

# Curbside Collection Systems and Containers

Case Study: GBB's Pasadena CA Project

**Metropolitan Washington Council of Governments**

**Recycling Committee**

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**Prepared by:**

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**In association with:**

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**City of Pasadena is in the process of implementing one of the most sophisticated routing and data collection / analysis systems installed by any municipality in the United States**

**Functionality Includes:**

- **Asset identification**
- **Collection route optimization**
- **Asset tracking**
- **GPS-based performance monitoring**
- **Customer Service Records management**



# City's Current Collection Situation

- Separate curbside collection of refuse, yard waste and recyclable materials
- Customers: 27,000 residential units
- 24 automated collection packers
- “Pay As You Throw” refuse program:
  - 100-gallon cart - \$26.10
  - 60-gallon cart - \$16.67
  - 32-gallon cart - \$10.05
- Yard waste and recycling service at no additional charge.
- Current routes were created manually in the early 1980's



# *One Trash Can per Unit*



# City of Pasadena Waste Service Issues

- Excessive overtime of collection crews
  - estimated to be almost \$300,000 / year
- Inaccurate inventory of carts on the field
  - 2004 spot audit indicated that 5%+ of residences have refuse containers for which they are not billed, or they are billed for a different size container
  - estimated loss of revenues of \$250,000 / year due to services inaccurately billed
- Inadequate customer service
  - Lack of information
  - Inaccurate information

***Asset Management in City of Pasadena  
with  
Integrated Waste Management  
Data Collection and Routing System  
Improvements***

- **GBB Project Team selected to perform the needed service**
  - **Project Team includes:**

**GBB**



# ***GBB Project & Components***

- a. Field Audit
- b. Route Optimization
- c. Asset Tracking System
- d. GIS Refuse Database
- e. Training





# *Field Audit*

Three-pass City field audit was conducted to:

- Physically inspect each of the City's 27,000 residential units setouts three-times
- Inventory the serial numbers all existing carts set out in the field (initial est. was 81,000 carts in service)
- Install Radio Frequency Identification (RFID) tags on all current carts
- Provide GPS data for container setout locations to augment the City database.

## Step 1 - Audit Preparation

- Customized software on handheld PDA's and used by team of field waste cart auditors to:
  - Capture data in the field/on routes
  - Inventory RFID tags placed in the field
- GBB trained team of field waste auditors to use the PDA and managed the data collection process

# What does RFID Stand For?

# What does RFID Stand For?

- Radio Frequency Identification (RFID)
- Examples:
  - Exxon/Mobil SpeedPass
  - Retailers with Electronic Article Surveillance (EAS) Tags
  - Prime Use: Tracking of High-Valued Assets
  - Major retailers initiatives for supply chain to store inventories
    - Wal-Mart, Best Buy, Target

# RFID is NOT Bar Codes

- Bar Codes – someone needs to take action of scanning the bar code label with a reader
- RFID tagging – the item is always on and available to be read, sometimes by multiple readers at the same time.

# What's an RFID tag look like? One Example Below!



# What's is an RFID tag look like once applied?



# *PDA Interface & Power-up*





# PDA Screenshot - Startup

Audit Trax 12:39

## Audit Ware

Monday	Auditor 0
Tuesday	RFID Starting # 0
Wednesday	Container Type
Thursday	Container Abbreviation
Friday	Quit

Keyboard icon

# PDA Screenshot – Route & Street Audit Selection



The screenshot shows a PDA application interface for route and street audit selection. The top status bar includes the Windows logo, the text "Steet Filter", and icons for signal strength, battery, and time (9:47). Below the status bar, there is a text input field for "Route Number" containing the value "7". Underneath is another text input field for the street name, "Pear Orchard Ln". The main area contains four radio button options: "Up" (selected), "Down", "Odd", and "Even" (selected). At the bottom, there are five buttons: "Return" (blue), "List" (green), "Prev" (yellow), "Start Auditing" (red), and "Next" (yellow). A keyboard icon and a small upward arrow are visible in the bottom right corner of the screen.

Steet Filter		9:47
Route Number	7	
Pear Orchard Ln		
<input checked="" type="radio"/> Up	<input type="radio"/> Odd	
<input type="radio"/> Down	<input checked="" type="radio"/> Even	
Return	List	
Prev	Start Auditing	Next

# PDA – Address/Can Info

Monday (2746 f) 9:47

3680		Pear Orchard Ln	
1YW01956 100M			
1YW01956 100M			
YDWL0018 100Y			
YDWL0018 100Y			
Lat	0.000000	Lon	0.000000
RT	1	list mode	
Return		Set GPS	
Prev	New Cart	New Addr	Next

Navigation icons: keyboard, arrow up

# PDA - Cart Setting Screen



The screenshot shows a PDA interface for setting a cart. At the top, the status bar displays the Windows logo, the text "Mondays Cont.", and icons for signal strength, battery, and volume, along with the time "11:11". Below the status bar, there are two text input fields: the first contains "1YW05920" and the second contains "100M". A large grey area in the center contains the label "Rfid" and a text input field containing "100571". At the bottom, there are three buttons: a blue "Return" button, a grey "Save" button, and an orange "Assign RFID" button. A keyboard icon and a small upward arrow are visible in the bottom right corner of the screen.

Mondays Cont. 11:11

1YW05920

100M

*Rfid* 100571

Return

Save Assign RFID

# *GBB field audit team w / leader*



# *GBB Field Auditor w/PDA*



# *RFID Tags on Containers*



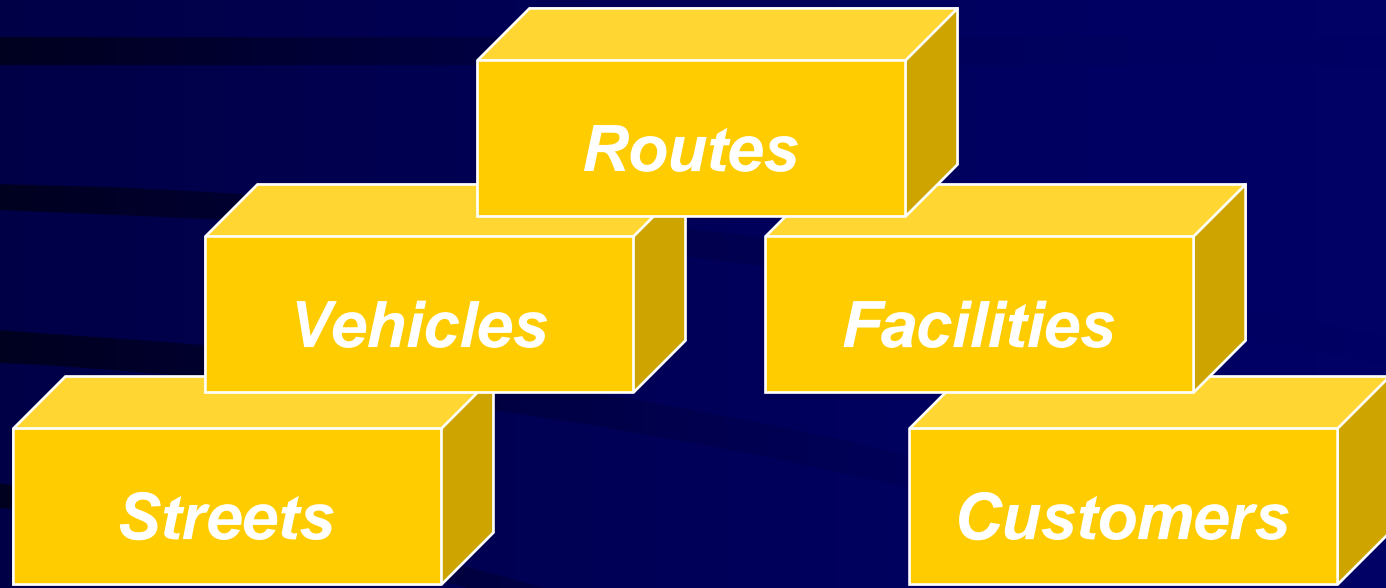
## ***2. Route Optimization***

- **FleetRoute route optimization software was used on waste, recyclables and organics curbside collection**
- **FleetRoute™ determined number of collection days and individual routes to be performed**
- **Balanced route times, customers and service days**
- **Created routes using GIS and algorithms specifically written for the waste industry**
- **Integrated routes with customer service and billings**
- **Goal: reduce overall collection costs (by >10%)**





# Flexible *Object Oriented Technology*



# Routes Maximize Each Vehicle's Productivity

**CIVIX Software FleetRoute**

File Edit View Theme Graphics Customers Streets Vehicles Facilities Cycles Districts Routes Tools Window Help

Scale 1: 43,581

**Actual Time of ...**

**Actual Time By Route**

**Route View**

- Garbage Vehicles
- Wed Routes
  - 31
  - 32
  - 33
- Facilities b.s.hp
  - Depot
  - Landfill
  - MRF
- Customers
- Streets
- Virtual Facility for R
- Virtual Facility for G

**Estimated Operating Cost By Vehicle**

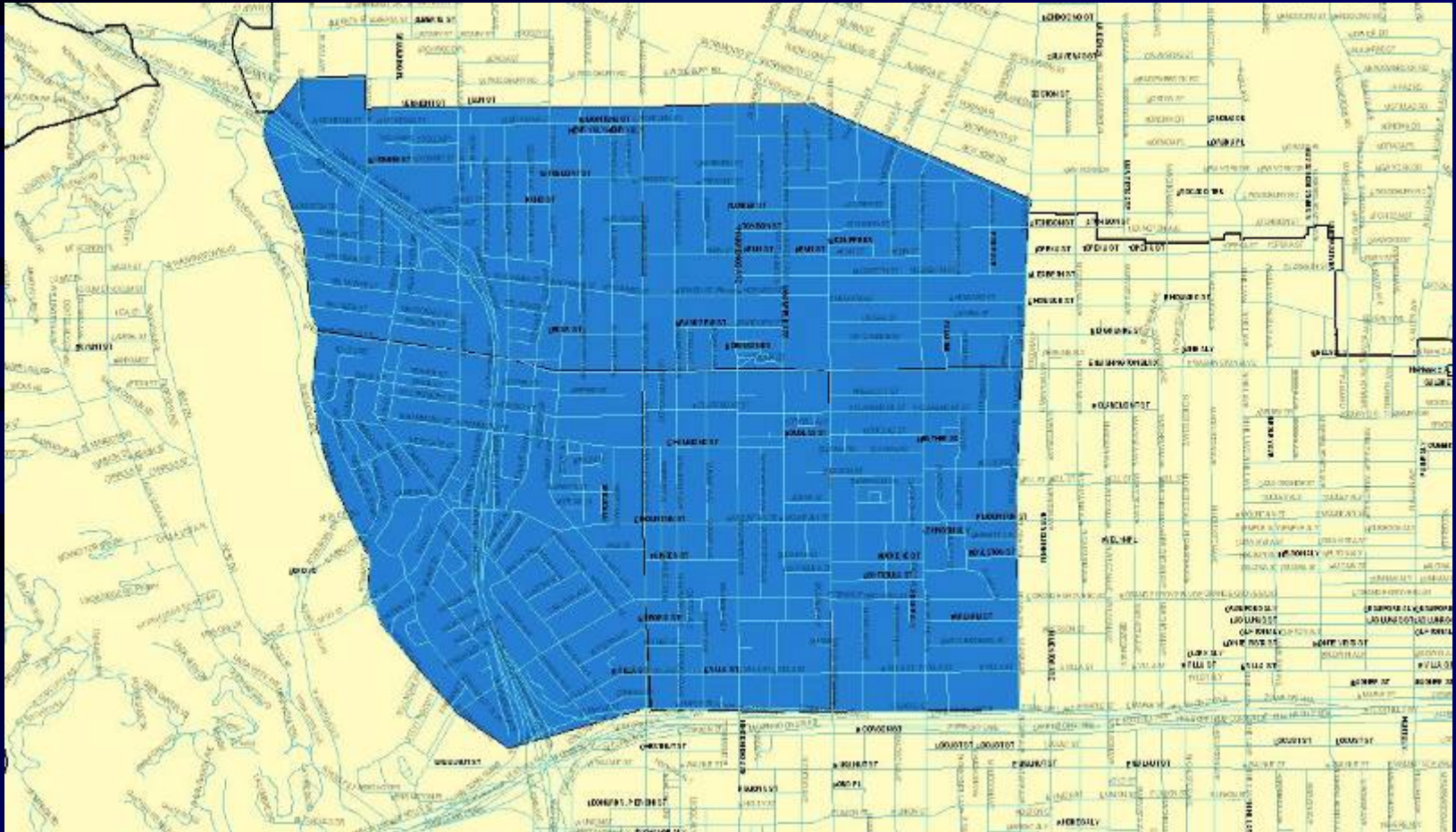
ESTIMATED DAILY OPERATING COST BY VEHICLE SUMMARY

Vehicle Number	Labor Standard	Labor Overtime	Maint. Costs	Fixed Costs	Tipping Fees	Total Cost
31	225.20	2.95	24.50	85.00	636.00	973.65

Acttime: 8.0700  
 Actdist: 92.4756  
 Name: Truck 2  
 Type: SideLoader  
 Id: 32  
 Actstops: 2013  
 Acttrips: 3  
 Begwaitim: 0.0000  
 Curqnty: 4.0339  
 Totqnty: 28.0008  
 Actbegfac: 1  
 Actendfac: 1  
 Actxifacs: 2.22  
 Breaktime: 0.0000  
 Xfipolicy: 1  
 Beghr: 6  
 Begmin: 30  
 Endhr: 15

# Assessment of Set-out Variances

*Heavy Areas = ~40% more waste/HH  
from ~3 persons/HH vs. 2 persons/HH*



# Collection Day Changes

## Final Analysis of Proposed Collection Day Changes for the City of Pasadena

Date prepared: 8/9/2006

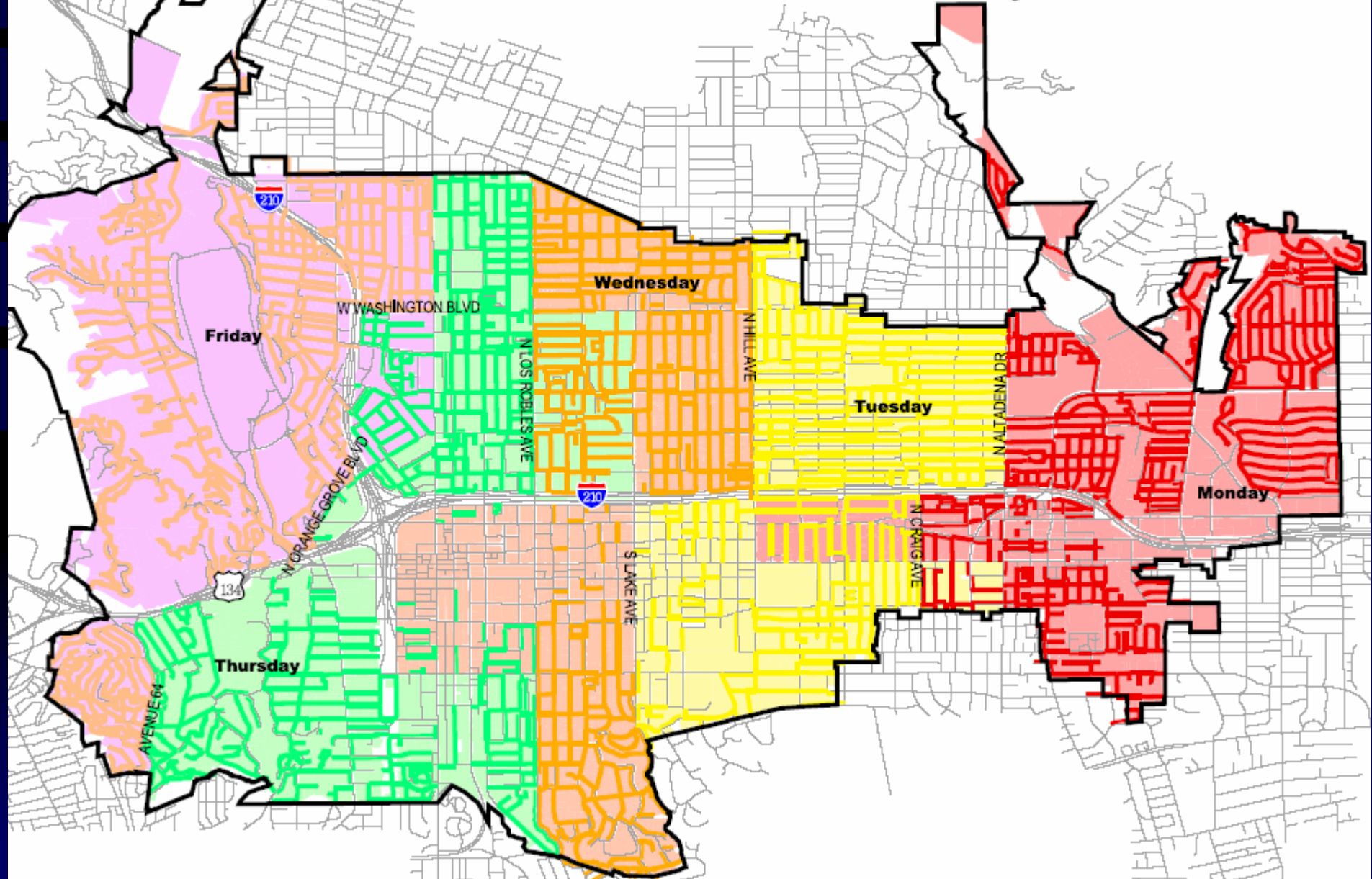
### Current Days (optimized routes, not using current routes)

Day	Number of Trucks	Total Hours Per Day	Average	Tons	Carts	Miles	Dump Trips
			Hours Per Day				
Monday	8	64.5	8.1	104.8	6303	303	16
Tuesday	8	58.7	7.3	107.3	5617	252	16
Wednesday	8	54.3	6.8	97.1	5204	212	16
Thursday	8	59.6	7.5	133.8	6105	254	16
Friday	8	63.4	7.9	125.3	6241	263	16
Average per Day	8	60.1	7.5	114	5894	257	16
Average per Truck	NA	7.5		14.2	736.8	32	2.0
Total		300		568	29470	1284	80

### Proposed Days

Day	Number of Trucks	Total Hours Per Day	Average	Tons	Carts	Miles	Dump Trips
			Hours Per Day				
Monday	8	59.9	7.5	93.4	5582	279	16
Tuesday	8	61.3	7.7	118.7	6338	270	16
Wednesday	8	59.9	7.5	125.0	6407	251	16
Thursday	8	57.4	7.2	123.8	5705	239	16
Friday	8	58.8	7.3	107.4	5438	235	16
Average per Day	8	59.5	7.4	114	5894	255	16
Average per Truck	NA	7.4		14.2	736.8	32	2.0
Total		297		568	29470	1274	80

# New and Old Collection Days



# Pasadena

Mixed Waste  
Friday

Date: Aug 14, 2006  
Scale: 1:50000

## Routes for Streets7262006.shp

-  1501
-  1502
-  1503
-  1504
-  1505
-  1506
-  1507








## Streets7262006.shp

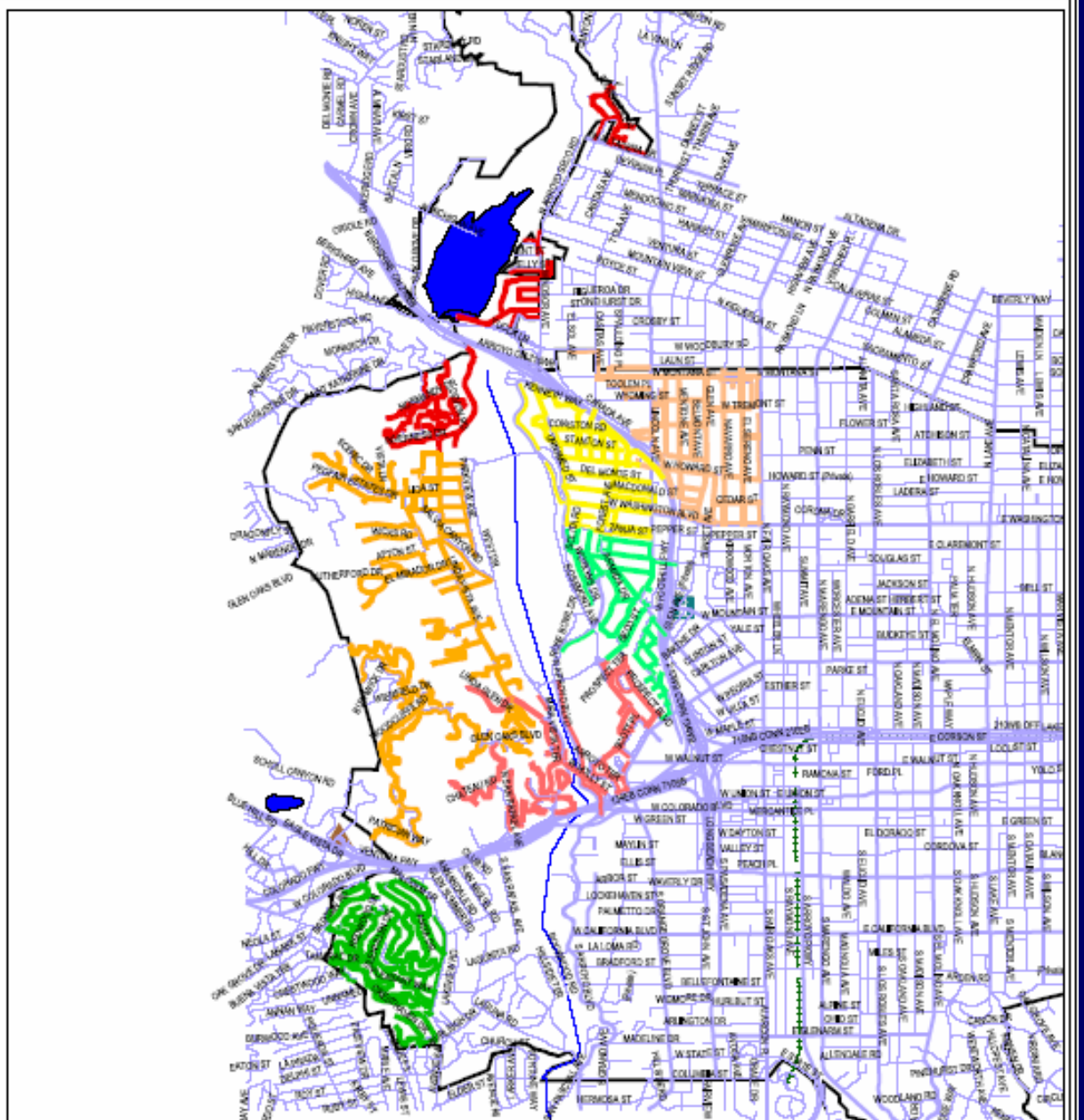
-  1
-  3
-  4
-  5
-  6

Street Names

Railroads

Facilities

-  DEPOT
-  LANDFILL
-  MRF
-  TS
-  Rivers
-  Reservoirs
-  Cityboundary









# Travel Directions Report

## Route No. 1502



Driver:	Vehicle:
Valid Days:	

**Remarks:**

Route computed on	Wednesday, August 9, 2006 9:07 PM
Route File:	c:\fr\data\pasadena\network\nt_mwd5_2006-08-09_19-41-27\rc_mwd5_rnd7_\mwd5_rnd7__1502.rt

Begin at DPW at 6:30.

Prep in vehicle for 15:00 min.

Start route	on W MOUNTAIN ST	(1) at 6:45 Drive from facility	2 blk	9 sec	0.05 mi
Turn right	(N) on MOUNTAIN ON 210WB	(3) at 6:45 Drive from facility	1 blk	15 sec	0.24 mi
Straight	(N) on W FOOTHILL PWY	(4) at 6:45 Drive from facility	1 blk	23 sec	0.37 mi
Straight	(N) on 210WD OFF LINCOLN	(5) at 6:46 Service both sides	1 blk	1:30 min	0.30 mi
			2 units	2 custs	93.12 lbs
Turn right	(N) on LINCOLN AVE	(6) at 6:47 Service right side	1 blk	1:41 min	0.06 mi
			5 units	5 custs	250.26 lbs
Turn left	(W) on CANADA AVE	(7) at 6:49 Service right side	1 blk	43 sec	0.10 mi
			1 unit	1 cust	52.38 lbs
Turn right	(NE) on ANDERSON PL	(8) at 6:50 Service right side	1 blk	2:24 min	0.09 mi
			7 units	7 custs	320.10 lbs

Travel Directions Report — Route No. 1502

				11 units	11 custs	434.56 lbs
Turn right	(W)	on WASHINGTON PL	(216) at 11:25 Service right side	1 blk	33 sec	0.05 mi
				1 unit	1 cust	40.74 lbs
Straight	(W)	on W WASHINGTON BLVD	(217) at 11:25 Service right side	1 blk	1:19 min	0.03 mi
				4 units	4 custs	209.52 lbs
Turn right	(N)	on MENTONE AVE	(218) at 11:27 Service right side	1 blk	53 sec	0.06 mi
				2 units	2 custs	93.12 lbs
Turn right	(E)	on PALISADE ST	(219) at 11:28 Service right side	1 blk	2:06 min	0.08 mi
				6 units	6 custs	212.43 lbs
Turn right	(S)	on GLEN AVE	(220) at 11:30 Drive deadhead	2 blks	17 sec	0.08 mi
Turn right	(NW)	on W WASHINGTON BLVD	(222) at 11:30 Service right side	1 blk	1:06 min	0.05 mi
				3 units	3 custs	133.86 lbs
Turn right	(E)	on WASHINGTON PL	(223) at 11:31 Service right side	1 blk	33 sec	0.05 mi
				1 unit	1 cust	40.74 lbs
Turn left	(N)	on GLEN AVE	(224) at 11:32 Service right side	3 blks	6:14 min	0.16 mi
				19 units	19 custs	818.68 lbs
Turn left	(W)	on DEL MONTE ST	(227) at 11:38 Service right side	1 blk	4:09 min	0.11 mi
				13 units	13 custs	534.47 lbs
Turn right	(N)	on MENTONE AVE	(228) at 11:42 Service right side	4 blks	12:36 min	0.49 mi
				37 units	37 custs	0.93 t
Turn left	(W)	on WYOMING ST	(232) at 11:55 To avoid U-turn	1 blk	13 sec	0.06 mi
Turn right	(N)	on NEWPORT AVE	(233) at 11:55 To avoid U-turn	1 blk	27 sec	0.13 mi
Turn right	(E)	on W MONTANA ST	(234) at 11:55 To avoid U-turn	1 blk	13 sec	0.06 mi
Turn right	(S)	on MENTONE AVE	(235) at 11:56 To avoid U-turn	1 blk	27 sec	0.13 mi
Straight	(S)	on MENTONE AVE	(236) at 11:56 Service right side	5 blks	11:30 min	0.55 mi
				32 units	32 custs	0.69 t
Turn left	(E)	on MACDONALD ST	(241) at 12:07 Service right side	1 blk	3:32 min	0.09 mi
				11 units	11 custs	494.70 lbs
Turn right	(S)	on GLEN AVE	(242) at 12:11 Drive deadhead	1 blk	9 sec	0.04 mi
Turn right	(W)	on PALISADE ST	(243) at 12:11 Service right side	1 blk	2:23 min	0.08 mi
				7 units	7 custs	331.74 lbs
Turn right	(N)	on MENTONE AVE	(244) at 12:14 Drive deadhead	2 blks	23 sec	0.11 mi
Turn right	(E)	on DEL MONTE ST	(246) at 12:14 Drive deadhead	1 blk	22 sec	0.11 mi
Turn right	(S)	on GLEN AVE	(247) at 12:14 Drive deadhead	1 blk	14 sec	0.06 mi
Turn right	(W)	on MACDONALD ST	(248) at 12:15 Service right side	1 blk	4:57 min	0.09 mi

## Route Statistics

Route Statistics						
Time	Customers	Units	Distance	Quantity	Transfer Trips	Blocks
07:12:25 hr(s)	853	855	35.24 miles	18.87 tons	2	280

Turn Analysis		
	Count	Relative Turn Penalties
Straight 'turns':	163	0 sec
Right Turns	69	2 sec
Left Turns	41	30 sec
Non-deadend U-Turns	0	600 sec
Deadend U-Turns	8	12 sec

U-Turn Avoidance by Class:	9
----------------------------	---

Time Analysis	
	hh:mm:ss
Time from Beginning Facility:	00:00:48
Time to/from Transfer Facilities:	00:16:16
Time to Ending Facility:	00:04:12
Intra-Route Deadhead Time:	00:11:50
U-Turn Avoidance Time:	00:07:50
Service Time:	05:01:39
Other Time:	01:29:51
<b>Total Time:</b>	<b>07:12:25</b>

## Notes:

1. A 'block' is defined as one side of a street between two intersections. The block number shown in parentheses after the street name is the first block of that street and will correlate to the path sequence numbers on the route's path maps.
2. All times and quantities are estimates.
3. Breaks should be taken at appropriate times and report clock times adjusted accordingly.
4. The information contained herein is based on a computer model of these streets and are provided as a guide only - they should not be taken for reality. All traffic laws take precedence over these directions and should be obeyed.

Report created by FleetRoute™

End of Report

## ***3. Asset Tracking System***

Purpose:

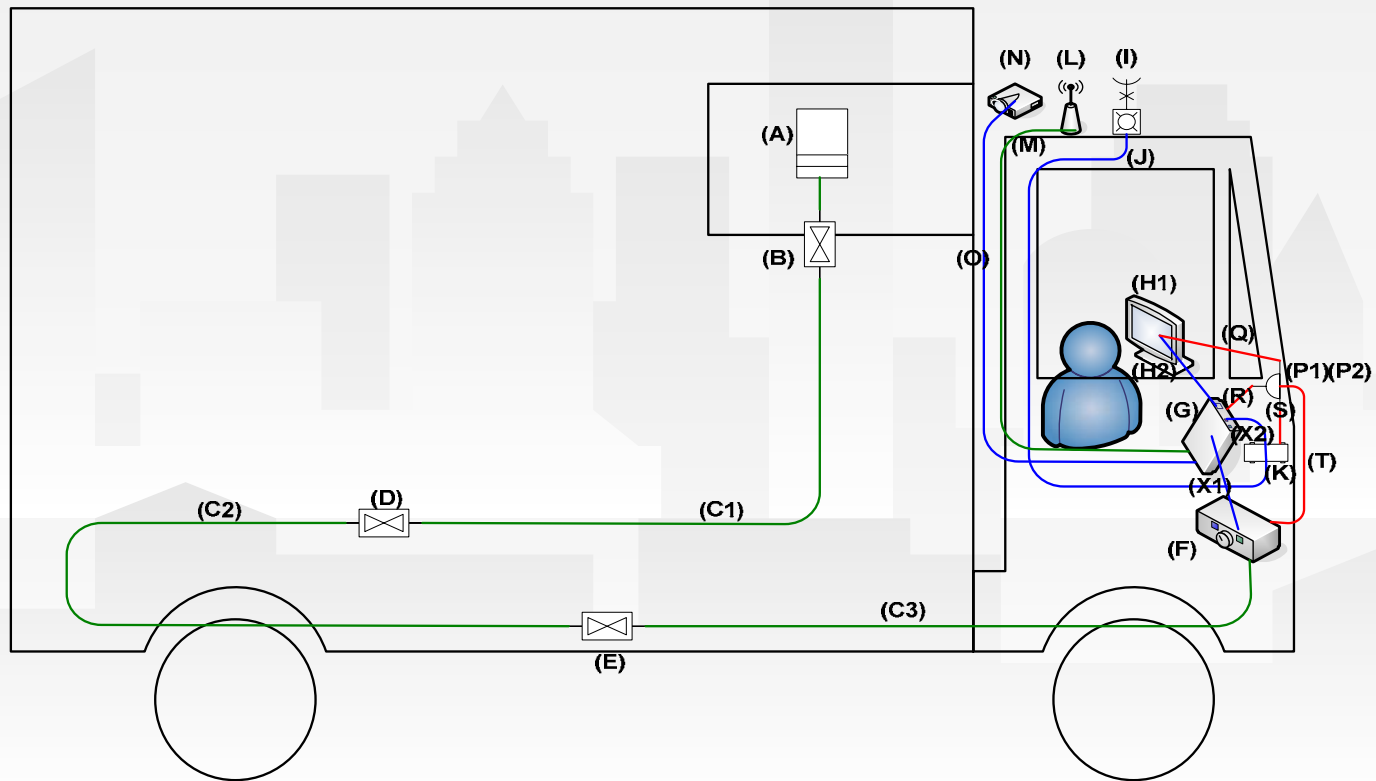
Used to optimize the interface between the waste collection truck cab and the dispatcher/office

# *Accu-Trax Mobile Features*

- Route Information transferred through WiFi -- replacing printed route books
- Real time GPS and cellular communication
- GPS truck tracking for accurate accounting of driver daily activity
- Container inventory and Tracking via RFID technology
- Camera Systems to capture “No cart out” or Extra’s
- Truck Mounted In-Cab touch screen for driver input and control center messaging

# Accu-Trax Components

Accu-Trax Mobile Truck Component Installation Detail



# *Cab over...Evening/Weekend Installation*



# Samsys Antenna – Final Location





# *Accu-Trax Mobile System Protection w / additional fan*



# Samsys RFID Transmitter



# *Roof Mounted Antenna, GPS Unit & External Camera*



# *WiFi Antenna Mounted on DPW Bldg.*



# *Equipment Installation in Cab*





# Touch Screen w/Camera Picture

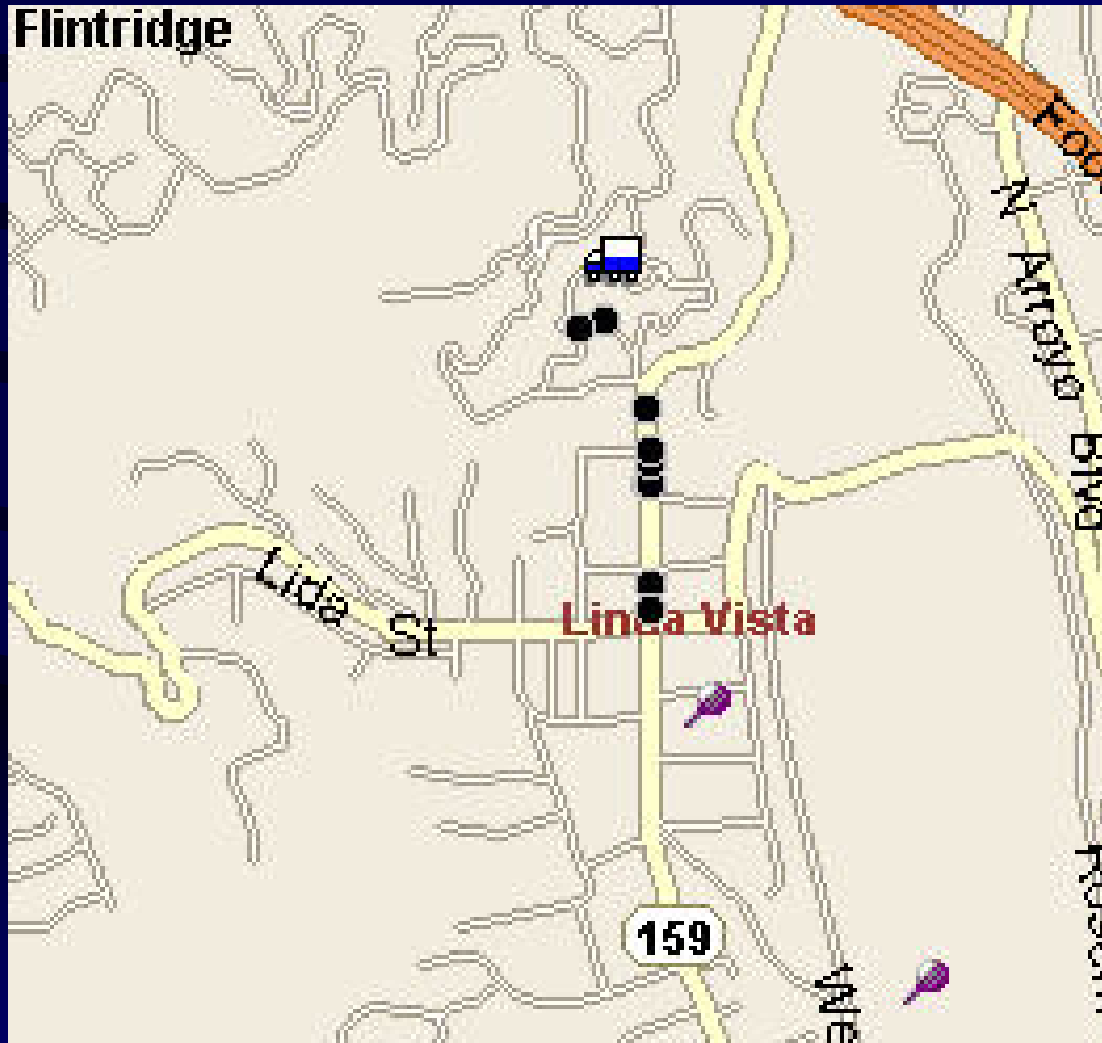


## 4. *GIS Waste Database*

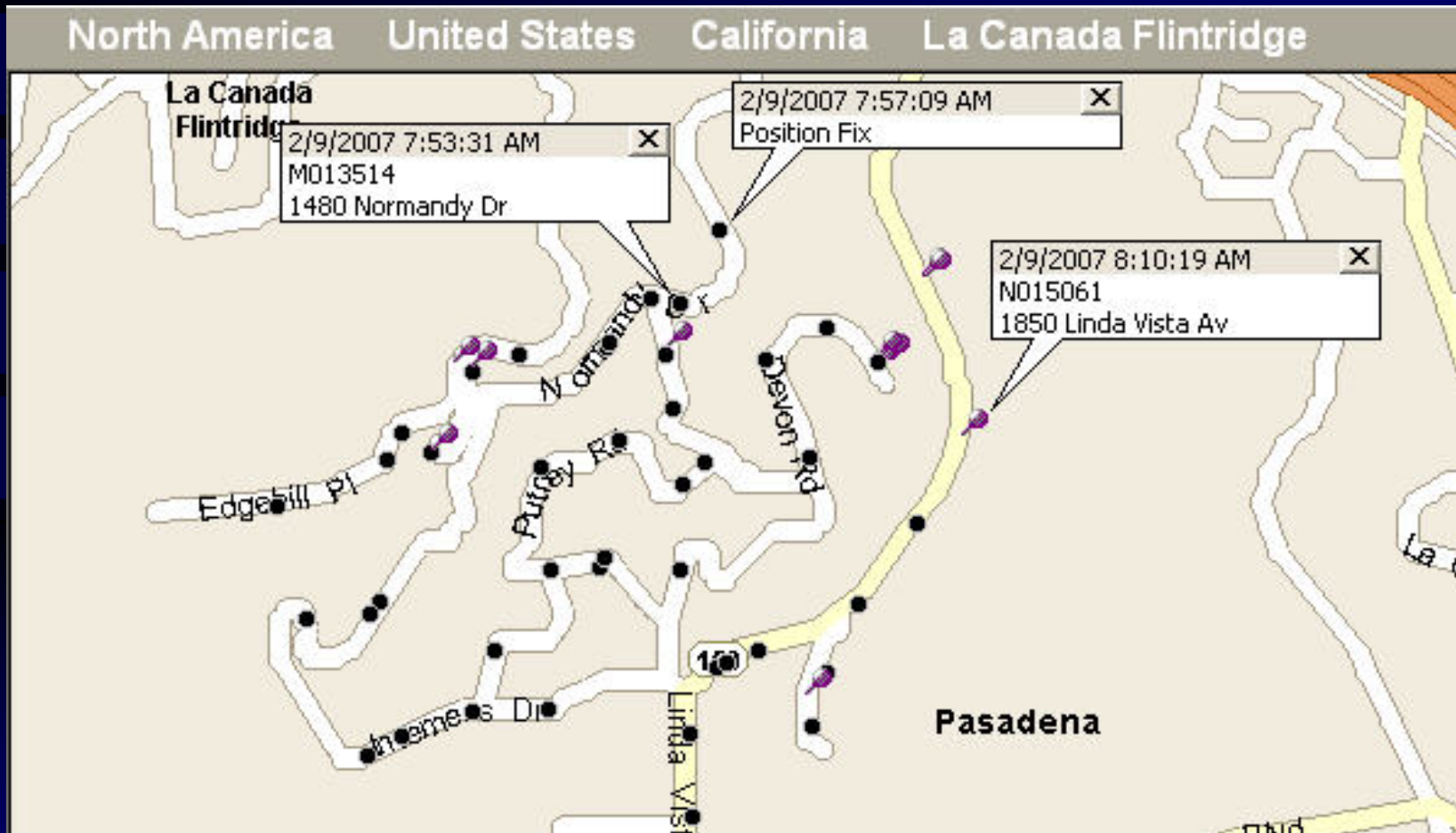
- Started field audits based on existing customer database system
- As audits were conducted, added GPS coordinates for container locations
- Cart GPS coordinates were added to the customer information
- Results: Customer – Carts – Locations – Invoicing are all integrated and linked together into the City system



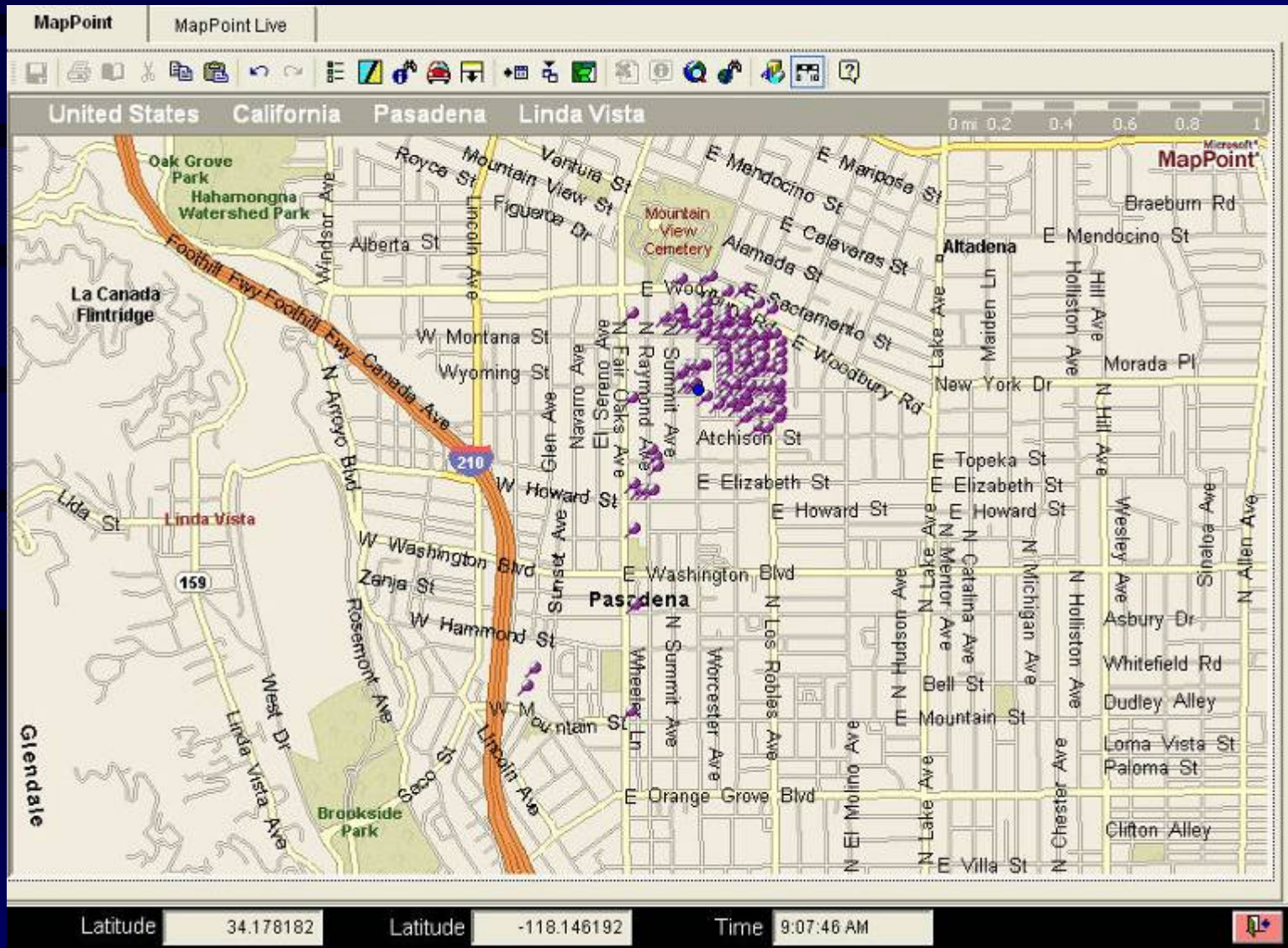
# Breadcrumbs 1 – Dots are RFID cart tips (pins are GPS fixes set, 2-120 seconds w/o tips occurring )



# Breadcrumbs-w/time & locations listed (pins are GPS fixes w/o tips occurring)



# Mapping Breadcrumbs on Time Interval





# Route 1 Log -Customers & Service Times

(Periods on Right --- Productivity w/Tips/Hr. log)

**Route Log**

Data Entry | List

Date: 2/9/2007 Day: Route: 0 Driver: Equipment Num: Requery

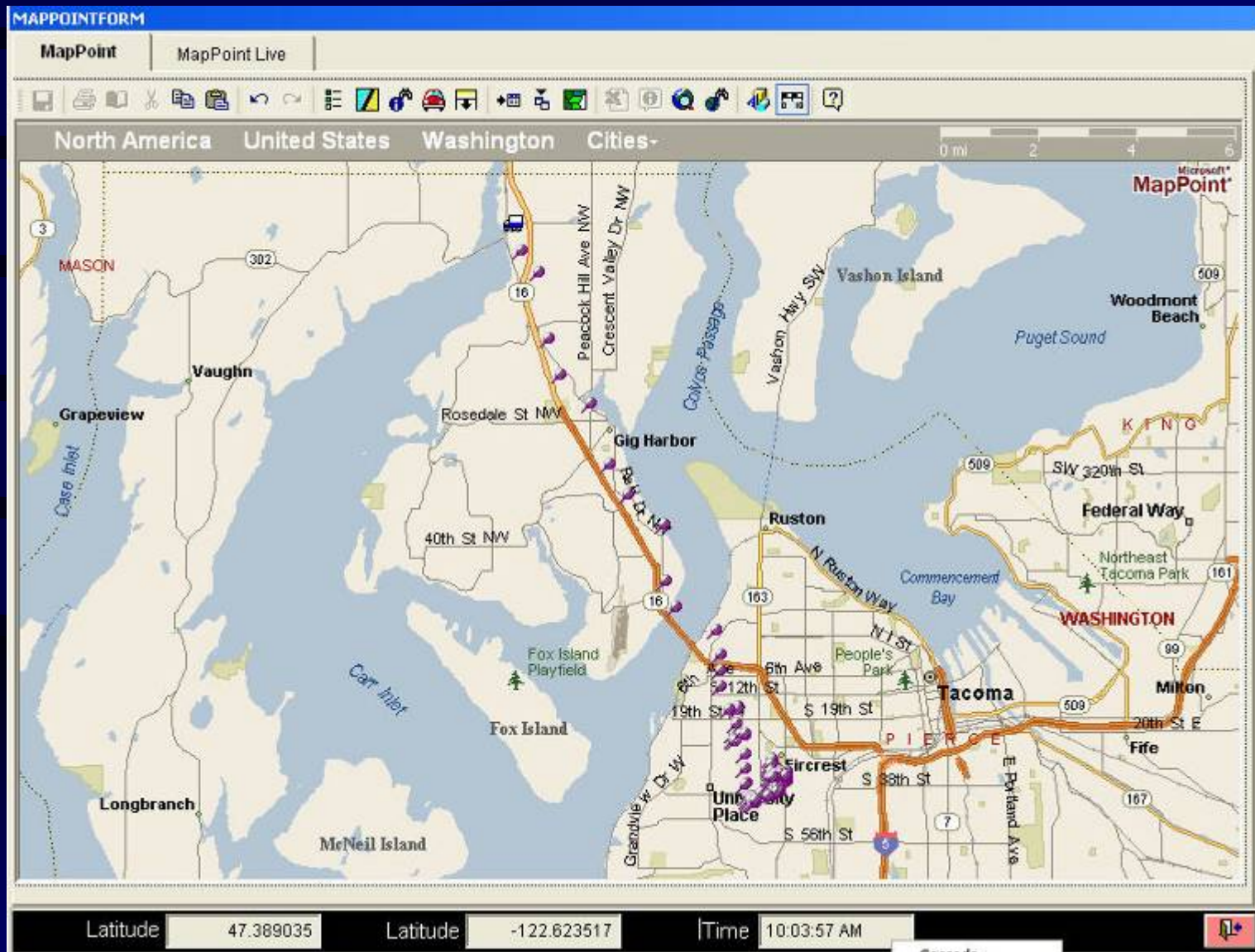
Date: 2/9/2007 1: Friday Starthours: 0 Endhours: 0  
 Route: 1 Driver: Starttime: / / Endtime: / /  
 Equipment Num: 1803 Startmiles: 0 Endmiles: 0

Fuel Event | Landfill Events | 206 gps fixes | **508 tips** | Route Events | Other Report

Tip Time	Location	Description	Contnum	Period	lc
2/9/2007 12:48:32 PM	1820 Knollwood Dr	100 Gal Cart	N023409	07:01am to 8:00am	79
2/9/2007 12:48:15 PM	1830 Knollwood Dr	60 Gal Cart	N609180	08:01am to 9:00am	87
2/9/2007 12:47:58 PM	1640 Knollwood Dr	32 Gal Cart	3T000931	09:01am to 10:00am	123
2/9/2007 12:47:40 PM	1650 Knollwood Dr	100 Gal Cart	T024148	10:01am to 11:00am	88
2/9/2007 12:47:21 PM	1670 Knollwood Dr	60 Gal Cart	M605892	11:01am to 12:00pm	54
2/9/2007 12:47:03 PM	1680 Knollwood Dr	100 Gal Cart	M013390	12:01pm to 1:00pm	77
2/9/2007 12:46:24 PM	1710 Knollwood Dr	60 Gal Cart	M605920		
2/9/2007 12:44:49 PM	1715 Knollwood Dr	60 Gal Cart	6R016645		
2/9/2007 12:44:19 PM	1685 Knollwood Dr	100 Gal Cart	L007598		
2/9/2007 12:44:00 PM	1685 Knollwood Dr	60 Gal Cart	M605495		
2/9/2007 12:43:39 PM	1675 Knollwood Dr	100 Gal Cart	M012907		
2/9/2007 12:43:22 PM	1665 Knollwood Dr	60 Gal Cart	L604151		
2/9/2007 12:42:34 PM	1555 Knollwood Te	60 Gal Cart	M005768		
2/9/2007 12:42:34 PM	1555 Knollwood Te	60 Gal Cart	M005768		
2/9/2007 12:42:01 PM	1575 Knollwood Te	100 Gal Cart	M013957		
2/9/2007 12:41:22 PM	1580 Knollwood Te	100 Gal Cart	M014453		
2/9/2007 12:41:01 PM	1570 Knollwood Te	100 Gal Cart	L005694		
2/9/2007 12:40:44 PM	1560 Knollwood Te	100 Gal Cart	M013955		
2/9/2007 12:40:24 PM	1550 Knollwood Te	100 Gal Cart	M012909		
2/9/2007 12:39:25 PM	1615 Knollwood Dr	100 Gal Cart	M013139		

Entered By: Date Entered: / / Fleet Status: [Navigation Icons]

# Route w/Collection vehicle now at Landfill



Thank You for your attention