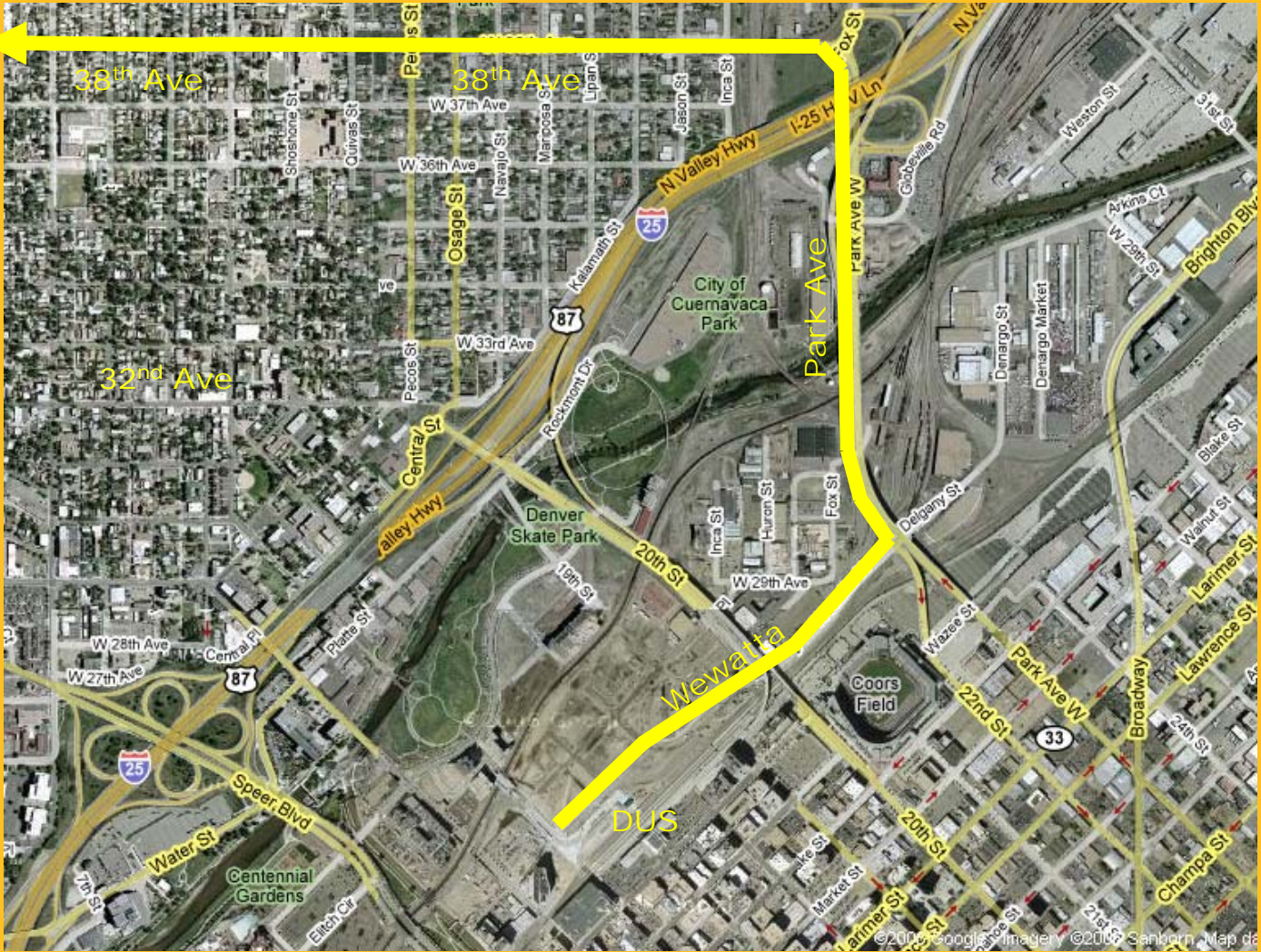






# Street Running: Alignment Options

# DUS 1- LRT from DUS to Park Avenue to 38<sup>th</sup> Avenue

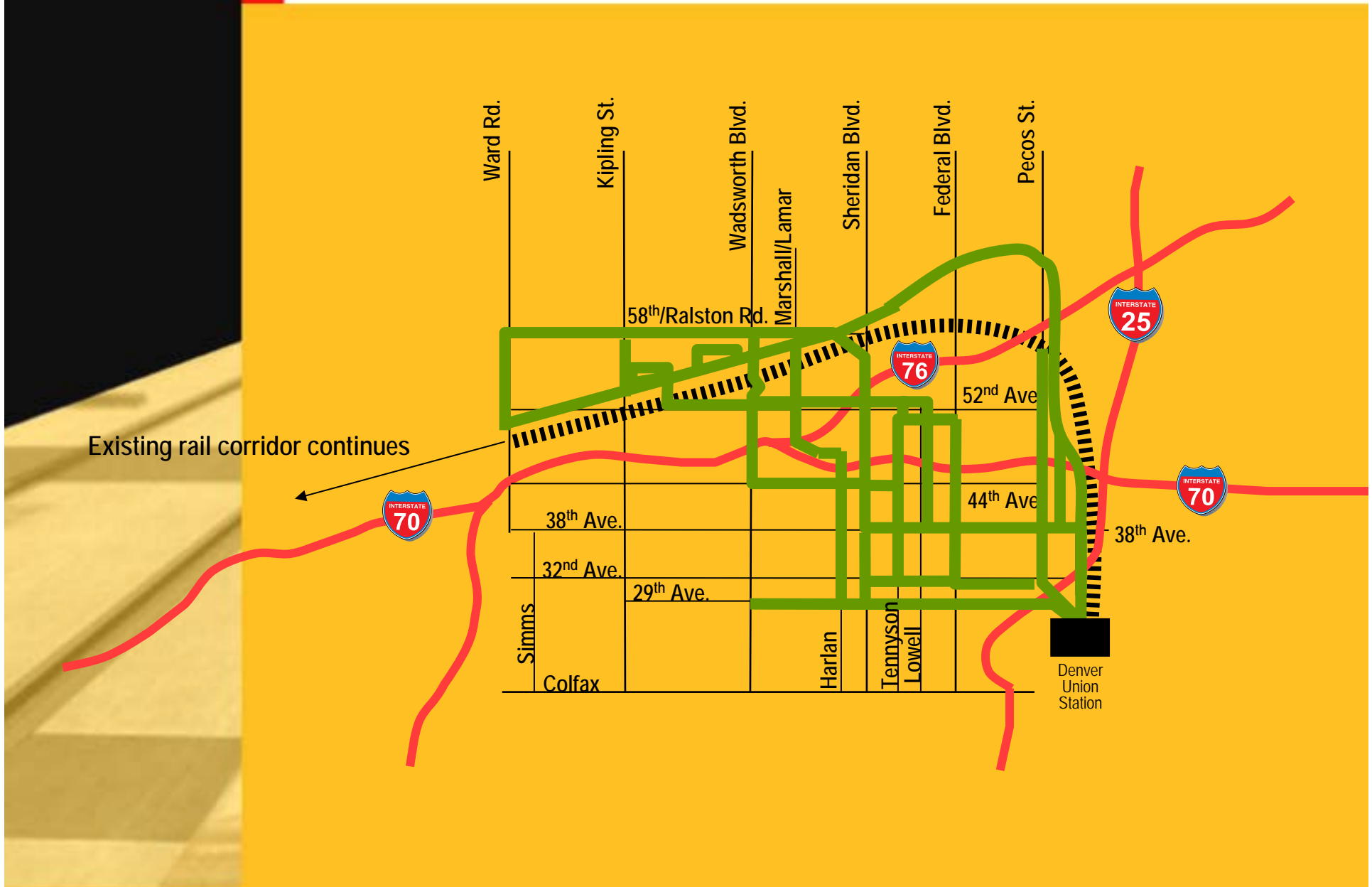




# DUS 2- LRT from DUS to 20<sup>th</sup> Street to 38<sup>th</sup> Avenue



# All routes explored for alternate LRT alignments



# Light Rail or Streetcar Decision Issues



	Light Rail	Streetcar
Purpose	<p>High capacity and demand</p> <p>Strong peak ~ commuters</p> <p>Multiple lines/same corridor</p>	<p>Moderate capacity and demand</p> <p>Steady all day demand</p> <p>Discreet routes ~ less demand</p>
Capacity	<p>1-4 car trains ~ 125 pass/car</p> <ul style="list-style-type: none"> <li>• 2-2.5 min ~ max frequency</li> <li>• 12,000 – 15,000 pass/hr</li> </ul>	<p>1 streetcar ~ 120 pass/car (<i>can operate in 2-car consists if needed</i>)</p> <ul style="list-style-type: none"> <li>• 5 min ~ max frequency (<i>could be more frequent if needed</i>)</li> <li>• 1,440 psgrs/hr (<i>5,760 max</i>)</li> </ul>
Design	<p>Exclusive or <i>semi-exclusive</i> right-of-way (<i>limited mixed flow</i>)</p> <ul style="list-style-type: none"> <li>• Single track in short distances if needed</li> <li>• Reliable schedules</li> <li>• Achieve max speed ~ 55 mph</li> </ul>	<p>Exclusive, semi-exclusive, or mixed-flow with traffic</p> <ul style="list-style-type: none"> <li>• Schedule includes delay</li> <li>• Street speed max ~ 30-35 mph</li> <li>• <i>Can reach 45 mph if conditions allow</i></li> </ul>

# Light Rail and Streetcar Operation Common Characteristics



Light Rail and Streetcar	
Power	<ul style="list-style-type: none"> <li>▪ Electric ~ overhead wire ~ 650 - 750 Vdc</li> </ul>
Track	<ul style="list-style-type: none"> <li>▪ Same ~ standard gauge typical, others possible</li> </ul>
Vehicles	<ul style="list-style-type: none"> <li>▪ Length ~ varies based on demand: <i>Streetcars ~ 50 -110+ feet; Light Rail ~ 80 - 95 feet</i></li> <li>▪ Width/Height: 7.5 to 10 ft wide, 10 to 13 ft high</li> <li>▪ Articulated ~ bendable joint(s) ~ sections: <i>Streetcars ~ multiple, up to 6; Light Rail ~ 2 to 3</i></li> <li>▪ Older and "historic" streetcars <i>not</i> articulated</li> <li>▪ Low floor vehicles ~ trend for new vehicles in most cities</li> </ul>
Environment	<ul style="list-style-type: none"> <li>▪ Block length ~ limits train size/number of cars <i>With short blocks ~ 1 or 2 car trains max</i></li> </ul>
Fare Payment	<ul style="list-style-type: none"> <li>▪ Off vehicle ticket machines ~ most systems <i>Some on-board purchase ~ streetcar operation</i></li> </ul>



# Light Rail and Streetcar Service Typical Differences



	Light Rail	Streetcar
Right-of-Way	primarily exclusive	primarily mixed-flow
Geometry/curves	min radius ~ >85 ft	min radius ~ <60 ft
Operating Rationale	limited-stop/express -regional rapid transit	local/limited-stop - line haul or feeder
Station Spacing	1/2 to 1 mile or more	2-3 blocks to 1/2 mile
Speed	with 1+ mile station spacing ~ 50 - 60 mph	limited by close station spacing ~ 25 - 35 mph (45 mph max)
Mode of Access	park/ride, bus, bike, walk	<i>same</i>
Seats / Standees	64/61 ~ 125 per car	30/90 ~ 120 per car
Trains / Capacity	1 to 4 cars / 125 to 500	<i>1 to 2 cars /120-240</i>
Peak Passengers	1,000-7,500 per hour	1,440-5,760 per hour



# Light Rail and Streetcar Service Typical Differences



	Light Rail	Streetcar
Function	high capacity, high demand	moderate capacity, moderate demand
Route Design	multiple lines/routes over common tracks	discreet lines/routes
Service Plan	accommodate high peak demand	moderate demand throughout day
Control	track signals, traffic signal pre-emption	on-site, with traffic signals, <i>or signal priority</i>
Construction	full depth ~ <i>3 to 6 ft.</i> utilities relocated	shallow slab ~ <i>12 to 18 in.</i> minor/no utility relocation
Communication	duct bank required	no duct bank
Grade separation	moderate to extensive	minor

# Light Rail and Streetcar Service

## City by City Examples



Type	Operating Characteristics
Streetcar	<ul style="list-style-type: none"><li>▪ Primarily in-street operation</li><li>▪ Some exclusive ROW</li></ul>
Light Rail	<ul style="list-style-type: none"><li>▪ Primarily exclusive right-of-way ~ streets and corridors</li><li>▪ Moderate to extensive grade separation ~ short elevated or underground sections</li></ul>
Hybrid	<ul style="list-style-type: none"><li>▪ Includes streetcar and light rail attributes</li><li>▪ Single cars and multi-car trains</li><li>▪ Subway or elevated in CBD or other activity centers</li><li>▪ Exclusive surface ROWs and mixed-flow sections</li><li>▪ Design/Operating constraints ~ based on most restrictive element in system (e.g. tight curves on street sections)</li></ul>



# Light Rail and Streetcar Service

## City by City Examples



Streetcar	Light Rail	Hybrid
<ul style="list-style-type: none"> <li>▪ Toronto</li> <li>▪ Denver – Welton segment</li> <li>▪ Pittsburgh – Allentown</li> <li>▪ Philadelphia – Media, Sharon Hill, Girard</li> <li>▪ Portland</li> <li>▪ Tacoma</li> <li>▪ New Orleans</li> </ul>	<ul style="list-style-type: none"> <li>▪ Denver</li> <li>▪ Los Angeles – Blue, Green, Yellow</li> <li>▪ San Diego</li> <li>▪ San Jose</li> <li>▪ Sacramento</li> <li>▪ Calgary</li> <li>▪ Edmonton</li> <li>▪ Portland – Blue, Red, Yellow</li> <li>▪ Salt Lake</li> <li>▪ Houston</li> <li>▪ Dallas</li> <li>▪ Saint Louis</li> <li>▪ Minneapolis</li> <li>▪ Baltimore</li> <li>▪ Jersey City</li> <li>▪ Newark</li> <li>▪ Buffalo</li> </ul>	<ul style="list-style-type: none"> <li>▪ Boston – Green Line</li> <li>▪ Cleveland – Blue/Green</li> <li>▪ Philadelphia – Subway/Surface</li> <li>▪ Pittsburgh</li> <li>▪ San Francisco – Muni Metro</li> </ul>

# Streetcar Examples



## **Toronto Traditional Streetcar**

- Center street alignment
- Std and artic vehicles
- In-street boarding above
- High floors – non-ADA



## **Portland Neo-traditional Streetcar**

- Side alignment
- Articulated vehicles
- Curbside boarding
- Low floors – ADA OK



## **Paris High-Capacity Streetcar**

- Street median alignment
- Multi-articulated vehicles
- Platform boarding
- Low floors – ADA OK



# Hybrid Streetcar/Light Rail Examples



## Hannover

- Downtown subway
- Street median and mixed-flow sections
- Multi-articulated vehicles and low/high stairs
- Singles to 3-car trains
- High platforms subway & selected surface stops



## Boston

- Downtown subway
- Street median and mixed-flow sections
- Articulated and low-floor vehicles
- Singles to 3-car trains
- Low platforms in subway and surface



## San Francisco

- Downtown subway
- Street median and mixed-flow sections
- Articulated vehicles
- Singles to 3-car trains
- High platforms subway & selected surface stops

# Light Rail Examples



## Salt Lake

- High floor vehicles
- Exclusive ROW
- 1-4 car trains



## Portland

- Low and high floor vehicles
- Exclusive ROW
- 1-2 car trains



## Houston

- Low floor vehicles
- Primarily Exclusive ROW
- 1-2 car trains



# Light Rail – Street Running Example: Portland Interstate Max



# Light Rail – Street Running Example: Portland Interstate Max





# Modern Streetcar Example: Portland





# Modern Streetcar Example: Portland



# Modern Streetcar Example: Tacoma

