United States General Accounting Office

GAO

Report to Congressional Committees

February 2001

HIGHWAY INFRASTRUCTURE

FHWA's Model for Estimating Highway Needs Has Been Modified for State-Level Planning

GAO-01-299

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Abbreviations

DOT	Department of Transportation
FHWA	Federal Highway Administration
HERS	Highway Economic Requirements System
HERS-ST	state-level version of the Highway Economic Requirements System
GAO	U.S. General Accounting Office
TEA-21	Transportation Equity Act for the 21st Century
GIS	geographic information system
HPMS	Highway Performance Monitoring System
MPO	metropolitan planning organization
EPA	Environmental Protection Agency
HERS/OR	Oregon's version of the Highway Economic Requirements System
HERS/IN	Indiana's version of the Highway Economic Requirements System

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United States General Accounting Office
Washington, D.C. 20548

February 14, 2001

The Honorable Bob Smith
Chairman
The Honorable Harry Reid
Ranking Member
Committee on Environment
and Public Works
United States Senate

The Honorable Don Young
Chairman
The Honorable James L. Oberstar
Ranking Democratic Member
Committee on Transportation
and Infrastructure
House of Representatives

Federal and state governments have played a vital role in the nation's economy by facilitating the movement of people and goods through significant investments in highways. At the federal level, the Department of Transportation's (DOT) Federal Highway Administration (FHWA) uses a computer model known as the Highway Economic Requirements System (HERS) to estimate the future investment required to maintain and improve the nation's highways. DOT reports the results of this analysis to the Congress on a biennial basis. However, state governments make a large number of highway infrastructure investment decisions. States currently use a variety of analytic tools to make these decisions. Interest in using HERS at the state level has grown. Two states—Indiana and Oregon—are already using customized versions of the model, and in December 2000, FHWA began a pilot project to test its state-level version of HERS, called HERS-ST, with interested states.

The Transportation Equity Act for the 21st Century (TEA-21) directed GAO to evaluate and report to the Congress on the extent to which the HERS model can be used to provide states with useful information for their planning efforts. Accordingly, this report describes (1) why FHWA developed a state-level HERS model, (2) how FHWA is making the state-level HERS model available to states, (3) how states expect to use the model, and (4) how FHWA could improve the model, including improvements already planned and additional changes that might increase the state-level HERS model's usefulness, including the incorporation of additional data. To address these issues, we built on our June 2000 report, which focused on the federal HERS model,[1] by reviewing documentation for the federal and state-level models and interviewing the models' developers and managers. We interviewed FHWA officials about the HERS-ST pilot project. In addition, to identify how states might use the HERS-ST model, we first randomly selected 8 states from a list of 16 states that initially volunteered to participate in FHWA's pilot project. For each of the selected states, we asked state transportation officials to identify how they plan to use the HERS-ST model and how, based on their current understanding, the model might be improved. Finally, to draw on the experiences that Indiana and Oregon have had with other state-level HERS models, we interviewed transportation officials from these states about changes that could be made to the HERS-ST model's assumptions and data to improve the usefulness of the model. See appendix I for further information on our scope and methodology.

Results in Brief

FHWA developed the HERS-ST model as an investment-analysis tool for highway planning at the state level. FHWA officials believe that some state departments of transportation will find the analysis that the HERS-ST model produces useful because it demonstrates the potential results of highway investment decisions from an economic point of view. These officials recognized that the national-level HERS model's ability to compare the benefits of alternative highway improvements to the related costs was an improvement over previous highway planning models, which used engineering standards to identify deficiencies and select improvements without regard to their economic merit. They concluded that developing a state-level HERS model might offer states a similarly useful analytical tool. In addition, two states—Indiana and Oregon—recently started using their

[1] *Highway Infrastructure: FHWA's Model for Estimating Highway Needs Is Generally Reasonable, Despite Limitations* (GAO/RCED-00-133, June 5, 2000).

own customized versions of the national model. These states have already found their models useful for determining future highway needs and planning highway projects. After its positive experience with the national-level HERS model and the model's successful adaptation in two states, FHWA began to develop HERS-ST in 1999. FHWA expects that states will use the HERS-ST model to facilitate planning for highway investment.

FHWA is conducting a pilot project for its prototype HERS-ST model with those states that volunteered to test the model. Interest in the HERS-ST model has been higher than FHWA officials first expected, with 20 states volunteering to participate in the pilot project. In December 2000, FHWA distributed to these states HERS-ST software, technical manuals, and sets of state highway data with which to run the model. FHWA then provided an overall orientation and technical training and addressed states' questions during a February 2001 workshop. Following a test period, FHWA plans to evaluate states' interest and success in using the model and report the results in August 2001. On the basis of that evaluation, FHWA will make decisions about whether or how to expand its support for the model and how to improve it.

Officials from a sample of eight of the states planning to participate in the HERS-ST pilot project reported that they are primarily interested in taking advantage of the model's use of benefit-cost analysis to assess alternative highway improvements. Though these officials had not yet used the model nor determined all the uses to which they might put the model, they identified as their most likely uses (1) comparing the benefits and costs of making alternative highway improvements, (2) developing or refining state transportation investment plans, and (3) assessing highway needs forecast by state district offices or local agencies. They further mentioned the possibility of using the model to produce planning and management tools such as long-range state highway plans.

If the HERS-ST pilot project shows that states view the HERS-ST model as a useful tool, FHWA expects to upgrade the model for future users. In doing so, it would consider both enhancements that have already been planned for the national-level HERS model and changes targeted specifically to HERS-ST. Enhancements planned for the national-level HERS model that could be incorporated into HERS-ST include an improved approach for calculating the long-term benefits of improvements, an improved method of pavement analysis, and upgrades to the model's vehicle emissions data. Changes specifically to improve the HERS-ST model's usefulness to states might include converting the model to a menu-driven system to improve its

ease of use or revising the model's data input format so that it matches FHWA's current state highway data reporting requirements. Our interviews with state officials also indicated that states might want to analyze more detailed highway information than HERS-ST now considers.

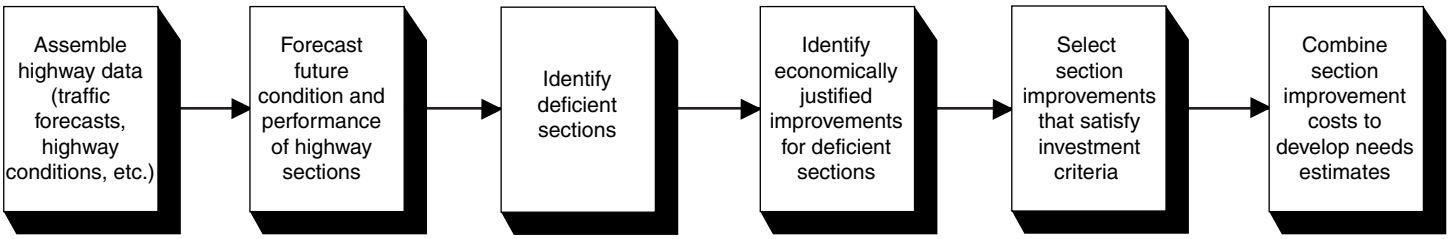
Background

DOT submits biennial reports, called *Conditions and Performance Reports*,[2] to the Congress, detailing the state of the nation's highways, bridges, and other surface transportation systems along with investment requirements for these systems. In developing its portion of the report, FHWA bases its estimates of investment requirements for most highways on the Highway Economic Requirements System (HERS) computer model. Before using the HERS model, FHWA used an engineering model that compared highway conditions with engineering standards, identified deficiencies, and calculated investment needs by totaling the costs of fixing all the deficiencies. In contrast, the HERS model compares the relative costs and benefits associated with potential highway improvements, such as widening or resurfacing, to identify those that are economically justified. The HERS model begins by assessing the current condition of the highway sections in its database. It then projects the future condition and performance of the highway sections on the basis of expected changes in factors such as traffic, pavement condition, and average vehicle speed. (See fig. 1.) The model identifies deficient highway sections, ranks improvements by economic merit (benefits exceeding costs), and then selects improvements. Benefits considered include reductions in factors like travel time, vehicle operating costs, accidents, and vehicle emissions over the lifetime of the improvement, while costs considered include the capital expenditures required to construct the improvement.[3]

[2]The most recent report in the series was *1999 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance*, DOT (FHWA-PL-00-016, May 2000).

[3]The technical specifications for both models are documented in *Highway Economics Requirements System Technical Report* DOT (FHWA, June 2000).

Figure 1: Simplified Representation of the HERS Modeling Process



Source: FHWA data.

The total cost of constructing selected improvements represents the future investment requirement for highways included in the HERS model. FHWA can calculate these costs on the basis of several different scenarios. For example, under the "economic efficiency" scenario, the model selects and implements all the improvements for which benefits exceed costs. Under the "maintain current (pavement) conditions" scenario, the HERS model selects and implements the least costly mix of improvements that would maintain average pavement conditions. Under a third scenario, designed to address road congestion, the HERS model selects the least costly improvements that would maintain current travel times.

To run the HERS model, FHWA uses highway condition and performance data that each state collects and annually updates on a sample of highway sections[4] representing different highway classes.[5] The highway sections range in length from 1 block to 10 miles. States are to report detailed highway data for sampled[6] highway sections. The data include information on highway capacity, traffic volume, pavement roughness, lane widths, and

[4]The HERS model is also capable of analyzing all sections in the highway classes it models. When the model uses a sample of highway sections, it also uses "expansion factors" that extrapolate highway conditions and improvement costs to a state or national level.

[5]FHWA maintains the resulting database, known as the Highway Performance Monitoring System (HPMS). The nine classes of highways reported for FHWA's HPMS database are (1) urban interstates, (2) rural interstates, (3) urban freeways and expressways, (4) urban other principal arterials, (5) rural other principal arterials, (6) urban minor arterials, (7) rural minor arterials, (8) urban collectors, and (9) rural major collectors. The three FHWA highway classes not reported for FHWA's HPMS database are (1) urban local roads, (2) rural local roads, and (3) rural minor collectors.

[6]In 1997, states reported detailed data for 125,000 sampled highway sections. The number of sample sections was reduced to 112,000 in 1999.

other physical characteristics. In addition to collecting these data, the states develop forecasts of traffic growth for each section.

We reviewed the HERS model and reported in June 2000 that HERS provided the Congress with a more useful and realistic estimate of needed highway improvements than earlier models had. In particular, we found that a major strength of the model is its ability to assess the relative benefits and costs associated with making alternative highway improvements. In addition, an expert panel of economists and engineers from the public and private sectors convened by FHWA in June 1999 found that FHWA has strengthened HERS over time and that recent refinements have increased the model's applicability and credibility. Nonetheless, we found that the HERS model also has some limitations. First, since the model analyzes each highway section independently rather than the entire transportation system as a whole, it cannot reflect how changes in one part of the system might affect another part of the system, such as how traffic might be redistributed[7] as improvements are made. Second, the HERS model uses a computational "shortcut" to approximate the lifetime benefits associated with an improvement. Several transportation modeling experts have questioned whether this approach reasonably approximates future benefits. Third, because the HERS model is not designed to quantify the uncertainties associated with its methods, assumptions, and data, the model cannot estimate the full range of uncertainty[8] within which its estimates vary. Finally, the model excludes certain classes of the nation's highways from its analysis, meaning that FHWA must use alternate methods to forecast investment needs for these classes of highways.[9]

[7]Although the effect of this limitation is unclear, explicitly modeling the entire transportation network is not possible with the current state of the art in modeling or available data. The HERS model incorporates the concept of price elasticity, which FHWA officials believe captures the net effect of all changes in the transportation network. The model uses price elasticity to assess the response of drivers to changes in the cost of traveling on a highway, partly mitigating the benefits of a highway improvement. For example, because improving a highway lowers travel costs, some drivers may respond by driving more often. As a result, traffic on the improved highway may increase more quickly than anticipated, reducing the future benefits of the improvement.

[8]In its 1999 biennial report on investment requirements, FHWA accounted for some uncertainties by doing "sensitivity analyses" to measure how much its HERS estimates change when the value of certain key inputs or assumptions used in the model are changed.

[9]The HERS model does not analyze the three classes of roads that are not included in FHWA's database: rural minor collectors, rural local roads, and urban local roads. Furthermore, HERS does not estimate investment requirements for possible new roads.

Like FHWA, state departments of transportation undertake planning and reporting activities to manage their highways and determine their capital needs. For example, under federal transportation planning requirements, states must carry out a process for considering the effect of transportation projects on a variety of factors, including the economy and the environment. States are also required to develop both long-range plans covering at least 20 years and transportation improvement programs (state investment plans) that cover at least 3 years. These requirements help ensure that state transportation projects come from a systematic planning process rather than from a "wish list" of transportation projects. To meet these planning and reporting requirements, some state DOTs have had to rely on their technical capabilities. Many states have developed pavement management systems to help them systematically analyze data on existing highways and project future pavement needs. For example, several states have used models, based on pavement engineering criteria, to analyze pavement needs either at the project level or for a whole statewide network. Some states have also adopted a predecessor of the HERS model developed by FHWA, called the Analytic Process model, that compares highway conditions with engineering criteria to identify potential improvements.

After FHWA developed the HERS model, two states contracted to have customized state-level HERS models developed for them. Oregon DOT, when updating its long-range statewide highway plan, hired the same consultant that had produced HERS for FHWA. That consultant recommended that Oregon DOT use a customized version of the HERS model for its statewide plan. Similarly, when Indiana DOT engaged the same consultant for a corridor planning study,[10] the consultant recommended that Indiana DOT use a customized version of the HERS model for its corridor planning analysis. Indiana DOT subsequently used its model's results to draft a new statewide highway plan.

[10]Corridor planning studies examine the feasibility of future highway improvements. A corridor connects significant end points and typically is longer than any single highway project. Corridor studies are initiated well in advance of specific improvement projects, allowing a highway agency to secure or preserve rights-of-way before any actual projects are initiated.

FHWA Developed the HERS-ST Model as an Investment Analysis Tool for Highway Planning at the State Level

After its positive experience with the national-level HERS model and the model's successful adaptation in Oregon and Indiana, FHWA began to formally develop HERS-ST in 1999. FHWA expects that states will use the model in a variety of ways to facilitate planning for highway investment.

The National-Level HERS Model Produces Useful Information About Highway Investments

Our review of the national-level HERS model showed that its results provide legislative and executive branch officials with useful information for decisions about highway investments. Legislative branch officials said they use the estimates to obtain general information on the nation's need for infrastructure investments and find the HERS estimates more useful than previous estimates that were based on engineering analyses alone.

FHWA views the national-level HERS model as a step forward in its efforts to meet the statutory requirement to report on the conditions and performance of the nation's highways and future national highway investment requirements. FHWA officials also said that the HERS model's benefit-cost approach complies with an executive order[11] that requires federal spending for infrastructure to be based on a systematic analysis of expected benefits and costs. FHWA concluded that state transportation and other officials might find HERS-type analysis helpful in analyzing highway investments as well as supporting federal planning requirements.

Two States Are Using Customized Versions of the HERS Model

Facing increased funding constraints along with a greater demand for expenditure accountability, Oregon officials made use of a customized HERS model to prioritize needs and determine deficiencies in its highway system.[12] Oregon officials cite their HERS model's effective use of benefit-cost analysis as a foundation for determining the best combination of

[11]Executive Order 12893, Principles for Federal Infrastructure Investments (1994), discusses the importance of continuous infrastructure investment to sustained economic growth. The order directs federal agencies with infrastructure investment responsibilities to plan for investments using a systematic analysis of expected benefits and costs.

[12]Oregon received its customized version of the HERS model in early 1998.

improvements and for allocating resources between programs. Oregon officials have found these benefit-cost results useful for highway planning, corridor planning, and goal setting. For example, when analyzing the 1999 Oregon Highway Plan (an element of the required long-range plan), state officials evaluated investment tradeoffs between system preservation projects—capital projects that ensure that a highway continues to serve its intended purpose—and modernization projects—capital projects that typically increase capacity. Oregon's report said that this analysis helped the Oregon Transportation Commission gain a clear picture of the condition of the highway system under different funding scenarios and thus helped the Commission make difficult investment decisions. (See app. II for information on the technical features of the Oregon model.)

Indiana's DOT sought out a modified version of the HERS model in an attempt to improve its planning process and, more specifically, to strengthen its technical planning tools.[13] Indiana officials wanted a model that would analyze benefits and costs for all of the state's highway projects, and they decided that a modified version of the HERS model would meet their needs. These officials used their HERS model to analyze highway investment needs over a 25-year period, including a comparison of the status of the highway system at different levels of funding. In addition, Indiana officials used their model to analyze highway investment needs at the district level within the state. The Indiana model has a unique feature that links specific model results with a geographic information system (GIS) that visually displays results on state highway maps. This feature allows the staff to compare district offices' and metropolitan planning organizations' priorities with the ones the model identifies. (See app. II for information on the technical features of the Indiana model.)

[13]Indiana received its customized version of the HERS model in 1998.

FHWA Developed the HERS-ST Model to Help States Plan and Manage Their Highways

After FHWA officials reviewed their positive experience with HERS, along with the positive experiences of Oregon and Indiana with their customized HERS models, they decided to consider developing a HERS model that all states could use. FHWA's Office of Asset Management[14] commissioned two studies to identify the potential role of a HERS model in helping states assess their highway investment needs and develop state highway plans. The studies demonstrated a potential state interest in a state-level HERS model. Therefore, FHWA developed a prototype state model, HERS-ST, from the national-level HERS model that any state could use for planning and programming activities. FHWA officials believe that states could use the HERS-ST model to perform benefit-cost analysis on highway improvements and to forecast the future condition and performance of state highway systems. In addition, the Office of Asset Management's *Asset Management Primer*[15] explains that HERS-ST has the potential to help state-level policy makers address resource allocation questions because the model can analyze "what if" questions using specific funding levels. For example, the model can show the long-term effects that different levels of spending or different emphases in investment could have on the condition and performance of highways. The primer also states that the model may even help some states meet new Government Accounting Standards Board provisions requiring states to report the cost of maintaining their transportation infrastructure assets.[16]

The HERS-ST model that FHWA developed is based on and operates in much the same way as the national-level HERS model, with a few noteworthy differences. Like the HERS model, HERS-ST (1) projects the future condition and performance of a state's highway system, (2) assesses whether any highway improvements are warranted, and (3) selects

[14]FHWA established the Office of Asset Management in February 1999 to help states systematically manage and analyze their highway assets. FHWA is to encourage states to systematically analyze the benefits and costs of highway infrastructure investments, according to Executive Order 12893.

[15]*Asset Management Primer*, DOT (FHWA-IF-00-010, Dec. 1999).

[16]Starting in 2001, state governments will have to follow a new accounting standard, known as GASB Statement No. 34, that generally requires governments to report their infrastructure assets at historic cost and depreciate them over time. Since depreciation may not always be appropriate, the rule also allows governments with adequate asset management systems to disclose the estimated amount required each year to maintain and preserve their assets. The HERS-ST model may help governments follow this second approach.

appropriate improvements using benefit-cost analysis. One difference between the HERS and HERS-ST models is that the HERS-ST model has an "override" feature that allows a state official to override highway improvement selections made by the model in order to reflect specific, local conditions. According to FHWA officials, the model's override feature will enable state officials to apply specific knowledge about highway improvements (such as whether implementing a particular improvement is feasible) that may not be reflected in the model's database. For example, an official might specify that the model reconstruct a highway section rather than resurface it because of problems with the underlying structure of the pavement that are not yet apparent from measurements of the pavement's roughness. The override feature is unique to the HERS-ST model. Another difference is that the HERS-ST model is capable of providing detailed results about each of the highway sections it analyzes, including information on the particular improvement selected, the expected future condition of the section, and the benefits and costs of making the improvement. By contrast, the HERS model generates only summary results for the classes of roads it analyzes.

In addition to these differences between the two models, the HERS-ST model offers states further options regarding what data to consider. State officials can adjust the HERS-ST model to reflect state conditions by, for example, using state highway construction costs rather than national average costs. And state officials may use HERS-ST either to analyze the statistical sample of their state's highways included in FHWA's Highway Performance Monitoring System (HPMS) database or, if they have the appropriate data, to analyze all highway sections in the state's system. While the HERS model could also analyze all highway sections, it is currently limited to analyzing only the sample of sections in the HPMS database. When the HERS-ST model's projections are based on sampled sections in the HPMS database, the projections may not account for all the highways for which a state department of transportation is responsible.[17] However, the state can, if it has appropriate data on all its highway sections, use the HERS-ST model to analyze every section in the state highway system, as Oregon and Indiana did with their customized HERS

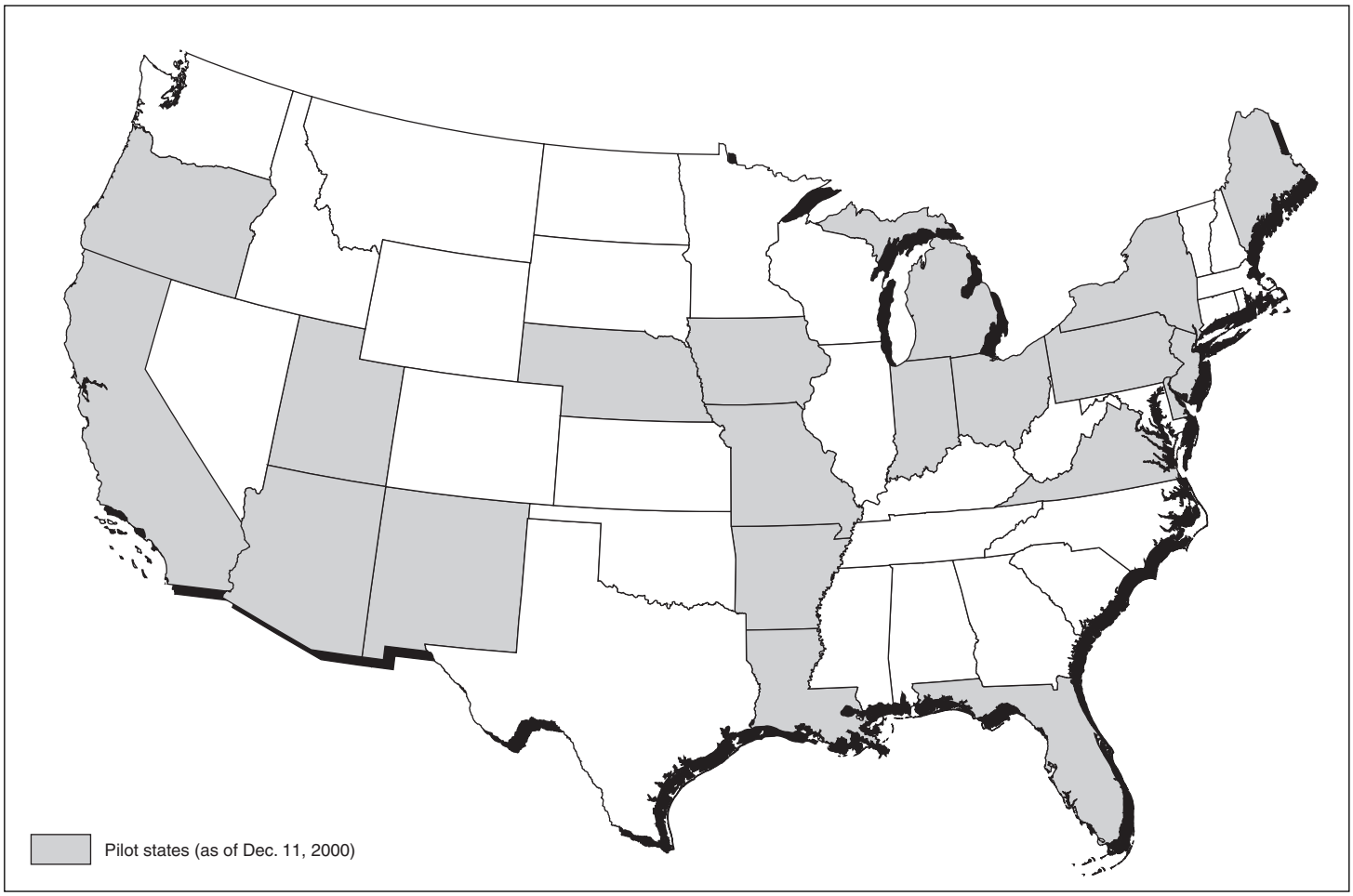
[17]The sample data may exclude highways for which the state is responsible, like local roads or rural minor collectors, or include highways for which the state is not responsible. For example, according to an Indiana official, Indiana's sample data addresses 30,000 miles of highway, of which only 12,000 miles are within state jurisdiction.

models. (See app. II for a more detailed comparison of the national-level HERS and HERS-ST models.)

FHWA Provided HERS-ST to States Through a Pilot Project

FHWA distributed the prototype HERS-ST model software to 20 states volunteering to participate in its pilot project, which is intended to gauge interest in the model and to further identify potential uses for and revisions to it. Interest in the model was higher than FHWA expected. According to an FHWA official, the agency expected to have five states participate in the pilot. However, the number of interested states grew to 20, including Indiana and Oregon, before the pilot began. (See fig. 2.) Indiana and Oregon officials said they wanted to participate in the pilot program to learn about new features incorporated into the HERS-ST model and to share their customized HERS model experience with other pilot states.

Figure 2: States Participating in the HERS-ST Pilot Program



Source: FHWA information.

In December 2000, FHWA distributed the model, along with technical manuals and state-specific sample data on highway sections needed to run the model, to the 20 pilot project states. This distribution took place about 2 months before the pilot's February 2001 kickoff workshop in New Orleans, Louisiana. The workshop was designed to train participating states in the use of the HERS-ST model. It included general information on the use of the model, information on Indiana's and Oregon's experiences with their customized HERS models, and technical review and training. FHWA officials plan to focus their efforts during the pilot program on providing technical support to participating states. FHWA officials also

hope to provide training for state policymakers to explain how the HERS-ST results can be used.

FHWA anticipated that the pilot project would conclude after approximately 2 months. However, the agency was prepared to extend the duration of the pilot if states indicated that additional time would be helpful. At the conclusion of the pilot, participants will be asked to report on (1) their experiences testing the model, (2) their assessment of the model's usefulness in state planning and programming activities, and (3) their recommendations for further FHWA initiatives with respect to the model. FHWA expects to report by August 2001 on states' comments and its own recommendations for further HERS-ST model initiatives. FHWA officials said that the agency will consider changes to the HERS-ST model at the end of the pilot project, depending on the number of states that identify particular changes as important.

States Participating in FHWA's Pilot Project Expect to Use HERS-ST to Supplement Their Planning Tools With Economic Information

Officials from almost all of the eight states we randomly selected[18] indicated that although they had limited knowledge about HERS-ST, they were looking forward to expanding their states' technical tools to better support their planning processes. When asked why they planned to participate, the state officials said that, while they did not have details of how the model works, they did not want to miss out on any tool that might improve their planning and highway management. In general, the state officials also expressed some level of dissatisfaction with their current planning tools. As one state official explained, her DOT was always looking to improve its planning process. (See app. III for the results of our discussions with state officials about the HERS-ST model.)

A number of state officials indicated that the HERS-ST model's benefit-cost analysis capability is an important feature that made the model attractive to them. In response to a question about why states wanted to participate in the pilot, officials from most of the states said that they hoped the model would help improve their knowledge about the economic impact of investment decisions. Officials from five of these states believe this would help the states prioritize projects and maximize the effect of their spending. An official in one state said that the state's highway funding depends, in

[18]See app. I for details of our methodology for selecting eight states to interview from among the states considered likely to participate in the HERS-ST pilot program when we contacted FHWA in September 2000.

part, on a study of infrastructure needs. However, the state's infrastructure study is based on the assumption that highway funding is unlimited. Thus, the official believes the results of the needs study are unrealistic. The official hopes HERS-ST can contribute economic reality to the state highway funding plan.

When presented with a list of potential uses for the HERS-ST model results, state officials we interviewed said that, if the model provided realistic results, they would consider using the results in the following tasks:

- comparing benefits and costs of making alternative highway improvements;
- developing state highway plans, such as state transportation investment plans, long-range highway plans, local highway needs forecast assessments, and corridor studies;
- satisfying the requirements of the Government Accounting Standards Board's provisions for reporting on the value of transportation infrastructure assets;
- allocating funds to offices within the state highway agency (for example, by district). (See app. III for a more detailed list of potential uses.)

For example, one state official indicated that his state plans to update its long-range highway plan shortly and hopes that HERS-ST may be useful for that work. Overall, officials indicated that the three most important uses for their states would probably be (1) performing benefit-cost analysis of alternative highway improvements, (2) developing or refining state transportation investment plans, and (3) assessing highway needs forecast by state district offices or local agencies.

Potential Improvements to the HERS-ST Model

If states involved in the pilot project find that the HERS-ST model is useful, FHWA expects to upgrade it for future state users. First, FHWA plans to make certain changes to the HERS-ST model to keep it current with analytical improvements planned for the national-level HERS model. Second, FHWA is considering changes designed to make the model easier for states to use. Finally, states might also ask that FHWA enhance the HERS-ST model so it can analyze more detailed highway information.

FHWA Plans to Upgrade HERS-ST

According to FHWA officials, if the pilot participants find the HERS concept attractive, FHWA will, as appropriate, provide for revising the HERS-ST model so that it will benefit from upgrades to the national-level

version of the model. FHWA officials said their improvement plans for the national-level version of HERS include eliminating the computational shortcut that we identified as a limitation in our June 2000 report. This shortcut is designed to approximate the lifetime benefits associated with a highway improvement. However, the approximation may not fully represent the lifetime benefits, and FHWA officials acknowledge that improvements in computing power have made it unnecessary. FHWA also plans to change the national-level HERS model by

- incorporating pavement performance data based on climate zones instead of assuming one rate of pavement deterioration,
- revising its highway-capacity analysis to reflect changes in the Transportation Research Board's Highway Capacity Manual,
- revising the emissions data used as soon as the Environmental Protection Agency finishes revising its emissions model, and
- updating pavement improvement costs, currently based on 1988 data, to represent 1998 or 1999 data.

HERS-ST Could Be Modified to Make the Model Easier for States to Use

As part of its evaluation of the pilot project, FHWA plans to ask state officials for suggestions of potential improvements to the model. Assuming the project continues past the pilot phase, FHWA officials say they will consider making those changes that will benefit multiple states. Our interviews with state, FHWA, and other officials indicate that states may ask FHWA to modify HERS-ST in ways that make the model easier to use without altering the model's analytical structure. One state official expressed concern over the user-friendliness of the model, having heard that the HERS-ST program is not user-friendly because it operates in an older DOS-based computer environment that department staff might not be familiar with. An FHWA consultant reviewing the HERS model concluded that updating the model so that it can operate in a more user-friendly menu-driven environment might be the key to increasing the number of states that use the model. FHWA officials agreed that a menu-driven program would make the model easier for states to use.

The HERS-ST model would also be easier for states to use if it accepted highway data in the same format that states use in their annual data submissions for FHWA's HPMS database. The HERS-ST model requires input in the 1993 data reporting format, not the current HPMS format. To assist states participating in the pilot project, FHWA provided each one with its highway data already reformatted for use with the HERS-ST model. However, state officials wishing to analyze other highway sections in their

states would have to reformat their data to the older format before the model could use it. An FHWA consultant, commenting on ways that the HERS model could be more useful to states, recommended that the model accept data corresponding to the latest format that FHWA requires for state HPMS data submissions. FHWA officials recognize that widespread use of the HERS-ST model would require addressing this situation.

HERS-ST Could Be Modified to Better Fit States' Analytic Needs

Our interviews with state and FHWA officials indicate that some states would like the HERS-ST model to analyze more detailed pavement management data. Many states have developed sophisticated pavement management systems that analyze more data than the pavement deterioration analysis done in the HERS or HERS-ST models. For example, a number of states already have pavement management systems that consider several types of pavement distress data. HERS-ST, like the HERS model, relies on data states report in the form of the International Roughness Index[19] or the Present Serviceability Rating.[20] Officials from four of the states we spoke with reported that they collect both roughness index data and serviceability rating data. However, these officials noted that they do not use roughness index data for planning purposes, preferring to rely on their serviceability rating or the other data for highway system planning. Officials from half of the states we contacted said they only collect roughness index data at FHWA's request and they base their internal planning analysis on pavement rating data in their pavement management systems. In addition, officials from two states said they were not satisfied with the quality of their states' roughness index data and preferred to rely on their pavement rating data.

FHWA officials also said they expect to address some of these concerns by incorporating more pavement distress data in the HERS model at some

[19]The roughness index is based solely on surface roughness measurements. Most states collect these data with specially equipped vans traveling at highway speeds. FHWA instructs states to report the roughness index for all the major roads in the country. FHWA encourages states to report the index for all other highway sections sampled for the national highway database.

[20]The serviceability rating is a subjective approach for quantifying pavement condition. Prior to 1993, FHWA asked states to report the serviceability rating for all highway sections in its national highway database. FHWA still allows states to report serviceability ratings for highway sections in its national database that are not major roads. If a state reports both roughness index data and serviceability rating data to FHWA, the HERS model uses the roughness index data for analysis.

point in the future. However, they will not do so until such data are available to FHWA from all the states.[21] FHWA officials said they are willing to support only one version of the HERS-ST model. But because states use various pavement distress measures, it is not clear to FHWA officials whether including these additional pavement data in the HERS-ST model would satisfy all states' concerns.

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Transportation for review and comment. Officials from the Department generally agreed with the report. These officials also provided technical and clarifying comments, which we incorporated into the report as appropriate.

We conducted our review from June 2000 through February 2001 in accordance with generally accepted government auditing standards.

We will send copies of this report to cognizant congressional committees; the Honorable Norman Y. Mineta, Secretary of Transportation; and the Administrator, Federal Highway Administration.

If you or your staff have any questions about this report, please contact me at (202) 512-2834. Appendix IV lists key contacts and contributors to this report.

Phyllis F. Scheinberg,
Director, Physical Infrastructure Issues

[21]Officials from the states we spoke with reported that their pavement planning data include pavement condition measures beyond roughness, such as rutting, cracking, and faulting. The American Association of State Highway and Transportation Officials recently developed standards for roughness, rutting, and faulting and is developing a standard for cracking.

Scope and Methodology

To determine why the Department of Transportation's (DOT) Federal Highway Administration (FHWA) developed a state-level version of the Highway Economic Requirements System (HERS) computer model and how FHWA expects that states will use the model, we first reviewed our work and resulting June 2000 report on the strengths, limitations, and uses of the national HERS model. We then interviewed FHWA officials about their state-level HERS model (HERS-ST). We also reviewed FHWA documents about the HERS-ST model and projects in FHWA's Office of Asset Management. Finally, FHWA officials and HERS contractors told us that two states—Indiana and Oregon—were using state-level HERS models. We visited Indiana and Oregon to discuss the use of these models with officials in the Indiana and Oregon state departments of transportation and obtained and reviewed available model documentation and state products generated using their HERS models.

To determine how FHWA is making the state-level HERS model available to states, we spoke with FHWA officials about their pilot-project plans. We also reviewed the pilot project workshop agenda and attended the workshop in February 2001. We reviewed HERS-ST model documents, including the draft *Highway Economic Requirements System Technical Manual* and the draft *Highway Economic Requirements System Users Manual*, and we talked with model developers to determine how the model was developed. Finally, we reviewed FHWA's evaluation plan for the HERS-ST pilot project and the time frame for the project.

To determine how states expect to use the HERS-ST model and its results, we reviewed reports by FHWA consultants on the potential role of HERS in state-level investment decisions and talked with officials from a random selection of 8 of the 16 states that planned to participate in FHWA's pilot project. The 16 states represent all states that FHWA reported were planning on participating in FHWA's pilot program as of September 5, 2000, with the exception of Indiana and Oregon. We excluded Indiana and Oregon from this random sample because both states are already using customized state-level HERS models, and we were already planning to conduct site visits for these two states. Table 1 shows the 8 states we contacted, as well as the 16 states from which we chose the sample.

Table 1: HERS Pilot Project States and Eight States Randomly Selected for Interviews

Universe of states and selected states	
Arizona	Missouri
Arkansas	Nebraska
Delaware	**New Jersey**
Florida	New Mexico
Iowa	**Ohio**
Louisiana	Pennsylvania
Maine	Rhode Island
Michigan	**Utah**

Note: These 16 states represent the states that were included in FHWA's pilot project as of September 5, 2000, with the exception of Indiana and Oregon. Randomly selected states are in bold.

Source: FHWA information.

To obtain consistent information from the eight states we contacted, we used a semi-structured interview format. See appendix III for a copy of the interview document with the results of our discussions with the eight states. As of December 11, 2000, the number of states that planned to participate in FHWA's HERS-ST pilot had grown to 20. See figure 2 in the letter for a map of the 20 states.

To identify potential changes that could be made to the model, we discussed this issue with a wide variety of groups, including FHWA officials, the consultant who developed the HERS-ST and the Indiana and Oregon HERS models, state officials using the Indiana and Oregon models, state officials planning on using the HERS-ST model, and others, such as academics, who have used the HERS model. We also reviewed information on pavement measurement data, including our previous work on pavement measures.[1]

[1] *Transportation Infrastructure: Better Data Needed to Rate the Nation's Highway Conditions* (GAO/RCED-99-264, Sept. 27, 1999).

Information About HERS Models

This appendix describes technical aspects of the HERS computer model and the three related models designed for use by state highway planners.

FHWA's HERS Model

The HERS model simulates infrastructure improvement decisions for the highways it models by comparing the relative benefits and costs associated with alternative improvement options. In conducting its analysis, HERS uses an extensive set of data that are primarily collected and updated by the states and maintained by FHWA in the Highway Performance Monitoring System database. In addition, the HERS model performs its analysis using several submodels representing specific highway processes, including traffic growth, pavement wear, vehicle speed, accidents, and highway improvement costs. The analysis, which is based on the current condition of the highway system, is conducted over four 5-year periods, for a total of 20 years. The HERS model draws information from the database and analysis from the submodels to identify deficient sections, evaluate alternative improvement options, and select and implement improvements. HERS uses benefit-cost ratios (benefits divided by costs) to evaluate and select improvements under several investment scenarios that FHWA developed. The benefits include reductions in travel times, vehicle operating costs, and agency maintenance, while the costs include the capital expenditures necessary to construct the improvement. The model reports its results in a series of tables showing the cost of improvements needed to support the model's investment decisions for each highway class and funding period analyzed.

The HERS model has several strengths:

- The model's major strength is its ability to assess the relative benefits and costs associated with alternative options for making improvements on the nation's highways. The HERS model selects for implementation only those improvements that are economically justified according to its analysis, a significant improvement over FHWA's previous methods, which used engineering standards to identify deficiencies and select improvements without regard to economic merit.
- Another strength of the HERS model is that FHWA has consulted with experts in order to assess the model's reasonableness and improve it. For example, in June 1999, FHWA convened an expert panel consisting of economists and engineers from the public and private sectors. This panel found that FHWA has strengthened the model over time and that the recent refinements have increased its applicability and credibility.

The HERS model has some limitations:

- First, because the HERS model analyzes each highway section independently rather than the entire transportation network, it cannot completely reflect changes occurring among all highways and modes in the transportation network at the same time. For example, it will not reflect how, as improvements are made, traffic might be redistributed from other existing highway sections to an improved highway section. By incorporating price elasticity into the model, FHWA officials assume that the model captures the net effect of all changes in the transportation network as well as in the overall economy. Although the implication of this limitation is unclear (it may over- or under-state the effect of changes in traffic resulting from a highway improvement), explicitly modeling the entire transportation network is not possible with the current state of the art in modeling or available data.
- Second, because the HERS model is not designed to quantify the uncertainty associated with its methods, assumptions, and data, the model cannot estimate the full range of uncertainty within which its estimates vary. As a result, the precision of the model's estimates is unknown. The HERS model's estimates rely on a variety of estimating techniques and hundreds of variables, all of which are subject to some uncertainty. However, changing the model to fully account for uncertainty in its factors is not likely to be cost-effective because it could require extensive and expensive reprogramming. We recommended in our June 2000 report that FHWA clarify, when publishing the results of HERS model analyses, that there is uncertainty associated with the results. State-level users can account for some uncertainty by conducting "sensitivity analyses" to measure how much the model estimates change when the values of certain key inputs or assumptions used in the model are changed.

- Third, the HERS model uses a computational "shortcut" to approximate the lifetime benefits associated with an improvement. Conceptually, benefits such as reductions in travel time accrue over each improvement's full lifetime, 20 years or more. However, in its initial evaluation of whether to improve a highway section, the HERS model calculates benefits only during the first 5-year period. To account for the benefits accruing after the first 5-year period, FHWA developed a shortcut that essentially uses an estimate of the improvement's construction cost as a proxy for the improvement's remaining future benefits.[1] FHWA developed the shortcut several years ago, when limitations in computer processing power necessitated simplifying some of the calculations. Given recent improvements in computing power, FHWA officials plan to modify the HERS model to account for lifetime benefits and see correcting the shortcut as a potential improvement for the HERS-ST model as well.
- Fourth, although FHWA has taken steps to ensure that the data used in the HERS model are reasonable, some of these data vary in quality. For example, the model uses emissions data that may not be representative of actual conditions. To estimate the emissions associated with traffic on a given section, the model uses information from the Environmental Protection Agency (EPA) on emissions rates per vehicle type and speed. Vehicle emissions, however, may depend more on how the vehicle is driven than on the total miles driven. FHWA officials told GAO they will update these data once EPA finishes revising its emissions data. In addition, we reported earlier that the pavement roughness data reported by the states to FHWA are not comparable, partly because the states use different devices and approaches for measuring roughness.[2] The HERS model uses the roughness data in projecting the pavement condition of each section. FHWA is supporting efforts to standardize states' pavement roughness measurements. Moreover, some information used in the model is dated. For example, the pavement resurfacing costs used in the HERS model are based on 1988 data (adjusted for inflation from 1988 to 1997). FHWA officials said they plan to update the HERS model's resurfacing costs, and the HERS-ST model offers users the option of introducing their own construction cost data.

[1]With this shortcut, the HERS-ST and HERS models assume that the remaining future benefits of an improvement can be approximated by the costs that would be avoided by making the improvement in the current 5-year period.

[2]*Transportation Infrastructure: Better Data Needed to Rate the Nation's Highway Conditions* (GAO/RCED-99-264, Sept. 27, 1999).

HERS Model Used in Oregon

The Oregon Department of Transportation obtained the first customized HERS model in 1998. Oregon hired a consulting firm, Cambridge Systematics, Inc., to help the state develop a long-range statewide highway plan. The consulting firm, which also developed the HERS model for FHWA, worked with Oregon officials to customize the HERS model, which resulted in the creation of HERS/OR. Oregon never received specific documentation for its model. But according to Oregon officials and the consultant, the model differs from the national-level HERS model in the following ways:

- HERS/OR allows the user to override the model's improvement decisions for specific sections, for example, for a road that cannot feasibly be widened due to a nearby mountain.
- HERS/OR's output includes two innovations: a section-by-section report providing details on individual improvements for each segment for each funding period and a revised summary table of improvements for the state's four unique highway classifications.
- HERS/OR's procedures for analyzing price elasticity are rudimentary when compared with the current HERS model, and data on vehicle accident costs are older.

HERS Model Used in Indiana

The Indiana Department of Transportation contracted in 1998 for a customized HERS model known as HERS/IN. HERS/IN is also similar to HERS, but has more unique features than HERS/OR:

- HERS/IN, like HERS/OR, analyzes all sections of its state highway system.
- HERS/IN uses its own data on construction costs, allowing the model to base its estimates of construction costs on more exact, local data.
- HERS/IN is capable of using pavement improvement decisions from the state's sophisticated pavement management system. However, Indiana DOT staff had not used this feature by the time we conducted our work.
- Unlike the national-level HERS model, HERS/IN allows its user choices for overriding modeled improvement decisions. For example, the user can specify the type of improvement, its cost, its timing, and the improvement's effect on highway capacity. Indiana DOT has not used this feature, according to officials.
- HERS/IN's output includes the basic national-level HERS output tables, plus section-by-section improvement tables like those of HERS/OR and tables that summarize highway improvements' benefits for users due to

decreased travel time, decreased operating costs, and increased highway safety. In addition, HERS/IN's output is used to generate maps to display the location of its improvement plans. The model is designed to feed its output data into a geographic information system software package that produces maps of the model's proposed improvements. The Indiana Department of Transportation officials said that this feature improves their ability to display the location of the HERS/IN model's decisions to policymakers. Furthermore, the maps help the state staff determine whether or not HERS/IN's decisions are realistic. For example, if two major improvements are proposed for nearby sections of highway, the maps could alert the agency that, to avoid traffic problems in that area, the projects should not be performed simultaneously.

- HERS/IN is able to consider the construction of new highways that might be needed to provide capacity for future travel demand. The Department has a sophisticated travel-demand model that supports this HERS/IN feature. Found in no other version of the HERS model, this feature allows Indiana DOT to specify new highways and the effect of capacity improvements on traffic systemwide, as well as to compare alternative improvements for addressing a capacity problem. Indiana DOT has not used this feature, according to officials.
- Unlike the HERS model, the HERS/IN model is not used to assess the effect of highway travel on the environment. According to state officials, the HERS/IN model could take environmental data into account when making its decisions, but the officials did not feel this feature was feasible in their model.

The HERS-ST Model

The HERS-ST model is the most recently designed HERS model. Generally, HERS-ST offers the analytic approaches available in the most recent HERS model revision. Because it is based on the HERS model, it has the same strengths and limitations that were noted above. However, the HERS-ST model differs from the national-level HERS model in the following ways:

- Unlike the HERS model, the HERS-ST model has an "override" feature that allows a user to override some or all of the improvement decisions made by the model. For example, the user can specify the particular type of improvement to be made on a highway section in any particular funding period. In the override mode, the model selects the user-specified improvements regardless of whether they are economically justified. According to FHWA officials, the model's override feature will enable state users to apply specific knowledge about highway

improvements (such as whether implementing a particular improvement is feasible) that may not be reflected in the model's database.

- In addition to the override feature, the HERS-ST model differs from HERS in the number of highway classes it can analyze and the level of detail of the results it generates. For example, the HERS-ST model can analyze highway sections from all 12 of FHWA's classes of roads, including rural minor collectors and urban and rural local roads. The HERS model is designed to analyze sampled sections from 9 of the 12 highway classes. Also, the HERS-ST model is capable of providing the user with detailed results on the highway sections it analyzes, including information on the particular improvement selected, the expected future condition of the section, and the benefits and costs of making the improvement. FHWA officials stated that this feature would enable the state user to study what happens on individual sections. By contrast, the HERS model generates only aggregate results for classes of roads.
- Both the HERS-ST and the HERS models also use data from studies of the national economy. However, the state user can modify some of these data to reflect conditions in his or her state. For example, both models count as a benefit any reduction in travel time brought about by a highway improvement. In making this calculation, FHWA uses average national hourly compensation data from the Department of Labor's Bureau of Labor Statistics to quantify the dollar value of travel time saved by travelers on work-related trips. In the HERS-ST model, the state user could substitute state-level data to derive an alternative estimate of travel time savings.

The HERS-ST model also offers the state user a choice between analyzing a statistical sample of highways represented in FHWA's HPMS database or the option of analyzing all highway sections in the state's system.

State Use of the HERS Model

While the HERS-ST model pilot project is FHWA's first attempt to promote state use of a HERS model, the agency previously released copies of the HERS model. The model's existence was well publicized because it had been described in DOT's biennial Conditions and Performance reports starting with the 1995 edition,[3] it was profiled in studies,[4] and it was cited in TEA-21. By 1998, FHWA was providing HERS model documentation and computer files to parties who requested them. FHWA reported that 18 requesters, including state DOT officials, academics, and consultants, obtained copies of the model between April 1998 and September 2000. Michigan DOT officials who obtained copies of the model found that it did not suit their needs. They said that the HERS model was not useful to them because it would not handle all of the roads the department needed to study; available data would need reformatting to work with the model; and the results were aggregated at the network level, which was too general to be useful for the state's purposes. On the other hand, a researcher at North Dakota State University's Upper Great Plains Transportation Institute found the HERS model useful for state-level applications. He analyzed intermodal freight diversion (rail to truck or truck to rail) on behalf of two state transportation agencies. He also used HERS equations to analyze rural highway preservation for a third state transportation agency.

To compare key differences between the HERS model and related state-level models, see table 2.

[3] *1995 Status of the Nation's Surface Transportation System: Condition and Performance, Report to Congress*, DOT (FHWA-PL-96-007, Oct. 27, 1995).

[4] *The Economic Effects of Federal Spending on Infrastructure and Other Investments*, Congressional Budget Office, June 1998; *Road User and Mitigation Costs in Highway Pavement Projects*, NCHRP Synthesis 269, Transportation Research Board, National Research Council, 1999.

Table 2: Key Differences Between the HERS Model and State-Level HERS Models

Model Feature	Current HERS	HERS-ST	HERS/OR	HERS/IN
Highway data sections considered	Analyzes a statistical sample of sections from the nation's highways in FHWA's nine highest highway classifications.	Analyzes a statistical sample of sections from state's highways in FHWA's nine highest highway classifications. State user can modify database to include data representing all state highways.	Analyzes all highway sections in state highway system or a sample of sections.	Analyzes all highway sections in state highway system.
Cost of travel time	Uses average national hourly compensation data to value travel time.	Uses average national hourly compensation data to value travel time. Allows state user to substitute state-level data for national data.	Allows user to substitute state-level data.	Allows user to substitute state-level data. Indiana DOT has not done so.
Highway improvement cost factors	Uses FHWA price index for federal-aid highway construction, adjusted to correspond to particular state.	Uses FHWA price index for federal-aid highway construction, adjusted to correspond to particular state. Allows state user to substitute more specific state-level data for default values.	Allows user to substitute state-level data.	Uses state-specified pavement costs that differ from those in HERS.
Vehicle crash costs	Uses updated analysis developed for FHWA's 1999 Conditions and Performance Report.	Uses updated analysis developed for FHWA's 1999 Conditions and Performance Report.	Uses older analysis developed for FHWA's 1997 Condition and Performance Report.	Uses updated analysis developed for FHWA's 1999 Conditions and Performance Report.
Air pollution damages	Uses information based on vehicle emissions data from Environmental Protection Agency's MOBILE5a model.	Uses information based on vehicle emissions data from Environmental Protection Agency's MOBILE5a model.	Does not address.	Does not address.
Price elasticity	Uses rigorous approach to assess effect of changes in travel cost on drivers' behavior.	Uses rigorous approach to assess effect of changes in travel cost on drivers' behavior.	Uses rudimentary procedure to assess effect of changes in travel cost on drivers' behavior.	Uses rudimentary procedure to assess effect of changes in travel cost on drivers' behavior.
Model output about improvements	Generates improvement cost data for each of nine highway classifications. Cost of individual sections is not reported.	Generates improvement cost data for each of nine highway classes and for each section.	Generates section-by-section report for each funding period, plus tables summarizing the state's four highway classifications.	Generates section-by-section report, plus maps to illustrate improvements. Also creates tables of user benefits (travel time, operating cost, and safety).

(Continued From Previous Page)

Model Feature	Current HERS	HERS-ST	HERS/OR	HERS/IN
User override mode	Allows user to specify conditions under which improvements would be mandatory. This feature is not used for FHWA's Conditions and Performance reports.	Allows user to specify type, cost, effect, and timing of an improvement.	Allows user to specify type and timing of an improvement for two funding periods.	Allows user to specify type, cost, effect, and timing of an improvement.
Model can analyze new highways	Does not allow user to specify new highway projects to be implemented in future years.	Does not allow user to specify new highway projects to be implemented in future years.	Does not allow user to specify new highway projects to be implemented in future years.	Allows user to specify new highway projects to be implemented in future years. Indiana DOT has not done so.

Questionnaire for States That Asked to Participate in FHWA's Pilot Program for the State HERS Model

GAO U.S. General Accounting Office

Questions Regarding the State HERS Model

Introduction

The U.S. General Accounting Office (GAO) was directed by the Transportation Equity Act for the 21st Century to review state use of the Highway Economic Requirements System (HERS) model.

Specifically, the Congress is interested in the reasons states asked to participate in the Federal Highway Administration's state HERS model pilot program and planned uses for the model. FHWA has created a special version of the HERS model for its state HERS pilot project. This version closely follows the national HERS model but adds certain features that are designed to help state level planners. We will refer to this model as the HERS/ST model throughout the rest of this discussion.

For this review, we are calling a random sample of states that asked to participate in the pilot program. We are asking you to help by answering a few questions. Thanks for agreeing to participate in our review.

The results of this data collection effort will be presented in a report which is scheduled to be issued in spring, 2001.

Instructions

We are providing this list of questions to help you prepare for our upcoming phone conference on November _____at _____am/pm. When reviewing these questions, please coordinate with the appropriate members of your department.

If you have any questions, please call:

Rick Calhoon
312-220-7620
(e-mail calhoonr.chro@gao.gov)

Cathy Colwell
312-220-7655
(e-mail colwellc.chro@gao.gov)

Thank you for your help

[Note: We interviewed eight randomly selected states with this instrument. (See app. I for more information on the methodology.) Some questions may have fewer than eight responses because not all states provided an answer to each question.]

State Participation in Pilot Project

1. What were the reasons your state asked to participate in FHWA's HERS/ST model pilot project?

   Eight states provided narrative responses.

2. How satisfied are you with your state's current highway planning models and methods? *(Check one)*

   1. **[0]** Very satisfied
   2. **[3]** Moderately satisfied
   3. **[2]** Somewhat satisfied
   4. **[1]** Neither satisfied or dissatisfied
   5. **[1]** Somewhat dissatisfied
   6. **[1]** Moderately dissatisfied
   7. **[0]** Very dissatisfied

3. Does your state anticipate using the HERS/ST model for any of the following activities? (*Check one for each.*)

ACTIVITIES	Yes	No	Uncertain
1. Develop long range (20 year) state highway plan	**4**	**2**	**2**
2. Develop or refine state transportation investment plan	**4**	**1**	**3**
3. Prepare financial reports on highway infrastructure assets (to satisfy new accounting standards of GASB Statement No. 34)	**4**	**1**	**3**
4. Develop corridor studies	**4**	**0**	**4**
5. Develop highway budget proposals for the state legislature or agency leaders	**3**	**0**	**5**
6. Compare the benefits and costs of alternative highway improvements	**6**	**0**	**2**
7. Help your state with decisions regarding allocation of funds to offices within the state highway agency (e.g. districts, geographic regions)	**4**	**2**	**2**
8. Help your state with decisions regarding allocation of funds to local government units	**1**	**3**	**4**
9. Help assess highway needs forecast by state district offices or local agencies (e.g. MPOs, cities, local highway districts)	**4**	**1**	**3**
10. Other (Please specify) _____	**1**	**1**	**2**

4. Of the activities listed above, which is considered your state's most important potential use for the HERS/ST model? (*Check one*)

1. **[0]** Develop long range (20 year) state highway plan
2. **[3]** Develop or refine state transportation investment plans
3. **[0]** State financial reports of highway infrastructure assets
4. **[0]** Develop corridor studies
5. **[0]** Develop highway budget proposals for the state legislature or agency leaders
6. **[3]** Compare the benefits and costs of alternative highway improvements
7. **[0]** Help your state with decisions regarding allocation of funds to offices within the state highway agency
8. **[0]** Help your state with decisions regarding allocation of funds to local government units
9. **[2]** Help assess highway needs forecast by state district offices or local agencies (e.g. MPOs, cities, local highway districts)
10. **[0]** Other (Please specify)

_____

5. On what parts of your state highway system do you collect HPMS sample section data? (*Check one*)

1. **[5]** HPMS sample sections only
2. **[0]** HPMS sample sections and some other sections of the state highway system (*Please specify)*

_____

3. **[3]** All sections of the state highway system

6. Please indicate (1) if your state currently uses any of the following tools for planning purposes and (2) if yes, whether or not your state anticipates using the HERS/ST model to supplement or replace this tool?

	(1) Does your state currently use any of the following tools for planning purposes? (*Check one for each*)		(2) If yes, does your state anticipate using the HERS/ST model to supplement or replace this tool? (*Check one for each*)	
	No	Yes →	Supplement	Replace
1. Highway Performance Monitoring System-Analytic Process (HPMS-AP)	4	4	3	0 1 uncertain
2. MicroBENCOST	6	2	2	0
3. StratBENCOST	8	0	0	0
4. Highway Design and Maintenance Model (i.e., the World Bank's HDM series of models)	8	0	0	0
5. Commercially-developed pavement engineering model (Please specify) _____	3	5	4	0 1 uncertain
6. Internally-developed pavement engineering model	3	5	4	1 uncertain
7. Planners' "rules of thumb"	1	7	6	0
8. Backlog project list	3	5	5	0
9. Other (*Please specify*) _____	0	4	3	0

DATA NEEDS

7. Please indicate (1) what measures of pavement condition your state currently uses in its transportation planning process and (2) of the measures that your state does not use, would your state like to use this measure?

Measures of Pavement Condition	(1) Does your state currently use this measure? (*Check one for each*)		(2) If not, would your state like to use this measure? (*Check one for each*)	
	Yes	No →	Yes	No
1. International Roughness Index (IRI)	4	4	1	3
2. Present Serviceability Rating (PSR)	5	3	0	3
3. Falling weight deflectometer data	2	6	3	1 1 uncertain
4. Ground penetrating radar data	0	8	3	5
5. Cracking data	7	1	0	1
6. Faulting data	6	2	0	2
7. Rut data	7	1	0	1
8. Skid data	4	4	0	4
9. Other (*Please specify*) _____	4	0	0	0

8. Excluding pavement condition data, what other highway data, not already reported to FWHA for HPMS sample sections, would be useful for modeling highway improvement needs?

Seven states provided narrative answers.

OVERALL HERS MODEL OPINION

9. Based on your current knowledge about the HERS/ST model, what are the strengths and limitations, if any, that might affect the usefulness of HERS/ST results for state-level decision making?

Six states provided narrative answers.

COMMENTS

10. Please provide below any comments about the questions in this document or any comments about the HERS/ST model or pilot program.

Seven states provided narrative answers.

GAO Contacts and Staff Acknowledgments

GAO Contacts

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Staff Acknowledgments

In addition to those named above, Richard Calhoon, Catherine Colwell, Timothy J. Guinane, Luann Moy, Judy K. Pagano, and Raymond Sendejas made key contributions to this report.

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