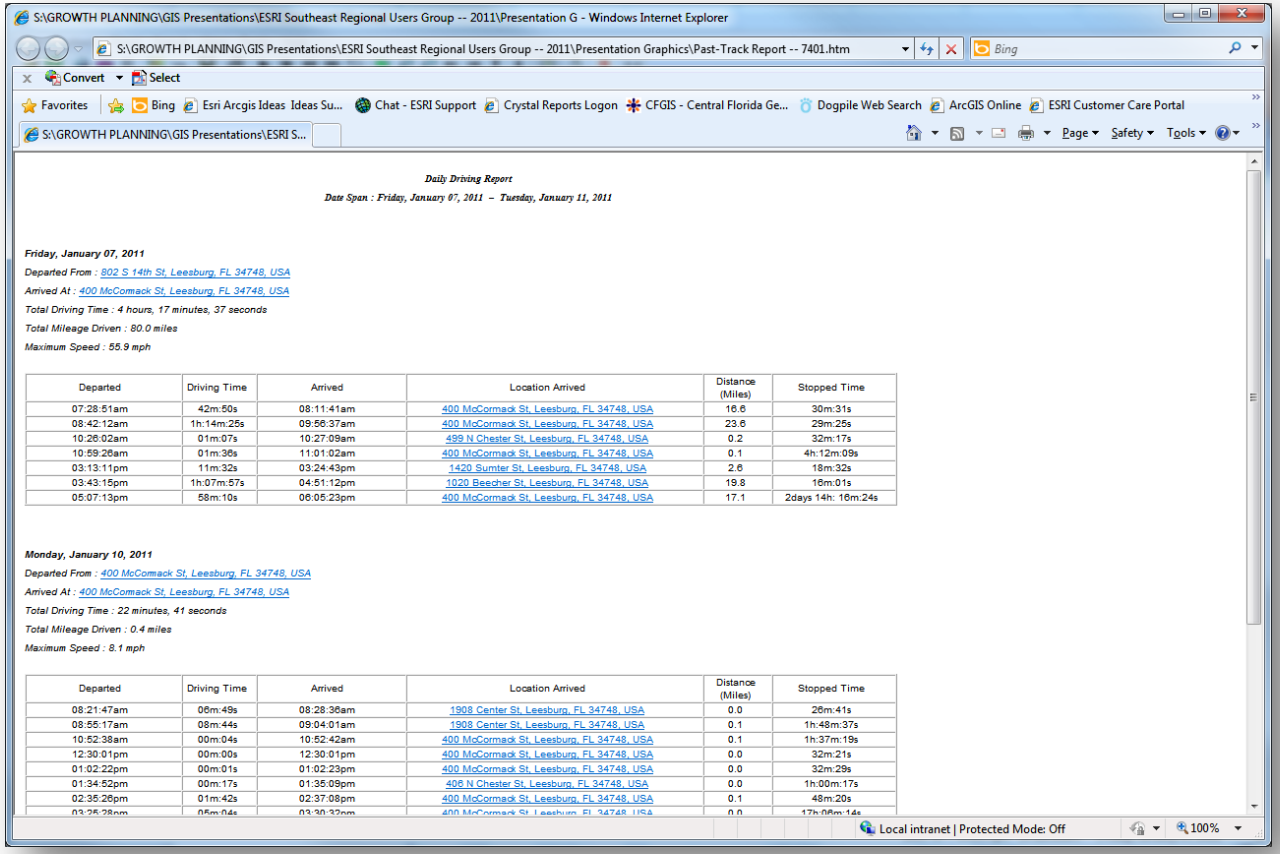


Data Reinforcement



Data Reinforcement

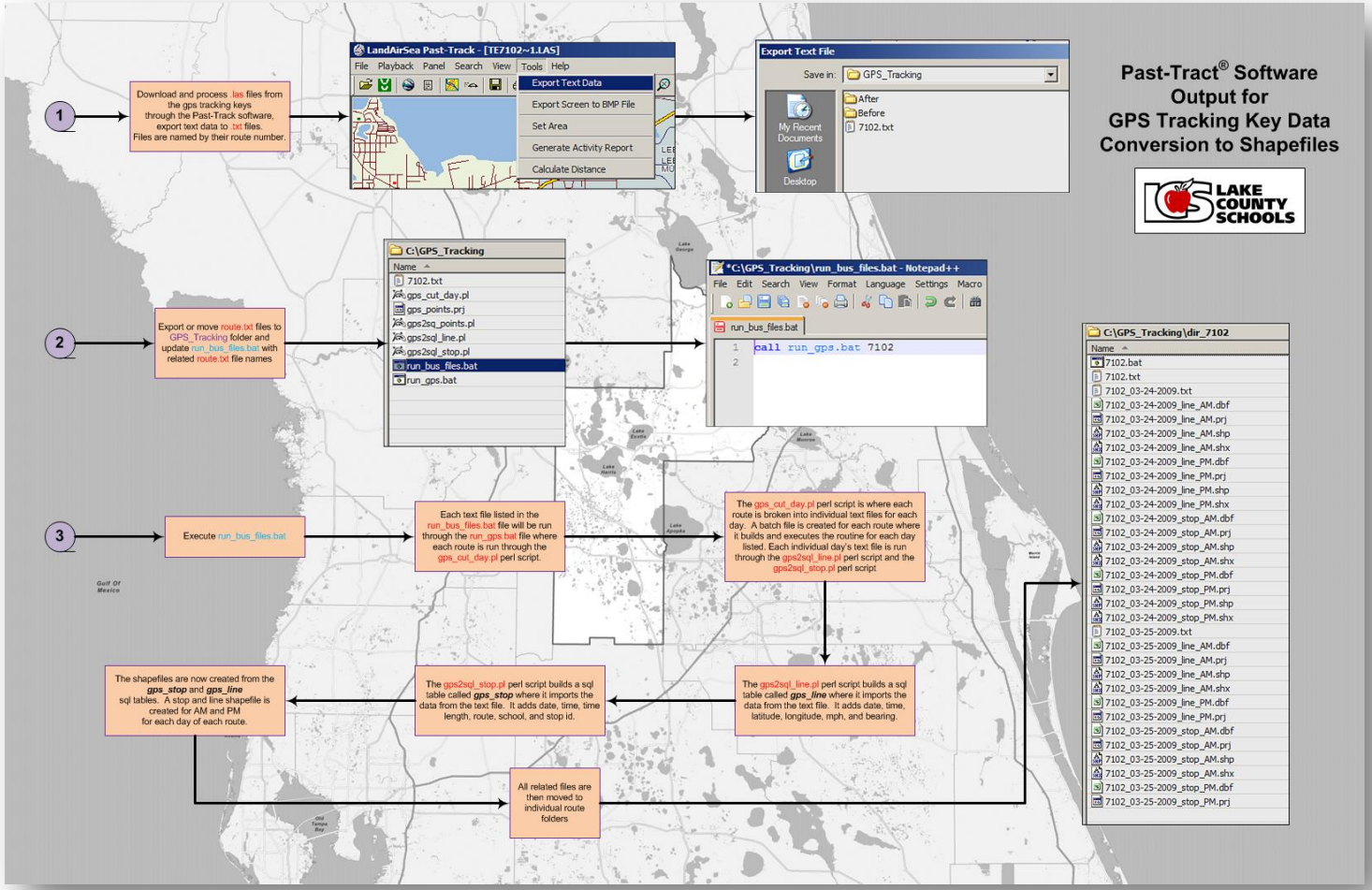
Review Reports in Past Track™



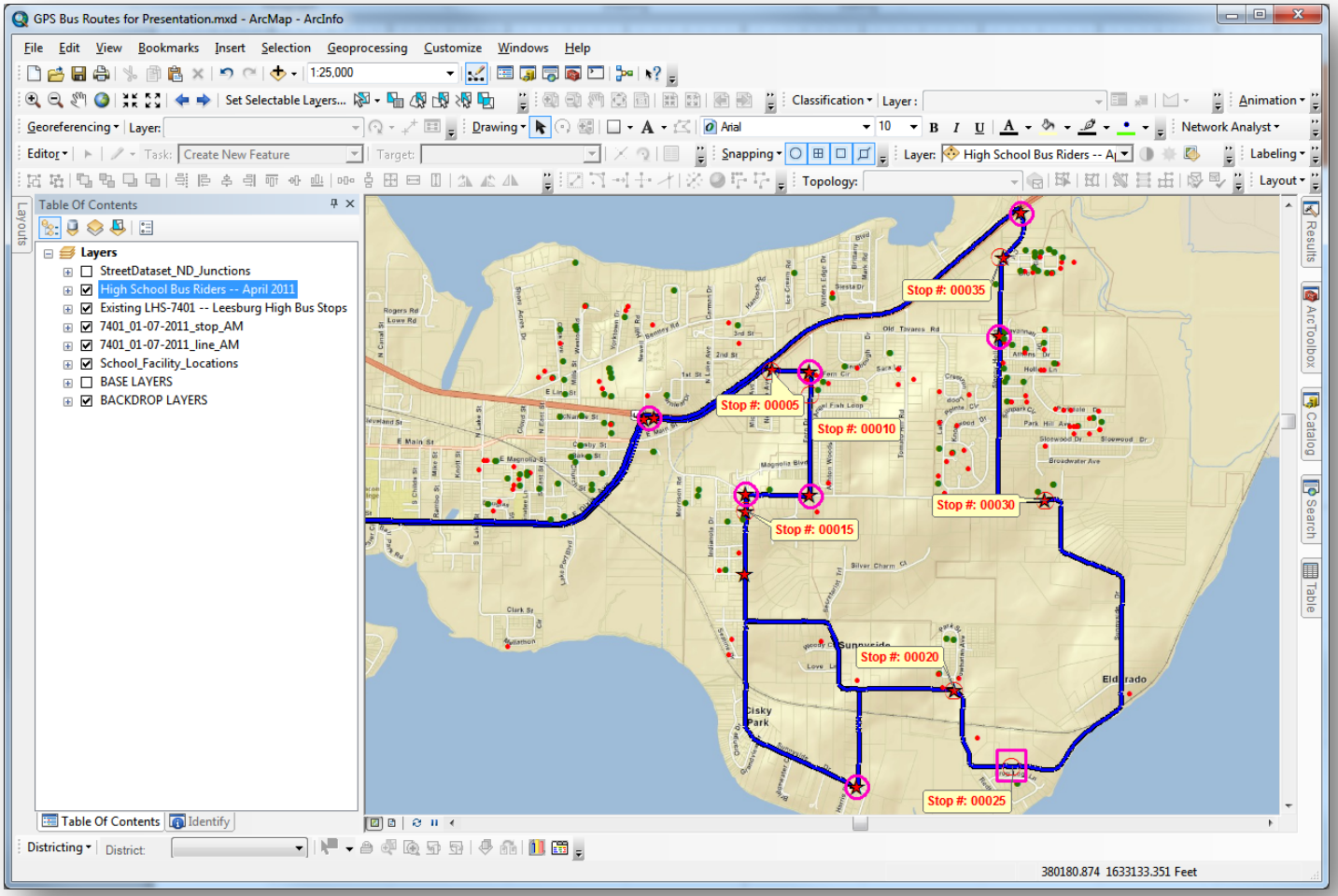
Conversion to GIS

- Exporting flat file from Past-Track™
- Run BAT files with scripts for export
  - Arcs representing bus routes
  - Point representing estimate of bus stops

Data Conversion



Assessing the Data



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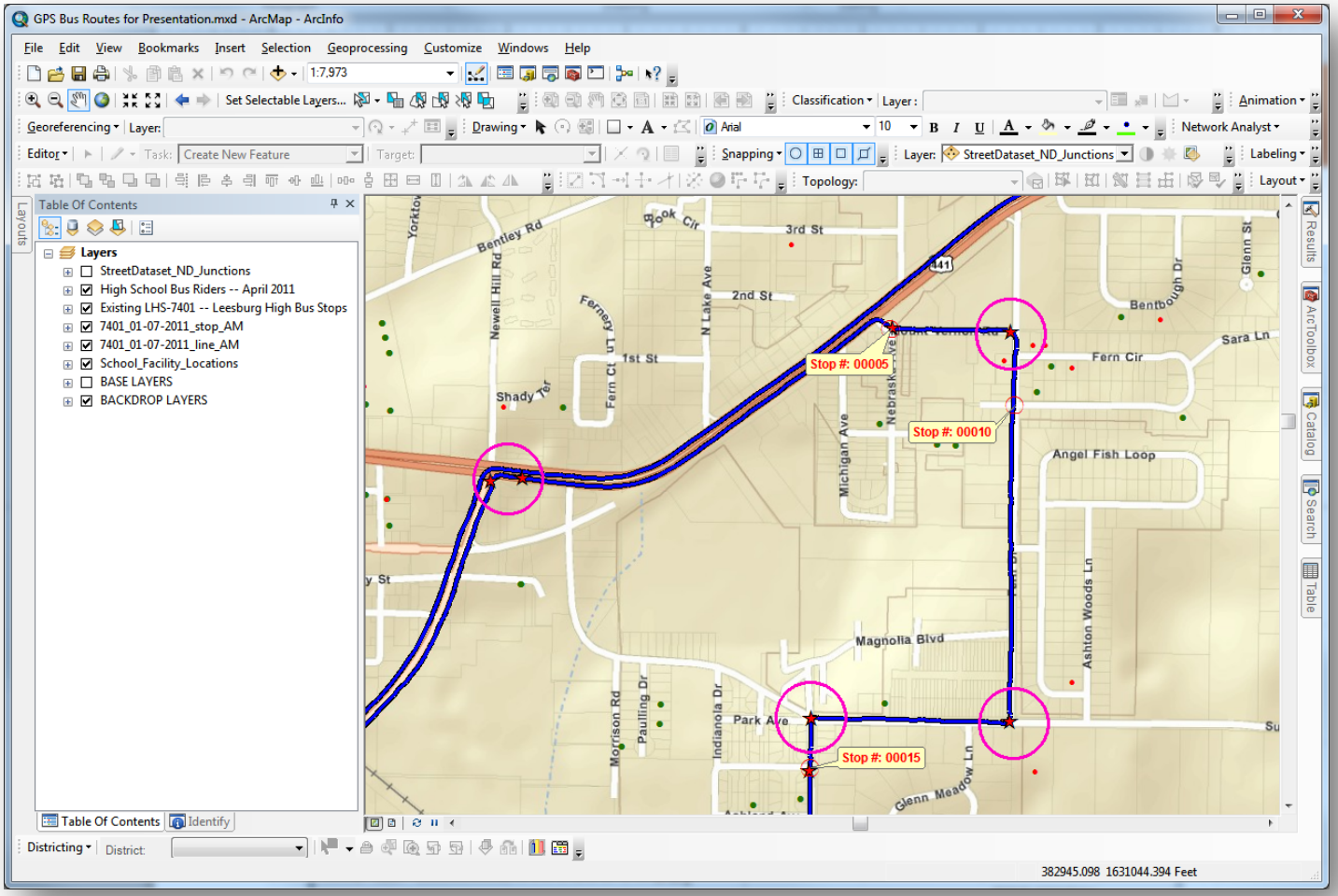

Measuring Success

Route 7617

(Treadway Elementary, Tavares Middle & Tavares High School Runs)

Existing Bus Stops = 46 Existing Mileage = 44.4
Proposed Bus Stops = 34 Proposed Mileage = 42.3
Number of Stops Saved = 12 Mileage Saved on Route = 2.1

Calculation of Average Speed for Existing Route

Treadway Elementary = 10.0 miles in 41 minutes or 16.7 mph
Tavares Middle = 11.8 miles in 42 minutes or 16.9 mph
Tavares High = 22.6 miles in 55 minutes or 24.6 mph
Average = 44.4 miles in 2 hours 18 minutes or 19.3 mph

Travel Time Saved = 2.1 miles/route @ 19.3 mph or 6.5 minutes/route or 13 minutes/day
12 stops/route @ 2 minutes/stop = 24 minutes/route or 48 minutes/day
Daily time saved = 13 minutes + 48 minutes = 61 minutes/day

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The Bottom Line

Daily Savings for Fuel & Maintenance = $12.76/route
Daily Savings in Personnel = $15.48/route

Total Daily Savings = $28.24/route

Total Annual Labor Time Saved = 36,600 hours or 5,228 average work days
Or 29 equivalent employees/year
(average work day is 7 hours/day)

Total Annual Travel Distance Saved = 151,200 miles

Annual Equivalent Daily Routes Eliminated = 1,338
(7.4 routes/day) (based on average of 113 miles/day/route)

Daily Savings = $28.24/route @ 200 routes = $5,648/day
Annual Savings = $5,648/day @ 180 day = $1,016,640/year

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Takeaway

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Takeaway

Questions

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General Information

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