SHIFT

KENTUCKY AHEAD

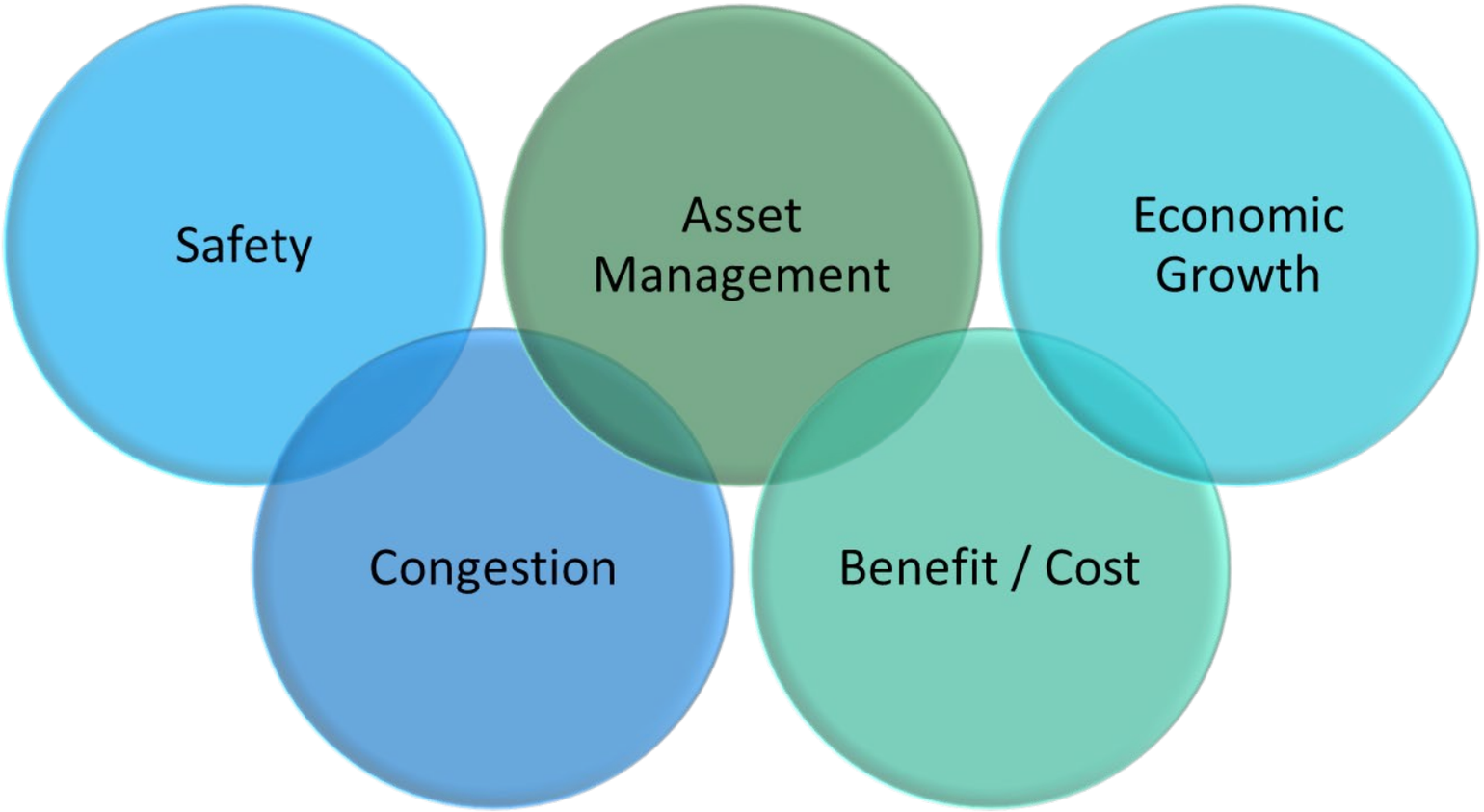
2020

STRATEGIC HIGHWAY INVESTMENT FORMULA FOR TOMORROW

FORMULAS

KENTUCKY TRANSPORTATION CABINET

Formula Components



Component Objectives

Safety

- Evaluate the project's 5 yr. Excess Expected Crashes.
- 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

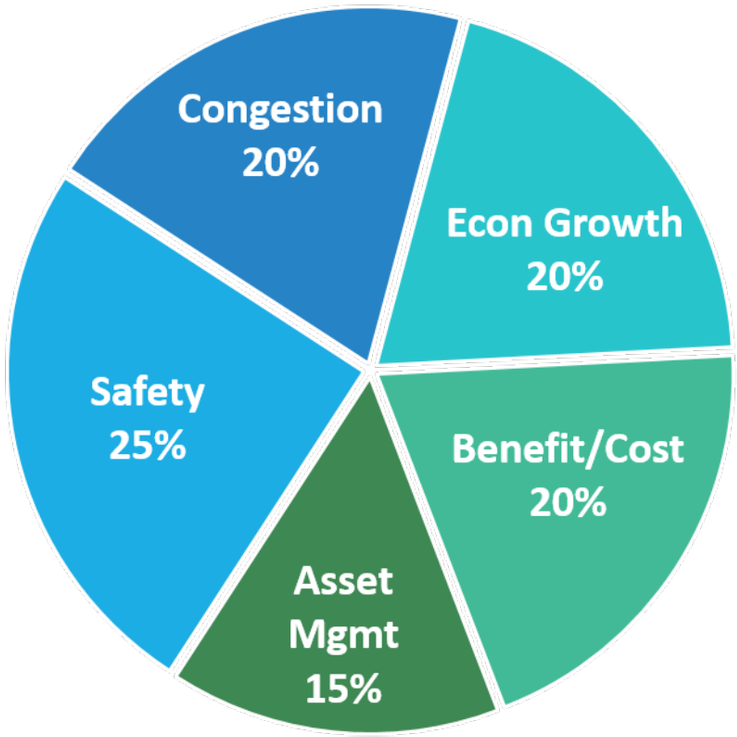
- Evaluate the expected benefits in dollars of travel time savings and safety benefits against the project costs.

Asset Management

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

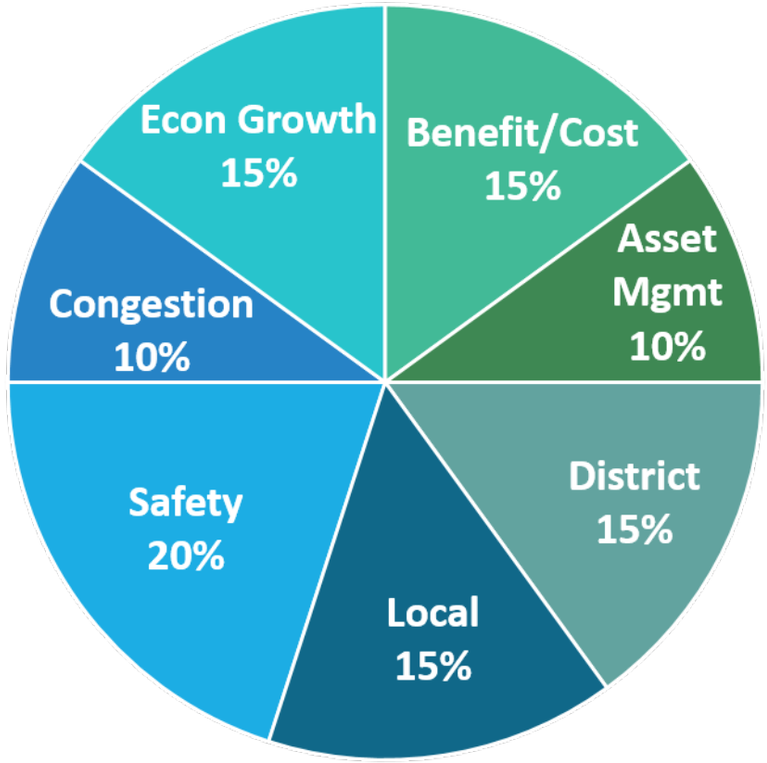
Statewide Funding Formula

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%**



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%



* Standard Regional % listing, Regions may adjust priorities by up or down by 5% with a minimum of 5% in any individual criteria. The overall data portion of the score will remain at 70%. The District and Local Priorities % may not be adjusted.

Crash History Formulas

Statewide: 15% Regional: 15%*

Statewide Score = 15% X Crash History Safety Measure (CHSM)

Regional Score = 15%* X Crash History Safety Measure (CHSM)

$$CHSM = (\sum EECs)_{\dagger scaled}$$

Measure	Description	Summary Method All crash data summarized over 5 yrs. 2013-2017	Source
EEC	Excess Expected Crashes	Expected Crashes – Predicted Crashes	Crash Database HIS

* Standard Regional % listing, Regions may adjust priorities by up or down by 5% with a minimum of 5% in any individual criteria.

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

Safety Part 2

Roadway Characteristics Formulas

Statewide: 10% Regional: 5%*

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

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

Measure	Description	Source
Urban Freeway: $0.25P_{S,avg}+0.25P_{S,min}+0.25P_L+0.25P_C$† (Scaled)	$P_{s,avg}$: Average points awarded for geometric constrained speed	HIS
Rural Freeway: $0.3P_{S,avg}+0.2P_{S,min}+0.25P_L+0.25P_C$ † (Scaled)	$P_{s,min}$: Minimum points awarded for geometric constrained speed	HIS
Urban Arterial: $0.25P_{S,avg}+0.25P_{S,min}+0.25P_L+0.25P_M$† (Scaled)	P_L: Points awarded for lane width	HIS
Rural Arterial: $0.3P_{S,avg}+0.1P_{S,min}+0.1P_{S,ratio}+0.2P_L+0.3P_C$† (Scaled)	P_c: Points awarded for lateral clearance	HIS
Urban Collector/Local: $0.25P_{S,avg}+0.25P_{S,min}+0.5P_L$† (Scaled)	P_M: Points awarded for median type & width	HIS
Rural Collector/Local: $0.2P_{S,avg}+0.2P_{S,min}+0.1P_{S,ratio}+0.2P_L+0.3P_C$† (Scaled)	$P_{S,ratio}$: Points awarded for S_{min}/S_{avg}	HIS

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

Congestion Formulas

Statewide: 20% Regional: 10%*

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

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

Functional Class	Congestion Measure
Interstates	$(VHD)_{Scaled}$
Other Freeway	$(95\% * VHD)^{\dagger}_{Scaled}$
Other Principal	$(90\% * VHD)^{\dagger}_{Scaled}$
Minor Arterial	$(85\% * VHD)^{\dagger}_{Scaled}$
Major Collector	$(80\% * VHD)^{\dagger}_{Scaled}$
Minor Collector	$(75\% * VHD)^{\dagger}_{Scaled}$
Local Road	$(70\% * VHD)^{\dagger}_{Scaled}$

Measure	Description	Summary Method	Source
VHD	Vehicle Hours of Delay	Sum of Vehicle Hours of Delay during weekdays 6am – 8pm along the project length.	2015 -2017 HERE link-referenced speed data or HERS-ST speed model

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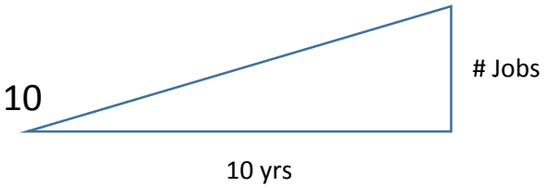
†Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

Economic Competitiveness Formula
Statewide: 10%

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

$ECM = 0.5 \times (Yrs\_Emp_{10yr}\ ^{\dagger}scaled) + 0.5 \times (VA_{\Delta CE}\ ^{\dagger}scaled)$

$Yrs\_Emp_{10yr} = (\#\_Jobs\ ^{\dagger}scaled) \times 1/2 \times 10$



Measure	Description	Source
Yrs_Emp_{10yr}	Cumulative # of years of employment created over a 10 year period 2017 - 2026	TREDIS
$VA_{\Delta CE}$	Value Added, % change in County Economy over 10 yr. period 2017- 2026	TREDIS
#_Jobs	# Jobs created over 10 year period 2017 - 2026	TREDIS

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

Accessibility / Connectivity Formula

Regional: 10%*

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

$ACM = f(P_{TYP}, TIER_{NEED}, AADT_{CAPPED})^{\dagger}$ **Scaled**

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

* Standard Regional % listing, Regions may adjust priorities by up or down by 5% with a minimum of 5% in any individual criteria.

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

†† See Slide 11 for Economic Growth Accessibility/Connectivity Criteria.

Economic Growth Score Part 1 Regional Cont.

Need Indices

Positive Indices:

- High School Education+ Index (2012-2016)
- Population Change Index (2000-2010)
- Median Household Income Index (2012-2016)
- Annual Wage and Salary Per Worker (2016)
- Per Capita Gross Domestic Product by County (2016)
- Labor Force Participation Rate (2012 - 2016)

Negative Indices:

- Annual Average Poverty Rate Index (2016)
- Unemployment Rate Index (2014-2016)

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

Ineligible Project Improvement Types:

- Transportation studies
- Other improvement types

Economic Growth Part 2

Freight Formulas

Statewide: 10% Regional: 5%*

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

FEGM =RRatio X ((Freight X AADT)/KHFN_Factor) †Scaled

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

FEGM =((Freight X AADT)/KHFN_Factor) †Scaled

Measure	Description	Summary Method	Source
RRatio	Truck Reliability Ratio	Length Weighted Average	HERE Data
Freight: Statewide: (0.20 X SU + 0.80 X CO) Regional : (0.60 X SU + 0.40 X CO)	Freight Statewide and Regional Factors SU: % Single Unit Trucks; Vehicle Class 4-7 CO: % Combo Unit Trucks; Vehicle Class 8-13	 Length Weighted Average Length Weighted Average	 HIS HIS
AADT	Annualized Average Daily Traffic	Length Weighted Average	Jackelope
KHFN_Factor: KHFN/$V_{TR,KHFN-MAX}$	KHFN: Kentucky Highway Freight Network Tier $V_{TR,KHFN-MAX}$: Max Truck Vol in each KHFN Tier††	Dominant Max	HIS HIS

* Standard Regional % listing, Regions may adjust priorities by up or down by 5% with a minimum of 5% in any individual criteria.

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

†† Coal Haul included as a tier 5 in KHFN for scoring purposes

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Benefit / Cost Formulas

Statewide: 20% Regional: 15%*

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

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

$$0.5 \text{ X } \left(\frac{BTTS}{C_{PROJ}}\right)^{\dagger}_{\text{Scaled}} + 0.5 \text{ X } \left(\frac{BSAF}{C_{PROJ}}\right)^{\dagger}_{\text{Scaled}}$$

Measure	Summary Method	Source
BTTS: Travel Time Savings Benefit $	(††Travel Time Savings) X (sum of delay costs by vehicle type)	KY Statewide Model HCM Method Jackelope HIS
BSAF: Safety Benefit $	(Safety Benefit Factor of improvement type) X (crash costs over last 5 yrs, 2013-2017)	Crash Database CHAF
CPROJ: Family Project Cost Phases R,U & C	Summary	SYP CHAF

* Standard Regional % listing, Regions may adjust priorities by up or down by 5% with a minimum of 5% in any individual criteria.

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

†† 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 Formulas

Statewide: 15% Regional: 10%*

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

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

AMM = Max(Pavement, Bridge)

Pavement = (PDIvalue + YEARvalue)† **(Scaled)**

Measure	Description	Summary Method	Source
PDIvalue	Pavement Distress Index weighting value Max 10	Dominant	PMS
YEARvalue	Year of treatment index value	Dominant	PMS

Improvement Types Included - Grade Separation of highway/Railroad Crossing, 2 lane to 4 lane divided-Rural, Arterial to Full Control, Upgrade to Grade Separation, Arterial to Partial Control, Access Consolidation, Modernize Roadway-Rural, Modernize & Widen Roadway-Rural, Modernize Roadway-Urban, Full Control to Interstate, 2 lane to 4 lane divided-Urban, Major Widening-Urban Streets and Major Widening-Rural Multilane.

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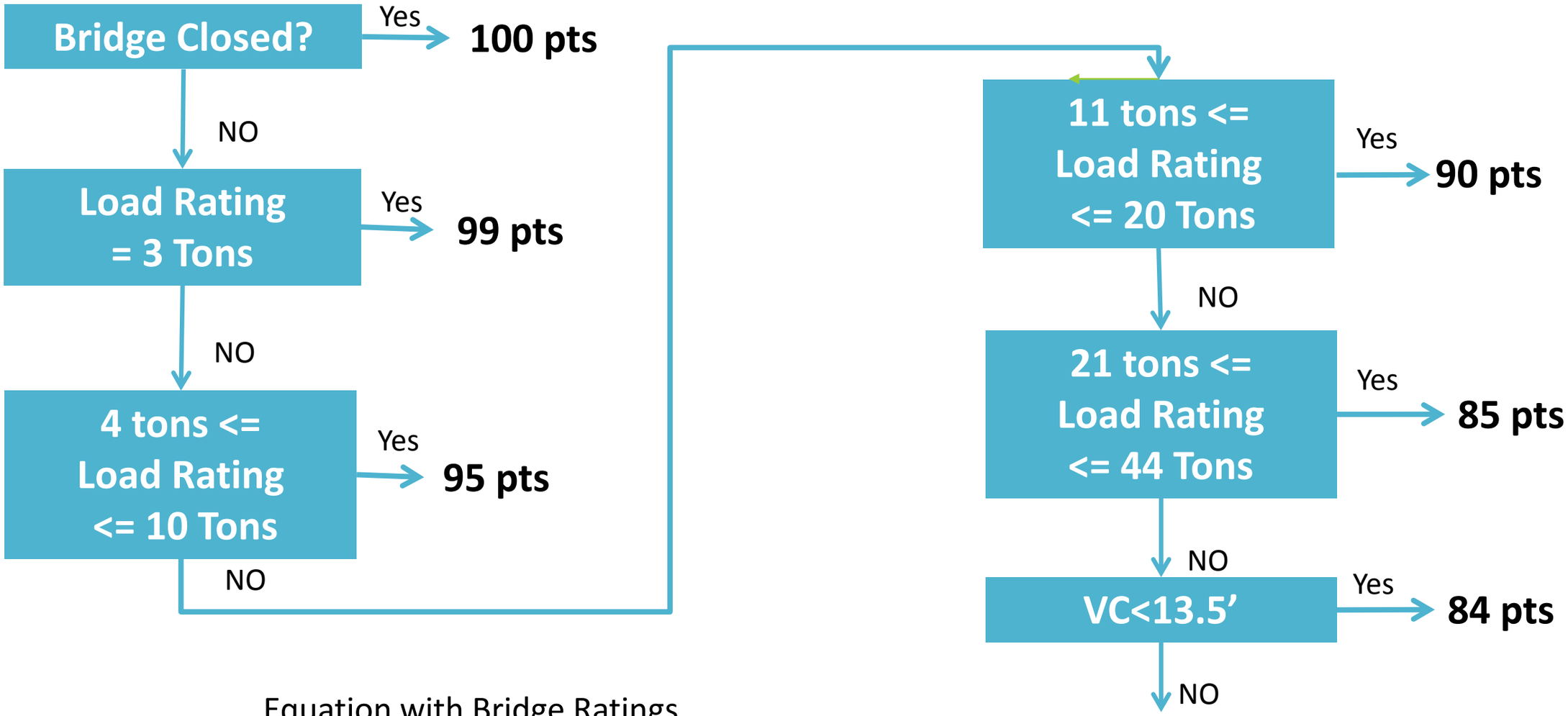
† Scale Pavement Measure before comparing to Bridge Measure

Asset Management Cont.

Bridge = f(BC, LR, VC, Ratings)

Measure	Description	Summary Method	Source
BC	Bridge Closed	If more than one bridge within project limits the maximum bridge score is used.	BRM
LR	Load Rating: Bridge Posting or Truck Type 4 posting	If more than one bridge within project limits the maximum bridge score is used.	BRM
VC	Vertical Clearance	If more than one bridge within project limits the maximum bridge score is used.	BRM
Ratings	Deck Rating (RD), Substructure Rating (RSB), Superstructure Rating (RSP)	If more than one bridge within project limits the maximum bridge score is used.	BRM

Bridge Measure



Equation with Bridge Ratings

3*[(9-RD) + (18 - 2*RSB) + (18 - 2*RSP)] - 3 +27/MIN(RD, RSB, RSP)

Data Sources

Term	Definition
BRM	Bridge Maintenance Database
BSSC	Bluegrass State Skills Corp County Tiers
CED	Cabinet for Economic Development
CHAF	Continuous Highway Analysis Framework
Crash Database	Summary of KY ops database for internal KYTC reporting
Emars	Financial database
HERE Data	2015 -2017 Kentucky Speed Data
HIS	Highway Information System database
KSDC	Kentucky State Data Center
PMS	Pavement Management System
Jackelope	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