

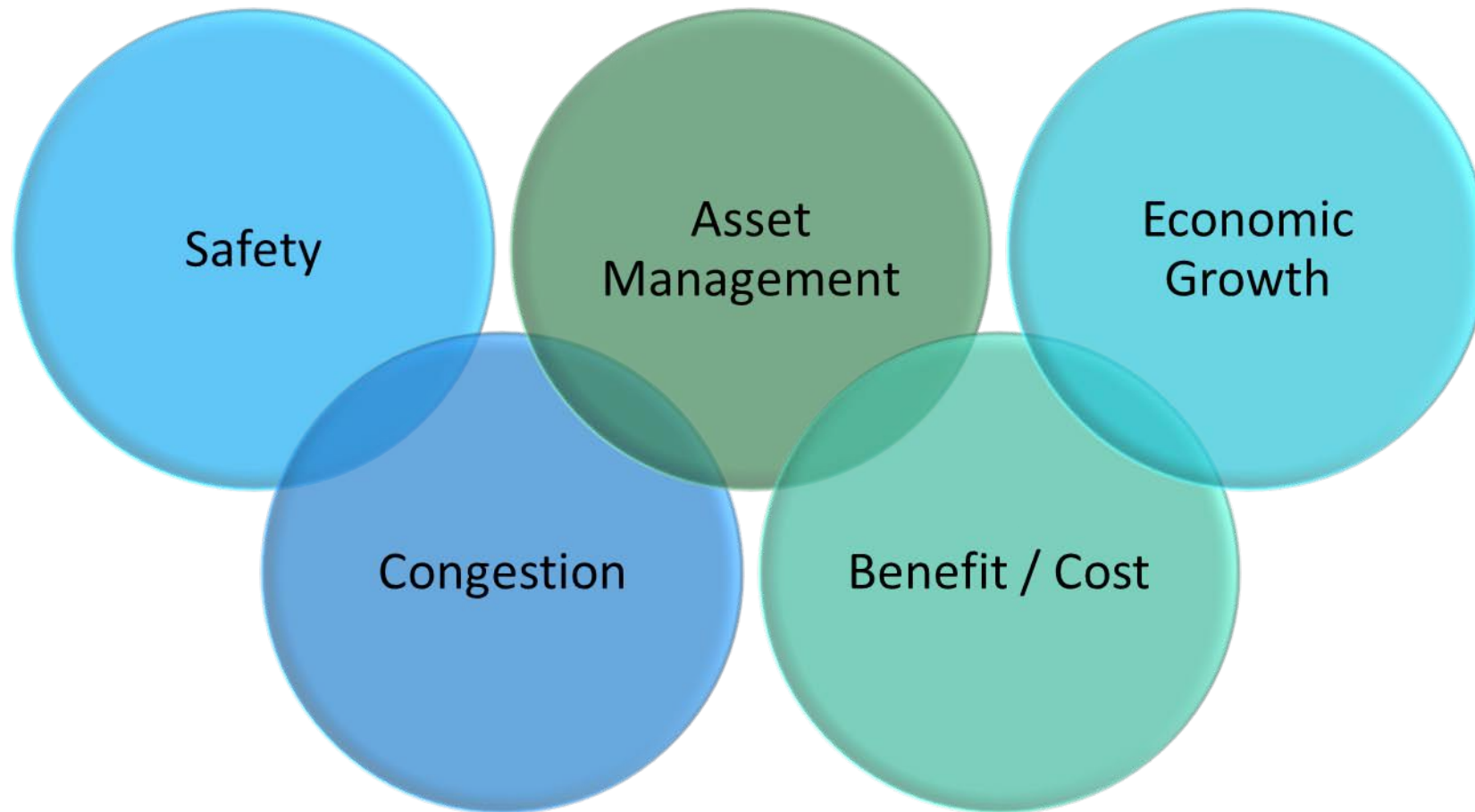


STRATEGIC HIGHWAY INVESTMENT FORMULA FOR TOMORROW

FORMULAS



Formula Components



Component Objectives

Safety

- Evaluate the project's 5 yr. crash history.
- Evaluate the roadway characteristics of the project area.

Congestion

- Evaluate capacity issues in the project area.

Economic Growth

- Quantify the project's economic competitiveness or accessibility/connectivity at a countywide level.
- Measure the impact on the freight network within the project area.

Benefit / Cost

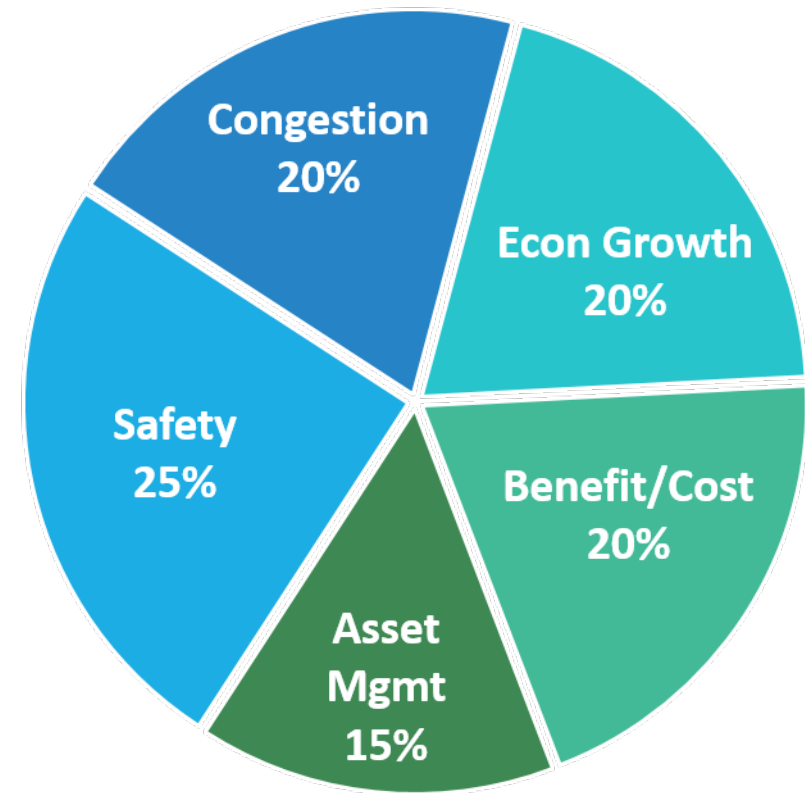
- Evaluate the expected benefits in dollars of travel time savings and safety benefits against the project costs.

Asset Management

- Add points to projects that also have pavement or bridge issues.

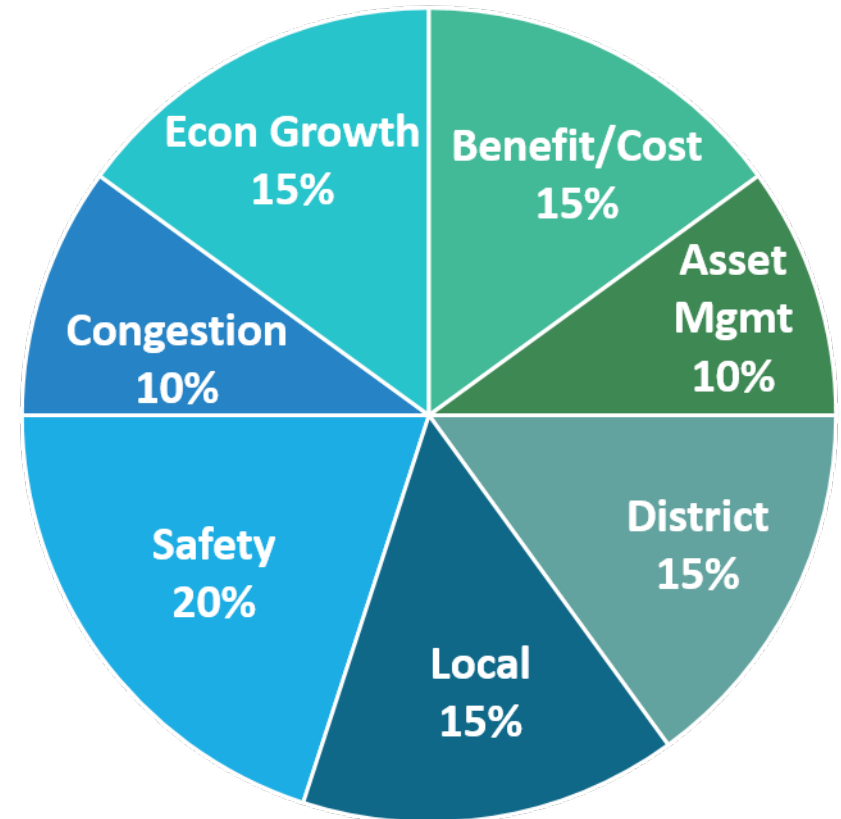
Proposed Statewide Funding Formula

Priority	Score
Improve Safety	25%
Reduce Congestion	20%
Fuel Economic Growth	20%
Spend Tax Dollars Wisely (Benefit /Cost)	20%
Preserve Infrastructure (Asset Management)	15%
TOTAL	100%



Proposed Regional Funding Formula

Priority	Score
Improve Safety	20%
Reduce Congestion	10%
Fuel Economic Growth	15%
Spend Tax Dollars Wisely (Benefit/Cost)	15%
Preserve Infrastructure (Asset Management)	10%
SUBTOTAL	70%
District Priorities (KYTC)	15%
Local Priorities (ADD/MPOs)	15%
TOTAL	100%



Safety Score Part 1

Crash History Formulas

Statewide: 15%

Regional: 15%

Statewide Score = 15% * Crash History Safety Measure (CHSM) for Segments or Intersections :

Regional Score = 15% * Crash History Safety Measure (CHSM) for Segments or Intersections :

$$\text{Segment (L>0.2): CHSM} = 0.25*((\text{CD*L})_{\dagger\text{scaled}}) + 0.25*(\text{CRF}_{\dagger\text{scaled}}) + 0.50*(\text{CF}_{\dagger\text{scaled}})$$

$$\text{Intersection (L}\leq\text{0.2): CHSM} = 0.5*(\text{CF}_{\dagger\text{scaled}}) + 0.5*(\text{CRF}_{\dagger\text{scaled}})$$

Measure	Description	Summary Method All crash data summarized over 5 yrs. 2011-2015	Source
CD*L	CD: Crash Density L: Project Length	Total # crashes 5 yr / cumulative length of roadway for facility type statewide Ending mile point minus beginning mile point	Crash Database PIF
CRF	Critical Rate Factor	Length Weighted Avg	Crash Database
CF	Crash Frequency	# of crashes over 5 yr period	Crash Database

[†]Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

Safety Score Part 2

Roadway Characteristics(RC) Formulas

Statewide: 10%

Regional: 5%

Statewide Score = Urban or Rural Roadway Characteristics Safety Measure * 10%:

Regional Score = Urban or Rural Roadway Characteristics Safety Measure * 5%:

Measure	Description	Summary Method	Source
<p>Urban (RC) = $0.3 * P_{c,avg} + 0.3 * P_{c,max} + 0.4 * P_{l,avg}$ † (Scaled)</p> <p>Rural (RC) = $0.3 * P_{c,avg} + 0.3 * P_{c,max} + 0.2 * P_{l,avg} + 0.2 * P_s$ † (Scaled)</p>	$P_{c,avg}$: Avg Horizontal Curve Pts	Formula based upon Length Weighted Avg Degree of Curve & Dominant Urban Classification & Functional Class	HIS
	$P_{c,max}$: Max Horizontal Curve Pts	Formula based upon Maximum Degree of Curve & Dominant Urban Classification & Functional Class	HIS
	$P_{l,avg}$: Avg Lane Width Pts	Formula based upon Length Weighted Avg of Lane Width & Dominant Urban Classification & Functional Class	HIS
	P_s : Avg Shoulder Pts	Formula based upon Length Weighted Avg of Outside Right Shoulder Width	HIS

†Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

Congestion Score

Formulas

Statewide: 20%

Regional: 10%

Statewide Score = 20% * Congestion Measure (CM) :

$$CM = 0.6 * (\text{VSF -scaled}) + 0.4 * (\text{DHV-scaled})$$

Regional Score = 10% * Congestion Measure (CM) :

$$CM = 0.8 * (\text{VSF -scaled}) + 0.2 * (\text{DHV -scaled})$$

Measure	Description	Summary Method	Source
VSF	Volume to Service Flow. †Scaled VSF used in calculations	Length Weighted Avg	HIS
DHV	Design Hourly Volume = K*AADT †Scaled DHV used in calculations. K: Design Hour Factor AADT: Annualized Average Daily Traffic	Length Weighted Avg Length Weighted Avg	TRADAS TRADAS

†Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

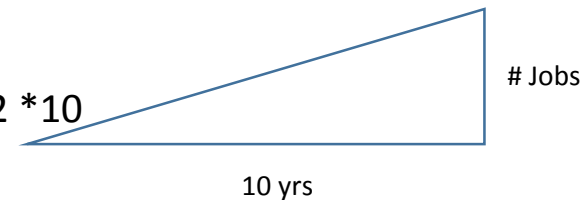
Economic Growth Score Part 1 Statewide

Economic Competitiveness (EC) Formula Statewide: 10%

Statewide Score = 10% * Economic Competitiveness Measure (ECM):

$$ECM = 0.5 * Yrs_Emp_{10yr} + 0.5 * (VA_{\Delta CE} - ^{\dagger} \text{scaled})$$

$$Yrs_Emp_{10yr} = (\#_Jobs - ^{\dagger} \text{scaled}) * 1/2 * 10$$



Measure	Description	Source
Yrs_Emp _{10yr}	Cumulative # of years of employment created over a 10 year period 2017 - 2027	TREDIS
VA _{ΔCE}	Value Added, % change in County Economy over 10 yr. period 2017- 2027	TREDIS
#_Jobs	# Jobs created over 10 year period	TREDIS

[†]Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

Economic Growth Score Part 1 Regional

Accessibility / Connectivity Formula

Regional: 10%

Regional Score = 10% * Accessibility/Connectivity Measure (ACM):

$$\text{ACM} = f(P_{\text{TYP}}, \text{TIER}_{\text{NEED}}, \text{AADT}_{\text{CAPPED}})$$

(Scaled)

Measure	Description	Summary Method	Source
P_{IT}	Project Improvement Type	Eligible Project Improvement Type†	SYP, PIF
$\text{TIER}_{\text{NEED}}$	Tiers based on County Economic Indicators	County Tiers based on Negative and Positive Economic Indices†	CED, KSDC and BSSC
$\text{AADT}_{\text{CAPPED}}$	Annualized Average Daily Traffic	Length Weighted Avg, Max 20,000 (cap higher values)	TRADAS

† See Slide 14 for Economic Growth Accessibility/Connectivity Criteria.

†Economic Growth Accessibility/Connectivity Criteria

Need Indices

Positive Indices:

- High School Education+ Index (2011-2015)
- Population Change Index (2000-2010)
- Median Household Income Index (2011-2015)
- Annual Wage and Salary Per Worker (2015)
- Per Capita Gross Domestic Product by County (2015)
- Labor Force Participation Rate (2011 - 2015)

Negative Indices:

- Annual Average Poverty Rate Index (2015)
- Unemployment Rate Index (2013-2016)

Pts by Project AADT & County Tier

Tiers	Points (Max 100)
Tier 1	AADT capped/200
Tier 2	AADT capped/200
Tier 3	AADT capped/300
Tier 4	AADT capped/300
Tier 5	AADT capped/600
Tier 6	AADT capped/600

Eligible Project Improvement Types:

- Arterial to Full Control
- Arterial to Partial
- Full Control to Interstate
- Construct Rd in New Location
- Upgrade to Grade Separation
- Grade Separated to Interchange
- Add Lane to Full Control Facility
- 2 to 4 Lane Divided Rural
- 2 to 4 Lane Divided Urban
- Install 2-Way Left Turn Lane
- Modernize Roadway w/Project Type:
Major Widening or Reconstruction

Economic Growth Score Part 2

Freight Formulas

Statewide: 10%

Regional: 5%

Statewide Score = 10% * Freight Economic Growth Measure (FEGM) :

Regional Score = 5% * Freight Economic Growth Measure (FEGM) :

Measure	Description	Summary Method	Source
$\text{FEGM} = P_{\text{TR}} * \text{AADT} / \text{KHFN} / V_{\text{TR,KHFN-MAX}}$ <p>† (Scaled)</p>	P_{TR} : Percent Trucks	Length Weighted Average	HIS
	AADT: Annualized Average Daily Traffic	Length Weighted Average	TRADAS
	KHFN: Kentucky Highway Freight Network Tier	Dominant	HIS
	$V_{\text{TR,KHFN-MAX}}$: Max Truck Vol in each KHFN Tier	Max	HIS

†Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

Benefit / Cost Score

Formulas

Statewide: 20%

Regional: 15%

Statewide Score = 20% * (Benefit / Cost) Measure (BCM) :

Regional Score = 15% * (Benefit / Cost) Measure (BCM) :

Measure	Description	Summary Method	Source
$\text{BCM} = (\text{B}_{\text{TTS}} + \text{B}_{\text{SAF}}) / \text{C}_{\text{PROJ}}$ (Scaled)	B_{TTS} : Travel Time Savings Benefit \$	[†] Travel Time Savings * sum of delay costs by vehicle type	KY Statewide Model HCM Method TRADAS HIS
	B_{SAF} : Safety Benefit \$	Safety Benefit Factor of specific improvement type * crash costs over last 5 yrs, 2011-2015	Crash Database PIF
	C_{PROJ} : Family Project Cost Phases R,U & C	Summary	SYP PIF

[†] Travel Time Savings for major improvements were calculated using the Kentucky Statewide Model. Travel Time Savings for smaller improvements are calculated via HCM iterative formulas.

Asset Management Score

Formulas

Statewide: 15%

Regional: 10%

Statewide Score = 15% * Asset Management Measure (AMM) :

Regional Score = 10% * Asset Management Measure (AMM) :

AMM = Max(Pavement, Bridge)

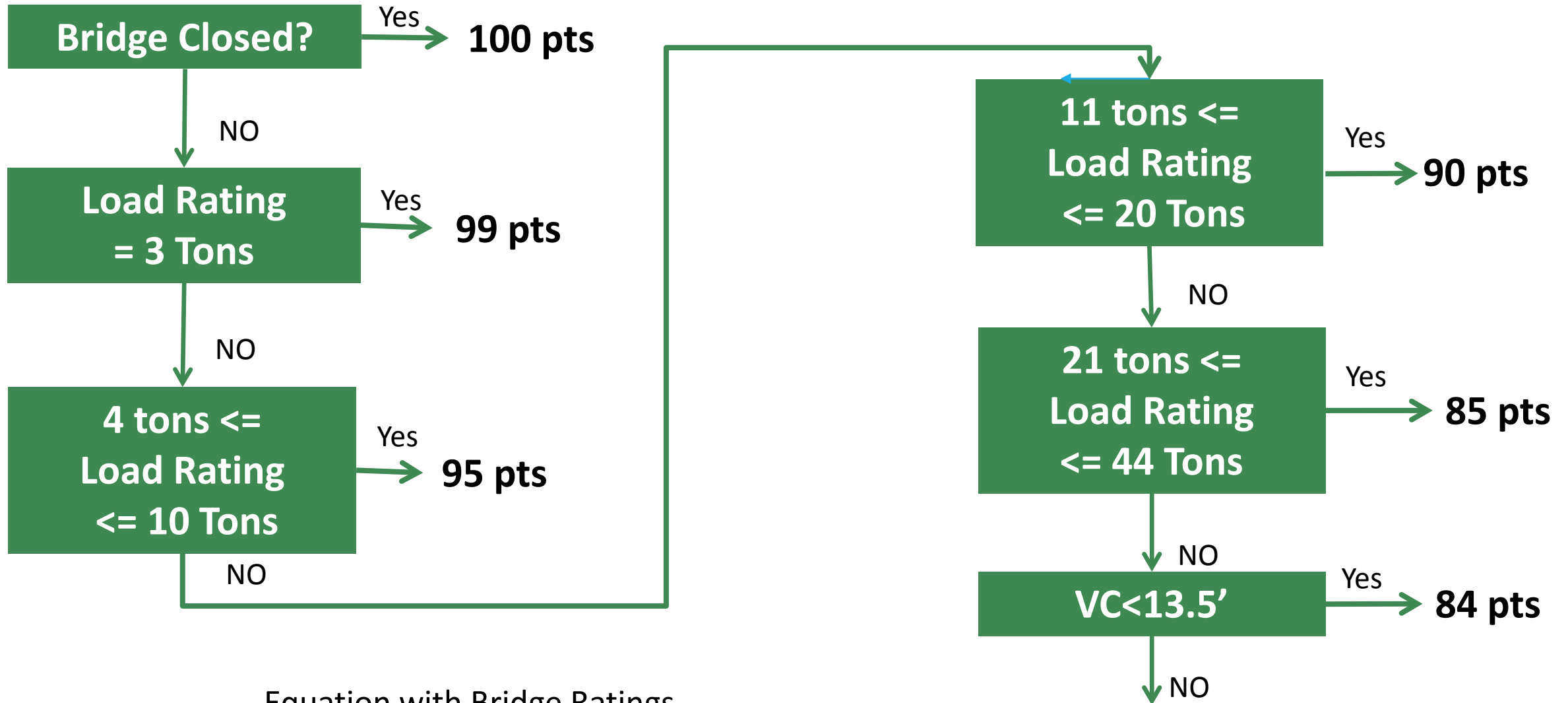
† Scale Pavement Measure before comparing to Bridge Measure

Measure	Description	Summary Method	Source
Pavement = $10 / (\text{Year}_{\text{NT}} - 2016 + 1)$ * $(\text{Cost}_{\text{TPM}} * L)$ † (Scaled)	Year _{NT} : Pavement Year of Next Treatment Cost _{TPM} : Est Cost of Treatment per Mile L: Length of project	Dominant Length Weighted Average Ending mile point minus beginning mile point	PMS PMS PIF
Bridge = f(BC, LR, VC, Ratings)	BC: Bridge Closed LR: Load Rating-Bridge Posted or TR4WT VC: Vertical Clearance Ratings: Deck Rating (RD), Substructure Rating (RSB), Superstructure Rating (RSP)	Series of sequential tests determine the points value. If more than one bridge within project limits the maximum bridge score is used.	BRM

Note: Improvement Types Excluded: Construct Road in New Location, Install Cameras and DMS, Highway /Railroad Crossing, Maintenance Improvement, Transportation Studies and Other Improvement Types

Asset Management Score

Bridge Measure



Equation with Bridge Ratings

$$3 * [(9 - RD) + (18 - 2 * RSB) + (18 - 2 * RSP)] - 3 + 27 / \text{MIN}(RD, RSB, RSP)$$

Data Sources

Term	Definition
BRM	Bridge Maintenance Database
BSSC	Bluegrass State Skills Corp County Tiers
CED	Cabinet for Economic Development
Crash Database	Summary of KY ops database for internal KYTC reporting
Emars	Financial database
HIS	Highway Information System database
KSDC	Kentucky State Data Center
PIF	Project Information Database
PMS	Pavement Management System
TRADAS	Traffic Count Database
Travel Time Savings	The Statewide model is used to determine Travel Time Savings in projects that can be modeled. Highway Capacity Manual formulas were used to calculate Travel Time Savings in projects that could not be modeled, but might show some savings.
TREDIS	Economic modeling program