Noise and Vibration Control for T-Rex Project

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TRB Summer 2010 Meeting
Denver, CO
TREX Project – Multimodal Design Build

$1.6 B transit and roadway improvement program

Nation’s first multimodal design build project - $1.2 B D-B contract

Collaboration between FHWA/FTA and CDOT/RTD

19 miles of new double track LRT alignment with 13 new LRT stations

17 miles of highway improvement and widening; including the construction of more than 60 bridges
General Construction Activities

Concrete paving

Utility work

Asphalt road surface removal and asphalt paving

Setting girders at structures
Noise and Vibration Activities

- Construction noise and vibration monitoring and control
- Traffic noise abatement
- LRT noise and vibration mitigation
Why Is Nighttime Construction Work Needed?

Keep 6 lanes of traffic open during peak travel hours, 5:30 a.m. to 8:30 p.m

Minimize inconvenience to public

A noise variance is need from City of Denver to conduct construction activities from 9 pm to 7 am
Variance Requirements

Bridge Demolition

Not to exceed an $L_{eq}$ of 78 dBA outside of “eligibility zone”
Not to exceed an $L_{max}$ of 86 dBA outside of “eligibility zone”
No more than 3 consecutive nights of activity, followed by 4 consecutive nights of no activity
Offer hotel vouchers to impacted households (eligibility zone)
Notification of major structure activity

General Construction Activity

Cannot exceed an $L_{eq}$ of 78 dBA
Cannot exceed an $L_{max}$ of 86 dBA
No more than 5 consecutive days at one location, followed by 2 consecutive nights at or below ambient noise levels
Nighttime Mitigation Measures

- Best Management Practices
- Equipment noise certification
- No impact pile driving
- Adjustable backup alarms
- Construction activities behind existing, new, or mobile soundwalls or sound curtains
- Nightly noise monitoring from 9 pm to 7 am:
  - Hourly and spot measurements
- Noise hotline
Mitigation Requirements: Equipment

Equipment used 5 or more days on Project needs to be certified for nighttime activities and recertified every six months.

All equipment needs to have back-up alarms that can be turned down during nighttime activities.
Notification

Per variance, notify households within a half-mile radius of bridge demolition activities during nighttime hours

Tools used:

Mailings and door hangers

Neighborhood meetings

Media outreach

Communication matrix

Project information line

Project website
Noise Hotline Program

24/7 Noise Hotline

A noise reading is conducted at the complaint site to determine if allowable noise levels have been exceeded.

To Date: no complaint has been validated as exceeding Variance noise levels.
Temporary Soundwalls

Acoustical drapes made of vinyl products
Temporary Wood and Blanket Soundwalls
Temporary Mobile Soundwalls

Innovative sound trailers

Provide 10 -12 dBA reduction
Hourly Average Noise Measurements

1300 Total Measurements (1/10/01 – 6/1/05)

78 Decibel Hourly Average (Leq) Noise Variance Limit
Instantaneous Maximum Noise Measurements

1300 Total Measurements
(1/10/01 – 6/1/05)

86 Decibel Instantaneous Maximum (Lmax) Noise Variance Limit
Louisiana Ave. Bridge

Mobile Soundwalls
(8 Trailers)

78 dBA

Eligibility Zone

Eligibility Zone

Mobile Soundwalls
(8 Trailers)

78 dBA
Bridge Demolition

- Franklin St. Bridge
- Railroad Bridge
Bridge demolition as public attraction

More than 200 people
33 soundwalls will be constructed to mitigate traffic and LRT impacts

12 committed walls will also be constructed

Total length will be approximately 60,650 feet

Heights are from 3 to 22 feet

Different patterns for the soundwalls
Soundwalls Along I-25
Soundwall with Different Heights
Noise Impact in Narrows
Conduct measurements of the existing LRT vibration.

Determine soil propagation characteristics at different locations using a fixed source vibration reference.

Predict the future LRT pass by vibration.

Determine building effects on vibration propagation.

Recommend mitigation measures to lower vibration to within FTA limits.

Residential – 72 VdB
Commercial – 75 VdB
LRT Vibration Measurements

Measured LRT passby vibration at the Southwest Corridor in Littleton, CO

![Graph showing 1/3 Octave-Band Train Passby Vibration Levels]

- 45 - 49 mph
- 50 - 55 mph

Knee Velocity Levels, V, relative to 1 micro-inch per second

1/3 Octave Bands, Hertz
A roller with 2 frequencies was used as a fixed vibration source

3 feet measurements near the existing tracks and at each test site
Fixed Source versus Train

Shape Measurement Comparison, Vert Axis.

- RG Train 25 Feet
- Train Background
- RG Roller 25 Feet
- Roller Background

RMS Velocity Level, VEL

1/3 Octave Band

Train Session: 73.7
Various Configurations
Vibration Impacts

- 8 Single family, 9 multifamily, and 1 commercial buildings would be impacted

- Approximately 7,650 track feet mitigation is required

- Distances of the impacted buildings to the near track - 15 to 70 feet

- Predicted vibration levels
  - Residential - 71.5 to 81.4 VdB
  - Commercial - 82.1 to 85.1 VdB
Test Setup

- Test Track-Bed
- Soundwall
- Vibratory Roller
- Concrete Drain Structure
- Property Wood Fence
- Exterior Location
- 2nd Floor Corner Location
- 2nd Floor Mid-Room Location
- Unit #35 (2nd Floor)
- Unit #32 (1st Floor)
- 1st Floor Location
- Condominium 2 Story Bldg.
Test Locations

Outside of building

2nd fl bedroom
Installing Shredded Tire Test Section

Shredded tire - 12 in

Sub ballast - 16 in

Ballast - 16 in

Testing the compaction
Vibration with Shredded Tire

RMS Velocity Level, VdB re: 1 micro-inch per second

1/3 Octave Band

Meas Roller @ 25ft
Pred Train @ 25ft
Pred Train with Ballast Mat
Pred Train with Shredded Tire
Background

Train Sum
Train w/ Mat Sum
Train w/ Tire Sum

77.8
73.8
73.3

Train Sum
Train w/ Mat Sum
Train w/ Tire Sum
Conclusion

Demonstrated commitment to meeting noise variance requirements

Continue to collaborate with City to ensure that mitigation and monitoring program is a success

Variance essential to meeting project goal: minimizing inconvenience to public and completing work almost two years ahead of schedule.

Denver residents voiced support for SECC's responsive/successful noise mitigation efforts
Questions