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Oregon Department of Transportation: Oregon Transportation Investment Act III – Bridge Delivery Program

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Secretary of State Audit Report

Summary

PURPOSE

The purpose of our audit was to determine whether the Oregon Department of Transportation's planning process for the Oregon Transportation Investment Act III Bridge Delivery Program resulted in cost-effective repair or replacement decisions.

BACKGROUND

To address aging bridges that were exhibiting serious cracking problems, the Legislature passed House Bill 2041 in 2003, the third phase of the Oregon Transportation Investment Act (OTIA III). The bill provides for an investment of approximately $2.5 billion to fund highway improvement projects over a ten-year period. Of this amount, $1.3 billion was for the replacement or repair of state bridges. The bill authorized the department to issue revenue bonds totaling $1.9 billion to finance the projects. Bond repayment will come from increased vehicle license and registration fees, truck weight mile taxes, a portion of the monies dedicated to the state modernization program, and traditional bridge program funding.

RESULTS IN BRIEF

We found the department's initial OTIA III Bridge Delivery Program planning process resulted in bridge scoping decisions (repair, replace, or no work) being made without taking sufficient time to fully assess the bridges and without complete cost and load rating information. Many of the initial scoping decisions were later revised, indicating they were not cost-effective.

Ideally, the department would have collected all the information necessary to accurately determine project scopes and estimate costs before requesting funding from the Legislature. This did not occur because department managers felt compelled to make initial scoping decisions quickly due to the possible seriousness of the bridge cracks.

Subsequently, the department began gathering additional information, including contracting with engineering firms for bridge assessments and with Oregon State University (OSU) for research on shear cracks. Beginning in September 2004, the department applied the results of the bridge assessments and the OSU research, along with updated department bridge inspections to reassess bridge scoping decisions for bridges in stages 2 through 5. Gathering the new information and reassessing the initial scoping decisions was vital for ensuring the department allocated program funding in the most cost-effective manner. However, when we reviewed this process, we noted the following concerns:

- The repair/replace cost ratio the department required that the two engineering firms use when they completed more in-depth bridge assessments was unsubstantiated.
- Department engineers provided the engineering firms with assessment criteria that were similar to criteria used in the initial assessments, and directed the firms to include almost all possible repair costs in repair cost estimates. This limited the objectivity and value of the firms' bridge scoping verifications.
- While preliminary results of the research on shear cracks indicated more time could be taken to address the bridges, the department continued to pursue an aggressive timeline for bridges in stage 1 of the program. Although we would not expect the department to make scope changes based on preliminary results, we question whether the department should have continued with an accelerated process.

Notwithstanding the above concerns, we commend the department for using the new information to reassess OTIA III bridge scoping decisions and improve their cost effectiveness.

In addition to issues noted above, however, we have concerns in the following areas: the need to define when seismic and widening costs should be included for cost-ratio comparison purposes, the opportunity costs of repairing or

RESULTS IN BRIEF (continued)
replacing bridges that currently have the capacity to carry 99 percent of truckload trips, and the accuracy of information provided in update reports.

RECOMMENDATIONS
We recommend the department:

- When possible, take adequate time to more accurately determine project scopes and estimate costs, before resources are requested. To improve cost estimates, the department should consider tracking all costs associated with early stage bridge projects.
- Develop and implement a process to inform load raters when bridge repair work is completed, and allocate sufficient resources to ensure ratings are complete and up-to-date.
- When making repair/replacement decisions, consider using life cycle cost analysis, and evaluate the repair/replacement cost ratio used in bridge scoping decisions to ensure it is substantiated.
- Ensure future professional services contracts, such as those requiring verification of engineering decisions, do not provide specific procedures or criteria that would limit the objectivity and value of the services provided.
- Establish and consistently apply criteria for including seismic and widening costs before scoping decisions affected by repair and replace cost estimates are finalized.
- Evaluate the opportunity costs of improving OTIA III bridges that have the capacity to carry 99 percent of truckload trips.
- Consider updating the economic modeling analysis to incorporate more recent bridge assessments or discontinue citing results of the analysis in current and future publications and websites.

AGENCY'S RESPONSE
The Oregon Department of Transportation generally agrees with the recommendations and is implementing all but one. The department's response is attached hereto, beginning on page 10.

Background

Oregon Bridges

Oregon has almost 6,500 bridges, including approximately 2,700 that are state-owned bridges managed by the Oregon Department of Transportation (department). The department is responsible for design standards, load capacity evaluation, inspection, and asset management for all state-owned bridges. Asset management includes determining when the repair or replacement of a bridge is necessary. To assist in these determinations, the department follows standards and guidelines set forth by the American Association of State Highway and Transportation Officials (AASHTO).

According to department information, almost half of the 2,700 state-owned bridges were built prior to 1960. Many of these bridges, which were built as part of the Interstate Highway system between 1947 and 1961, were of the reinforced concrete deck girder (RCDG) design. The bridges were built to meet the AASHTO design codes current at that time. However, AASHTO design codes have since changed to increase bridge performance. In addition, the volume of truck traffic in Oregon has increased, and the federal maximum allowable truck gross vehicle weight limit has increased from 72,000 to 80,000 pounds.

Discovery of Growing Shear Cracks

According to department management, in 1999 a department bridge inspector identified the first significant structural cracks in an eastern Oregon bridge. The cracks were shear cracks, diagonal fissures in the support region of a bridge that, if not remedied, can eventually result in catastrophic failure. Additional inspections of other RCDG design bridges from the same era revealed similar shear cracking. Although prior department bridge inspections identified the shear cracks at least as early as 1987, the inspection reports did not generally note crack measurements, just that the cracks existed. Department management reported that, in 2001, bridge inspectors noticed the shear cracks were growing.

Bridge Options Report

In 2003, the department produced the Oregon Economic and Bridge Options Report (EBOR), which presented an investment strategy to address the cracked RCDG bridges on freight routes. The strategy addressed approximately 365 interstate and state highway bridges at an estimated cost of $1.3 billion.

The department's initial implementation strategy included fixing the bridges in five stages over a 10-year period. The following table shows the number of bridges to be repaired and replaced and the cost of each stage, as shown in the EBOR:

	State Bridges		
Stage	**No. of Bridges to Replace**	**No. of Bridges to Repair**	**Cost ($ million)**
1	5	18	60.7
2	36	83	495.8
3	15	89	481.9
4	21	56	193.9
5	10	33	104.9
Total	**87**	**279**	**1,337.2**

Subsequent to the EBOR, the department targeted a number of bridges within stages 2 through 5 that it determined needed work ahead of the scheduled timeline for these stages. The projects were designated as Stage 1A projects.

Included in the EBOR was an economic modeling analysis of the effects of different courses of action on the Oregon economy. The results of the economic modeling provided more information to the Oregon Transportation Commission, the Governor and the Legislature in support of the department's bridge program strategy.

In response to the cracked bridge problem, the Legislature passed House Bill 2041 in 2003, the third phase of the Oregon Transportation Investment Act (OTIA III), which provides for an investment of approximately $2.5 billion to fund OTIA projects. Of this amount, $1.3 billion was for the replacement or repair of state bridges. The bill authorized the department to issue revenue bonds totaling $1.9 billion to finance the projects. Bond repayment will come from increased vehicle license and registration fees, truck weight mile taxes, a portion of the monies dedicated to the state modernization program, and, beginning in 2008, approximately $31 million per year from the department's traditional bridge program.

The Legislature also attached a budget note to the bill specifying that the department would be expected to contract with the private sector to manage the bridge repair and replacement program as well as the overall implementation of HB 2041. In order to stimulate the economy for Oregon businesses, the Legislature expected that the firm selected by the department to manage the bridge repair and replacement program would provide design-engineering services, but not engage in construction projects that are part of the bridge repair and replacement program. Instead, the Legislature intended that the department maximize the involvement of Oregon construction firms and employees. To meet these expectations, the department hired Oregon Bridge Delivery Partners, a joint venture formed by HDR Engineering, Inc. and Fluor Enterprises, Inc.

Importance of Capital Decision-Making Process

OTIA III is one of the largest infrastructure investments in Oregon's history. To enhance the effectiveness of such a significant investment, the decision-making process needs to ensure choices made will have the highest and most efficient returns to the taxpayer and to the government. Best practices for this type of endeavor include conducting a comprehensive needs analysis, identifying resources needed, assessing condition of current assets, evaluating alternative approaches, and ranking and selecting projects based on established criteria. Without a sound decision making process, capital projects can end up costing more than anticipated and may not meet the needs and goals of an agency.

Audit Results

The purpose of our audit was to determine whether the Oregon Department of Transportation's planning process for the OTIA III Bridge Delivery Program resulted in cost-effective repair or replacement decisions. Our review focused on the decision making process and did not include engineering analyses. For example, we did not attempt to analyze the bridge load ratings completed by the bridge engineers. We did, however, review whether load ratings had been completed for the OTIA III bridges.

We found the department's initial process resulted in bridge scoping (repair, replace, or no work) decisions being made without taking sufficient time to fully assess the bridges and without complete cost and load rating information. Many initial scoping decisions were later revised, indicating they were not cost-effective.

Ideally, the department would have collected all the information necessary to accurately determine project scopes and estimate costs before requesting funding. This did not occur because department managers felt compelled to make initial scoping decisions quickly due to the possible seriousness of the bridge cracks. Additionally, department managers noted they felt pressure from the Federal Highway Administration (FHWA) to quickly address the cracked bridges.

Subsequent to the initial scoping decisions, the department contracted with two engineering firms to complete more in-depth bridge assessments. The department also contracted with Oregon State University (OSU) to study bridge shear cracks. Beginning in September 2004, the department applied information from the engineering bridge assessments, the OSU research report on shear cracks, and updated bridge inspection reports to reassess bridge scoping decisions for bridges in stages 2 through 5. Gathering the new information and reassessment of initial scoping decisions was vital for ensuring the department allocated project funding in the most cost-effective manner. However, when we reviewed this process, we noted the following concerns:

- The repair/replacement cost ratio the department required that the two engineering firms use when they completed more in-depth bridge assessments was unsubstantiated.

- Department engineers provided the engineering firms with assessment criteria similar to that used for the initial assessments, and directed the firms to include almost all possible repair costs in repair cost estimates. This limited the objectivity and value of the firms' bridge scoping verifications.
- While preliminary results of the shear crack research, available in July 2003, indicated more time could be taken to address the bridges, the department continued to pursue an aggressive timeline for bridges in stage 1 of the OTIA III bridge delivery program.

Notwithstanding the above concerns, we commend the department for using the new information to reassess bridges in the stages 2 through 5 and make them more cost effective. However, in addition to issues noted above, we also have concerns in the following areas:

- The need to define when seismic and widening costs should be included for cost-ratio comparison purposes;
- The opportunity costs of repairing or replacing bridges that can carry 99 percent of truckload trips; and
- The accuracy of information provided in update reports.

We discuss these audit results in more detail in the sections below.

Initial Process to Determine Bridge Scopes

After bridge inspectors identified growing bridge shear cracks, department field employees assigned a crack stage to the bridges based on the number, density, and location of the cracks. Department bridge inspectors also measured and recorded crack widths. Department bridge engineers then assessed all state bridges, including those with RCDG bridge designs built from 1947 to 1961, for possible repair or replacement. When we reviewed this initial assessment process, we noted two issues related to the lack of sufficient time and information to determine the initial bridge scopes.

More Time and Information Needed to Assess Bridges and Estimate Costs

We found the initial process to determine OTIA III bridge scopes and cost estimates was completed without taking sufficient time to fully assess the bridges and without complete information.

For each state-owned highway bridge, department bridge engineers spent just three to five minutes to review the available information, forecast how many years the bridge could carry truck traffic, and determine the necessary scope of bridge work (repair, replacement, or no work). Available information for the bridges included some or all of the following: inspection reports, load ratings, bridge drawings, bridge logs, crack widths, and crack stages. Several engineers we talked with mentioned that the time taken for the initial bridge assessments was limited.

According to the prior State Bridge Engineer, the department also completed OTIA III bridge cost estimates quickly and without complete information. Traditionally, the department's bridge designers estimated the cost to replace a bridge using unit costs based on average bid-cost data from the past three years. The bid-cost data focus on direct labor and materials. However, the prior State Bridge Engineer and another department manager commented that information about ancillary costs, such as environmental mitigation costs and utility costs, was not adequate for cost estimation purposes. Additionally, the department has not consistently tracked administration costs, such as contract monitoring, on a project basis.

For the OTIA III bridges, department bridge engineers reviewed prior bridge cost estimates, which were approximately $150 per square foot. They also reviewed several recent bridge projects and noted costs were greater than $150 per square foot. Based on these more recent costs, department engineers selected a multiplier of two, resulting in a $300 per-square-foot cost estimate. The higher estimation was intended to cover additional costs that might have been omitted in the $150 per-square-foot estimates, such as ancillary costs, inflation for coming years, and possible cost increases due to increased demand for bridge construction.

We compared the bridge scope decisions in the EBOR with bridge scope decisions as of September 2006 to determine the number of bridges with changes after the department's initial assessment of bridge scopes. Of 362 bridges listed in the EBOR, 187 (approximately 52 percent) had changed scopes, including 74 bridges now scoped as 'no work.' The fact that approximately 52 percent of the bridge scoping decisions changed indicates the initial list was not cost effective.

Also, the department refined the OTIA III bridge cost estimates after developing the initial cost estimates. We compared the cost estimates for bridges in the EBOR with cost estimates as of April 2005 and September 2006. Two hundred bridges in the EBOR had the same scope (or tentative same scope) as of April 2005. The total cost estimate for repair and replacement of these bridges according to the EBOR was approximately $812.5 million. In contrast, as of April 2005, the department estimated the cost of these bridges at about $1.1 billion, approximately $251.5 million (31 percent) higher than the original estimate. As of

September 2006, there were 175 bridges that had the same bridge scope as that listed in the EBOR. The EBOR estimated the cost of these bridges at approximately $670.0 million. The September 2006 cost estimates for these bridges totaled $1.1 billion, approximately $433.3 million (65 percent) higher than the original estimate.

In one instance, a stage 2 bridge was initially estimated to cost $58.4 million using the $300 per-square-foot estimate. In April 2005, the department estimated the cost at $94.2 million. As of September 2006, the cost estimate was $207.3 million. In another instance, the department initially estimated the cost of four stage 1 bridges scoped as replace at approximately $5.1 million. Subsequently, the department revised the estimate for these four bridges to approximately $8.75 million, an increase of 71 percent. A department memorandum stated that the change was due to the inaccuracy of the initial scoping and estimating.

Also, because the increase in the cost estimates of the four bridges caused stage 1 to be over budget, department bridge engineers revisited two bridges to determine whether they could be repaired instead of replaced. The bridge engineers concluded that both bridges could be repaired. However, the savings from repairing one bridge helped the department bring stage 1 back within budget. A department bridge manager noted the department then decided to stay with the replace decision on the second bridge because the contract was already out to bid and the bids came back with reasonable estimates. He noted further that had the department reviewed the bridge more thoroughly earlier in the process, the scope decision might have been to repair the bridge.

A Government Accountability Office (GAO) report on best practices in capital project decision-making notes projects that are expensive, span a number of years, or are crucial to the organization's strategy or structure usually require more analysis, support, and review than projects that cost less, have shorter time frames, or have less organization-wide impact. It also states that decision makers should have good information about cost estimates, risks, and the scope of a planned project before committing substantial resources.

According to department engineers, more in-depth scoping and cost estimations were not possible due to time constraints and a sense of urgency because of the possible seriousness of the cracks. Additionally, department managers told us they felt pressure from the Federal Highway Administration (FHWA) to quickly address the cracked bridges.

We recommend, when possible, the department take adequate time to more accurately determine project scopes and estimate costs, before resources are requested. To improve cost estimates, the department should consider tracking all costs associated with early stage bridge projects.

Many Bridge Load Ratings Were Missing or Not Updated

Another problem we noted with the department's initial scoping process was that many OTIA III bridge load ratings were missing or not updated. A load rating is a calculation of a bridge's safe load carrying capacity. Load ratings are based on existing structural conditions of the bridge, material properties, truck loads, and traffic conditions at the bridge site. They are used for prioritizing projects, posting bridge weight limits, and issuing load permits. According to a department load rater, if the condition of the bridge changes (e.g., due to repair work, collision, addition of pavement, deterioration due to aging), the load rating is no longer current.

A bridge is load rated for controlling elements, such as the girders and the crossbeams. The load rating for the weakest element is the controlling load rating. In general, a bridge is considered adequate to carry the truckload for which it is being rated if the controlling load rating is greater than 1.0. The department rates bridges for both legal loads and permit loads.[1]

The department maintains a database of bridges that have been load rated. We reviewed the database load ratings for the bridges listed in the EBOR. Of the 362 bridges initially assessed for repair or replacement, the database showed 76 (approximately 21 percent) had no load ratings, and 122 (approximately 34 percent) were completed in 1995 or earlier. According to a department load rater, there is no set time span that would cause a load rating to be outdated due to age deterioration. However, he noted the 1994 and 1995 load ratings done on the OTIA III bridges would typically not have considered the shear cracks.

We also noted 10 bridges for which records indicated bridge repairs were done, such as overlays or deck repairs, but their load ratings were not updated. According to a department Load Rating Engineer, the load raters are not always informed when repair work is completed. Additionally, the department does not have a central location or database containing information on repair work completed on the bridges.

AASHTO guidelines specify that bridge owners should maintain a complete, accurate, and current record of each bridge under their jurisdiction. Complete information

[1] Legal loads include trucks with gross vehicle weights up to 80,000 pounds. Permit loads include trucks with gross vehicle weights up to 304,000 pounds.

is vital to the effective management of bridges and provides a record that may be important for repair or replacement decisions. When maintenance or improvement work has altered the condition or capacity of the structure, the capacity should be recalculated.

We recommend the department develop and implement a process to ensure load raters are informed when repair work on a bridge is completed, and allocate sufficient resources to ensure ratings are complete and up to date.

Engineering Firms Hired to Complete Bridge Assessments

In April 2003, the department contracted with two engineering firms to conduct engineering assessments of the OTIA III bridges. The results of these assessments were used to prepare Engineering Baseline Reports (EBRs). Each EBR summarizes information about the current bridge structure, including conditions at the bridge site, the repair/replacement options evaluated (including the preferred option), construction issues and potential impacts at the site, estimated schedule and budget, and technical reference materials. In those instances when the contractor's recommendation was 'no work', a memorandum was generally completed detailing the basis for the recommendation. However, a complete EBR was not produced.

We noted two issues regarding the engineering assessments. First, the repair/replacement cost ratio the department specified was unsubstantiated. Second, the department required that contractors use criteria for making bridge assessments that were similar to criteria used in the initial assessments. We discuss these issues in more detail below.

Cost Ratio Criterion Unsubstantiated

Economic analysis tools allow transportation officials to quantify the costs of alternative options for a given project. One option used by state transportation departments is a cost ratio comparing the initial estimated costs of repair versus replacement. Another option, a life cycle cost analysis, considers all agency expenditures and user costs throughout the life of an alternative and is not limited to just initial investments. The FHWA encourages transportation agencies to use life cycle cost analysis in choosing cost-effective project alternatives.

For the engineering assessments, the department specified that contractors use a 50 percent cost ratio as one of the criteria for determining the scope of work to be completed on each bridge.[2] According to this criterion, if the estimated cost to repair a bridge is more than 50 percent of the estimated cost to replace it, the bridge scope should be replace. No life cycle costs are considered.

According to the prior State Bridge Engineer, the 50 percent ratio was based on engineering judgment. The department did not complete a cost analysis or review past bridge projects and associated costs to develop the ratio. In addition, we noted the department's 1999 Bridge Needs Analysis used a different cost ratio (70 percent) as a criterion for when a bridge should be replaced. This cost ratio was also based on engineering judgment.

We surveyed 10 western states regarding use of a cost ratio as a criterion for bridge repair or replacement. Of the 10 states surveyed, there was no consistent ratio cited. Answers varied from states that did not use a cost ratio in their decisions to ratios varying from 40 to 80 percent.

The designation of the ratio percentage could have a significant effect on bridge scoping decisions and costs. Of 171 bridges in stages 1, 1A, and 2, 82 bridges had EBRs that included both an estimated cost of repair and an estimated cost of replace. Of these 82 bridges, 23 (28 percent) had estimated ratios of 40 to 60 percent. The difference in the estimated cost to replace these bridges versus the estimated cost to repair them totaled approximately $53.5 million. Without an analysis that provides support for the use of the 50 percent cost ratio, the department may be replacing bridges when repairing them may be more cost effective or, conversely, repairing bridges when replacing them would be more cost effective.

We recommend when making repair/replacement decisions, the department consider using a life cycle cost analysis. When the department uses a cost ratio, it should evaluate the ratio to ensure it is substantiated.

Verification of Bridge Scoping Decisions Limited

We question whether the engineering assessments for the OTIA III bridges provided an objective verification of the bridge scoping decisions. One of the main goals of the assessments was to verify the reasonableness of the repair or replacement recommendations in the EBOR. However, department engineers provided the contractors with assessment criteria that were very similar to criteria used in the initial three- to five-minute assessments, and directed the contractors to include almost all possible repair costs in repair cost estimates. This limited the objectivity and value of the bridge scoping verifications.

Both in our discussions with engineers and our review of documentation, we noted

[2] For various reasons, repair/replace cost ratios were not always developed. For example, if repairing a bridge was not a viable option, no repair cost estimate was completed.

comments regarding the limits placed on the contractors' decisions regarding bridge scopes. One department engineer commented to us that the contractors were bound to the criteria provided by the department, which limited their decisions. Another indication of the limitation on the contractors' judgment was evident in one of the contractor's internal review notes, which stated, "My take since the beginning has been that many of the bridges I have looked at should not be touched at this time, but rather observed to determine if there is a serious shear capacity problem." The contractor commented further that the direction from the department, however, was to follow the criteria the department provided. Also, in an internal communication, another department engineer voiced concern that providing the contractors with the criteria the department used would result in the contractors arriving at the same conclusion and would not provide a true verification.

In addition, for repair cost estimates, the department directed the contractors to include costs to upgrade the bridges to full standards including shoulder widths, guardrails, widening, and phase 1 seismic retrofits[3]. In some cases, this practice caused repair/replacement cost ratios to exceed 50 percent, forcing the contractors to a replace decision.

Best contracting practices include expressing desired outputs in clear, concise and measurable terms, but without detailed procedures as to how work is to be accomplished.

We compared the EBOR scoping decisions to the decisions the contractors reached. Of 312 EBRs completed, 262 (approximately 84 percent) had the same or a more conservative scoping decision than the department's initial decision. Because verification of the initial scoping decisions was one of the main goals of the engineering bridge assessments, we question whether the department received full value for the amount it paid (approximately $8.8 million).

We recommend the department ensure that future professional services contracts, such as those requiring verification of engineering decisions, do not provide specific procedures or criteria that would limit the objectivity and value of the services provided.

Preliminary Results of Oregon State University Research Received

Department management stated that initially there was a lot of anxiety about the safety of the bridges because of the shear cracks. Lacking information on the capacity of bridges with shear cracks and knowing bridge failure due to these types of cracks can be catastrophic, the department understandably implemented an accelerated process for bridge repair and replacement. Department management meeting minutes from early 2003 support the agency's emphasis of an extremely tight time schedule, noting stage 1 needed to be open to all travel by 2005.

In October 2002, the department contracted with Oregon State University (OSU) to investigate the behavior of shear-cracked reinforced concrete bridges. The objective of the research was to develop a method to estimate the current load capacity and remaining life of cracked girders. The research included field-testing of cracked bridges, laboratory evaluations of large size beams, analysis of testing results, and development of assessment methods for the cracked bridges.

In July 2003, the department received an interim report that included preliminary results. The preliminary results indicated the department had more time to address the bridges. Specifically, the preliminary results showed the presence of cracking does not necessarily indicate reduced load-carrying capacity. Additionally, according to a department research engineer, the research showed the cracked beams still retained capacity under loads over 300,000 pounds. Early results of testing with moving loads showed similar results, with bridges retaining capacity with loads over 300,000 pounds.

Despite having these preliminary results, the department continued the accelerated process for stage 1 bridges. Several department engineers we spoke with were concerned about the process continuing with scoping decisions based on the initial assessments.

Although we would not expect the department to implement changes based on preliminary results, we question whether the department should have continued with the accelerated process for the stage 1 bridges.

As we noted above, we think the department should take sufficient time in the future to complete adequate analyses for bridge scoping decisions.

Reassessments Done For Bridges in Stages 2 Through 5 But Concerns Remain

In September 2004, after receiving the draft final report of the OSU research project, the department started reassessing bridge scoping decisions for bridges in stages 2 through 5. The department also considered information from updated inspection reports and the EBRs. These reassessments have resulted in changes to 187 bridge scoping decisions.

We commend the department for using the new information to ensure scoping decisions for bridges in stages 2 through 5 are

[3] Seismic retrofits may be phase 1, which secures the beams to the columns, or phase 2, which strengthens the columns, footings and piling.

more precise. However, in addition to the issues noted above, we have concerns regarding two other areas. First, the department did not establish firm criteria for the inclusion of seismic retrofit and widening costs prior to beginning the reassessments. Second, the department did not consider the opportunity costs of repairing or replacing bridges in stages 1 through 4 that have the capacity to carry 99 percent of truckload trips.

Seismic Retrofit and Widening Costs

For the engineering bridge assessments, the department directed the contractors to include almost all possible repair costs in the estimates, including widening costs and phase 1 seismic retrofit costs. In September 2004, after engineering bridge assessments were completed, the department began a reassessment of the bridge scoping decisions based on information that had become available after the EBOR. In January 2005 memoranda, the department stated that the reassessment of the bridge scoping decisions included a "clarification of the goals and philosophy of the OTIA III program (regarding seismic retrofit, scour, widening, and ancillary work)" and that "where these items were not aligned with the goals and philosophy of the OTIA III program, their costs were removed for comparison purposes." The memoranda noted when the cost of repairing a bridge was approaching 50 percent of the cost to replace it, the bridge would be strongly considered for replacement.

However, as late as May 2005, eight months after beginning the reassessments of the bridge scoping decisions, the department had still not defined the criteria for when seismic retrofit costs should be considered or removed for cost comparison purposes. Additionally, a department bridge manager noted staff was still negotiating with the FHWA to set firm parameters for when widening would be an issue.

Seismic and widening costs may be significant and may cause repair costs to exceed 50 percent of estimated replacement costs. For example, during our audit, we noted one stage 1 bridge on Oregon Highway 224 scoped as replace. The cost estimate for repair costs included $500,000 for seismic retrofit. With the seismic costs included, the repair to replacement ratio was approximately 59 percent. Without this amount, the ratio would decrease to approximately 27 percent.

In another case, the EBR for a stage 2 bridge on Interstate 5 provided three repair cost estimates, as follows:

Scope	Cost	Percent of replacement cost ($1.98 M)
Repair with seismic retrofit and widening	$1.60 M	81%
Repair with widening, no seismic retrofit	$1.21 M	61%
Repair without widening or seismic retrofit	$.73 M	37%

Depending on which costs are included in the repair estimates, the scoping decision could be to repair or replace the bridge.

As these examples illustrate, the lack of a firm criterion regarding seismic retrofit and widening may result in inconsistent scoping decisions.

We recommend the department establish and consistently apply criteria for including seismic and widening costs before scoping decisions affected by repair and replace cost estimates are finalized.

Repair and Replacement of Bridges with Capacity to Carry 99 Percent of Truckload Trips

The economic modeling analysis presented in the EBOR did not consider the opportunity costs of repairing or replacing bridges that have the capacity to carry 99 percent of truckload trips. The department chose to improve OTIA III stage 1 through stage 4 bridges to be able to carry all truck traffic, including single trip permit loads. The single trip permit loads can weigh up to approximately 300,000 pounds. However, trucks over 105,500 pounds make up less than 1 percent of truckload trips. Consequently, a bridge with a load capacity of 105,500 would accommodate 99 percent of truckload trips. Yet under the OTIA III bridge delivery program, a bridge with this capacity in stages 1 through 4 would need to be repaired or replaced. According to department managers, the decision to repair or replace bridges for single trip permit loads was based on feedback from the trucking industry and the results of the economic modeling analysis.

The economic modeling did not analyze the dollar impact to the state's economy if the bridges were restricted to 105,500 pounds. According to a department analyst, this scenario was not modeled because the impact to the economy would be minimal.

Further, a June 2005 department report titled "Evaluation of the State Bridge Program" notes "the condition of state bridges off OTIA III routes is expected to continue to decline as a significant amount of funding otherwise available for repair and replacement of deficient bridges is used for payment of OTIA III bond debt service ($31 million per year or more)." The report notes traditional bridge program funding will decrease from $74.2 million in 2007 to

$38.2 million in 2008, largely due to OTIA III debt service.

Given the relatively small percentage of truckload trips over 105,500 pounds and funding needs for repair or replacement of other deficient bridges throughout the state, money spent to address the 1 percent of truckload trips may be better spent on other bridges.

We recommend the department evaluate the opportunity costs of improving OTIA III bridges in stages 1 through 4 that have the capacity to carry 99 percent of truckload trips.

Other Matters

Economic Analysis Should Be Updated

The department used its integrated economic, land use, and transport model to analyze the effects of different courses of action in response to the cracked bridges. The model considered impacts on Oregon's transportation system, economy, and local roads and communities. Results of the modeling were presented to the Oregon Transportation Commission and the Legislature to assist in funding decisions for the OTIA III program.

The department established parameters to allow the model to estimate the effects on the economy of restricting truck use due to the deterioration of the cracked bridges. According to the EBOR, the expected deterioration rate of cracked bridges is critical in designating the future year when each bridge restriction would begin. The department's Bridge Section estimated the expected deterioration rates for bridges that were included in the modeling. Rates of one to 15 years were assigned to each cracked bridge, based on the crack stage and crack width at the time of the analysis.

Information provided to the Legislature in 2005, as well as recent department publications and websites, cite a potential impact of $123 billion and 88,000 jobs lost through 2025. Yet, the department has changed its assessment of the deterioration of the bridges. Of 362 bridges originally listed as requiring repair or replacement, 74 bridges (approximately 20 percent) are now recommended for 'no work'. The department expects these bridges to last 20 more years. Consequently, the existing economic modeling analysis of the effects of deteriorating bridges on the Oregon economy may not provide accurate information.

We recommend the department consider updating the economic analysis to incorporate more recent bridge assessments or discontinue citing the results of the analysis in current and future publications and websites.

Agency's Response:

The department generally agrees with the recommendations and is implementing all but one. The department's response is attached hereto, beginning on page 10.

Objectives, Scope and Methodology

The objective of our audit was to determine whether the Department of Transportation's planning process for the Oregon Transportation Investment Act III Bridge Delivery Program resulted in cost-effective repair or replacement decisions. To accomplish this we:

- Reviewed pertinent laws and agency policies and procedures;
- Interviewed agency staff and managers to gain an understanding of agency operations and activities related to the OTIA III bridge delivery process;
- Interviewed private firm, federal, and university engineering professionals;
- Reviewed meeting minutes and other agency communications related to the OTIA III bridge delivery process;
- Reviewed Engineering Baseline Reports, bridge inspection reports, and other documentation pertaining to bridge projects;
- Obtained data on OTIA III bridge load ratings; and
- Surveyed 10 western state transportation departments regarding the bridge project selection process, including the use of cost analysis in making bridge scoping decisions.

We determined load rating data received from the department was sufficiently reliable for our audit purposes. We based this conclusion on preliminary data assessment and testing, which included tracing the data provided by the agency to source documentation.

We conducted our fieldwork from August 2004 through October 2005. At the request of department management, we also reviewed bridge scopes and cost estimates updated through September 2006. We conducted our audit in accordance with generally accepted government auditing standards.

Department of Transportation's Response to the Audit Report

ODOT concurs with most of the recommendations presented in the audit, and is implementing all but one. As noted in the audit, the engineering bridge assessments, the Oregon State University (OSU) report, and updated inspection reports are all part of the review process that ODOT instituted to assess the initial scoping decisions and reach the most reliable decisions within the shortest timeframe. This improved decision making was planned, expected and envisioned as a natural outcome of the efforts put in place to accomplish the program.

In a practical sense, ODOT feels that the immediate actions taken in response to the bridge cracking were prudent and necessary to protect Oregon's motorists and the state's economy. The audit refers to pressure from the Federal Highway Administration (FHWA) to quickly address the problem bridges. However, the audit does not adequately describe the extent of the FHWA pressure. FHWA was prepared to reduce the amount of funds that Oregon receives if Oregon did not immediately take actions to reduce loads on the distressed bridges. The economic study available at the time indicated that such load reduction would have prohibited movement of over 30% of the freight that flows through Oregon, a devastating impact on the economy. Such a reduction could have reduced future productivity by $14 billion, and cost 16,000 jobs, according to the information available at that point. ODOT's actions to quickly move forward with corrective fixes on those most distressed bridges addressed the FHWA concerns, provided adequate protection for motorists, and did so without imperiling Oregon's economy.

Also, the audit should have acknowledged the work of a Blue-ribbon Bridge Strategy Task Force, which predated the Bridge Options Report and set the stage for the agency's approach to the bridge crisis. The Task Force consisted of professional bridge engineers from OSU, FHWA, American Association of Highway and Transportation Officials (AASHTO) Bridge Committees, Oregon bridge construction companies, representatives from the Oregon Trucking Associations and ODOT. The Task Force validated the cracking problem and ODOT's methodology for determining load-bearing capacity of cracked bridges.

Audit Recommendations—ODOT Response

When possible, take adequate time to more accurately determine project scopes and estimate costs before resources are requested. To improve cost estimates, the department should consider tracking all costs associated with early stage bridge projects.

Implemented. *As noted in the audit, it was not possible to provide complete detailed scoping for all of the cracked bridges before the program began. However, complete detailed scoping was performed on 95% of the bridges in OTIA III. Immediate action on the other 5% was necessary to address FHWA concerns and keep the most critical economic routes open.*

The FHWA was prepared to reduce Oregon's funding if we did not take immediate actions to reduce loads on the most distressed bridges. These reductions would have prohibited movement of over 30% of the freight that flows through Oregon. ODOT's actions to quickly move forward with corrective fixes on these most distressed bridges addressed the FHWA concerns, provided adequate protection for motorists, and did so without placing Oregon's economy at risk.

While the original estimate process used by ODOT may not have been accurate on a bridge-by-bridge basis, it has shown to be accurate on a program-level basis. This preliminary look was only the first step in an extremely comprehensive process to determine the degree of the threat to public safety and the economy, and then to produce more updated scoping based on more time-consuming processes. ODOT never intended the original estimate to be used for design acceptance. It was acknowledged from the start that the initial recommendations were based on preliminary data that were considered insufficient for specific bridge design decisions.

If the comprehensive scoping had been completed at the outset of the program as suggested in the audit, several million dollars would have been spent preparing detailed scopes for projects that had no funding at the time, and would have delayed the work on the distressed bridges for more than a year.

Develop and implement a process to inform load raters when bridge repair work is completed. and allocate sufficient resources to ensure ratings are complete and up-to-date.

Implemented. *A data field has been added to bridge inspection reports to call attention to load raters that a change in status has occurred, and a process has been added to the Construction Manual to ensure that the Bridge Management Unit is notified when repairs to bridges have been completed.*

When making repair/replacement decisions, consider using life cycle cost analysis, and evaluate the repair/replacement cost ratio used in bridge scoring decisions to ensure it is substantiated.

Implementation ongoing. *ODOT uses the same repair/replace model as other state transportation departments. The model determines whether the estimated cost to repair a bridge would be more than 50% of the cost to replace it. This methodology provides a reasonable assessment of capital investment and is commonly used in the transportation industry as well as other civil engineering fields. ODOT will continue to work with our colleagues in assessing this model and refining the methodology.*

Ensure future professional services contracts, such as those requiring verification of engineering decisions, do not provide specific procedures or criteria that would limit the objectivity and value of the services provided.

Implemented. *We always strive to ensure that our contracts capitalize on the knowledge of professional experts. We believe that the contract used on the OTIA III project did not include specific criteria or procedures to limit professional judgment or objectivity.*

Establish and consistently apply criteria for including seismic and widening costs before scoping decisions affected by repair and replace cost estimates are finalized.

Implemented. *ODOT had implemented these procedures prior to the audit. The program developed a "Policy on Scope of Work Elements for Repair Bridges within the OTIA Ill Bridge Program". Included are provisions for phased seismic retrofits where certain criteria are met within the agency's Bridge Design and Drafting Manual. These costs are included in the estimates and factored into calculating the repair-replace ratio. Replacement bridges will be designed to the current seismic design standards.*[1]

With respect to widening, we negotiated with FHWA and presented them with a list of bridges to be widened in accordance with negotiated criteria. Widening for capacity or safety reasons will occur only for bridges scoped for replacement. This cost is included for the purposes of calculating the repair/replace ratio.

Evaluate the opportunity costs of improving OTIA III bridges that have the capacity to carry 99 percent of truckload trips.

ODOT does not agree with this recommendation. *It is not an opportunity cost issue. If Stages 1-4 bridges were not able to carry the other 1% of truckload trips, critical needs would not have been met. For example, the citizens of Southern Oregon would have been without electricity because a steam generation vessel needed to repair an electrical generation facility that had gone off line could not have been transported. Similarly, when a large corporation was considering where to locate a windmill turbine manufacturing facility in the western United States, the top consideration it used to evaluate potential sites was whether a jurisdiction had the highway infrastructure to allow the transport of their permitted loads. Finally, this 1% of loads oftentimes are factory equipment, heavy machinery, and other essential components that fuel the economic engine in the state. ODOT believes these critical economic reasons outweigh the potential savings achieved by eliminating 1% of truckloads in the state.*

Consider using the economic modeling analysis to incorporate more recent bridge assessments or discontinue citing results of the analysis in current and future .publications and websites.

Implemented. *The economic analysis is what the original program decisions were based on. As such, it is part of the historical record and should be maintained. However, when this analysis is cited, ODOT will caveat the analysis as the original analysis.*

We appreciate the opportunity to respond to this audit. As always, the partnership between the Secretary of State's Audits Division and the Oregon Department of Transportation is a productive one. We appreciate the spirit of the audits to help make our processes work better for the citizens of Oregon. We have already implemented the majority of the recommendations contained in this audit and will continue to do our very best to use resources in the most efficient manner.

[1] When we followed up with the department regarding its response to this recommendation, management noted that the department had an approved draft repair policy in place shortly before the conclusion of our initial fieldwork that it was using to evaluate bridges.

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The courtesies and cooperation extended by the officials and staff of the Oregon Department of Transportation were commendable and much appreciated.

This report, a public record, is intended to promote the best possible management of public resources. Copies may be obtained:

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