Appendix I - Miscellaneous White Papers, Memoranda, and Calculations

Appendix I-1: Factoria Recycling and Transfer Station-
Sizing Calculations and Assumptions

Appendix I-2: Eric Mead, "Factoria Recycling and Transfer Station (RTS) Tipping Floor Design Evaluation", memo, addressed to Fred Bennett, August 12, 2010.

Appendix I-3: Eric Mead and Karissa Kawamoto, "Factoria Recycling and Transfer Station (RTS) Boundary Line Adjustment Overview", technical memo, addressed to Fred Bennett, July 12, 2010.

Appendix I-4: Cary Stewart, Tony Wang and Aziz Rahman, "Factoria Recycling and Transfer Station (RTS), Transfer Truck Travel Time/Routing Study - Travel Time Summary", technical memo, addressed to Eric Mead, May 11, 2010.

Appendix I-1: Factoria Recycling and Transfer Station-
Sizing Calculations and Assumptions

Factoria Recycling and Transfer Station

Sizing Calculations and Assumptions

During the development of the tipping floor size and layout, various calculations and industry standard measures were used and are presented below. The sections below coincide with the development criteria identified in Section 3 of the Factoria Recycling and Transfer Station Facility Master Plan.

Number of Unloading Stalls

The following assumptions and 2007 peak level data were used to estimate the number of unloading bays required for commercial and self-haul customers at the Factoria RTS:

Peak Weekday Volume -	162 tons per hour from 22 commercial trucks
	25 tons per hour from 41 self-haul vehicles
Unloading Time -	Commercial Haulers = 8 minutes
	Self-Haul = 16 minutes
Unloading Stall Width -	Commercial = 16 feet
	Self-Haul = 12 feet

$$Commercial = \frac{22 vehicles}{hrs} \, x \, \frac{8 \min}{vehicle} \, x \, \frac{1\ hour}{60 \min} = 3 bays$$

$$SelfHaul = \frac{41 vehicles}{hr} \, x \, \frac{16 \min}{vehicle} \, x \, \frac{1\ hr}{60 \min} = 11 \, bays$$

Emergency Waste Storage

The following assumptions were used to evaluate the required tipping floor area within the transfer station necessary to accommodate the emergency waste storage volume:

- Emergency Waste Storage Volume: 800 tons (average day in 2030) x 3 days = 2,400 tons

- Density of waste in stockpile: 350 lbs/cubic yard
- Height of Stockpile: 12 feet
- Stockpile sideslopes: 1 (horizontal):1 (vertical)
- Volume of Stockpile = Average Area of Stockpile at Center of Stockpile x Total Height
- Length of Stockpile at Tipping Floor (at Base of stockpile) = Length of stockpile at Average area + 12 feet, assume one side against a push wall
- Width of Stockpile at Tipping Floor (at Base of stockpile) = Width of stockpile at Average area + 12 feet

Container and floor space required for three scenarios to accommodate the emergency waste storage volume were evaluated as shown below:

Scenario	Waste in Containers (Tons)	Waste on Tipping Floor (Tons)	Required Tipping Floor Area (Square Feet)	Dimensions of Stockpile at base (tipping floor)
No storage in containers	0	2,400	37,400	187 feet by 200 feet
10 storage containers	250	2,150	34,410	187 feet by 184 feet
20 storage containers	500	1,900	30,670	187 feet by 164 feet

Assumes 25 tons per container

An example calculation for the 20 storage containers scenario is shown below:

- Stockpile Volume: 1,900 tons x 2,000 lbs/ton x 1 cubic yard/350 lbs x 27 cubic feet/1 cubic yard = 293,143 cubic feet
- Stockpile height: 12 feet
- Average area of the stockpile = 293,143 cubic feet/12 feet = 24,430 square feet
- Length at Average Area (of stockpile): 175 feet (assumed)
- Width at Average Area (of Stockpile): 24,430/175 feet = 140 feet
- Length at base of stockpile = 175 feet + 12 feet = 187 feet
- Width at base of Stockpile = 140 + 12 feet = 164 feet
- Area for Stockpile on Tipping Floor = 187 feet x 164 feet = 30,670 square feet

Pre-load Stationary Compactor

To determine the number of compactors needed to handle peak day volumes, the following assumptions and calculations were used:

- Size for 150% of average day in 2030,

- Average day in 2030 is 800 tons, and
- 15 – 18 minutes to fill a container with an average of 22-26 tons of waste, but assume conservative conditions of 18 minutes to fill and 22 tons per container.

Based on the above assumptions the number of compactors for the new Factoria RTS is determined as follows:

- Required throughput Capacity = 1.5 x 800 tons = 1,200 tons per day (peak day in 2030).
- Each stationary preload compactor processes a minimum of 730 tons per day based on a 10 hour operating day: (10 Hours x (60 Minutes/Hour) / (18 Minutes/Load) x (22 Tons/ Load).
- Number of Compactors = 1,200 tons per day/730 tons per compactor = 1.6.

Appendix I-2: Eric Mead, “Factoria Recycling and Transfer Station (RTS) Tipping Floor Design Evaluation”, memo, addressed to Fred Bennett, August 12, 2010.

ONE COMPANY *Many Solutions*℠

Memo

To:	Fred Bennett, King County Solid Waste Division		
From:	Eric Mead, PE, HDR	Project:	Factoria Recycling and Transfer Station
CC:	Eric Richardt, King County Solid Waste Division Neil Fujii, King County Solid Waste Division		
Date:	August 12, 2010	Job No:	124743

RE: Factoria Recycling and Transfer Station (RTS) Tipping Floor Design Evaluation

HDR has prepared this Memorandum to document the tipping floor design evaluation process conducted by the King County Factoria RTS Facility Master Plan (FMP) Task Force and to provide a recommendation to the Solid Waste Division Management Team (SWDMT) for the type of tipping floor for the new Factoria RTS.

Background

Transfer stations are generally constructed and operated with either a flat floor across the entire building or some type of grade separation (multi-level) that separates the self haul (residential) customers and waste transfer equipment. HDR recommended that the County consider use of a flat floor for the Factoria RTS based on needs (i.e., flexibility) identified during programming and design workshops. Also, HDR has design experience with both types of floors and has generally found that most transfer station owners/operators prefer a flat floor to a grade separated floor.

Approximately 6 feet of grade separation at the Factoria RTS would be achieved by constructing a wall between the self haul disposal area and the commercial unloading area. The wall would also extend approximately 42 inches above the self haul area thereby providing a 9 ½ foot wall between the commercial and self haul areas of the station. Self haul customers would unload their materials by lifting them over the wall and depositing them on the lower (commercial level) floor. A front end loader (FEL) would be used to push self haul waste along the 9 ½ foot high wall to the compactor hoppers.

Based on previous facility design experience and the Task Force's request to design a facility with maximum flexibility for planned and future waste management operations, HDR proposed a flat floor design for the new Factoria RTS. A flat floor would be constructed at the same elevation across the entire tipping floor, and the self haul customers would be separated from the commercial vehicles and transfer equipment (i.e., FEL) by a permanent low wall (24 inches high), a temporary or moveable barrier (i.e., jersey type barrier), or a windrow (waste row) created by recent waste disposed by the self haul customers.

Process

King County SWDMT requested that HDR provide education to the Factoria RTS FMP Task Force members regarding operational considerations of a flat floor as most King County transfer stations currently operate with some grade separation. Subsequently, a subgroup of the Task Force visited three regional transfer stations of similar size and waste tonnage to the proposed Factoria RTS that operate with a flat tipping floor including:

Mountlake Terrace Transfer Station (Owned and Operated by Snohomish County),
Olympic View Transfer Station (Operated by Waste Management, Owned by Kitsap County), and
Hidden Valley Transfer Station (Owned/Operated by LRI in Pierce County).

The tour attendees also had the opportunity to discuss facility operations with the respective transfer station staff. HDR also provided to King County staff the contact information for transfer stations nationwide designed by HDR and their subconsultants and assisted in developing a questionnaire for operators of facilities that operate with flat tipping floors.

King County SWD staff sent out a table of tipping floor evaluation criteria to Task Force members including notes from the first two transfer station tours (the third tour had not yet been conducted). During the final FMP workshop (Workshop #4, July 21st, 2010), the Task Force reviewed/discussed the evaluation table prepared by King County along with some additional considerations based on HDR's design experience. The evaluation table was revised based on input from the Task Force members and is included with this memo.

King County SWD staff met with representatives from Allied Waste Services, Waste Management, and Cleanscapes on August 5, 2010 to discuss the Factoria RTS. During the meeting the representatives reviewed the tipping floor plan, site layout and exterior renderings of the proposed station. The representatives were pleased to see the large separation between self-haul and commercial entrances to the building. The representatives also indicated their preference of directly dumping onto the floor versus dumping directly into a pit (like current Factoria station). The representatives believed that the proposed larger floor area for maneuvering of commercial haulers vehicles would result in reduced opportunities for accidents. The group also noted that the FEL operator was the key to providing safe navigation within the facility. The concepts of an "entry light" control of the traffic, automated wheel wash at the commercial exit to the building and the use of RFID charge cards at the second outbound scale were all well-received.

The commercial hauler representatives also suggested the access drive to the parking lot located in front of the station's offices be revised to prevent automobile traffic from crossing commercial traffic, and automobiles should be kept from sharing the commercial drive. It was also suggested that the commercial driveway could be wider to allow for increased queuing of trucks (up to 10 trucks), via double stacking, in the event of dumping delays within the station.

Evaluation

The assessment of the type of tipping floor proposed for the Factoria RTS included both design and operational considerations. Evaluation criteria were grouped into the following major categories:

1) Construction cost
2) Ease of phased construction
3) Operational costs
4) Health and safety
5) Flexibility/recyclability
6) Self haul customer
7) Local examples

The FMP Task Force agreed on the following key features of a flat tipping floor:

- More operational flexibility during phased facility construction,
- Better waste screening capability,
- Easier cleaning of the tipping floor,
- More overall flexibility for waste pile management and expansion for future operations,
- Increased mobility of recyclables, waste, and staff between the recycling area and the tipping floor, and
- Faster unloading for self haul customers (not lifting over a wall or cable) resulting in less time onsite.

Key considerations of a grade separated tipping floor included:

- Good separation between self haul customers and the equipment operators and commercial vehicles for safety concerns,
- Communication between transfer station operators is less critical if self haul customers are not sharing the same floor as commercial vehicles and transfer station equipment,
- The unloading location is readily apparent for self haul customers (physical wall to back up to) as opposed to a windrow or other less permanent location on a flat floor, and

- Maintains standardization with other King County transfer station (i.e. Shoreline and Bow Lake).

More detailed descriptions of the considerations for both floor types are contained in the attached evaluation table. It should be noted that construction costs and annual operating costs, including staff requirements, for a facility with either type of tipping floor were considered to be similar and were therefore not considered critical factors in selected a preferred floor design.

Results

The Task Force reviewed/discussed the pros/cons between a flat and grade separated tipping floor for the Factoria RTS. The Task Force concluded that a flat floor was more advantageous for most of the criteria that was considered. The Task Force also discussed the differences between a fully open flat floor and a flat floor with some form of barrier. The types of barriers considered include a permanent low wall or temporary barrier such as jersey barriers (K-rails). The Task Force was undecided regarding the best approach for the type of barrier to use in the flat floor configuration, and the discussion was tabled with the understanding that this decision could be made at a later date in the design process after gaining further input.

Evaluation: Flat Floor vs. Grade Separated Floor for the Self Haul Unloading Area

Item #	Consideration	Comment	Advantage (Flat or Separated)	Workshop #4 Notes
1	**CONSTRUCTION COST:**			
1a	Building	**Flat** – Standard construction **Grade separated** - Requires time, money for additional wall structure	Flat	
1b	Site Grading (Cubic Yards of Cut/Fill/Net)	**Flat** – 129K cut/38K fill /90K net **Grade separated** - 115K cut/42K fill/73K net ***Note: cost of 1a and 1b differences are estimated to be even*	GS	
1c	Roof Height	**Flat** – No change required across floor **Grade separated** - Roof would need to be higher over recycling area to maintain floor elevation with self haul area	Flat	Need to determine clearance requirements for recycling operations but could increase height over recycling area.
2	**EASE OF PHASED CONSTRUCTION**			
2a	Temporary seismic bracing of “open” end wall at end of Phase 1	Same phased construction build out for both scenarios	Neutral	
2b	Temporary Operations	**Flat** – More flexibility to access entire floor during construction **Grade separated** - Limited to commercial area (lower level)	Flat	Could direct self-haul traffic along the long end of the building to expand during temporary and permanent operations
3	**Operational Costs:**			
3a	Staffing	**Flat** – 4 to 5 per shift **Grade separated** - 4 to 5 per shift	Neutral	
3a-1	# of workers/category of workers	**Flat** – 1 spotter, 1 FEL, 1 compactor, 1 HHW/recycle, 1 scalehouse **Grade separated** - Same as flat floor	Neutral	Likely more staff required, but assumestill same between flat/grade
3b	Efficiency of Staff			
3b-1	Movement of staff between self haul and commercial areas	**Flat** – High. All areas of floor are accessible. **Grade separated** - More difficult to move equipment and staff between levels	Flat	Thea asked how Larry sees stopping traffic during MSW movement. Does not see as an issue. Liked the idea of a signal controlled by FEL. Alternately, could shut down group of stalls to clean portion of floor
3b-2	Ease of moving garbage	**Flat** – Can push or pull waste. May need stop traffic during MSW loading **Grade separated** - Push waste alongside wall. May need to limit FEL movement during self-haul unloading	Neutral	

Item #	Consideration	Comment	Advantage (Flat or Separated)	Workshop #4 Notes
3b-3	Extent of push walls	**Flat** – Less total walls required **Grade separated** - Push wall need along self-haul area	Flat	
3b-4	Visibility of entire floor by staff	**Flat** – Good visibility for all staff **Grade separated** - Limited visibility by FEL onto self-haul. Limited visibility into MSW area by spotter	Flat	
3b-5	Ease of waste screening	**Flat** – High **Grade separated** - more difficult to see behind safety wall. Difficult to identify and remove unacceptable waste	Flat	
3b-6	Last minute diversion/recovery of materials	**Flat** – Easy. Can result in cost savings and revenue **Grade separated** - Difficult. Cannot divert materials at lower level while self-haul is unloading	Neutral	Considered Neutral issue by King County Staff
3b-7	Standardization between facilities	**Flat** – Similar equipment and staffing roles to grade separation **Grade separated** – Closer to other King Co. facilities		Concern raised about TSO's working at multiple facilities with different operations
3c	Maintenance			
3c-1	Floor Cleaning	**Flat -** Can move cleaning equipment across entire floor area **Grade separated -** Equipment required to move between levels, or manual sweeing. More hose connections and collection points may be required.	Flat	
3c-2	O&M Costs (Preliminary based on 180,000 tons per year; 500 tpd)	**Flat -** \$1.5 to \$1.7 million; \$8.30 to \$9.40 per ton **Grade separated -** same as flat floor		
4	**Health and Safety**			
4a	Separation of self haul vehicles from commercial	**Flat** – Good. Separate traffic routes and entrance/exit doors **Grade separated** - Good. Separated by elevated wall	Neutral	
4b	Separation of self haul vehicles from loading equipment	**Flat** – Can separate with windrow or solid barrier. Potential conflict for FEL projecting materials **Grade separated** - Good separation. Potential conflict for materials falling on FEL	Grade	
4c	Self haulers falling into waste disposal area	**Flat** – No falls from height **Grade separated** - Need barrier (i.e. wall, cables). Potential falls from	Flat	
4d	Self haulers exposed to disposed garbage (potential for waste tracking)	**Flat** – Can be separated by movable barrier or operational procedures (i.e. FEL bucket brush) **Grade separated** - Limited except for spillage while unloading and hoisting over wall. Manual sweeping required	Neutral	
4e	Access to building entrance and exit	**Flat** – Separate entrance and exit **Grade separated** - Same as flat floor	Neutral	
4e-1	Roadway Grade Incline (especially during inclement weather)	**Flat -** 5.5-6% maximum **Grade separated -** same as flat	Neutral	
4f	Communication/Awareness	**Flat** – Critical. Spotters /FEL needs to know movement of all vehicles **Grade separated** - Less critical. Important for spotters, less critical for FEL	Grade	Primary concern for Thea. Larry feels they have good radio communication. TSO standardization is a concern of CJs. Larry doesn't feel it is an issue w/good training

Item #	Consideration	Comment	Advantage (Flat or Separated)	Workshop #4 Notes
5	**FLEXIBILITY / RECYCLABILITY**			
5a	Future Operational Floor Configurations	**Flat** - Very good for future operational changes, space may be modified as necessary. **Grade separation** - Limits ability to repurpose space for future changes	Flat	Josh wants to make it clear in document that flat floor is key to increased diversion & recycling
5b	Access between recycling and tipping floor	**Flat –** Easy to move materials (i.e., waste rejects from recycling area) between areas **Grade separation –** Difficult to move materials between areas	Flat	
6	**SELF HAUL CUSTOMER**			
6a	Waste unloading Efficiency (Time onsite) LEVEL OF SERVICE Criteria	**Flat** - Easy unload within short time – customers' generally prefer **Grade separation** - May be difficult depending on fall protection method	Flat	
6b	Unloading location	**Flat –** Not as readily apparent if no barrier (could address with physical barrier or operations) **Grade separation** - Readily apparent	Grade (if no barrier for flat)	
6c	Number of unloading stalls	**Flat –** Can easily expand for peak weekend traffic **Grade separation –** Difficult to change operations	Flat	
7	**LOCAL EXAMPLES**	**Flat -** Mountlake Terrace; Olympic View; SPU SRDS[1] ; SPU NRDS[1]; Tacoma TS[1]; Skagit County TS[1] **Grade Separated -** Shoreline RTS, Airport Road TS; Bowlake RTS[1]	Flat (more public and private operations trending toward flat)	

[1] Designed, not yet constructed

Appendix I-3: Eric Mead and Karissa Kawamoto, “Factoria Recycling and Transfer Station (RTS) Boundary Line Adjustment Overview”, technical memo, addressed to Fred Bennett, July 12, 2010.

ONE COMPANY
Many Solutions℠

Technical Memo

To:	Fred Bennett, PE		
From:	Eric Mead, PE Karissa Kawamoto	Project:	FACTORIA Recycling and Transfer Station
CC:			
Date:	July12, 2010	Job No:	124743

RE: Boundary Line Adjustment Overview

This memorandum presents an overview of the City of Bellevue's Boundary Line Adjustment (BLA) process to aid King County with decision-making for the new Factoria Recycling and Transfer Station (RTS) site plan.

Introduction

Boundary line adjustments (BLAs) are also referred to as lot line adjustments. A BLA may involve the adjustment (e.g., relocation) or removal of a property line between lots. BLAs are processed by the planning department of local jurisdictions often as a subdivision or a plat. The criteria for approval of BLAs are less intensive due to the nature of the request (e.g., to change the configuration of a property, not the creation of additional properties). Typically, BLAs are less complex and therefore faster to process through the system than most land use permit applications.

How might a BLA be used for Factoria RTS?

In preparing the scope of work for the new Factoria RTS project, the design team assumed that some type of BLA would be processed by the City of Bellevue either for:

- Elimination or consolidation of property lines under common King County ownership for the transfer station; or,
- To alter or modify the shared boundary line between the transfer station site and the Eastgate property.

In early 2010, King County staff and members of the design team held a meeting with City of Bellevue (COB) planning staff to preliminarily discuss the new Factoria RTS project. Based on discussions during the meeting, it was determined that a BLA would not be required to eliminate unnecessary property lines during the land use approval process. The COB staff indicated that the site plan as a whole would be reviewed under the Conditional Use Permit irrespective of the various parcel boundaries. Further, the COB would enforce dimensional standards such as setbacks only from the perimeter property lines and not the interior parcel/lot lines. A BLA for the shared lot line between the Eastgate property and existing transfer station was not discussed with COB staff.

The design team believes there are several benefits of shifting the property line south onto the Eastgate property including:

- More flexibility for construction phasing and access,
- More space to layout the permanent scalehouse plaza (including the desired 3 sets of truck scales),

- Ability to better manage the grade difference across the site
- More area to locate retaining walls and storm drainage facilities
- Greater ability to provide continuous operations of the existing transfer station facility while the new RTS is constructed.

The design team believed that since the existing transfer station property and the Eastgate property were both owned by King County, then a BLA could be achieved with minimal effort. For this reason, the design team also believed that if additional developable space was needed for the project then it could more easily be acquired by moving the common property line to the south into Eastgate property.

BLA Criteria

The COB regulates BLAs pursuant to Section 20.45B.260 of their land use development code. The key to a successful BLA is to ensure that the BLA application provides sufficient information to answer the following:

- Would the BLA result in a nonconforming setback or other zoning dimensional regulation or is there an increase in any existing non-conformance?
- Are there any previous plat or development approvals (i.e. conditions of approval) affecting any of the property that would be violated as a result of the proposed BLA?
- Would each lot continue to have suitable access meeting the subdivision and zoning code requirements?
- Does each lot have utility services available to it?
- Are any and all easements necessary to provide access and utilities shown on the recording document?

The BLA document must be prepared by a professional land surveyor registered in the State of Washington pursuant to WAC 332-130 and recorded pursuant to requirements of RCW 58.09 (survey map). The COB has a short list of items (see attached) it requires be shown on the BLA application to assist the planner in answering the above questions and processing the application.

Application Materials

The City of Bellevue requires the following items for a BLA application:

- Title Report for each property affected (not more than 30 days old)
- Survey Intake Form and BLA Application Form
- King County Assessor's Map
- New BLA survey map suitable for recording
- Fees due at submittal $766 for all departments – a portion of which is considered a deposit and remaining funds after review would be returned.

Conclusion and Recommendation

BLA applications are generally considered the easiest permit to process from both the City planner and the property owner perspectives. Modifying the east-west property line location between the Factoria RTS and the Eastgate property has many advantages as previously discussed. The design team believes that a BLA for the lot line between the Eastgate property and the existing transfer station can be relatively easy for several reasons including:

- Common ownership (King County)
- Same zoning designation,
- Same comprehensive plan, and
- Both large parcels and feature distinct points of access that would be unaffected by the BLA.

The BLA process could be stand alone and completed prior to submittal of the Conditional Use Permit. This would most likely result in a quicker turnaround by the City. It could also be submitted concurrently as part of the Conditional Use Permit Application where it would then be tied to that process and the conditions imposed by the City as part of the land use permit.

The Factoria RTS design team recommends completion of a BLA for the project.

Appendix I-4: Cary Stewart, Tony Wang and Aziz Rahman, “Factoria Recycling and Transfer Station (RTS), Transfer Truck Travel Time/Routing Study - Travel Time Summary”, technical memo, addressed to Eric Mead, May 11, 2010.

ONE COMPANY
Many Solutions℠

Technical Memo

To: Eric Mead	
From: Cary Stewart, Tony Wang, Aziz Rahman	Project: FACTORIA RECYCLING AND TRANSFER STATION PROJECT
CC: WD Baldwin	
Date: May 11, 2010	Job No: 124743

RE: Transfer Truck Travel Time/ Routing Study- Travel Time Summary

The following is a summary of the truck travel time and routing study for the new Factoria Recycling and Transfer Station (FRTS). The FRTS is located at the ends of SE 30th and SE 32nd Streets east of Richards Road in Bellevue, WA. There are four potential routes with driving times of ten minutes or less to 405 South at Coal Creek Parkway. The roadway characteristics for each of the routes are presented in Table 1. Each of these routes starts at the east end of SE 32nd Street and then proceeds to Richards Road where a left (south direction) or right (north direction) turn is made depending on the route.

Route 1: Left turn onto Richards Rd/Factoria Blvd SE then turning right onto Coal Creek Pkwy SE then turning left onto the 405 South on-ramp

Route 2: Left turn onto Richards Rd then right turn onto WB 90 on-ramp, exiting WB 90 at E Mercer Way and then returning to EB 90 then onto 405 South

Route 3: Right turn onto Richards Rd then left turn onto Lake Hills Connector Rd then turning left onto SE 8th then turning left onto 405 South

Route 4: Left turn on Richards Rd then turning left onto SE Eastgate Way then turning right onto WB 90 then onto 405 South

Table 1 Roadway Characteristics

	Route 1	Route 2	Route 3	Route 4
Number of: Right-turns	1	1	1	1
Left-turns	2	3	2	2
Signals	14	4	9	7
Stop signs	0	0	0	0
Tight turns for trucks	-	LT @ E Mercer Way & I-90 East On-ramp	LT @ Lake Hill Connector Rd & SE 8th Pl	LT @ SE Eastgate Way & 156th Ave SE
Length(mi)	2.8	5.4	5.7	5.2
Adjacent Land Uses[1]	10% R/ 90% C	10% R / 90% F	25% R/25% V/ 50% F	25% C/ 75% F

[1] R – residential; C – commercial/office professional; V – vacant; F - freeway

Currently, the transfer trucks exiting the FRTS primarily use Route 1. The purpose of this study was to assess alternative travel routes for the FRTS transfer trucks.

HDR staff utilized a GPS enabled passenger car to follow the transfer trucks for Route 1 to collect travel time data. To confirm representative travel times for the transfer trucks 6 trips were done for Route 1. It was determined from this that the travel time by passenger car for each of the other routes should be similar to the travel times by transfer trucks along the same routes. HDR then performed 2 trips on the other three routes utilizing the GPS enabled passenger car. HDR staff believes that 2 trips for each of the other 3 travel routes are adequate because they were done at peak hours and represent worst case travel times.

GPS logged data are presented in speed - distance curves included with this memo. These curves illustrate the speed of the vehicle along each of the routes versus the distance traveled. A dip in the graph represents a stop, often at a traffic signal red light. Due to the signalized intersections, the travel time on the arterial portion of Route 1 does not show significant differences between peak and non-peak hours. However, freeway portions of all routes have significant travel time differences between peak and non-peak hours. Therefore, transfer truck drivers should consider peak hour freeway congestion when selecting a travel route. Table 2 presents the travel times for all of the travel routes. Figure 1 through Figure 4 present the travel time summary for individual routes.

Table 2 Average Travel Time and Average Stop Rate for Routes 1 through 4.

	Distance (mile)	Average Speed (mph)	Average Travel Time (m:s)	Average Stop Rate (# per run)	Travel Time	
					Min.	Max.
Route 1	2.8	20.0	8:21	5.8	6:49	9:15
Route 2*	5.4	37.9	8:30	2.0	8:15	8:44
Route 3*	5.7	28.2	12:11	3.5	10:57	13:26
Route 4*	5.2	26.8	11:35	8.5	10:52	12:18

*: Freeway portions of all routes have significant travel time difference during peak and non-peak

SUMMARY

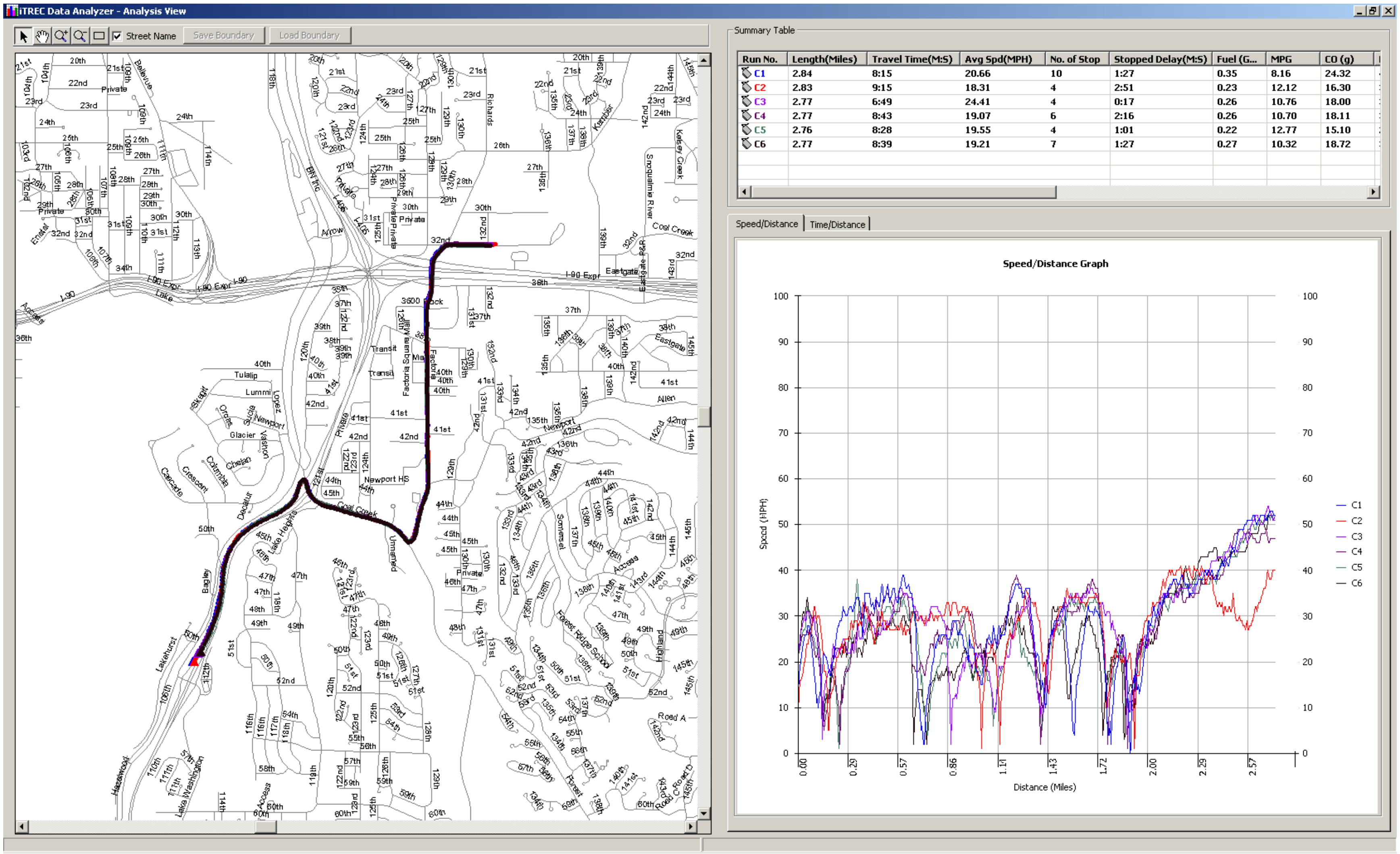
Route 1, typically used by transfer trucks now provides the shortest route and the shortest average travel time. It also has more stops that could result in higher fuel use and more emissions during acceleration.

Route 2 provides a similar average travel time as Route 1 but has the advantage of providing fewer opportunities for stopping. However, Route 2 also has the longest portion on the freeway. When congestion levels on the freeway are free flow this will result in lower fuel usage and less emissions.

Routes 3 and 4 are only viable if the freeways are congestion free.

As part of the Facility Master Plan, HDR will use this memo as part of the information to complete a traffic impact analysis to assess the impact of the FRTS on traffic within the project area.

Figure 1 Route 1 Travel Time Summary



Run No.	Length(Miles)	Travel Time(M:S)	Avg Spd(MPH)	No. of Stop	Stopped Delay(M:S)	Fuel (G...	MPG	CO (g)
C1	2.84	8:15	20.66	10	1:27	0.35	8.16	24.32
C2	2.83	9:15	18.31	4	2:51	0.23	12.12	16.30
C3	2.77	6:49	24.41	4	0:17	0.26	10.76	18.00
C4	2.77	8:43	19.07	6	2:16	0.26	10.70	18.11
C5	2.76	8:28	19.55	4	1:01	0.22	12.77	15.10
C6	2.77	8:39	19.21	7	1:27	0.27	10.32	18.72

Figure 2 Route 2 Travel Time Summary

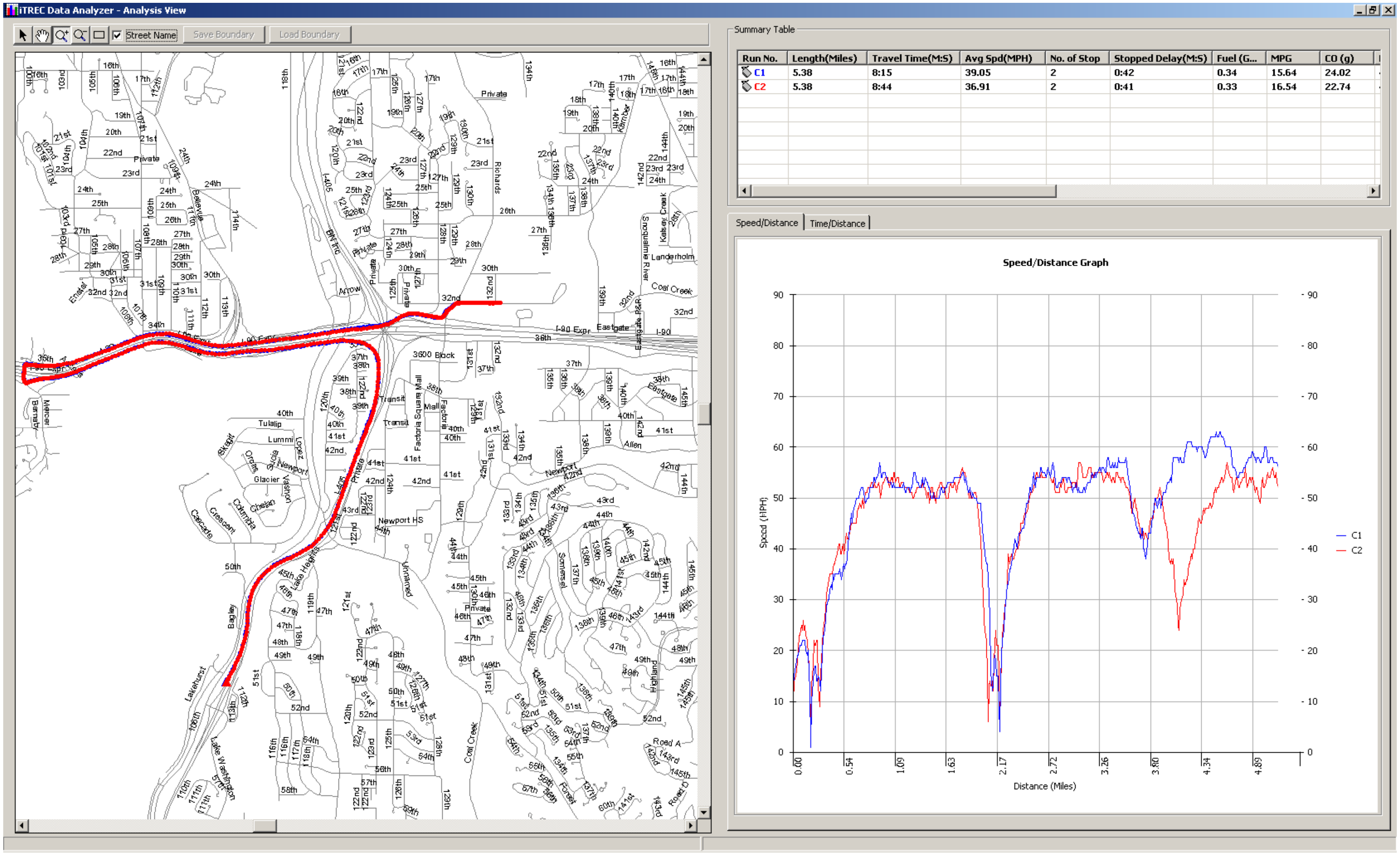


Figure 3 Route 3 Travel Time Summary

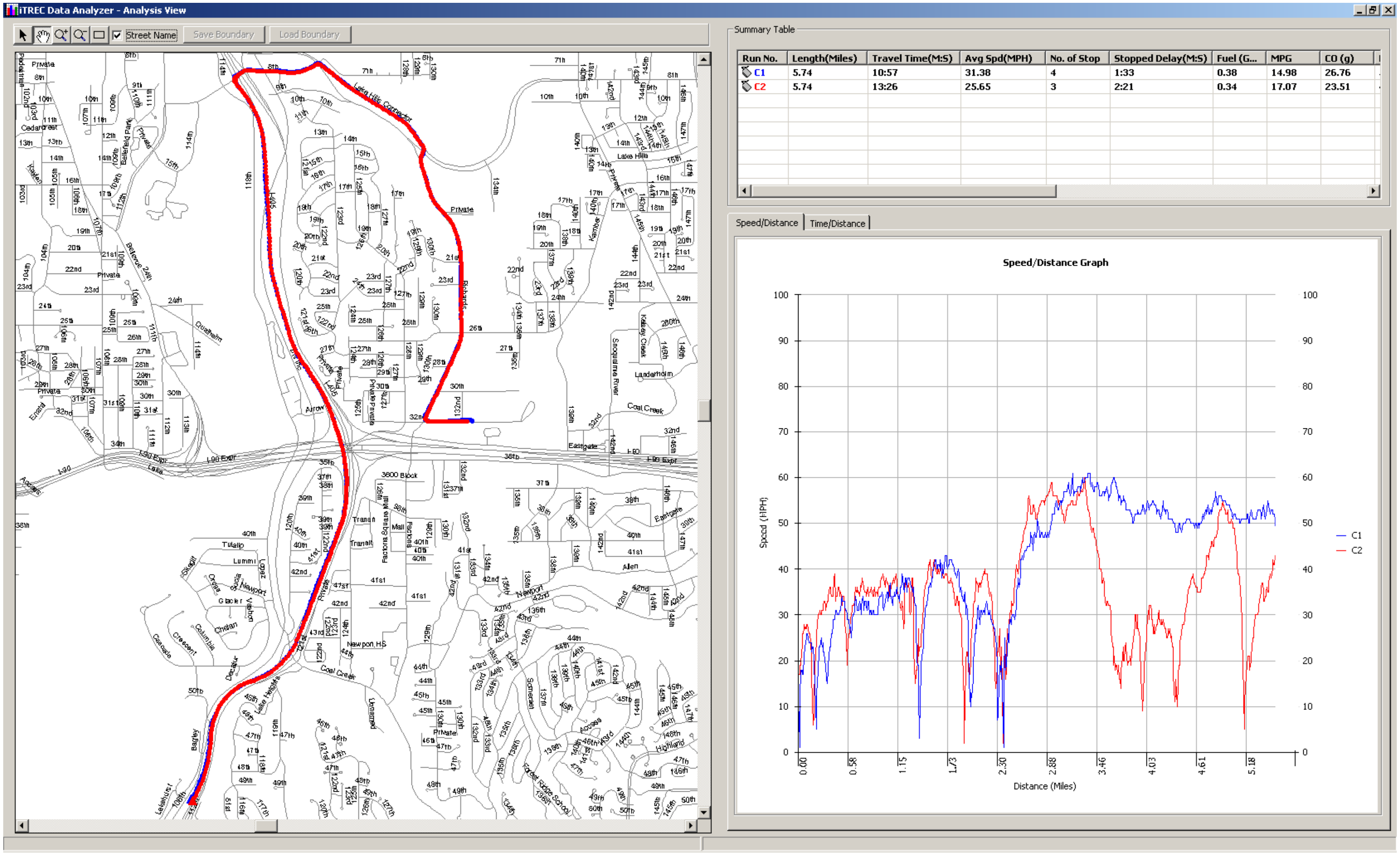
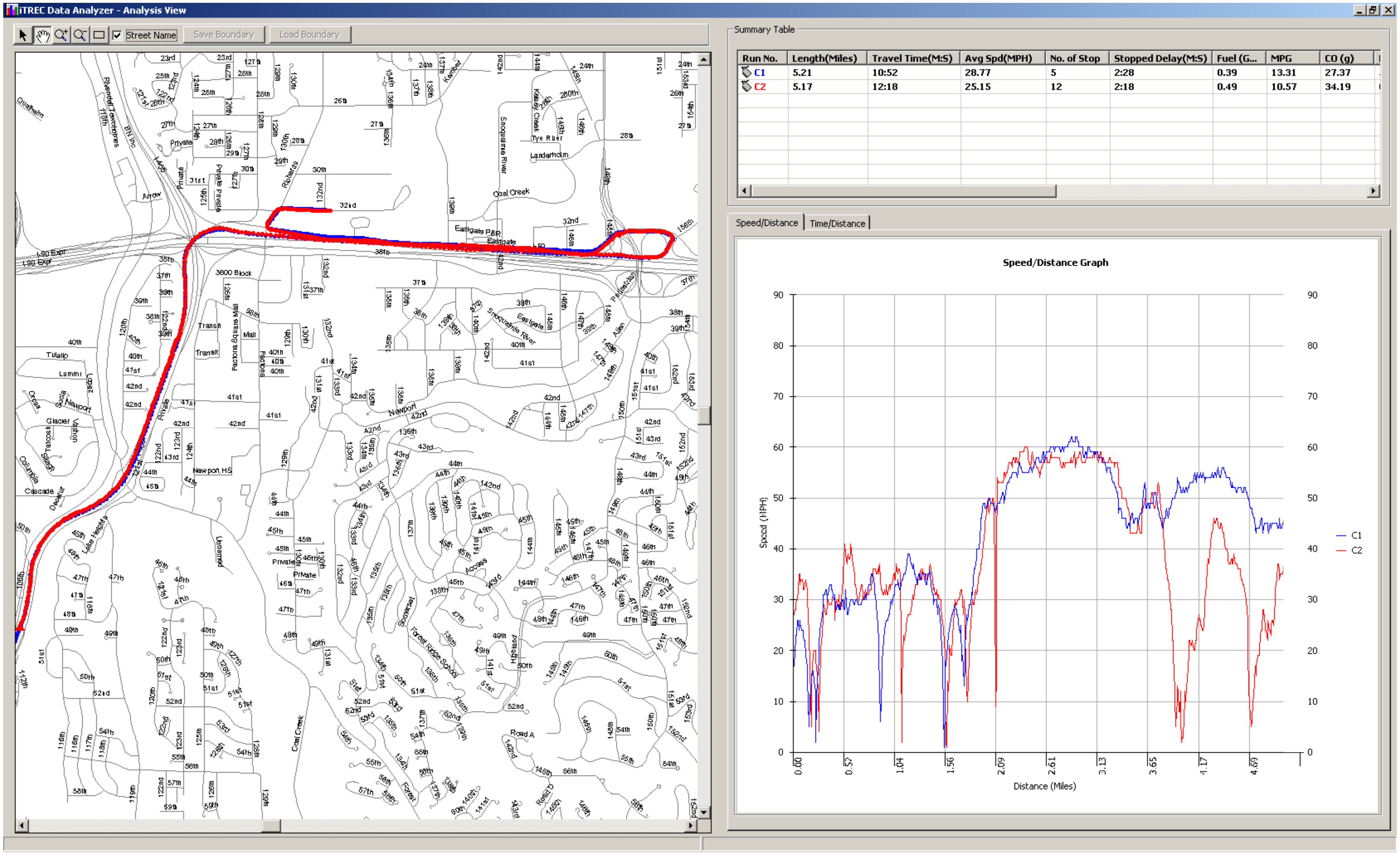


Figure 4 Route 4 Travel Time Summary



Run No.	Length(Miles)	Travel Time(M:S)	Avg Spd(MPH)	No. of Stop	Stopped Delay(M:S)	Fuel (G...	MPG	CO (g)
C1	5.21	10:52	28.77	5	2:28	0.39	13.31	27.37
C2	5.17	12:18	25.15	12	2:18	0.49	10.57	34.19