Developing Infrastructure-Relevant Guidelines for Preliminary Conceptual Planning of a New Light Rail Transit System

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Background

- Light rail transit (LRT) systems ("full-size" and "streetcar") continue to generate interest in cities across North America.

- Local planners, transit agency personnel, other professionals, civic leaders, and community stakeholders need guidelines resource.

- Project aim: Initiate development of such a resource.
Approach

• Prep work toward conceptual design manual for systems-level "view from 30,000 feet"

• Occasional drill-down details where useful

• This presentation — overview with highlights from full paper

• Full paper on LightRailNow.Wordpress.com
Route Selection: Corridors

NCHRP/TRB definition: "Normally, a corridor is considered to be a 'travel shed,' an area where trips tend to cluster in a general linear pattern ..."
Vehicle Clearances Profile

- OCS Contact Wire
  - Varies
  - 1.3 ft (400 mm)
  - 11.6 ft (3.5 m)
- Pantograph
- Cab
- Track Gauge
  - 4 ft 8.5 in (1435 mm)
- Roadway or sidewalk
- Light rail transit vehicle dynamic envelope
  - 8.6 ft (2.6 m)
- Edge pavement markings
- Vertical clearances to contact wire
  - Minimum 13 ft (4112 mm)
  - Standard 16-18 ft (4860-5460 mm)

Adapted by LH from Hamilton Public Works

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Clearance Profiles: Curvature

• Standard minimum curve radius = 82 ft. (25 m), sharper turning capability possible

• Tight curves limit train speed, cause "wheel squeal" and wear on both wheels and rails

• Recommended curve radii range from 100 feet (30 m) (streets) to 300 feet (91 m) or more (exclusive alignments)
Clearance Profiles: Gradients

- 6% gradient = desired maximum, but grades of 9% and greater are possible
Typical Surface Alignment Options

- Double-track
- Bi-directional single track
- Paired directional tracks on parallel streets
- Interlaced (gauntlet) track

Photo: Eric Haas/NYCSubway.org
Photo: Stefan Baguette
Graphic: Taylor Gibson
Photo: YouTube

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LRT Alignment Considerations

• Abandoned railway lines and public arterials usually preferred

• Sharing tracks/ROW with "heavy" railroad is technically possible ... but problematic

• Freeway alignments often present serious challenges

• Subway/elevated alignments more expensive
Common Alignment Profiles/Costs
Arterial Alignments

Typical Total System Costs

Street/arterial lane: $63 million/mile ($39 million/km)
Roadway median: $32 million/mile ($20 million/km)
Common Alignment Profiles/Costs

Exclusive Alignment

Abandoned railway alignment: $24 million/mile ($15 million/km)

Shared use of active railway line: $35 million/mile ($22 million/km)
Common Fare Collection Methods

Operator collects fares

Turnstiles

Passenger self-service (recommended)

Photos: PhiladelphiaPlaneto.com, Los Angeles Times, Portland Tribune

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Station Platform Profile

Dimensions

Typical platform width
- Curbside 8-10 ft (2.4-3.0 m)
- Trackside 10-16 ft (3.0-5.0 m)
- Center island 15-20 ft (4.5-6.0 m)

Typical platform height
- Lowfloor standard 14" (330-356 mm)
- With bridgeplate 8-10" (203-354 mm)

Bridgeplate

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Common Station Configurations

Center island platform: width 15-20 ft (4.5-6.0 m)

Curbside platform: often includes 8-10-ft (2.4-3.0-m) "bulgeout" of sidewalk

Side platform: width 10-16 ft (3.0-5.0 m) — often staggered across intersections


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Station Park & Ride Facilities

- 300-350 SF/space, 100 spaces/AC (250-270/hectare)
- Average $3500/space
Traction Electric Power: Substations

- Provide nominal 750 VDC to power trains
- Small cabinets or buildings, typically ~ 100-200 SF (9-20 m²)
- ~ 0.5 MW to 3.0 MW
- Spaced ~ 0.5-2.0 miles (800-3200 m)

LRT TPSS
- Convert Utility power to 825V dc power for light rail
- TPSS are needed about every mile along light rail alignment – there are close to 50 on system.
- Each TPSS is typically rated at 1.5 MegaWatts.

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OCS: Simple Trolley Wire vs Catenary

Diagram: Sumida Crossing
Photos: Flickr, Houston Chronicle
Common Signal Systems

Railway-type systems: Typically automatic block signals (ABS), but may include cab signals, ATS, ASC, ATO, CBTC, PTC

Street operation systems: Integrated with traffic signal system, special signals control train movements; may involve signal prioritization

Photos: L. Henry
### Elements of Typical Communications Systems

- Radio communications
- PA system
- Variable message board (VMB) links (aka PIDs)
- CCTV
- Automated fare collection
- Automatic vehicle location (AVL)
- Supervisory Control and Data Acquisition (SCADA) system
Typical Rolling Stock Assumptions

Full-performance LRT car, 90-100 ft. (27.3-30.3 m) — 150 passengers

Full-performance LRT car, 75-85 ft. (22.7-25.8 m) — 125 passengers

Streetcar, 65-70 ft. (19.7-21.2 m) — 110 passengers

Photos: GoMetroRail.org, Siemens, OldTrails.com
Plausible Average Speed Assumptions

LRT in urban arterial: 15 mph (24 km/h)
LRT in railway: 20 mph (32 km/h)

Streetcar in urban arterial: 12 mph (19 km/h)
Streetcar circulator: 9 mph (14 km/h)

Photos: L. Henry, Peter Ehrlich
Example: Estimating Fleet Size

- Assume 8-mile route, urban arterial, projected ridership 25,000
- Peak-hour/peak-direction ridership = 10% of total = 2,500
- Average speed 15 mph = >30 min end-to-end, implies 20 "short" (125-pax) cars needed
- With 15% spares, fleet size = 23 railcars
Storage and Maintenance Facility

- Space per railcar: 770-2760 SF (71-253 m²)
- Cost per car-space: $416,000-$1,546,000
Summation

• Hopefully helpful to North American communities in considering, evaluating, and conceptualizing new LRT systems

• Guidelines could be useful for planners, civic leaders, decisionmakers, and community stakeholders to give a general understanding of LRT design and technical issues

• Comprehensive manual could elaborate and expand on many of the topics discussed

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Further Information

Copy of paper:
LightRailNow.Wordpress.com

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