# The Highway Economic Requirements System (HERS): How HERS Works

*presented to*

Committee for a Study of the Future Interstate Highway System

*presented by*

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Think Forward

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# *What We'll Accomplish Today*

- Provide an overview of the HERS model for application to the Future Interstate Study
- Explain why it was created and how it has been used
- Discuss its strengths and limitations
- Offer some approaches to overcoming limitation

# *The Modeling Dilemma*

*"**Essentially, all models are wrong, but some are useful.**"*

*~ George Box*

- All models have similar limitations makes their ability to perfectly predict the future tenuous, but are useful for:
  - Control and isolate factors that only rigorous experimental designs can identify
  - Comparison of the ***relative*** merits of different treatments

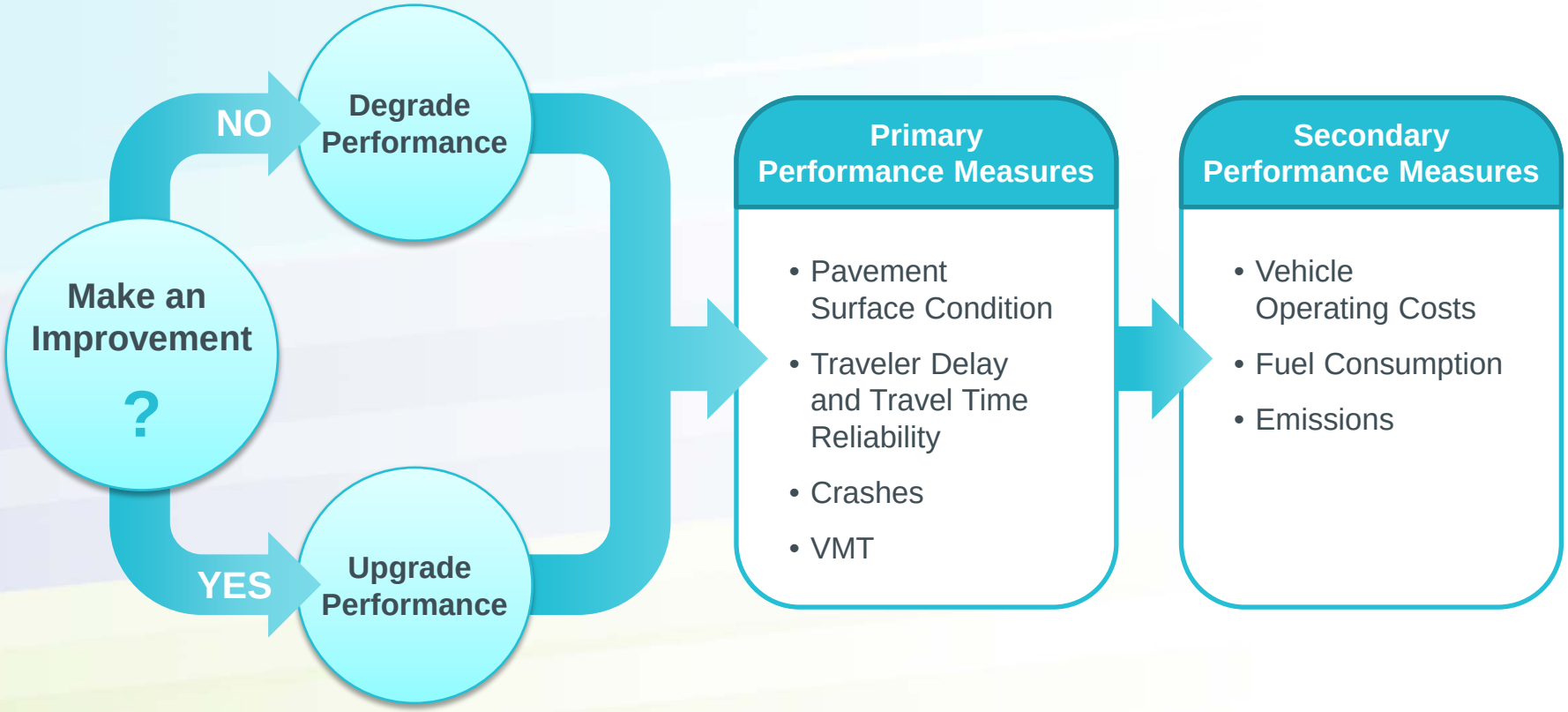
# *HERS Overview*

- Created to assist FHWA in a variety of policy studies, especially the recurring *Conditions and Performance Report* to Congress; also used by several states for future needs analysis
- Essentially a model that simulates how agencies would invest in highways on a benefit/cost basis
- Tests what the cost and performance impacts are of those investments over time
  - » Based on current and predicted deficiencies based on state-reported inventory and travel
  - » Tallies costs and performance implications of making (or not making) investments

# HERS: Types of Investments

- Pavement surface
- New capacity – more lanes
- Cross-section – grades, curves, and shoulders
- Operations strategies – incident management, ramp metering, advanced signal control, active traffic management

# HERS: Performance Categories



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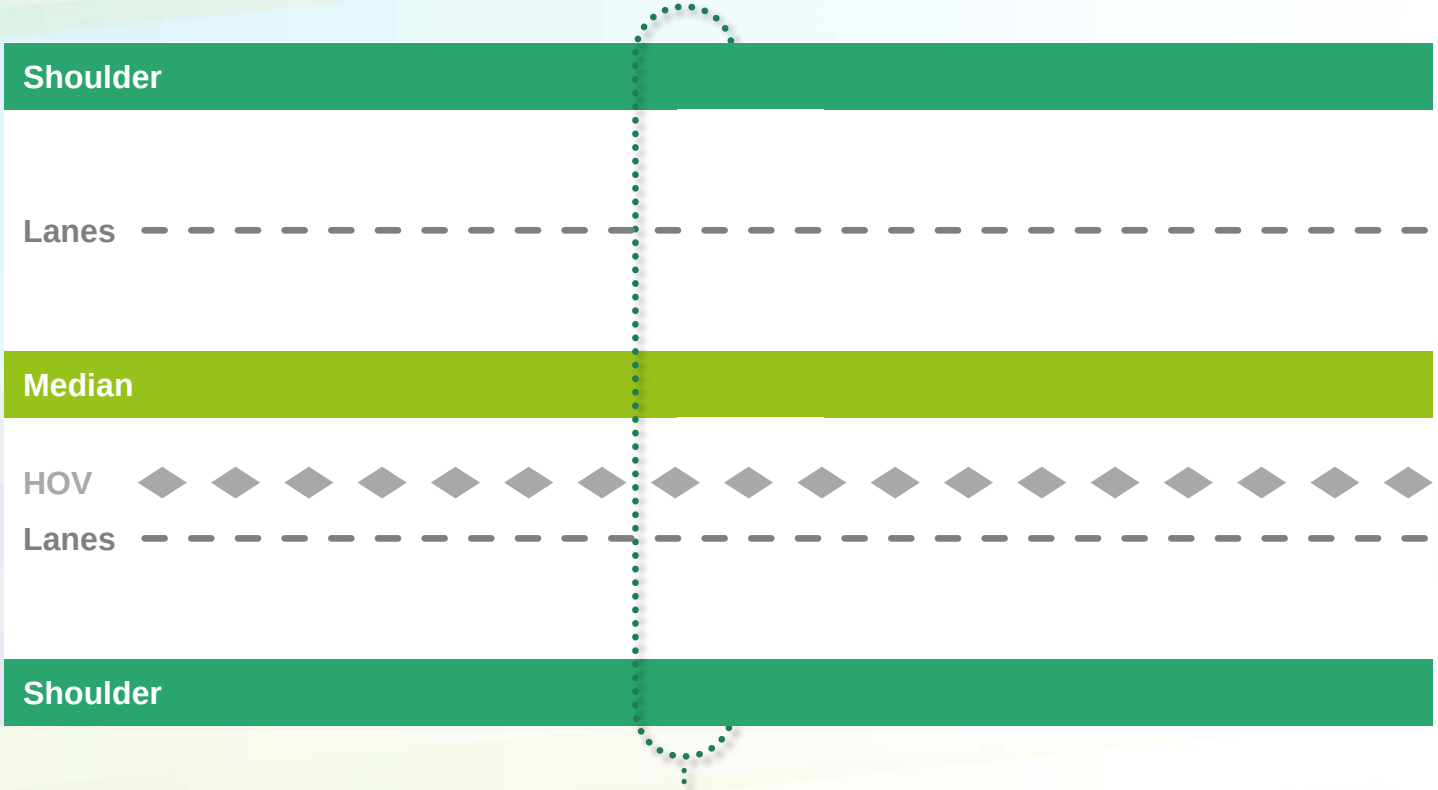
# *Highway Performance Monitoring System (HPMS): The Data Engine Behind HERS*

- Roadway inventory data collected and submitted by the states
  - » Mostly the same data the states use for their own planning
- Full Extent vs. Sample Panel
  - » 23,600 miles vs. 46,900 Interstate miles covered in the Sample Panel used by HERS (50% coverage)
- Data are reported by relatively short highway sections

# HPMS Data Types




- Pavement Surface Condition
- Traffic Count
- Truck Count
- Traffic Forecast
- Tolls



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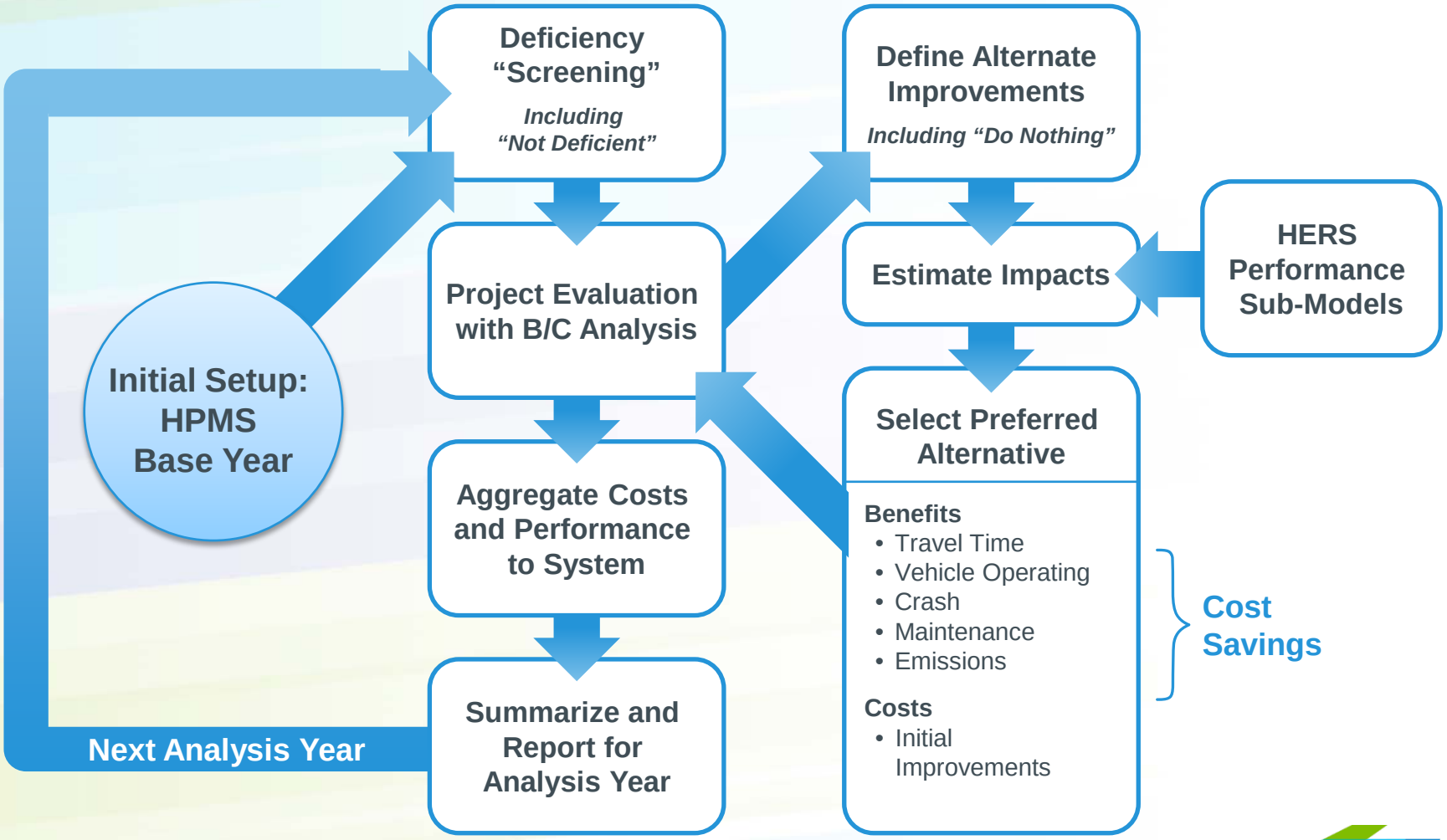
# HERS: High Level Program Flow



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# HERS: Submodels for Performance

- Use many of the same procedures that are used by agencies for planning studies, but tailored to fit the available data and national scope of HERS

- Pavement surface condition
  - Data for the new pavement equations: HPMS dataset plus default data tables from Mechanistic-Empirical Pavement Design Guide (MEPDG)
  - Also uses internal forecasts of cracking, faulting and rutting in the estimation of future IRI

# *HERS Submodels (cont.)*

- Speed and delay
  - Based on latest Highway Capacity Manual procedures for travel time reliability
  - Includes the effects of queuing
- Crashes
  - Based on Highway Safety Manual procedures, using the pure prediction models rather than the model/crash data approach taken by the HSM
  - Many default values assumed

# HERS Submodels (cont.)

- Emissions and fuel consumption
  - Based on EPA's MOVES model but many default values are needed
- Vehicle operating costs
  - Fuel consumption
  - Oil consumption
  - Tire wear
  - Maintenance and repair
  - Depreciable value

# *HERS: Strengths*

- National in scope
  - » Same data and procedures used for all states
- Data and technical procedures very similar to what states and MPOs would use for their own needs analyses
- Provides insight into the tradeoffs between investment and performance
  - » Used successfully in other studies (“Bottom Line”)

# HERS: Strengths

- Consider modeling a starting point – results to be interpreted through multiple lenses
  - Agency practices
  - Noncovered impact areas
  - New technologies (automated vehicles)

# HERS: Limitations

- Works on ***independent*** HPMS roadway sections
  - » Real projects tend to be much longer and encompass multiple types of treatments
- Bottlenecks: a crude approximation
  - » Based on capacity of a basic freeway segment
  - » Interchanges are the worst bottlenecks but neither the data nor analysis procedures are available
    - – Lack of interchange configuration also an issue for truck size and weight

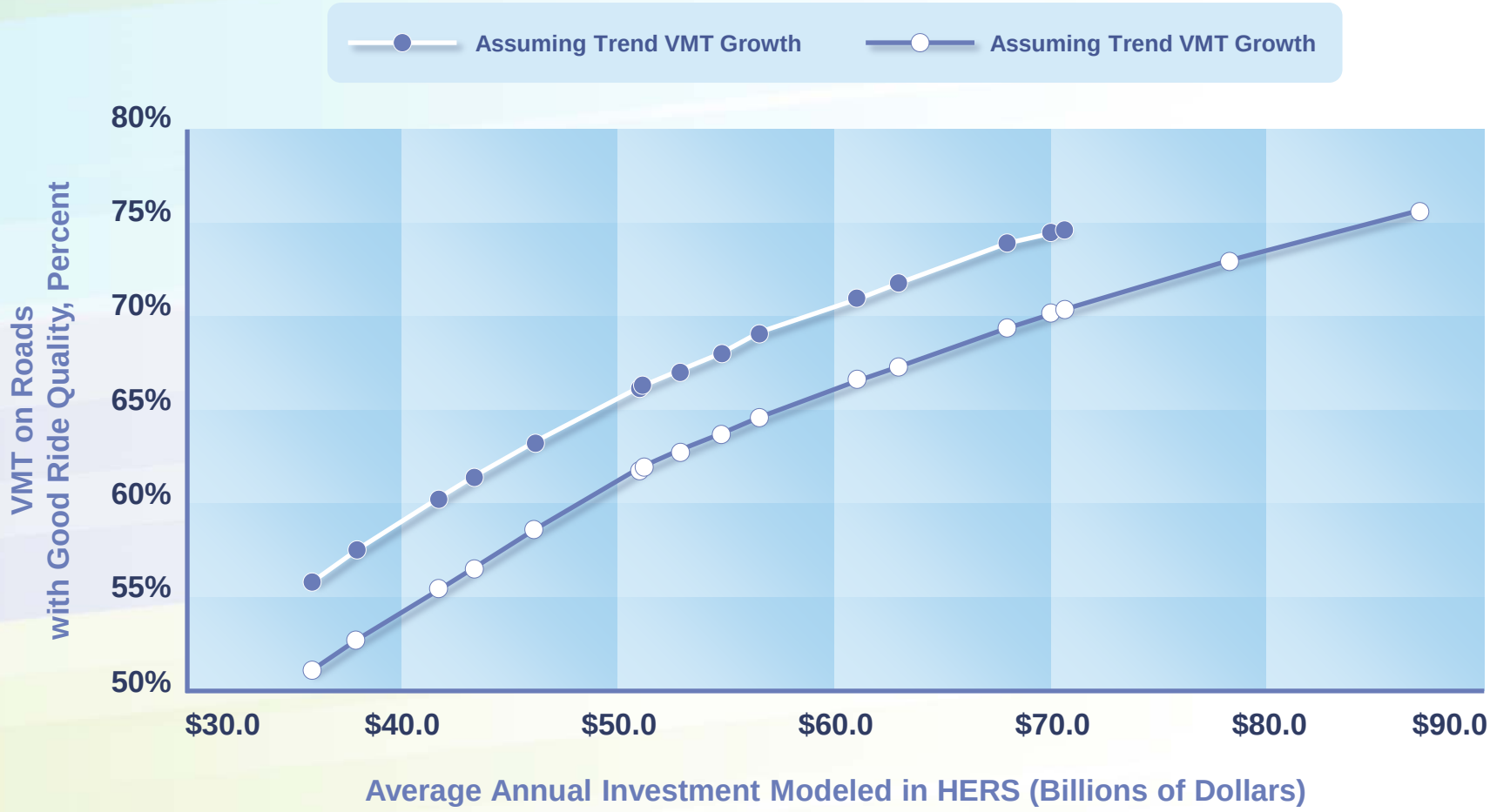
# HERS: Limitations

- Considers pavement ***surface*** condition only
  - Problems/aging with entire pavement structure ignored
- Limited number of improvement types
  - Many safety improvements not considered
  - Demand management

# *HERS: Limitations*

- HERS is NOT a travel ***demand*** model
  - » No network on which to "flow" demand estimation
  - » Traveler response to improved/worsening conditions handled by simple elasticities
- HPMS traffic forecasts not specific to a highway section
  - » Supposed to be generalized growth rate from a travel demand model for a region…
  - » But also can be derived from trends or statewide VMT forecasts
- Truck counts and peaking factors also based on generalized data

# What Kind of Results Can Be Attained?



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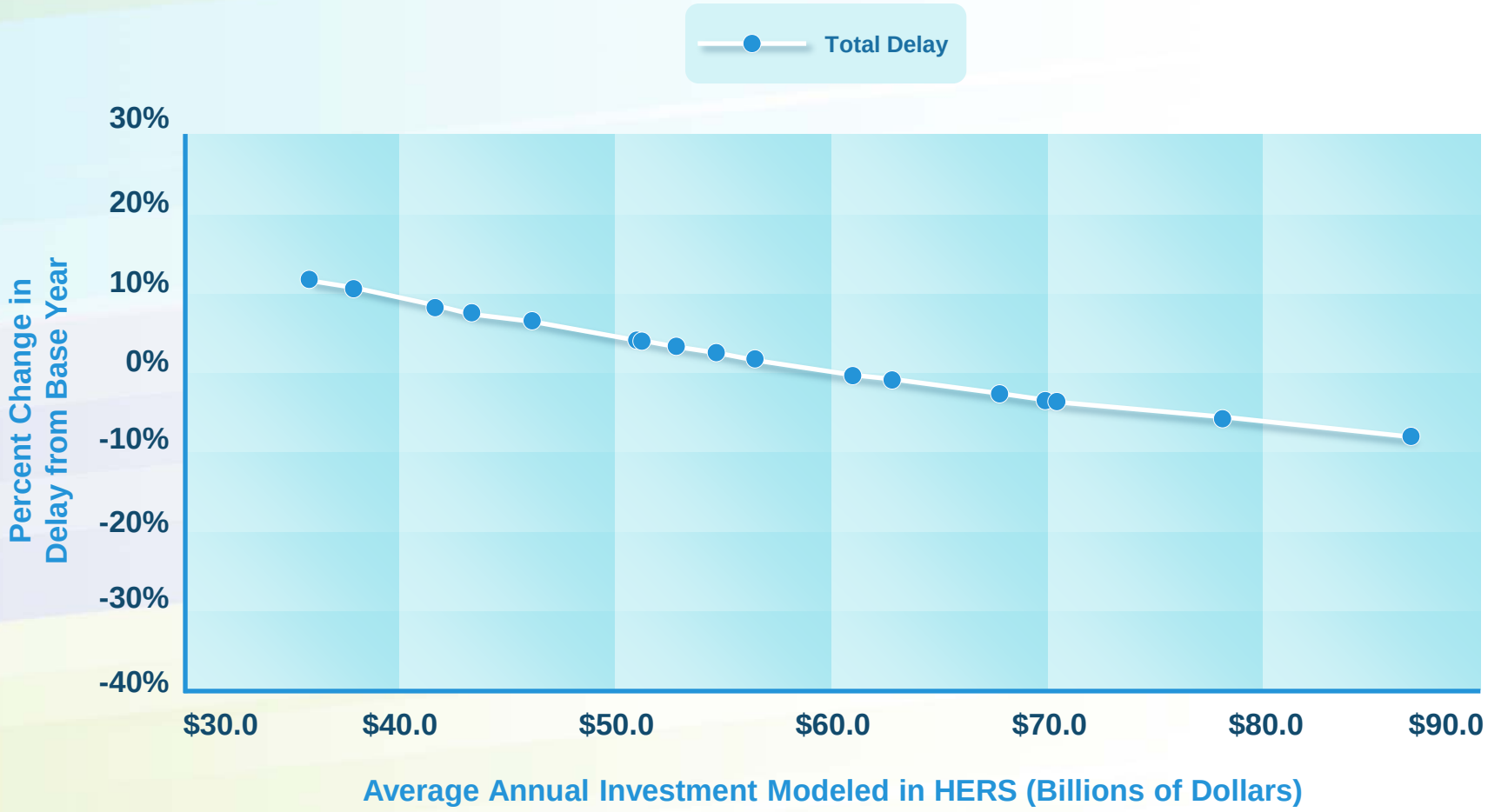




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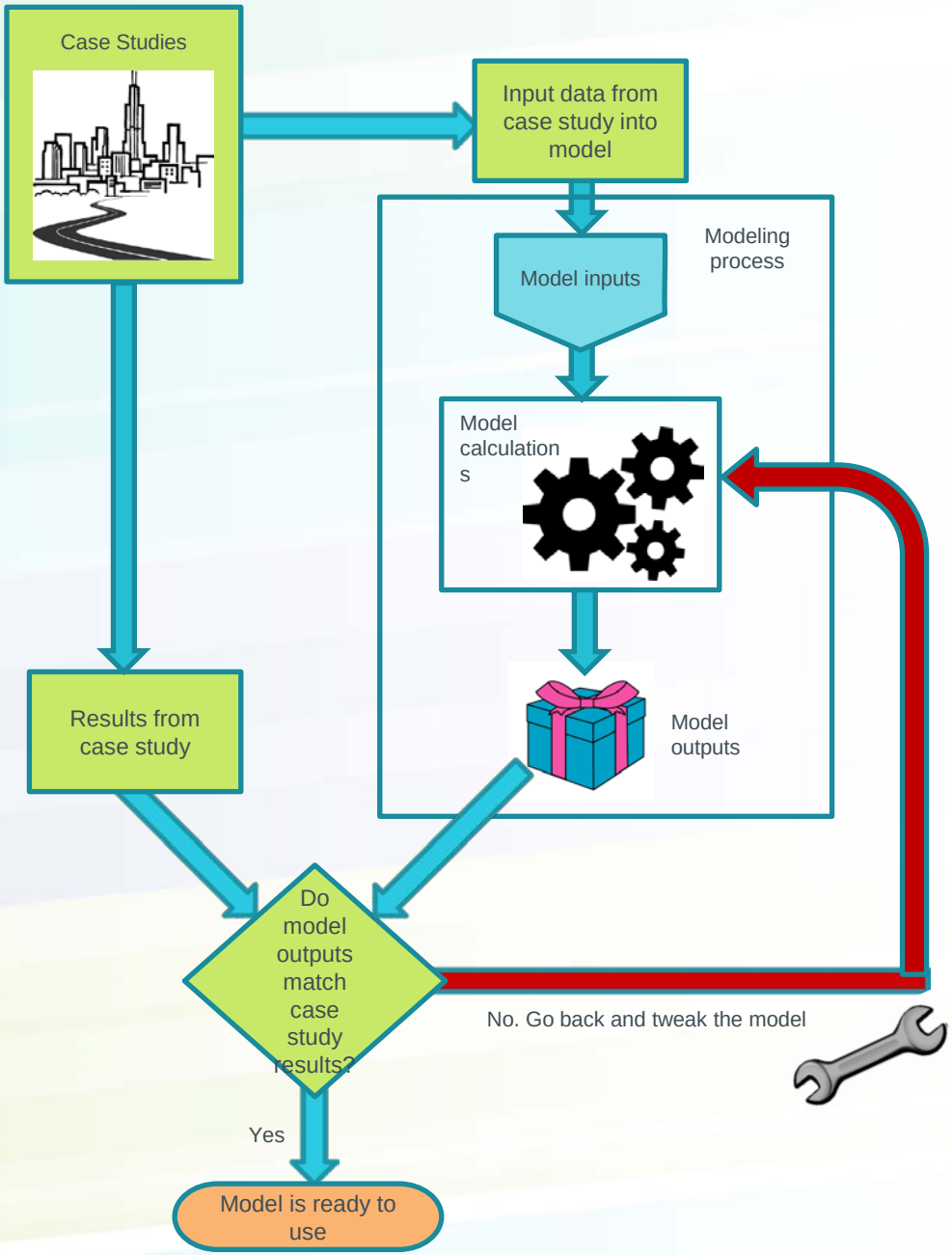
# *How to Avoid the Black Box Syndrome*

- Externally identify trends and test them within HERS
  - » Use selected case studies to document various futures.
  - » Set alternative improvement types, default values and parameters for testing
    - – Example: Pavement Health Track (PHT) models, which specifically include a maintenance cost model to account for service life extensions associated with various pavement preservation treatments

# How we plan to use case studies to inform the models

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# *How to Avoid the Black Box Syndrome*

- Use HPMS and state-derived data outside of HERS
  - » Extract key algorithms from HERS
  - » Example:  Bottleneck analysis
- When in doubt, do sensitivity analysis
  - » Many factors could influence results, both exogenous (VMT, new technologies) and endogenous (algorithms and default data)

# *How to Avoid the Black Box Syndrome*

- Examine how states and MPOs are conducting their own needs analyses and planning for the future of their Interstates
  - Potentially glean from desk audit style case studies
  - 20-25 year time horizon most likely
  - Tap pavement, bridge, freight and safety plans and management systems
  - Consider and test demand forecasts in use
  - Consider other investment rationales used by agencies not accounted for in models such as Sustainability, Livability,  and Economic Progress