



Session 4

23 CFR 772: Cost Effectiveness Reasonableness Criteria

- ▶ Facilitator: Jon Evans, New Hampshire DOT
- ▶ Participants:
 - ▶ Bill Bowlby, Bowlby & Associates, Inc. (FHWA research)
 - ▶ Jon Evans, New Hampshire DOT
 - ▶ Jim Ozment, Tennessee DOT
 - ▶ Jim Ponticello, Virginia DOT
 - ▶ Amber Phillips, Georgia DOT

FHWA Research on 23 CFR 772: Streamlining, Analysis, and Outreach

- Phase I, Task 3, Examination of Noise Abatement Feasibility and Reasonableness Factors Permitted under 23 CFR 772
- Purpose: To examine the factors in 23 CFR 772 as implemented in SHA noise policies to identify variations and optimized combinations of values
- Researchers: RSG, Bowlby & Associates, Inc., and Environmental Acoustics



Feasibility and Reasonableness Factors Studied

■ Feasibility

- **Feasibility Noise Reduction:** Noise reduction of at least 5 dB that must be achieved for a noise abatement measure to be feasible
- **Feasibility Quantity:** Minimum number or percentage of *impacted* receptors that must achieve a 5 dB reduction

■ Reasonableness

- **Benefited Noise Reduction:** Minimum noise reduction for a receptor to be counted as benefited by an abatement measure
- **Noise Reduction Design Goal (NRDG):** Minimum noise reduction that must be achieved for an abatement measure to be reasonable
- **NRDG Quantity:** Minimum number or percentage of *benefited* receptors that must achieve the NRDG
- **Cost Effectiveness (CE):** Allowable cost per benefited receptor (CPBR) or allowable barrier area per benefitted receptor (APBR)

■ Consideration of Viewpoints studied separately



Feasibility Reduction Design Goal and Quantity

Feasibility Quantity (Number or Percent of Impacted Receptors)	Number of SHAs by Feasibility Reduction
	5 dB
1	13
2	1
3	1
40%	1
50% of first-row impacted	3
50%	5
>50% of first-row impacted	3
>50%	10
60% of first-row impacted	2
67% of first-row impacted	2
67%	1
70%	1
75% of first-row impacted	4
75%	2
80% of first-row impacted	1
80% of first-row and 67% of all impacted	1
80%	1



Benefited Noise Reduction and Noise Reduction Design Goal

NRDG	Number of SHAs Using Benefited Noise Reduction					
	5 dB	6 dB	7 dB	8 dB	9 dB	10 dB
7 dB	36	A*	2	--	--	--
8 dB	3	A	A	1	--	--
9 dB	1	A	A	1	1	--
10 dB **	4	A	2	1	A	A

* A= allowable combination in the regulation, but not used by SHAs

** Includes one SHA (MDOT) using 10 dB at one benefited receptor and 7 dB at 50% of all benefited receptors.



Noise Reduction Design Goal and Quantity

NRDG Quantity (Number or Percent of Benefited Receptors)	Number of SHAs by NRDG			
	7 dB	8 dB	9 dB	10 dB
1	14 ¹	2 ²	2 ³	1
1 first-row	3 ⁴	--	--	1
1 at 10 dB and 50% of all at 7 dB	--	--	--	1 ⁵
10%	2	--	--	--
10% of first-row benefited	1	--	--	--
25%	1	--	1 ⁶	--
40% of first-row benefited	1	--	--	--
40%	2	--	--	--
50% of first-row benefited	3	--	--	--
50%	4 ⁵	--	--	1
>50% of first-row benefited	1	--	--	--
>50%	3	--	--	1
60% of first-row benefited	2	--	--	--
65%	--	--	--	1
67% of first-row benefited	1	--	--	--
67%	1	--	--	--
75% of first-row benefited	2	1	--	--
80% of first-row benefited	--	--	--	1
80%	--	1	--	--

CPBR and APBR as a Function of NRDG (Slide 1 of 3)

■ Wide ranges in values

- Cost per Benefited Residence
 - \$20,000 to \$55,000
- Unit Costs
 - \$18/sf to \$70/sf
- Area per Benefited Residence (6 SHAs)
 - 750 sf to 2,700 sf

■ Normalized all CPBRs to APBRs

APBR (or CPBR/Unit Cost), SF allowance	Cost per Benefited Receptor (or Area per Benefited Receptor) [<i>bold italics</i> indicates the upper or lower end of a range]	Unit Cost, \$/SF	Number of SHAs by NRDG			
			7 dB	8 dB	9 dB	10 dB
250	<i>250 base (post-Sep 2005) / 2,400 max</i>	Uses area	1	--	--	--
477	\$21,000	\$44.00	1	--	--	--
700	<i>\$36,127 base / \$71,222 max</i>	\$51.61	1	--	--	--
714	<i>\$50,000 / \$55,000 (severe impacts)</i>	\$70.00	1	--	--	--
786	<i>\$50,000 / \$55,000 (severe impacts)</i>	\$70.00	1	--	--	--
800	\$20,000	\$25.00	1	--	--	--
833	<i>\$25,000 / \$30,000</i>	\$30.00	1	--	--	--
857	\$30,000	\$35.00	--	1	--	--
909	\$40,000	\$44.00	1	--	--	--
945	\$42,509	\$45.00	--	--	--	1 *
960	<i>\$24,000 base / \$37,000 max</i>	\$25.00	--	1	--	--
1,000	\$25,000	\$25.00	--	--	--	1
1,000	<i>\$24,250 / \$48,250 max</i>	\$24.25	1	--	--	--
1,000	<i>\$25,000 / \$30,000</i>	\$30.00	1	--	--	--
1,000	\$30,000	\$30.00	--	--	--	1
1,000	<i>\$30,000 / \$37,500 (51% prior)</i>	\$30.00	1			
1,000	\$31,000	\$31.00	1	--	--	--
1,250	<i>\$30,000 / \$37,500 (51% prior)</i>	\$30.00				
1,000	\$40,000	\$40.00	1	--	--	--



CPBR and APBR as a Function of NRDG (Slide 2 of 3)

APBR (or CPBR/Unit Cost), SF allowance	Cost per Benefited Receptor (or Area per Benefited Receptor) [<i>bold italics</i> indicates the upper or lower end of a range]	Unit Cost, \$/SF	Number of SHAs by NRDG			
			7 dB	8 dB	9 dB	10 dB
1,029	\$36,000	\$35.00	--	--	1	--
1,053	\$40,000	\$38.00	1	--	--	--
1,137	\$42,244	\$37.16	1	--	--	--
1,167	\$35,000	\$30.00	1	--	--	--
1,200	\$30,000	\$25.00	2	--	--	--
1,200	<i>\$30,000</i> / \$40,000 (severe impacts)	\$25.00	1			
1,250	\$25,000	\$20.00	1	--	--	--
1,333	\$40,000	\$30.00	1	--	--	--
1,380	\$36,127 base / <i>\$71,222 max</i>	\$51.61	1	--	--	--
1,389	\$25,000	\$18.00	1	--	--	--
1,400	1,400 SF (uses \$42,000 based on current unit cost of \$30/SF)	Area-based	1	--	--	--
1,400	\$35,000	\$25.00	1	--	--	--
1,400	\$49,000	\$35.00	1	--	--	--

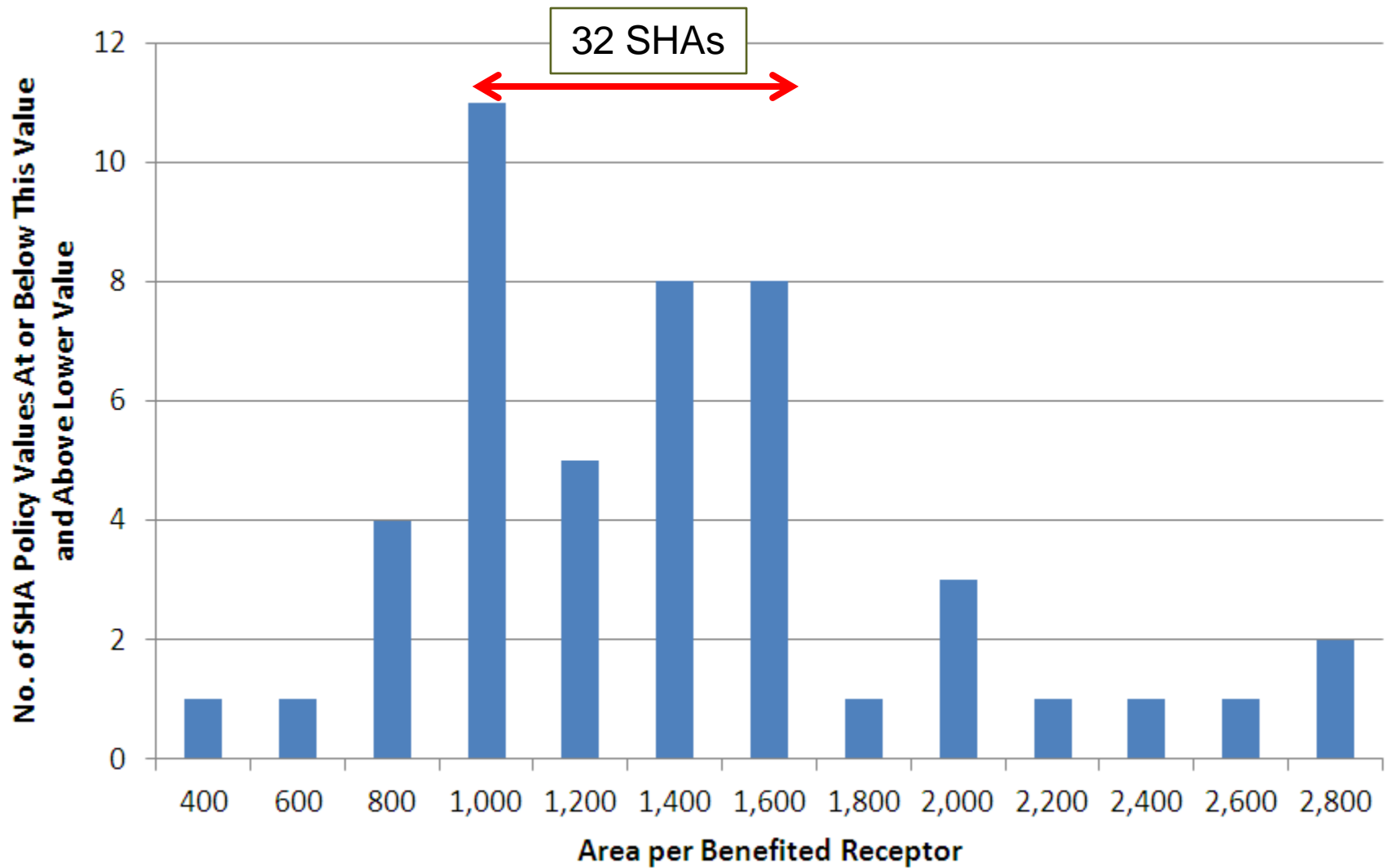


CPBR and APBR as a Function of NRDG (Slide 3 of 3)

APBR (or CPBR/Unit Cost), SF allowance	Cost per Benefited Receptor (or Area per Benefited Receptor) [<i>bold italics</i> indicates the upper or lower end of a range]	Unit Cost, \$/SF	Number of SHAs by NRDG			
			7 dB	8 dB	9 dB	10 dB
1,429	\$40,000	\$28.00	1	--	--	--
1,440	\$36,000	\$25.00	1	--	--	--
1,480	\$24,000 base / <i>\$37,000 max</i>	\$25.00	--	1	--	--
1,500	\$45,000	\$30.00	1	--	--	--
1,500	\$30,000	\$20.00	--	1	--	--
1,600	\$30,000 / <i>\$40,000 (severe impacts)</i>	\$25.00				
1,600	\$40,000	\$25.00	1	--	--	--
1,600	1,600 SF	Uses area	1	--	--	--
1,667	\$30,000	\$18.00	--	--	1	--
1,990	<i>\$24,250 / \$48,250 max</i>	\$24.25	1	--	--	--
2,000	2,000 SF for wall / \$80,000 for berm or insulation	Uses area	1			
2,000	2,000 SF	Uses area	1	--	--	--
2,175	\$43,500	\$20.00	1	--	--	--
2,400	250 base (post-Sep 2005) / <i>2,400 max</i>	Uses area	1	--	--	--
2,500	2500 SF + 35 SF/dB Increase	Uses area	1	--	--	--
2,700	2,700 SF (3,700 SF for Common Noise Environment average)	Uses area	1	--	--	--
2,750	\$55,000	\$20.00	1	--	--	--

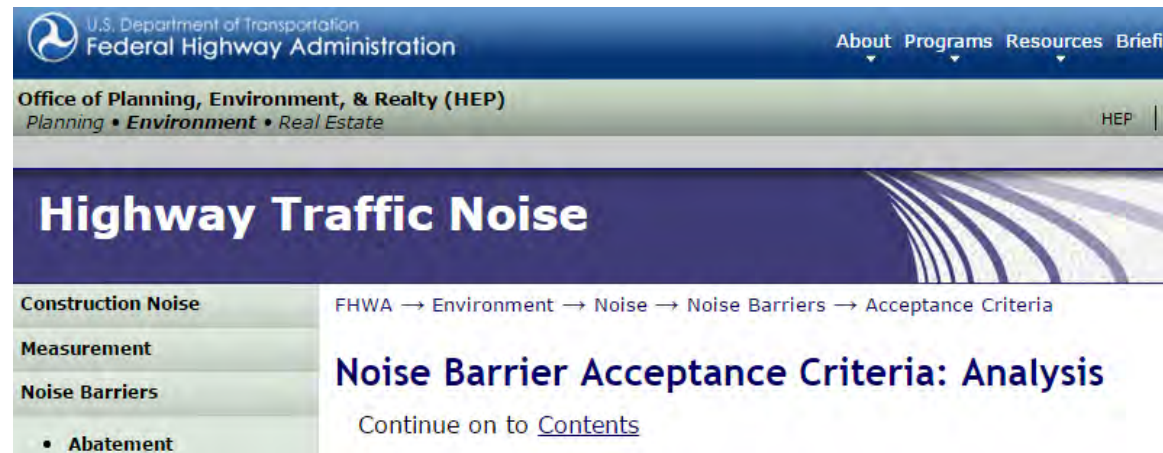


Normalized Area Per Benefited Residence

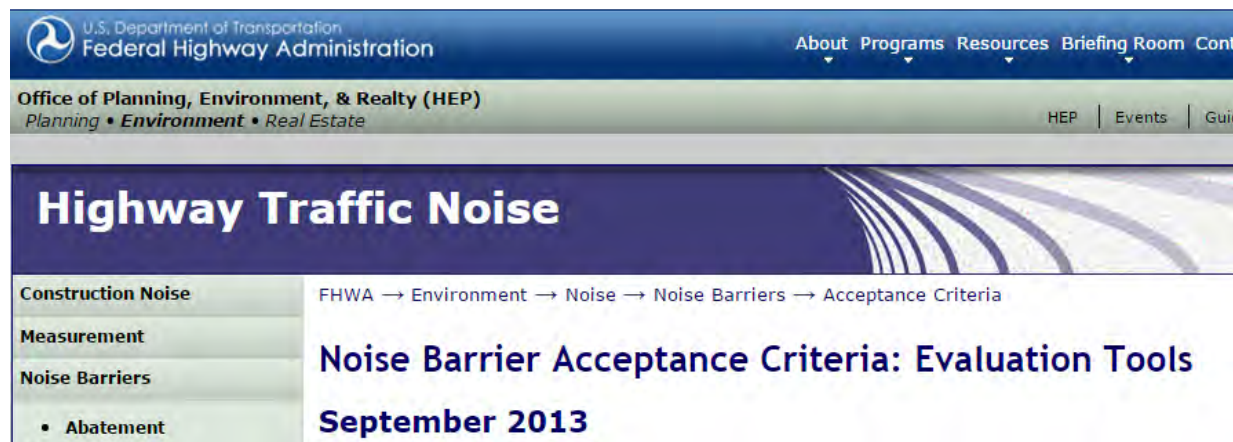


Noise Barrier Acceptance Criteria Documents, FHWA web site

- http://www.fhwa.dot.gov/environment/noise/noise_barriers/acceptance_criteria/analysis/



- http://www.fhwa.dot.gov/environment/noise/noise_barriers/acceptance_criteria/evaluation_tools/



NHDOT's Optional Reasonableness Criteria

Jon Evans

NHDOT Air & Noise Program Manager

Background

- NHDOT in final stages of updating Type I policy and implementation of Type II policy
- Updated policy includes improvements to NHDOT's local official/public outreach program required for:
 - Type II program implementation
 - Consideration of date of development when determining Type I reasonableness
- Opportunity for NHDOT to combat increased noise sensitive development adjacent to state highways

Goals

- Include date of development as a factor for determining reasonableness
- Further encourage noise compatible planning
 - Already required for participation in Type II program

Reasonableness Criteria

- Cost effectiveness:
 - Base Effectiveness Criteria (EC) of 1,500 s.f. / benefited receptor
 - Date of Development: Base EC lowered by the following values according to the % of benefiting receptors permitted for development one year after implementation of policy

Properties permitted for development after DATE	Adjustment factor subtracted from base EC
1-25%	100 s.f.
26-50%	200 s.f.
51-75%	300 s.f.
76-100%	400 s.f.

- Noise Compatible Planning: Base EC increased by 200 s.f. if located within municipality that has enacted noise compatible planning and development regulations



TDOT's Noise Barrier Reasonableness Criteria

October 21, 2015

Background

- **TDOT's noise policy prior to 2005**

- ✓ \$25,000 per benefited residence

- and also

- “TDOT will give greater consideration to (1) residential areas along highways on new location, (2) residential areas that were constructed before an existing highway, and (3) residential areas that have been in place along an existing highway for an extended period time. TDOT will give less consideration to residential areas that have developed along an existing highway without proper consideration of traffic noise impacts by the local community or developer.”*

- ✓ Issue: Section not being applied uniformly or at all

Background

- **2005 Noise Policy**
 - ✓ Allowance system based on the characteristics of each impacted area

Allowable Cost per Benefited Residence =

Base Allowance	\$_____
+ Development Date/New Alignment Allowance	\$_____
+ Noise Levels Allowance	\$_____
+ Build Versus Existing Noise Levels Allowance	\$_____
Total	\$_____

Reasonableness Criteria

- **2011 Noise Policy**
 - ✓ Switch to area from cost
 - ✓ Modified allowances

Allowable Area per Benefited Residence =

Base Allowance	_____	sf
+ Previous Type I Widening Allowance	_____	sf
+ Design Year Noise Levels Allowance	_____	sf
+ Noise Level Increase Allowance	_____	sf
+ Noise Compatible Planning Allowance	_____	sf
Total	_____	sf

Reasonableness Criteria

Allowance Type	Criteria	Allowance (square feet)
Base Allowance	Residences pre-date the highway ⁽¹⁾ or the project is on a new alignment.	1,500
	Residences post-date the highway ⁽²⁾ but were constructed before September 16, 2005. ⁽³⁾	750
	Residences were constructed after September 16, 2005. ⁽³⁾	250

(1) The majority (more than 50%) of impacted residences existed before the original highway construction.

(2) The majority (more than 50%) of impacted residences were constructed after the original highway construction.

(3) TDOT's previous noise policy became effective on September 16, 2005. FHWA's approval of this policy was contingent upon TDOT's completion of a public outreach program to 1) notify local jurisdictions of the changes in TDOT's new noise policy and 2) encourage them to consider noise compatible land use planning when noise-sensitive land uses are proposed adjacent to TDOT's highways. As a result, development that occurs after this date receives less consideration in the reasonableness analysis.

Reasonableness Criteria

Allowance Type	Criteria	Allowance (square feet)
Previous Type I Widening Allowance ⁽⁴⁾	Residences pre-date a Type I widening project on the adjacent highway.	200
Design Year Noise Levels Allowance ⁽⁵⁾	69 dBA or less	0
	70 – 74 dBA	100
	75 dBA or more	200

(4) The majority (more than 50%) of impacted residences existed before the most recent Type I project that added through traffic lanes.

(5) Based on an average of the impacted first-row receivers' levels (design year noise levels for Type I projects and existing noise levels for Type II projects).

Reasonableness Criteria

Allowance Type	Criteria	Allowance (square feet)
Noise Level Increase Allowance ⁽⁶⁾⁽⁷⁾	0 – 4 dB	0
	5 – 9 dB	200
	10 or more dB	400
Noise Compatible Planning Allowance	The local government of the jurisdiction in which the project will be constructed has no policies to require that noise be considered in the land development process.	0
	The local government of the jurisdiction in which the project will be constructed has adopted official and enforceable policies to require that noise be considered as an integral component of the land development process.	100

(6) An average of the increases from existing noise levels to design year noise levels for the Build Alternative at the impacted first-row receivers.

(7) Not applicable for Type II projects.

Example Application

NAA 5 (Greenwood Subdivision)		
Base Allowance	Residences constructed after SR 268 but before 2005.	750
Previous Type I Widening Allowance	SR 268 has not been widened since it was constructed.	0
Design Year Noise Levels Allowance	The average predicted sound level for first-row impacted residences is 67 dBA.	0
Noise Level Increase Allowance	The average predicted sound level increase is 4 dBA.	0
Noise Compatible Planning Allowance	Rutherford County has no official policies to require that noise be considered as an integral component of the land development process.	0
Total Allowance		750
NAA 8 (Primm Springs Subdivision)		
Base Allowance	Residences constructed after SR 268 but before 2005.	750
Previous Type I Widening Allowance	SR 268 has not been widened since it was constructed.	0
Design Year Noise Levels Allowance	The average predicted sound level for first-row impacted residences is 70 dBA.	100
Noise Level Increase Allowance	The average predicted sound level increase is 6 dBA.	200
Noise Compatible Planning Allowance	Rutherford County has no official and enforceable policies to require that noise be considered as an integral component of the land development process.	0
Total Allowance		1,050

Experience

- **Advantages**

- ✓ **Fairness**

- Uses constructed before the road receive greater consideration
 - Uses constructed adjacent to the existing road receive less consideration

- ✓ **Eliminates issues with costs**

- Estimating, updating, explaining, defending
 - Changes in costs can change barrier decisions

- ✓ **More in line with NEPA**

- **Disadvantages**

- ✓ **More analysis**

- ✓ **More difficult to explain to the public**



WFR Worksheet

WFR Worksheet

Overview

- **Documenting rational behind noise mitigation.**
- **Completed for each noise impacted area that warrants noise abatement considerations.**
- **Information obtained during Environmental Phase.**
- **Worksheets are finalized prior completion of FNAD report for FHWA approval.**
- **Worksheets become part of permanent project file; considered part of decision making document.**

WFR Worksheets

Warranted

- Does the community meet the date of Public Knowledge?
- Do noise levels approach or exceed the NAC?
- Does project cause a substantial increase in noise levels?

VDOT Highway Traffic Noise Abatement Warranted, Feasible, and Reasonable Worksheet	
Note: Not all questions apply depending on the design phase which may cause differing answers between preliminary and final design phase. Answers to the questions may change depending on the design phase of the project.	
Date:	9-Jun-14
Project No. and UPC:	UPC 76244
County:	Loudoun
District:	NOVA
Barrier System ID:	Barrier System 1
Community Name and/or CNE#	CNE B
Noise Abatement Category(s)	Barrier System 1
Design phase:	Final design
Warranted	
1 Community Documentation (if applicable)	
a. Date community was permitted. (Per 23CFR 772 this is the date the building permit was issued).	N/A
b. Date of approval for the Categorical Exclusion (CE), Record of Decision (ROD), or Finding of No Significant Impact (FONSI):	N/A
c. Does the date in 1.a precede the date in 1.b? If yes, proceed to Warranted Item 2. If no, consideration of noise abatement is not warranted. Proceed to "Decision" block and answer "no" to warranted question. As the reason for this decision, state that "Community was permitted after the date of approval of CE, ROD, or FONSI, as appropriate."	NA
2 Criteria requiring consideration of noise abatement	
a. Project causes design year noise levels to approach or exceed the Noise Abatement Criteria?	Yes
b. Project causes a substantial noise increase of 10 dB(A) or more?	No

WFR Worksheets

Feasible

Acoustical feasibility

- 5 dB(A) of noise reduction to 50% or greater of impacted receptors

Engineering feasibility

- Safety, drainage, utilities, etc.

Feasibility	
1	Impacted receptor units
a.	Number of impacted receptor units: 11
b.	Number of impacted receptor units receiving 5 dB(A) or more insertion loss (IL): 11
c.	Percentage of impacted receptor units receiving 5 dB(A) or more IL 100%
d.	Is the percentage 50 or greater? Yes
2	Will placement of the noise barrier cause engineering or safety conflicts, e.g drainage issues or site distance issues? No
3	Will placement of the noise barrier restrict access to vehicular or pedestrian travel? No
4	Will placement of the noise barrier conflict with existing utility locations? No

WFR Worksheets

Reasonable

Cost-effectiveness

- Democratic vote
- 1,600 ft² or less per benefited receptor

Design goal

- 7 decibels of noise reduction at 1 impacted receptor

View points of benefited receptors

- 50% of the benefited respondents must favor construction

Reasonableness	
1 Surface Area (Square foot)-Benefit Factors	
a. Surface Area (Total square foot) of the proposed noise barrier. (ft ²)	42,656 SF
b. Impacted noise sensitive receptor(s) receiving 5 dB(A) IL or more.	11
c. Non-impacted noise sensitive receptor(s) receiving 5 dB(A) IL or more.	50
d. Total number of benefited receptors.	61
e. Surface Area per benefited receptor unit. (ft ² /BR)	699 SF/BR
f. Is (1e) less than or equal to the maximum square feet per benefited receptor (MaxSF/BR) value of 1600?	Yes
g. Does the barrier provide an IL of at least 7 dB(A) for at least one impacted receptor in the design year?	Yes
2 Additional Noise Barrier Details	
a. Length of the proposed noise barrier. (ft)	3,280 ft
b. Height range of the proposed noise barrier. (ft)	13-13 ft
c. Average height of the proposed noise barrier. (ft)	13 ft
d. Cost per square foot. (\$/ft ²)	\$48.5
e. Total Barrier Cost (\$)	\$2,068,816
f. Barrier Material	
3 Community Desires Related to the Barrier	
Do at least 50 percent of the benefited receptor unit owner(s) and renters desire the noise barrier? If yes, continue to "decision" block. If no, the barrier can be considered not to be reasonable. Proceed to "decision" block and answer "no" to reasonableness question. As the reason for this decision, state that "The majority of the impacted receptor unit owners do not desire the barrier."	
	Yes

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WFR Worksheets

Other

Additional Noise Barrier Details

- Length
- Height, Height Range
- Cost (Unit Cost, Total Cost)
- Barrier Material (Reflective, Absorptive)





Policy Changes

Georgia DOT
Amber Phillips

Main Areas of Change

- Clarification on Reasonable Reduction Goal
 - When designing a wall or earth berm the design should begin with a wall/berm that would reduce noise levels by 7 dB(A). Every attempt will be made to design a feasible and cost reasonable wall that reduces as many impacted receptors by 7dB(A) as possible
- Discussion of Design Build
 - Added in additional details about the procedures and the timing of updates, public outreach, and construction activities.

Main Areas of Change

- Updated cost estimates based on actual costs over the past 5 years
 - Updated from \$20 to \$25 dollars per square foot
 - No change to \$55,000 per benefited receptor (data shows that over the past 5 years, we spent approximately \$33,000 on average per benefited receptor)
- Building Permits
 - No state Laws; therefore, we had to address building permits. Once a permit is pulled, it is the expectation that construction would begin shortly; however, to allow for short delays (where local laws/regulations allow) permits will be considered up to 3 years. Permits older than
 - 3 years, will not be considered current.
- Detailed Methodology for Determining Noise Wall Treatments
 - In Georgia, prior to 2011, we constructed mainly metal walls. After 2011, we changed to textured concrete such as ashlar. We were asked to come up with a standard approach to be consistent from project to project.

Conclusions

- More detailed examples were provided in the policy to lower the risk of differing interpretations.
- Clearer guidance on Feasible and Reasonable Goals, reduces noise wall modeling differences
- A discussion of Design Build projects, helps explain the process approach prior to LET



Session 4 - Questions

Waldman, CO (1 of 2):

- ▶ If alternative noise abatement measures are used, per 772.15(c)(2) to (5), how is cost effectiveness determined?
- ▶ Are different cost allowances used for particular geographic area(s) within the state?; 772.13(d)(2)(ii)
- ▶ What cost benefit index do you use (e.g., cost/benefited receptor or cost/benefited receptor/dB(A))?; 772.13(d)(2)(ii)
- ▶ Do you have more than one noise barrier unit cost (e.g., \$45 per square foot)? If yes, what are they and what do they depend on?; 772.13(d)(2)(ii)



Session 4 - Questions

Waldman, CO (2 of 2):

- ▶ What value is used in your definition of “noise reduction design goal”?; 772.13(d)(2)(iii)
- ▶ How many benefited receptors must achieve the noise reduction design goal in order to be deemed reasonable?; 772.13(d)(2)(iii)
- ▶ Do you consider optional reasonableness factors (e.g., date of development)? If yes, which one(s)?; 772.13(d)(2)(v)
- ▶ What is your threshold for the noise reduction which determines a benefited receptor?; 772.13(e)



Session 4 - Questions

- ▶ Runkle, IL: In IL, feasibility criterion is 5 dB(A) reduction for at least 1 impacted receptor. Does any state require a reduction for at least 2 impacted receptors?
- ▶ Polcak, MD: Maryland has developed a procedure called a “site constraint assessment” to quantify and account for extra cost items (not related to the parent Type I project) that may be required to specifically facilitate construction of a noise barrier. (a separate document will be provided.)



Session 4 - Questions

- ▶ Moch, ND: How is inflation accounted for in cost analysis?
- ▶ Evans, NH: Discussion on the advantages and disadvantages of a cost based effectiveness criteria versus an area based effectiveness criteria.
- ▶ Umscheid, TX: For states that have taken advantage of the Statement of Likelihood to reverse a decision based on engineering feasibility, what engineering thresholds were determined too high; i.e. was this based on a list of certain items that are determined “too hard” or “impossible to build” or was there a further analysis of costs?



Session 4 - Questions

- ▶ Berrios, FL: What are other states doing? Methods used to calculate cost reasonableness.
- ▶ Shellenberger, PA: What satisfies the 772 requirement to reevaluate reasonableness criteria on a periodic basis. Does FHWA need to be involved?
- ▶ Newvine, OR:
 - ▶ Consider wall impacts to 1st row residents not eligible to vote.
 - ▶ How are states moving ahead with feasible/reasonable abatement when total costs not known?



Session 4 - Questions

- ▶ What to use for unit costs for barriers? Actual vs. “policy” costs? Which costs to consider (e.g., on structure, on retaining wall, absorption, transparency aesthetics, safety, drainage, utilities, guardrail concrete safety barrier, clearing, maintenance of traffic, erosion control, etc.)
- ▶ Should criteria be based on impacted receptors instead of benefited receptors?