SOAH DOCKET NO. 473-10-4398
PUC DOCKET NO. 38230

APPLICATION OF LONE STAR TRANS-MISSION, LLC FOR A CERTIFICATE OF CONVENIENCE AND NECESSITY FOR THE CENTRAL A TO CENTRAL C TO SAM SWITCH/NAVARRO PRO-POSED CREZ TRANSMISSION LINE	§ § § § § §	**BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS**

CROSS-REBUTTAL TESTIMONY

OF

MARK LAUTENSCHLAGER

FOR

BOSQUE PROPERTY OWNERS

August 31, 2010

1434

CROSS-REBUTTAL TESTIMONY OF MARK LAUTENSCHLAGER

Q. Please state your name and business address.

A. My name is Mark Lautenschlager, and my address is 819 Chipaway Dr, Apollo Beach, Florida.

Q. In what capacity are you testifying and what is the purpose of your testimony?

A. I am testifying as a professional engineer with experience in reviewing transmission line design and analyzing all other electric utility technical practices. I have been retained by the Concerned Southern Bosque County Property Owners Association ("Bosque Property Owners") to evaluate and respond to the direct testimony of Harold L. Hughes, Jr., filed on behalf of Yellowbird Ranch.

Q. Please describe your academic qualifications and professional experience as they relate to your testimony.

A. I received a bachelor of science degree in electrical engineering from Tri-State University, Angola, Indiana. I am a licensed professional engineer (PE) in Florida, Indiana, and Pennsylvania.

I prepared the route selection analysis for the testimony of Dr. Robert Romancheck and rebuttal testimony in a recent case at the Commission, the Riley-Krum West 345-kV CREZ Line (Docket No. 38140). In 2004, I was part of a team that conducted a justification study of three transmission lines for the Kentucky Public Service Commission. The work included verifications of appropriate use of electrical studies, considerations for alternatives routes, and the methods used for public input.

I am experienced in reviewing transmission line design, as well as analyzing all other electric utility technical practices. Much of my time during the past 10 years has been spent conducting technical audits of electric utility practices for utility management and for public utility regulators. The methods used for selecting transmission routes are similar to those I use for conducting utility audits, in that both involve applying benefit analyses to determine the best overall solutions.

I conducted technical audits at ComEd in Chicago, Ameren-Illinois, Alabama Power, Georgia Power, Potomac Electric, Northwestern Energy, Central Maine Power, Bangor Power, Cap Rock Energy, and Nova Scotia Power. My auditing work involved delving into the way the utilities plan, design, specify, operate, and maintain the reliability of their transmission, substation, and distribution systems. I also review their practices and recommended improvements. I also prepare detailed practical and analytical evaluations of the utilities' practices. I identify inadequacies, and recommend solutions. Following the 2003 Northeast Blackout, I directed a transmission system adequacy study at ComEd for the Illinois Commerce Commission. In 2006, I conducted root-cause analyses of five $10,000,000 cable-fault caused substation fires at ComEd, which had resulted in massive sustained customer outages. My recommendations were implemented and subsequent cable faults have not resulted in outages or damage.

Early in my career, I was a substation and relay engineer for American Electric Power Corporation. Subsequently, I was the field design, construction, and commissioning engineer for four 400kV substations and transmission lines in the country of Iran for Harza Engineering (now MWH). I then worked 20 years for the High Voltage Maintenance Corporation as Senior Vice President, Engineering and Operations. I have been a consultant for the last 10 years.

My qualifications are set out more fully in my resume, which is provided as Attachment ML-1 to this testimony.

Q. What is the purpose of Mr. Hughes's testimony?

A. Mr. Hughes compared his recommended Route 249 with Lone Star's preferred Route 14. Using selected route criteria, he concluded that Route 249 better meets the commission's routing guidelines.

Q. Do you agree with Mr. Hughes's conclusion?

A. No, I do not. Mr. Hughes used only criteria that are favorable to the selection of Route 249. The effect of his choice of criteria can be demonstrated by replicating his analysis, with three important route criteria that he ignored:

(1) Length through threatened and endangered species habitat.
(2) Length along transmission lines.
(3) Length across crop land.

I first replicate Mr. Hughes's analysis using the data that was available to him from Lone Star's application and applying each criterion in turn, as he did. I then evaluate the routes by simultaneously considering all meaningful criteria.

Q. Which route is preferable on the basis of the length through threatened and endangered species habitat?

A. For this criterion, Lone Star's Route 14 is preferred over Hughes's Route 249 because much less of Route CSS14 passes through threatened and endangered species habitats. But because Routes 230, 264, and 246 pass through no habitat (as measured by Lone Star), they are preferable to either Route 14 or 249.

Table 1: Miles of Routes through Threatened and Endangered Species Habitats

Maximum Length Routes CSS 101, 183 & 200	*Hughes's Recommended Route CSS 249*	*Lone Star Preferred Route CSS 14*	*Minimum Length Routes CSS 230, 264 & 246*
12	4.7	1.5	0

Q. How do the routes compare on the basis of the length along transmission lines?

A. For this criterion, Lone Star's Route 14 is better than Hughes's Route 249 because substantially more of Route 14 parallels existing transmission line right-of-way. Based on my experience, this is an important criterion because routing near existing transmission line right-of-ways reduces the impact of a new line on community values and aesthetics.

Table 2: Miles of Routes Parallel with Existing Transmission Lines

Maximum Length Route CSS 97	*Hughes's Recommended Route CSS 249*	*Lone Star Preferred Route CSS 14*	*Minimum Length Route CSS 228*
44.2	14.2	26	8.3

Q. What route is preferable on the basis of length across crop land?

A. For this criterion, the preferred route, 14, is preferable to Hughes's Route 249, because much less of Route 14 passes through crop land. Minimizing length across cropland is an important criterion for selecting the route because transmission poles placed within crop fields can substantially interfere with efficient crop production.

Table 3: Miles of Routes Across Crop Land

Maximum Length Route CSS 230	*Hughes' Recom-mended Route CSS 249*	*Lone Star Pre-ferred Route CSS 14*	*Shortest Length Route CSS 14*
49.3	47.3	30	30

Q. If Mr. Hughes had considered these three criteria, which routes would his analysis indicate as the best routes?

A. My findings indicate Mr. Hughes's analysis would not have led him to conclude that Route 249 is better than Route 14. His analysis led him to that conclusion because he used only criteria favorable to that route. As a result, considering other criteria dramatically changes the conclusion drawn from his method of evaluating the routes.

Q. If Mr. Hughes had considered all of the criteria, would he have reached a different conclusion about which route is best?

A. Yes. Instead of stepping through the comparisons one criterion at a time, I conducted a weighted-deviation-from-mean analysis for 10 of the routes that enables me to consider all the criteria simultaneously. I eliminated Route 16 because it passes the most habitable structures, and I eliminated Routes 101, 183, and 200 because they each pass through 12 miles of threatened and endangered species habitats.

In addition, it was unnecessary to include two criteria in the analysis. None of the routes paralleled railroads or were near AM radio towers. I eliminated "length along corridors" because it is the total of the lengths of the individual types of corridors, which are already included.

In direct testimony offered on behalf of Chalk Mountain Community Alliance, LLC, Tom Van Zandt analyzes all of the available data using a similar technique. Our methods are similar except for the choice of the statistical metric. Both of us conclude that Route 246 is the clear choice as the superior route.

Q. How does a weighted-deviation-from-mean analysis appropriately balance the criteria set out in Lone Star's application?

A. This method of analysis simultaneously addresses multiple independent criteria and takes into account differences in the scale of the values used to measure the criteria. Cost measured in millions of dollars can be meaningfully compared with tens of habitable structures. The routes are then ranked according to the overall impact of each route.

The criteria were grouped by areas of concern as defined by the commission. Within each group, the criteria were weighed as low, medium, or high impact, and each group is weighed against each other. The final ranking is based on the sum of the weighted differences within each group and the groups together. This weighted-sum metric allows us to rank the overall impact of each route on the landowners, environment, and community values.

Q. In your opinion, what route would Mr. Hughes's route comparisons have supported had he properly considered all the criteria?

When all the meaningful criteria are included in the analysis, Route 246 has the least overall impact on the landowners, the environment, and community values. Table 4 displays the ranking of the routes, taking all meaningful criteria into consideration simultaneously.

Table 4: Ranking of 10 Routes Considering All Criteria

Ranking	*Route*	*Rating*
1	CSS 246	2.952
2	CSS 264	2.618
3	CSS 249	2.560
4	CSS 229	2.077
5	CSS 228	1.045
6	CSS 230	0.161
7	CSS 97	-0.960
8	CSS 33	-3.258
9	CSS 14	-3.330
10	CSS 1	-3.651

My conclusion is that Route 246 best meets the commission's guidelines and should be selected as the superior route for the transmission line in this case.

Q. Does this conclude your testimony?

A. Yes.

Curriculum Vitae
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Education and Professional Registrations

- Attended the Rose Poly Institute of Technology (now Rose-Hulman) in Terre Haute, Indiana, from August 1965 to June 1966, and transferred to Tri-State College (now Trine University) in Angola, Indiana, in January 1967. Graduated in December 1969 from Tri-State College with a Bachelor of Science degree in Electrical Engineering.

- Registered professional engineer in Indiana, Florida, and Pennsylvania.
  Indiana No. PE10606492, Florida No. 65822, Pennsylvania No. PE-043993-R

Work History

- Before and during college, worked summers and holidays on power line and substation construction crews for contractors in Indiana and Illinois, and as a junior distribution engineer for the Northern Indiana Public Service Company (NIPSCO) in Angola, Indiana.

- Upon graduation, worked 5 years (December 1969 to April 1975) for the Indiana Michigan Electric (now Power) Company (part of American Electrical Power) as a substation testing engineer and as a senior relay engineer in Marion, Indiana. Led inspection, testing, maintenance, and commissioning of substation equipment, relays, and controls for equipment rated from 12000-volts to 765000-volts. Conducted distribution and transmission relay setting calculations and evaluated electrical and oil testing results. Led the assembly, vacuum-filling, and commissioning and repair of large power transformers.

- Worked 3 years (April 1975 to May 1978) for the Harza Engineering Company (now MWH Engineering) as the on-site design, construction, and commissioning engineer for a large transmission line and substation project located in the country of Iran. Conducted final electrical, relaying, and control design work, supervised the construction of the substations and the installation of equipment, tested all electrical equipment, and commissioned the four main Iranian transmission-grid 400000-volt/230000-volt substations and transmission lines for the Iranian Power Company. Conducted electrical short-circuit impedance and relay setting calculations and instructed Iranian power company employees how to operate and maintain the substations.

- Worked 20 years (May 1978 to August 1998) for the High Voltage Maintenance Corporation (HVM) as the Indiana division engineer (1978-1984), as the manager for the Dayton, Indiana, Michigan, and Missouri divisions, and as the corporate senior vice-president of engineering (1984-1998). HVM became an Emerson Electric company in 1996. He also was the OSHA, EPA, and QC compliance officer. Led the installation, maintenance, and testing of industrial, hospital, government, and electric utility electrical power equipment, primarily in Indiana, Ohio, Michigan, Illinois, and Missouri. Trained electrical testing engineers and technicians for the High Voltage Maintenance Corporation, the International Electrical Testing Association, and the AVO training institute. While at HVM, he conducted forensic investigations of two electrocutions, and several transformer and switchgear failures. Led the commissioning of electrical power equipment installations, including the controls and relaying for a nuclear power plant switchyard for the Consumer Power Company in Michigan. Led the assembly and commissioning of large power transformers and specified, operated, and trained others in operating transformer vacuum-oil filling rigs. He provided technical and safety guidance for HVM's engineers and technicians. Led the maintenance, testing, rebuilding, SF6 gas recovery and refilling, and testing of High voltage SF6 circuit breakers at a power plant in Illinois, including the utilization of SF6 gas leak detection methods and determining methods for repairing SF6 gas leaks. Designed control and relay circuits, specified electrical power equipment for clients and testing equipment for HVM, and he conducted short-circuit and relay setting studies for clients. Evaluated testing results, advised clients, and prepared formal equipment condition reports for clients. Developed generic electrical power equipment pre-energizing and energizing checklists for HVM's use when it was contracted to act a commissioning agent for new electrical equipment installations. Contributed to the development of a new method for reducing harmonics, which reduce energy costs, on industrial power systems.

- Mr. Lautenschlager left HVM in August of 1998 and started Electrical Risk Consultants (ERC International, Inc.) of Apollo Beach, Florida, in January 1999. He has been working (1999-2006, 2007-present) as a senior electrical power and electrical utility consultant. He conducted electrical power equipment testing and maintenance seminars for testing company engineers and technicians, for the Center for Professional Advancement in New Jersey, and for the TUV Akademie Middle East Training Company in the country of Abu Dhabi. He developed substation testing and maintenance programs for an Alcoa Aluminum plant in Evansville, Indiana.

He was subcontracted part-time by ERC to the Liberty Consulting Group from 2000 to present as a senior consultant (about ½ of available time). For Liberty, he audited and evaluated distribution and transmission systems, and transmission and distribution substations, maintenance and reliability programs and performances, and investigated and conducted root-cause analyses for large electrical power outages and substation equipment failures occurring in Illinois and Nova Scotia. He also investigated the operations, maintenance, engineering, and reliability practices of Commonwealth Edison Energy (ComEd in Chicago), Nova Scotia Power, Ameren-Illinois Electric Company, Georgia Power, Alabama Power, Northwestern Energy (Montana), Central Maine Power Company, Bangor Maine Power Company, and for Cap Rock Energy in Texas. The Liberty reports on the ComEd and Ameren investigations and conclusions can be found on the Illinois Commerce Commission internet web site. In 2004, I was part of a team that conducted a justification study of three 345kV transmission lines for the Kentucky Public Service Commission. The work included verifications of appropriate use of electrical studies, considerations for alternatives routes, and the methods used for public input.

- Provided consulting evaluations of a large transformer failure at a nuclear power plant in Florida. He continues to provide part-time consulting services for the Liberty Consulting Group for follow up of the Ameren-Illinois investigation.

- Mr. Lautenschlager worked 9 months (November 2006-August 2007) full-time as senior consultant with the Rimkus Consulting Group in Tampa, and then part-time from August 2007 to present. He has conducted about 80 electrical forensic investigations for Rimkus. Although he prepared verbal and written expert reports for the Rimkus and Liberty investigations.

- Mr. Lautenschlager is also currently conducting test technician training seminars for NETA testing companies and at the 2010 NETA Power Test Conference, as well as continuing on-going evaluations of Ameren reliability and maintenance programs.

- In 2010, he is also working for Kevin Kennedy Associates preparing Transmission Route Selection Testimony.

Professional Organizations and Professional Recognitions

- Mr. Lautenschlager was a member of the International Electrical Testing Association (NETA) board of directors from 2005 to 2008, president of NETA for 2007 and 2008, and he was a member of the NETA technical standards committee from 2004 through 1998. In 2000, he led the NETA review committee for the acceptance of the NETA transformer acceptance testing standards by the Ameren National Standards Institute (ANSI). He was the NETA annual technical conference papers chairperson from 1993 through 1997.
- He was the NETA Man of the Year in 1995 and awarded lifetime NETA affiliate membership.
- He is a member of the Institute of Electrical and Electronics Engineers (IEEE).

Published Articles Included
In miscellaneous magazines

- Electrical Construction and Maintenance magazine, June, 1980, “A discussion of current transformer testing”

- Electrical Construction and Maintenance magazine, August, 1981, "Testing protective relay circuits"
- Pulp & Paper magazine, December 1982 "Transformer maintenance and testing guide"
- Facilities Management Operations and Engineering magazine, January, 1985. "Preventive maintenance and testing of electrical systems"

In NETA World magazine

Spring 1994, "Measuring turns ratios involving WYE windings with inaccessible neutrals"

- Summer 1994, "Understanding negative power factors"
- Fall 1994, "Can water enter a nitrogen-blanketed transformer under pressure?"
- Summer 1995, "What to do when two buses are 60-degrees out of phase"
- Fall 1995, "Protect transformers with surge protectors"
- Winter 1995, "Purpose of transformer nitrogen blankets and conservators"
- Summer 1996, "Power-factor problems"
- Fall 1996, "Transformer overheating due to improperly adjusted SCR drives"
- Winter 1996, "Reducing short-circuit problems"
- Summer 1997, "Keep water and air out of transformers"
- Fall 1997, "Ferro-resonance can cause transformers to fail"
- Winter 1997, "Protect transformers with surge protectors"
- Spring 1998, "Transformer differential protection tips"
- Summer 1998, "Don't sample Askeral"
- Fall 1998, "Corona, Is there anything good about it?"
- Winter 1998, "Transformer degassing to remove combustible gases"
- Spring 1999, "Rules for removing water from transformers"
- Fall 1999, "Analyses of transformer failures"
- Winter 1999, "The mystery of transformers"
- Spring 2000, "Guidelines for selecting no-load taps on power transformers"
- Summer 2000, "A guide for paralleling electrical systems"
- Winter 2000, "Transformer failure data"
- Summer 2008, "A guide to paralleling electrical systems," Reprint
- Spring 2010, "Using Root-Cause Analysis to find underlying causes of bad situations"

Table A: Raw Data from Lone Star

Metric / Route	CSS1	CSS14	CSS33	CSS230	CSS246	CSS264	CSS97	CSS228	CSS229	CSS249	mean
1 **A. Total Length**	185.3	187.2	191.7	185.5	179.6	186.1	197.6	192.8	193.6	184	188.3
B. Length Parallel with Existing ROWs											
2 Length along transmission lines	26	26	32.6	11.7	37.9	43.5	44.2	8.2	9.3	14.2	25.4
3 Length along roads/hwys	6.5	9.2	11.3	15.1	14.4	9.1	22.5	22.1	21.9	25.9	15.8
4 Length along pipelines	40.3	40.3	40.3	93.6	67.3	59.7	15.4	50.7	50.7	58.3	51.7
5 Length along railroads	0	0	0	0	0	0	0	0	0	0	0
7 Total length along corridors	113.7	116.5	121.8	146.8	144.7	140.4	137.8	135	134	138.6	132.9
C. Length Parallel with Property Lines											
6 Length along property boundaries	49.8	52.7	50.9	41.5	42.1	42.6	83.5	76.7	74.6	67.8	58.2
11 Length across rangeland	94.6	101	104.4	97.6	94.6	104.7	94.8	101.3	104	90.7	98.8
12 Length across cropland	30.6	30	31.5	49.3	42.8	32.3	38.9	37.8	36.7	47.3	37.7
13 Length across mobile irrigation systems	0	0	0	0.5	0.5	0.5	0.3	0.5	0.8	0.5	0.4
D. Prudent Avoidance											
8 Habitable structures w/in 500'	84	85	93	107	103	100	126	124	106	112	104
E. Receation and Park Area											
9 Length across park/rec areas	0.8	0.8	0.8	0.8	0.5	0.3	0	0	0	0	0.4
10 Park/rec areas w/in 1,000'	0	0	0	0	1	1	1	0	0	1	0.4
33 Foreground visual zone of park/rec. areas	3.4	3.4	3.4	3.4	11.6	9.1	1	0	0	1	3.6
F. Historical and Aestethic Values											
28 Length across open water	0.5	0.5	0.7	1	1.2	1.1	0.7	0.6	0.6	0.7	0.8
34 Foreground visual zone of highways	19.3	19.4	24.6	27.5	18.7	22.3	18.4	21	21.4	17.4	21
21 # cultural resource sites crossed	6	6	6	1	0	2	8	4	3	0	3.6
22 # cultural resource sites w/in 1,000'	10	8	8	1	2	4	7	4	3	1	4.8
23 Length through HPA's	34.1	32	31.9	22.2	19.7	20.1	27.3	21.2	19.6	20.7	24.9
31 U.S or state highways crossed	19	19	19	20	14	14	16	14	14	14	16.3
32 Other public road crossings	101	99	102	126	119	106	116	105	103	121	109.8
G. Environmental Integrity											
14 Length across upland woodland	55	51.1	50.7	31.7	36.1	44.2	59.5	49.1	48.3	40.6	46.6
15 Length across bottomland forest	1.9	1.7	1.6	2	1.9	1.5	1.6	1.4	1.3	1.7	1.7
16 Length across emergent wetlands	2	2.1	2	2.7	1.8	1.2	1.4	1.3	1.3	2.1	1.8
17 Number of streams crossed	366	353	357	298	293	326	357	317	306	279	325.2
18 Length parallel to streams w/in 100'	8.6	7.6	7.5	6	6.8	7.3	9.2	7.1	6.3	6.7	7.3
19 Rare/unique plant locations in ROW	2	2	2	2	0	0	0	0	0	0	0.8
20 Length thru T&E species habitat	1.5	1.5	1.5	0	0	0	4.7	5.8	4.7	4.7	2.4
H. Airstrips and Towers											
24 # FAA-reg airstrips w/in 20,000' (>3200')	6	6	6	4	3	3	4	2	2	2	3.8
25 # FAA-reg airstrips w/in 20,000' (<3200')	2	2	2	0	2	2	5	2	3	2	2.2
26 # private airstrips w/in 10,000'	3	3	3	1	1	1	2	1	1	1	1.7
27 # heliports w/in 5,000'	1	3	3	0	0	0	1	0	0	0	0.8
29 # AM towers w/in 10,000'	0	0	0	0	0	0	0	0	0	0	0
30 # FM/other towers w/in 2,000'	3	3	4	6	6	7	5	5	5	6	5

Note: The criteria and metrics are grouped by categories suggested by the PURA § 37.056(c) and (c)(4) plus route length and airstrips and radio towers. Estimated costs are not included, because the deviations were very small and the cost model is fairly rough at this stage since the line has not been sited.

Table B: Difference of Means With Weighting

Metric	CSS1	CSS14	CSS33	CSS230	CSS246	CSS264	CSS97	CSS228	CSS229	CSS249	mean	more is	wt
A. Total Length	1.6%	0.6%	-1.8%	1.5%	4.6%	1.2%	-4.9%	-2.4%	-2.8%	2.3%			1.00
weighted sum	1.6%	0.6%	-1.8%	1.5%	4.6%	1.2%	-4.9%	-2.4%	-2.8%	2.3%			
1 Total Length	-1.6%	-0.6%	1.8%	-1.5%	-4.6%	-1.2%	4.9%	2.4%	2.8%	-2.3%	188.3	neg	high
B. Length Parallel with Existing ROWs	-78.5%	-61.5%	-22.2%	22.7%	70.5%	44.3%	46.2%	-29.8%	-26.7%	32.6%			1.00
weighted sum	-78.5%	-61.5%	-22.2%	22.7%	70.5%	44.3%	46.2%	-29.8%	-26.7%	32.6%			
2 Length along transmission lines	2.4%	2.4%	28.3%	-53.9%	49.2%	71.3%	74.0%	-67.7%	-63.4%	-44.1%	25.4	pos	high
3 Length along roads/hwys	-58.9%	-41.8%	-28.5%	-4.4%	-8.9%	-42.4%	42.4%	39.9%	38.6%	63.9%	15.8	pos	high
4 Length along pipelines	-22.1%	-22.1%	-22.1%	81.0%	30.2%	15.5%	-70.2%	-1.9%	-1.9%	12.8%	51.7	pos	high
C. Length Parallel with Property Lines	15.5%	20.4%	12.5%	-61.7%	-42.6%	-16.5%	43.8%	28.4%	19.5%	-9.4%			1.00
weighted sum	15.5%	20.4%	12.5%	-61.7%	-42.6%	-16.5%	43.8%	28.4%	19.5%	-9.4%			
6 Length along property boundaries	-14.4%	-9.5%	-12.5%	-28.7%	-27.7%	-26.8%	43.5%	31.8%	28.2%	16.5%	58.2	pos	high
11 Length across rangeland	-4.3%	2.2%	5.7%	-1.2%	-4.3%	6.0%	-4.0%	2.5%	5.3%	-8.2%	98.8	neg	low
12 Length across cropland	-18.8%	-20.4%	-16.4%	30.8%	13.5%	-14.3%	3.2%	0.3%	-2.7%	25.5%	37.7	neg	high
13 Length across mobile irrigation systems	-100.0%	-100.0%	-100.0%	25.0%	25.0%	25.0%	-25.0%	25.0%	100.0%	25.0%	0.4	neg	very low
D. Prudent Avoidance	19.2%	18.3%	10.6%	-2.9%	1.0%	3.8%	-21.2%	-19.2%	-1.9%	-7.7%			1.00
weighted sum	19.2%	18.3%	10.6%	-2.9%	1.0%	3.8%	-21.2%	-19.2%	-1.9%	-7.7%			
8 Habitable structures w/in 500'	-19.2%	-18.3%	-10.6%	2.9%	-1.0%	-3.8%	21.2%	19.2%	1.9%	7.7%	104	neg	high
E. Receation and Park Area	-23.6%	-23.6%	-23.6%	-23.6%	-105.6%	-63.2%	30.6%	100.0%	100.0%	30.6%			1.00
weighted sum	-23.6%	-23.6%	-23.6%	-23.6%	-105.6%	-63.2%	30.6%	100.0%	100.0%	30.6%			
9 Length across park/rec areas	100.0%	100.0%	100.0%	100.0%	25.0%	-25.0%	-100.0%	-100.0%	-100.0%	-100.0%	0.4	neg	med
10 Park/rec areas w/in 1,000'	-100.0%	-100.0%	-100.0%	-100.0%	150.0%	150.0%	150.0%	-100.0%	-100.0%	150.0%	0.4	neg	low
33 Foreground visual zone of park/rec. areas	-5.6%	-5.6%	-5.6%	-5.6%	222.2%	152.8%	-72.2%	-100.0%	-100.0%	-72.2%	3.6	neg	low
F. Historical and Aestethic Values	-120.7%	-95.3%	-114.5%	87.6%	118.8%	46.5%	-141.6%	21.8%	63.2%	159.5%			1.00
weighted sum	-120.7%	-95.3%	-114.5%	87.6%	118.8%	46.5%	-141.6%	21.8%	63.2%	159.5%			
28 Length across open water	-37.5%	-37.5%	-12.5%	25.0%	50.0%	37.5%	-12.5%	-25.0%	-25.0%	-12.5%	0.8	neg	med
34 Foreground visual zone of highways	-8.1%	-7.6%	17.1%	31.0%	-11.0%	6.2%	-12.4%	0.0%	1.9%	-17.1%	21	neg	low
21 # cultural resource sites crossed	66.7%	66.7%	66.7%	-72.2%	-100.0%	-44.4%	122.2%	11.1%	-16.7%	-100.0%	3.6	neg	high
22 # cultural resource sites w/in 1,000'	108.3%	66.7%	66.7%	-79.2%	-58.3%	-16.7%	45.8%	-16.7%	-37.5%	-79.2%	4.8	neg	med
23 Length through HPA's	36.9%	28.5%	28.1%	-10.8%	-20.9%	-19.3%	9.6%	-14.9%	-21.3%	-16.9%	24.9	neg	med
31 U.S. or state highways crossed	16.6%	16.6%	16.6%	22.7%	-14.1%	-14.1%	-1.8%	-14.1%	-14.1%	-14.1%	16.3	neg	low
32 Other public road crossings	-8.0%	-9.8%	-7.1%	14.8%	8.4%	-3.5%	5.6%	-4.4%	-6.2%	10.2%	109.8	neg	low
G. Environmental Integrity	-154.2%	-136.8%	-131.6%	-34.4%	228.0%	224.6%	-28.8%	-26.1%	30.1%	19.9%			1.00
weighted sum	-154.2%	-136.8%	-131.6%	-34.4%	228.0%	224.6%	-28.8%	-26.1%	30.1%	19.9%			
14 Length across upland woodland	18.0%	9.7%	8.8%	-32.0%	-22.5%	-5.2%	27.7%	5.4%	3.6%	-12.9%	46.6	neg	high
15 Length across bottomland forest	11.8%	0.0%	-5.9%	17.6%	11.8%	-11.8%	-5.9%	-17.6%	-23.5%	0.0%	1.7	neg	low
16 Length across emergent wetlands	11.1%	16.7%	11.1%	50.0%	0.0%	-33.3%	-22.2%	-27.8%	-27.8%	16.7%	1.8	neg	med
17 Number of streams crossed	12.5%	8.5%	9.8%	-8.4%	-9.9%	0.2%	9.8%	-2.5%	-5.9%	-14.2%	325.2	neg	med
18 Length parallel to streams w/in 100'	17.8%	4.1%	2.7%	-17.8%	-6.8%	0.0%	26.0%	-2.7%	-13.7%	-8.2%	7.3	neg	med
19 Rare/unique plant locations in ROW	150.0%	150.0%	150.0%	150.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	0.8	neg	high
20 Length thru T&E species habitat	-37.5%	-37.5%	-37.5%	-100.0%	-100.0%	-100.0%	95.8%	141.7%	95.8%	95.8%	2.4	neg	high
H. Airstrips and Towers	-23.5%	-54.8%	-56.0%	27.6%	22.8%	21.5%	-22.6%	30.6%	24.9%	29.4%			0.25
weighted sum	-94.1%	-219.1%	-224.1%	110.3%	91.2%	86.2%	-90.2%	122.5%	99.8%	117.5%			
24 # FAA-reg airstrips w/in 20,000' (>3200')	57.9%	57.9%	57.9%	5.3%	-21.1%	-21.1%	5.3%	-47.4%	-47.4%	-47.4%	3.8	neg	high
25 # FAA-reg airstrips w/in 20,000' (<3200')	-9.1%	-9.1%	-9.1%	-100.0%	-9.1%	-9.1%	127.3%	-9.1%	36.4%	-9.1%	2.2	neg	med
26 # private airstrips w/in 10,000'	76.5%	76.5%	76.5%	-41.2%	-41.2%	-41.2%	17.6%	-41.2%	-41.2%	-41.2%	1.7	neg	med
27 # heliports w/in 5,000'	25.0%	275.0%	275.0%	-100.0%	-100.0%	-100.0%	25.0%	-100.0%	-100.0%	-100.0%	0.8	neg	med
30 # FM/other towers w/in 2,000'	-40.0%	-40.0%	-20.0%	20.0%	20.0%	40.0%	0.0%	0.0%	0.0%	20.0%	5	neg	low

Note: The percent deviations-from-mean (arithmetic average of metrics) are indicated. Each criterion is weighted from high (100%), Medium (50%), Low (25%), to very low (10%). Low and very low weights are given to low impact criteria where the percent deviation-from-mean is high. All categories are weighted 100%, except for route length (50%) and airstrips and towers (25%).

Table C: Weighted-Sum Metrics

Metric	CSS1	CSS14	CSS33	CSS230	CSS246	CSS264	CSS97	CSS228	CSS229	CSS249
Weighted sum by route =	**-3.643**	**-3.327**	**-3.267**	**0.169**	**2.975**	**2.624**	**-0.985**	**1.033**	**2.063**	**2.572**
Weighted sum by category =										
A. Total Length	0.016	0.006	-0.018	0.015	0.046	0.012	-0.049	-0.024	-0.028	0.023
B. Length Parallel with Existing ROWs	-0.785	-0.615	-0.222	0.227	0.705	0.443	0.462	-0.298	-0.267	0.326
C. Length Parallel with Property Lines	0.155	0.204	0.125	-0.617	-0.426	-0.165	0.438	0.284	0.195	-0.094
D. Prudent Avoidance	0.192	0.183	0.106	-0.029	0.010	0.038	-0.212	-0.192	-0.019	-0.077
E. Receation and Park Area	-0.236	-0.236	-0.236	-0.236	-1.056	-0.632	0.306	1.000	1.000	0.306
F. Historical and Aestethic Values	-1.207	-0.953	-1.145	0.876	1.188	0.465	-1.416	0.218	0.632	1.595
G. Environmental Integrity	-1.542	-1.368	-1.316	-0.344	2.280	2.246	-0.288	-0.261	0.301	0.199
H. Airstrips and Towers	-0.235	-0.548	-0.560	0.276	0.228	0.215	-0.226	0.306	0.249	0.294