

# **Culvert Management System Implementation and Seminar**

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## **Executive Summary**

The FHWA Culvert Management System Seminar project presented and documented the implementation of a federally funded culvert management system software product in a County bridge inspection program. Investigators culminated the year-long research implementation project with a day-long seminar including the installation and use of the software with hands-on practice, the issuance of a free copy of the culvert management system, and additional design and construction aids that were utilized during the investigation process by the studied County. This report compiles the implementation processes completed during the life of this project. The implementation process consisted of literature research, software installation and use, data-gathering visits, and peer review. County Engineers, Alabama Department of Transportation (ALDOT) officials, and associated researchers served in advisory roles to steer and review findings. The implementation and review process yielded a satisfactory implementation of an FHWA-sponsored culvert management database and the tools to utilize the database for input, prioritization, and reporting of bridge replacement needs and costs at the local government level. Next, the investigators developed a structured demonstration program to distribute the results of the implementation to interested local government officials, county engineers, ALDOT engineers, and city engineers. Finally, exit questionnaires were distributed, collected, and analyzed. They are presented in this report to demonstrate the effectiveness and impact of this implementation project. In these ways, the investigators supported the UTCA theme, "Management and Safety of Transportation Systems" and contributed to the transfer of this vital technology to those who can immediately benefit from its application.

## **Section 1**

### **Introduction, Problem Statement, Overall Project Approach**

#### **1.1 Introduction**

In the local government budgeting process, the prioritization of funding is an extremely important yet exceedingly difficult task. Critical choices in funding are often made with only a nod to the immediate costs of installation and materials, while little or no grasp is demonstrated for long-term costs and user costs. A recent critical study by Perrin & Jhaveri (University of Utah, 2003) utilizing the principles of opportunity costs and user benefits stated that of 50 state DOT's and seven Canadian provinces surveyed, only 15 keep written records of maintenance and repair costs of culverts. Furthermore, it was found that only two of the 15 departments producing records consider more than the immediate material costs in choosing a repair type.

The obvious explanation is that this oversight has arisen from a lack of advance planning, a lack of technical planning tools, and a lack of emphasis on the importance of prioritizing this portion of the county road infrastructure. In reference, Davidson and Grimes (UTCA, 2001) state:

In fact, counties have very limited resources to earmark for evaluating their bridge replacement programs. Complex analytical tools are available for use on structures that qualify as NBIS bridge-length. However, these tools are not always easy to use or applicable to smaller structures. In particular, the ABIMS (Alabama Bridge Inspection & Management System) now being utilized through the Alabama Department of Transportation is exemplary of an NBIS inventory system. Unfortunately, the system is quite burdensome to apply to minor (LT20) structures. By altering the coding on a single element, a user can elect to input minor structures but all 450+ items, including scour and maintenance data, must then be input. Although achievable, the monumental task of entering minor structures into ABIMS has not been attempted to the knowledge of the investigators. As a result, there is a quantifiable need for development and distribution of simplified tools and an adaptable database engine to assist Counties and municipalities in prioritizing bridge structures for replacement.

In light of these findings, Shelby County agreed to be the lead participant in this database implementation project so that a substantial proof of concept and demonstration of need could be established for the wider utilization of culvert management systems.

## **1.2 Problem Statement**

The purpose of this project was to develop and deliver one-day seminars to train interested Alabama Department of Transportation (ALDOT), County, and Municipal employees and consultants in the proper implementation and use of the Federal Highway Administration's (FHWA) Culvert Management System (CMS) and to demonstrate innovative techniques for management, design, and rehabilitation or replacement of local roads bridges less than 20 feet in length (LT20's) and culverts.

## **1.3 Overall Project Approach**

The first phase of this research required that Shelby County implement the FHWA CMS in their routine culvert inspection and replacement operations. Shelby County became the field demonstration case for collecting, inputting, and evaluating data through the FHWA CMS database interfaces.

At the same time, the investigative team was developing the curriculum for the series of one-day seminars that were to be presented at the termination of the field implementation. This development included such particulars as class content, subject length, subject breadth, subject depth, expectations of the seminar participants, and handout materials. During this time, course materials were initially sketched, and additional support data was collected and analyzed for course inclusion.

Next, a test seminar was presented to a small list of invited participants representing each constituent of the target audience. These participants were selected early during the course development process and were routinely consulted for development review. This first seminar was essentially a shortened trial run of the day-long seminar, and was conducted as an informal working session receiving immediate feedback from the advisory participants. The seminar was hosted in a training facility in Shelby County with 10 participants, and initial and long-term feedback on the seminar's success was very positive.

The full day seminars were presented in March 2006 at the ALDOT Computer Training Center in Montgomery, Alabama. A total of 3 seminars were conducted with 32 participants. Each seminar was conducted by James Davidson and Thomas Grimes of UAB and by Roman Selig of Hanson Construction Products of Birmingham, Alabama. The general consensus of the participants was again very positive with several interesting suggestions for future research being offered.

Future possible research activities include working with UTCA, ALDOT, and FHWA to fix "bugs" in the database and revising database content, presenting the seminar to a regional or national audience of participants, and discussing the future implementation successes and difficulties encountered by participant organizations.

## **Section 2**

### **Background**

#### **2.1 A Brief Survey of Culvert Management**

A recent survey of structures and asset management systems research indicates that there continues to be a lack in both breadth and depth of culvert management system and culvert maintenance research. In 2001, the hydraulics branch of the FHWA attempted to address this dearth of academic, government, and industry attention by introducing a Culvert Management System supported by a Microsoft Access 1997 database engine. It appears that the movement toward voluntary culvert management system use has stalled in spite of this significant contribution. Therefore, it is necessary to introduce the elements of structural management as applied to culverts and smaller bridge structures.

A culvert management system provides data that can be used for several purposes. First, the data provides information to transportation agencies that can assist in developing cost-effective bridge maintenance and replacement programs. Second, the data can be used as defensible support for specific funding requests. Finally, the data can provide a detailed picture of the effectiveness of ongoing culvert maintenance activities. (TRB Research Record No. 1184, 1988)

Several types of data can be provided from effective culvert management systems. These include historical conditions, historical funding levels, anticipated deterioration rates, costs of various maintenance activities, costs of various replacement activities, present condition of the system and of individual culvert installations, overall costs of specific projects, prioritizing of proposed projects, listing of maintenance needs, and projected budget needs for system-wide or specific maintenance activities.

A management planner has several needs to accurately forecast or prioritize a culvert management program. These are proposed funding levels at a given time, how that level of funding affects future funding needs of the system, charts/graphs that show proposed funding, optimal funding, and resulting culvert replacement needs. All of these outputs are valuable tools for accurately depicting culvert management system results. (Kivisto & Fleming. TRB & NRC, 1995)

It is necessary to consider the level of service that road networks and individual structures are expected or desired to meet. First, general condition ratings or condition codes for specific structural elements can be used to prioritize culvert maintenance or replacement activities. Next, limits of acceptable, intermediate, and desirable levels of service may be projected using data from the culvert management system. The level of service can be defined by load capacity, clear deck width, vertical roadway overclearances, and other structural and geometric factors. Also, level of service goals can depend on independently functioning variables such as average daily



traffic (ADT) or average daily truck traffic (ADTT). Functional classification, a variable that is dependent on ADT and other factors, can be used to further classify the level of service model. This classification system may be applied to segments between intersections, corridors between major and minor points, county-wide systems of travel, and local roads. The functional classification of a network allows for assigning integer values to each level of function of a roadway, and can be used to further categorize a culvert or roadway network's level of service.

Today's state-of-the-art culvert management programs are usually designed to allow an intermediate to experienced user to input his own prioritization protocol through his understanding of his governing organization's maintenance needs and goals. The FHWA CMS presented in this seminar is a specific example of a management tool that allows the user as little or as much detail as required to maintain and present his data. All features including input, output, prioritization rules, maintenance activity types, condition codes, and reports are almost fully programmable by the user. Thus, the FHWA CMS presents an effective, flexible, and adaptable management interface for a system of culverts and smaller bridge structures.

## **2.2 The Cost of Failure**

One of the main features of a properly designed and populated culvert management system database is its accountability to the public via a historic record of inspection. This record of inspection and the resulting strategic maintenance and replacement protocols can replace the current "ad hoc" replacement protocols, which is an important consideration. Furthermore, the development of supportable maintenance and replacement programs can help government engineers to foster a greater sense of public trust in the governmental engineering community (Perrin & Jhaveri, University of Utah, 2003).

Specific examples of culvert failures and replacement protocols are presented in the body of this seminar to build a strong argument in favor of the voluntary assumption of culvert inspection, management, and maintenance and replacement guidelines. Use of economic cost calculations based on material types, lifetime projections, and construction and user costs are presented in detail and discussed.

## **2.3 Culvert Design and Construction Considerations**

Although culvert design and construction has previously been researched, standardized and presented to all levels of government and industry, significant details and current issues are often gleaned from continuing contact between academia, practicing engineers, and industry representatives. Hanson Pipe Products of Birmingham, Alabama, formerly known as Sherman Concrete Pipe, graciously participated in funding the first series of FHWA CMS seminars, and also offered in-kind presentations and design materials to the seminar participants.

In particular, Hanson representatives lead an informative discussion on the state of practice in concrete culvert fabrication and on proposed changes in ALDOT's design standards for pipe

materials. These changes include accounting for variances in the design values for Manning's "n" due for differing pipe materials. A very effective argument was presented for the need to account for roughness variances due to corrugations, material deformations, and other factors that may not be as prevalent in other pipe materials. It was noted by the Hanson presenter that although concrete manufacturers have long increased their recommended design n values by 20% due to age, weathering and other field factors, this addition is not reflected in the design literature that has been published for plastic and corrugated metal pipes. Therefore, there may be significant support in the future for a change in the current design and construction specifications for culvert pipes and boxes.

## **2.4 A Short History of Culvert Management in Shelby County, Alabama**

The first recorded concern over the growing LT20 deterioration problem in Alabama can be traced to ALDOT Memorandum 94-07, dated January 21, 1994. This memorandum noted that then Governor Jim Folsom, Jr. had appointed a task force to study the feasibility of a program similar to his father's mid-century Farm to Market Economic Development program. Each county was required to submit a summary of the total number of LT20's on paved and unpaved roads and the number of structurally deficient LT20's on paved and unpaved roads. The required information was to be forwarded to the ALDOT County Transportation Engineer's office for compilation and delivery to the task force members.

However, only 44 of 67 Alabama counties participated in the feasibility study. From the 44 participant counties, a projected statewide LT20 replacement cost of \$116,875,234.80 was extrapolated. Projected deficiencies at that time were estimated to total 2,322 deficient structures for all 67 counties. Thus, the average LT20 replacement cost in 1994 was estimated to be \$50,333.87 per structure.

In 1997, the Shelby County Highway Department embarked on an ambitious National Bridge Inspection Standards (NBIS) and LT20 bridge replacement prioritization program. The 1994 inventory of LT20's indicated that Shelby County maintained 94 such structures and that 80 were considered structurally deficient. The initial goal of the replacement program was an average of 12 deficient LT20's per year, or one LT20 per month. This pace would have guaranteed the virtual elimination of structurally deficient LT20's by the end of 2005.

Also in 1997, Shelby County bridge inspectors completed a second LT20 inspection cycle. This cycle was used to verify the initial deterioration data provided to ALDOT in 1994. An overall condition rating range from 0 (imminent failure requiring immediate closure) to 10 (new structure) was established. At that time, the bridge inspector was given discretion in assessing marginal rating values based on NBIS inspection guidelines. This assumption was found to be satisfactory since the NBIS guidelines critically judge global decay based on individual member characteristics. Therefore, accepted NBIS inspection techniques were successfully employed to refine the initial LT20 sufficiency measurements.



**Figure 2-1. Timber structure showing signs of distress**

The initial and second rounds of inspection data were manually tabulated to show county road number, the location along the county road, structure type, posting, and sufficiency rating. Again, a global sufficiency ranging from 0 to 10 was assigned. At first, the handwritten data was compiled and typed. However, it was soon evident that the use of available spreadsheet programs would greatly enhance efforts to manage the LT20 network of bridges. As a result, the Shelby County LT20 Prioritization Database began to evolve.

At the request of the Shelby County Commission, the County Engineer instructed his staff to prepare a comprehensive catalog of all future infrastructure enhancements. The LT20 database was modified to include cost data and to establish a replacement priority protocol. The initial estimate yielded a total program cost of \$2.2 million over a period of 15 years. A prioritized replacement list of 87 structures was established, and a rudimentary adjustment for inflation was added to the total program cost. Finally, it was found that this program would require an annual funding of approximately \$150,000 a year over the 15-year period.

A review of Shelby County LT20 replacements to date indicates that all posted LT20's have been replaced. In addition, several NBIS structures have been successfully "sized down" to LT20 status by replacement with structures less than 20 feet in total span length. Therefore, the prioritization policies of Shelby County seem to have a positive impact on the county's ability to identify and execute a successful bridge replacement program. This is the first known LT20 management program by Alabama local governments. As this report was being prepared, Shelby County's bridge management team was implementing techniques established in the LT20 prioritization program to NBIS bridges for replacement prioritization by Federal Bridge

Replacement Funds, GARVEE Amendment 1 Bridge Bond Funds, and County Special Project Funds.



**Figure 2-2. Reinforced concrete box culvert**

In 2000, Shelby County participated with the University of Alabama at Birmingham (UAB) and the University Transportation Center of Alabama (UTCA) in the establishment of a nascent culvert management database. Various reports concerning the success of this project were submitted to UTCA, and at least two post-graduate degrees were awarded as a result of the project's research and findings. Additional research in the inspection and structural rating of smaller bridge structures in Shelby County was initiated by the research teams that had developed in the initial culvert management project (see Section 6, References).

In 2001, Shelby County informally adopted the FHWA Culvert Management System (FHWA-LT-02-001, Washington, DC, 2001) as its model culvert management database. Although Shelby County continues to use the CMS as a means to track inspection and work needed, it is felt that additional debugging of the database engine must be performed by FHWA before the system will be fully suitable for Shelby County's exclusive use. As a result, Shelby County still maintains the originally developed LT20 Prioritization Database, and uses the FHWA CMS database in tandem.

Further development of both databases will include incorporation of the data in the Shelby County Geospatial Information System (GIS). Work toward this goal is currently in progress, and features are currently being tested and placed online. Shelby County's eventual goal is to make as much of the non-sensitive culvert management data and other highway data that is available for free access over the Internet.

## **2.5 The State of Practice in Shelby County, Alabama**

Currently, Shelby County maintains a culvert database consisting of 88 bridges and culverts having a span length of 20 feet or less and a cross-sectional opening of 40 square feet or more. The structures in this database are routinely inspected at a frequency of two years, and data is immediately input into the FHWA CMS database for Shelby County. As the cumulative result of several related research projects, Shelby County now has at least three inspection rounds of data on most of its in-service LT20 structures. Shelby County anticipates that this data will offer valuable insight into the development and aging process of a smaller structure network.

Over the past several years, Shelby County has participated in the development and testing of several facets of culvert management through an ongoing partnership with the School of Civil, Construction, and Environmental Engineering at UAB. Foremost has been the formulation and testing of culvert inspection tools and processes for smaller structures. In particular, Shelby County has completed field trials of various LT20 inspection aids and forms. After several iterations, the Shelby County FHWA CMS Field Data Sheet was conceived, tested and adopted for formal use. A blank copy of this form is included in Appendix G of this report.

Other recent improvements to Shelby County's LT20 inspection and replacement program have included the formal adoption of fly ash flowable fill as backfill material and as non-structural filler material in pipe lining and other culvert replacement projects. Shelby County uses over 150 cubic yards per year of this recycled engineered material. Additional testing may eventually lead to the incorporation of this material in the general subdivision specifications and utility permitting specifications in Shelby County.

Finally, the Asset Management Division of FHWA recently visited Shelby County to assess the viability of the county's culvert management system and to document the county's use of the FHWA Culvert Management System database. As a result, representatives of FHWA are pursuing federal, state, and local government interest in bug fixes and user-recommended changes to their culvert management software. Thus, the culvert management team at Shelby County, Alabama continues to lead in the development and application of tools, systems and processes to improve the management of smaller bridge and culvert structures.

## Section 3 The Planning Seminar

### 3.1 Composition of the Steering Committee

The FHWA CMS Seminar Steering Committee was composed of maintenance and design personnel from ALDOT, County government, related industry representatives, and academia. There were a total of eight participants representing five separate organizations. A detailed composition of the steering committee is presented below.

**Table 3-1. Details of CMS steering committee participation**

| Agency                               | Department   | Number Of Participants |
|--------------------------------------|--|------------------------|
| Alabama Department of Transportation | County Transportation  | 1                      |
|                                      | Third Division   | 1                      |
| Calhoun County Highway Department    | Engineering  | 1                      |
| Shelby County Highway Department     | Engineering  | 3                      |
| Sherman Prestress, Inc.              | Design   | 2                      |
| University of Alabama at Birmingham  | Department of Civil, Construction, and Environmental Engineering | 2                      |

It is significant to note that the composition of the Steering Committee included a broad spectrum of knowledge, education and skill levels from non-discretionary engineering technician to professional engineer, from sales representative to design production manager, and from engineering graduate student to professor. The authors feel that this broad spectrum greatly aided in the development of a full seminar that led to the best outcome for its participants.

### 3.2 Composition of the Planning Seminar

The Planning Seminar was conducted on March 21, 2006 at the Shelby County Sheriff's Training Center in Columbiana, Alabama. The atmosphere of this seminar was kept as informal as possible to encourage immediate response and peer-level questions. The presenters took the first few minutes of the seminar to outline a set of ground rules to create an informal atmosphere, encourage immediate feedback, and establish a peer-to-peer working group format. The presenters then listed a brief seminar outline and outcome expectations. In addition, refreshments, coffee, and networking breaks were provided to foster and maintain the informal work session environment.

#### *3.2.1 Presentation of the Course Material*

Since the Planning Seminar was conceived by the presenters as a half-day work session, all course material presentations were abbreviated for timeliness. Presentation of the culvert management software was limited to screen grabs and brief descriptions of important entry

items. Items that were discussed in depth by the Steering Committee participants included those that were most important in establishing and maintaining a working database.

The Steering Committee presentation concluded with a very informal roundtable discussion of the merits of each portion of the abbreviated seminar presentation. Several useful constructive comments were recorded, and the presenters expressed their appreciation for each committee member's input.

### ***3.2.2 Classroom and Survey Response***

Immediate response to most items presented was very positive. Several comments were made by the Steering Committee concerning the timeliness of the issues presented, and the presenters were congratulated for their preparation and presentations.

The greatest interest was expressed by the Steering Committee in the "Cost of Failure" portion of the presentation. The Committee agreed that the information was important to provide to the full seminar participants but suggested that the analytical calculations be limited to a brief overview to maintain participant interest. The Committee further suggested that the presentation of the software should be accompanied by classroom exercises that would allow seminar participants to explore the CMS software's functionality as a significant portion of the learning process.

## **Section 4**

### **The Full Presentation Seminars**

#### **4.1 Installation and Testing**

The first day of the full presentation seminar week was spent by one of the presenters installing the FHWA CMS Database software on the ALDOT Computer Training Center's computer network. The presenter was assisted by an ALDOT Computer Services network administrator who installed one subscription of the database engine on each of thirteen computers. Then, the project database was loaded and tested on each computer. After several adjustments, the network administrator was satisfied that each computer was running the software and accompanying database correctly. Then, the administrator placed shortcut icons on each computer's desktop, and issued a helpdesk number to the presenter in the event that there were any problems with the setup or program execution during the seminars.



**Figure 4-1. First session of the FHWA CMS seminar**

#### **4.2 Seminar Participation and Response**

During the week of March 20, 2006, the FHWA Culvert Management System Seminar was conducted at the ALDOT training facilities in Montgomery, Alabama. Immediate feedback was gathered from each participant using a simple qualitative questionnaire to measure participant



interest and satisfaction. Participant composition and evaluation are herein presented to document the success of the seminar.

#### 4.2.1 *Composition of Participants*

A total of 34 participants including presenters were present during the three one-day seminar sessions. The participant makeup included engineers and engineering technicians from 16 counties in Alabama, two Alabama municipalities, one state university, and one industry. A detailed listing of the participating agencies and number of participants per agency is shown in Table 4-1 below.

**Table 4-1. Details of CMS full seminar participation**

| AGENCY                              | NUMBER OF PARTICIPANTS |
|-------------------------------------|------------------------|
| Autauga County                      | 3                      |
| Blount County                       | 1                      |
| Chambers County                     | 2                      |
| City of Birmingham                  | 1                      |
| City of Mobile                      | 3                      |
| Dale County                         | 1                      |
| Etowah County                       | 1                      |
| Franklin County                     | 2                      |
| Hanson Pipe and Products            | 1                      |
| Jefferson County                    | 2                      |
| Madison County                      | 1                      |
| Marshall County                     | 1                      |
| Mobile County                       | 2                      |
| Pike County                         | 2                      |
| Shelby County                       | 2                      |
| St Clair County                     | 2                      |
| Sumter County                       | 1                      |
| Talladega County                    | 2                      |
| Washington County                   | 3                      |
| University of Alabama at Birmingham | 1                      |

#### 4.2.2 *Participant Evaluation of the Seminar*

Each participant was asked to fill out a short, non-statistical survey on their qualitative judgment of the effectiveness of the FHWA CMS Database Seminar. An example participant survey and a full accounting of participant responses are reproduced in Appendix H. Significantly, all responses were limited to “Excellent” or “Satisfactory” for all responding participants, and all but one responding participant agreed that he would recommend the seminar to a non-attending colleague. Overall, the seminar was well received, while special emphasis was placed by the participants on the presenters’ knowledge of the subject matter and the presenters’ responsiveness to questions. The presenters noted that the participants seemed interested and engaged in the subject matter discussions, and the participants often asked questions that led to consideration of possible future research paths.

When asked for additional written comments, one participant responded that the seminar was “very informative.” Another stated that his county would “try to use” the software. One

participant noted that the brochure was too “wordy.” Two participants asked for the seminar to be “shortened” or “limited to a half-day” seminar. Finally, one participant noted that the pipe industry presentation should have been “shortened,” and that the seminar should “have a plastic pipe” demonstration.

The authors believe that the participant evaluations reinforced their conclusion that the FHWA CMS Database Seminar series was a successful application of UTCA’s technology transfer emphasis. Rather than finding discouragement from neutral or negative comments, the research team was encouraged that an atmosphere was created that allowed the participants the freedom of expression to critically judge the outcome of their seminar experience.

## **Section 5**

### **Project Conclusions and Recommendations**

#### **5.1 Effectiveness of Curriculum**

To provide an immediate measure of this seminar's effectiveness, the research team developed a student evaluation form that was offered to all seminar participants at the close of the FHWA Culvert Management System seminar. The evaluation form is reproduced in full in Appendix F of this report along with a full compilation of the results of the evaluation and individual seminar participant responses that were recorded on the evaluation form.

It is worthwhile to note that the overall seminar was evaluated by the participants as excellent, and that a majority of written comments were either positive or neutral in nature. Thus it is the opinion of the research team that the expectations of the seminar participants were met or exceeded. However, only time will tell whether the underlying theme of the seminar, that of successful culvert management requiring careful preparation, execution and sweat equity, was understood and was accepted.

An encouraging byproduct of the seminar was the interest by and contact from the Federal Highway Administration's Asset Management Division that occurred just two weeks after the seminar was presented. In addition, the research team participated in an FHWA field visit to Shelby County to discuss the county's implementation of the FHWA Culvert Management System. At that time, the research team was able to express the seminar participants' critical comments and to forward the participants' suggestions for changes and improvements to the software. Most of these suggestions were made verbally by the participants during the course of the seminar presentations and were recorded by the team members. These and other recommendations that resulted from the research, development, and presentation of the FHWA Culvert Management Seminar are presented in Section 5.2 of this report.

The atmosphere of the seminar was such that questions were often prescient to the next topic to be covered and often led to a more thorough enjoyment and understanding of the previous topics. Furthermore, the classroom exercises and the participants' access to the working program seemed to greatly increase the level of interest in the subject. For further detail on the seminar format, the Lesson Plan Handout, a list of Classroom Materials, the Detailed Lesson Plan, and the Classroom Exercises Handout are included in Appendices A, B, C and D of this report. To summarize, the seminar participants were very complimentary of the level of preparation and seminar format.

## 5.2 Recommendations for Future Development

One factor in the success of a seminar presentation is the response of the seminar participants. As previously noted, the overall participant response to the FHWA Culvert Management Seminar was very positive, and the discussion periods were lively and well-attended. The major theme of questions focused on the plans for future development of the software. During the presentation, the research team expressed to the participants that the most effective way to communicate an interest in the continuation of the Culvert Management System by FHWA or another entity was for its actual and potential users to call for upgrades and bug fixes. A short list of program bugs and other shortcomings were discussed by the seminar participants, and the research team is making progress in passing these requests to FHWA through its Asset Management Division.

In particular, it was noted by the research team that although the evaluation database functions completely, there was difficulty in achieving a fully functional “real-time” Shelby County database. As the program is currently written, it is impossible to effectively execute the next module if the previous subroutines do not function. In addition, some of the calculations appear to be processing properly in the canned database while in a comparative “real-time” database functionality is impeded by missing inputs. However, a careful reading of the underlying code by the research team has failed to reveal the phantom inputs that are causing the program to “hang up” or “crash” during calculations. This is rather unfortunate since contact with the program authors has not effectively established a means to repair the database errors.

Finally, the database software as it exists today is an older stand-alone version that is not currently being maintained by the original authors or publishers. As a result, response to queries concerning program execution and possible bugs has been non-existent. A need is evident for maintenance and updates by an entity willing to express ownership in the executable coding of the database software.

As this database software is the outcome of a completed NCHRP project, the Federal Highway Administration through its Asset Management Division has recently expressed to Shelby County, the Alabama Department of Transportation, and to other state transportation departments that it has an interest in taking ownership of the distribution, maintenance, upgrading and future development of the FHWA Culvert Management System. Thus, an important first step toward the future sustainable efficacy of the FHWA CMS has been made. In conclusion, any continuing interest demonstrated by the seminar presentation team, the seminar participants, and the seminar’s supporting research partnership could become an influential factor in sustaining the FHWA programming for this valuable management tool.

## Section 6 References

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**Appendix A  
Lesson Plan Handout**

**CULVERT MANAGEMENT SYSTEM  
Lesson Plan Overview**

|                                    |      |                   |
|------------------------------------|------|-------------------|
| <b>SETUP AND TROUBLESHOOTING</b>   | 1:00 | 7:00 AM to 8:00   |
| <b>REGISTRATION AND SIGN-IN</b>    | 0:30 | 8:00 to 8:30      |
| <b>FIRST MORNING SESSION</b>       |      |                   |
| Introductions                      |      |                   |
| Facilities                         |      |                   |
| Rules of Order(Davidson/Grimes)    | 0:15 | 8:30 to 8:45      |
| Purpose and Benefits of a CMS      |      |                   |
| Shelby County's Experience         |      |                   |
| Computer Requirements              |      |                   |
| Manual Layout (Davidson/Grimes)    | 0:45 | 8:45 to 9:30      |
| System Layout                      |      |                   |
| Inventory Module (Grimes)          | 0:30 | 9:30 to 10:00     |
| <b>MORNING BREAK</b>               | 0:15 | 10:00 to 10:15    |
| <b>SECOND MORNING SESSION</b>      |      |                   |
| Condition Module                   |      |                   |
| Work Needs Module                  |      |                   |
| Input Examples (Grimes)            | 1:15 | 10:15 to 11:30    |
| Classroom Problem (Grimes)         | 0:30 | 11:30 to 12:00 PM |
| <b>LUNCH BREAK</b>                 | 1:00 | 12:00 to 1:00     |
| <b>FIRST AFTERNOON SESSION</b>     |      |                   |
| Work Funding Module                |      |                   |
| Schedule Module                    |      |                   |
| Input and Output Examples (Grimes) | 1:00 | 1:00 to 2:00      |
| Classroom Problem (Grimes)         | 0:30 | 2:30 to 3:00      |

|  |      |                 |
|--|------|-----------------|
| <b>AFTERNOON BREAK</b>   | 0:15 | 3:00 to 3:15    |
| <b>SECOND AFTERNOON SESSION</b>                                |      |                 |
| Vendor Technical Presentations                                 |      |                 |
| Class Summary, Evaluations, Certificates<br>(Grimes, Davidson) | 1:15 | 3:15 to 4:30    |
| <b>DISMISSAL</b>   |      | 4:30 PM         |
| <b>REVIEW AND DEBRIEF</b>                                      | 1:00 | 4:30 to 5:30 PM |

## **Appendix B Classroom Materials**

### **HANDOUTS**

|                                       |            |
|---------------------------------------|------------|
| FHWA Culvert Management System CD     | (Grimes)   |
| FHWA Culvert Management System Manual | (Grimes)   |
| Lecture Notes and Slides              | (Grimes)   |
| List of Culvert Inspection Resources  | (Grimes)   |
| UAB Information Sheets                | (Davidson) |
| Technical Data Sheets and Handouts    | (Vendors)  |
| Evaluation Form                       | (Davidson) |
| Certificate of Completion             | (Davidson) |

### **CLASSROOM RESOURCES**

|                              |                    |
|------------------------------|--------------------|
| Overhead Projector           | (ALDOT)            |
| Classroom Computers          | (ALDOT)            |
| Laptop(s)                    | (Grimes, Davidson) |
| Culvert Inspection Resources | (Grimes)           |
| White Board                  | (ALDOT)            |
| Markers and Eraser           | (ALDOT, Grimes)    |
| Slide Presentation           | (Grimes, Davidson) |



## **APPENDIX C**

### **Detailed Lesson Plan**

#### **DAY 1**

##### **SETUP AND TROUBLESHOOTING**

System setup for each machine must be performed previously by ALDOT with Grimes present to troubleshoot. Grimes will need a laptop to view slides and conduct classroom examples and exercises. All handout materials may be stored in classroom overnight.

#### **DAYS 2 THRU 4**

##### **REGISTRATION AND SIGN-IN**

This is a secure location that requires visitor passes and daily sign-in and sign-out to gain admission. Attendees should be instructed to try to arrive 15 minutes early to allow for this added burden. Additionally, a sign-in sheet with morning and afternoon session blocks for initialing will be passed to the participants at the beginning of each session.

##### **FIRST SESSION**

Introductions— Davidson and Grimes introduce themselves.

Facilities—Davidson briefly thanks ALDOT for use of the facilities and explains the sign-out procedures.

Rules of Order—Grimes lists bathroom and breakroom locations, overviews layout of class times, breaks, and lunch.

Purpose and Benefits of a CMS—Davidson emphasizes the need for a standardized inspection program including a short history of culvert failures in the state. Davidson reviews the current status of CMS in the state and county systems.

Shelby County's Experience—Davidson presents a short history of UAB's and Shelby County's cooperative research efforts. Davidson overviews briefly the research efforts that have lead to this presentation. Davidson turns the morning program over to Grimes, and Grimes specifically summarizes his research and the evolution of the FHWA CMS.

Computer Requirements—Grimes lists the minimum computer requirements for the FHWA CMS to operate properly. Grimes describes the type of program that is being utilized by the CMS. Grimes details the strengths and weaknesses of the current version of the CMS.

Manual Layout—Grimes briefly overviews the layout of the CMS manual and indicates that this layout controls the structure of the classroom lectures and exercises.

#### 1 Manual Layout

- 1.1 System Layout
- 1.2 Inventory Module
- 1.3 Condition Module
- 1.4 Work Needs Module
- 1.5 Work Funding Module
- 1.6 Scheduling Module
- 1.7 Appendices

System Layout—Grimes points out the parallels between the CMS and its accompanying manual.

#### 2 System Layout

- 2.1 Description of Modules
  - 2.1.1 Inventory Module
  - 2.1.2 Condition Module
  - 2.1.3 Work Needs Module
  - 2.1.4 Work Funding Module
  - 2.1.5 Scheduling Module
- 2.2 Program Operation
- 2.3 Reports
- 2.4 System Utilities Option

Inventory Module—Grimes walks participants through the use of the module.

#### 3 Inventory Module

- 3.1 Using the Inventory Module
  - 3.1.1 Adding a New Culvert
  - 3.1.2 Locating an Existing Culvert
  - 3.1.3 Deleting an Existing Culvert
  - 3.1.4 Searching for Selected Culverts
  - 3.1.5 Obtaining Reports
- 3.2 Returning to the Main Menu

**MORNING BREAK**

## **SECOND SESSION**

Condition Module—Grimes walks participants through the use of the module.

### 4 Condition Module

#### 4.1 Accessing the Condition Module

##### 4.1.1 Control Information

##### 4.1.2 Inspection Information

##### 4.1.3 General Condition Information

##### 4.1.4 Inspection Ratings—Roadway

##### 4.1.5 Inspection Ratings—Culvert Structure & Channel

#### 4.2 Using the Condition Module

##### 4.2.1 Adding a New Culvert Condition

##### 4.2.2 Locating an Existing Culvert Condition

##### 4.2.3 Deleting an Existing Culvert Condition

##### 4.2.4 Obtaining Reports

#### 4.3 Returning to the Main Menu

Work Needs Module—Grimes walks participants through the use of the module.

### 5 Work Needs Module

#### 5.1 Maintenance and Repair Activities

##### 5.1.1 Adding a New Maintenance and Repair Activity

##### 5.1.2 Locating an Existing Maintenance and Repair Activity

##### 5.1.3 Deleting an Existing Maintenance and Repair Activity

##### 5.1.4 Obtaining Reports

#### 5.2 Returning to the Work Needs Menu

#### 5.3 Repair Types

##### 5.3.1 Adding a New Repair Type

##### 5.3.2 Locating an Existing Repair Type

##### 5.3.3 Deleting an Existing Repair Type

##### 5.3.4 Obtaining Reports

#### 5.4 Returning to the Work Needs Menu

#### 5.5 Calculate the Current Work Need

##### 5.5.1 Review the Current Work Needs

##### 5.5.2 Obtaining Reports

#### 5.6 Returning to the Work Needs Menu

#### 5.7 Returning to the Main Menu

Input Examples—Grimes demonstrates a culvert input example or specific portions of different culvert inputs as is required to reinforce the lecture demonstration.

Classroom Exercise—Participants are given a specific exercise or exercises with follow-up questions that require the utilization of several features of each module. At least 10 minutes of this session are devoted to reviewing exercises and answering participant questions.

## **LUNCH BREAK**

## **THIRD SESSION**

Work Funding Module—Grimes walks participants through the use of the module.

### 6 Work Funding Module

- 6.1 Processes Performed
- 6.2 Accessing the Work Funding Module
- 6.3 Using the Work Funding Module
  - 6.3.1 Establishing the Funding Cycle
  - 6.3.2 Define the Model Field Weighting
  - 6.3.3 Calculate the Initial Weighted Priority
  - 6.3.4 Review the Current Work Needs
  - 6.3.5 Identify the Available Funding
  - 6.3.6 Input Deterioration Curves
  - 6.3.7 Perform the Funding Analysis
  - 6.3.8 Review the Work Funding
- 6.4 Returning to the Main Menu

Schedule Module—Grimes walks participants through the use of the module.

### 7 Scheduling Module

- 7.1 Processes Performed
- 7.2 Accessing the Scheduling Module
- 7.3 Using the Scheduling Module
  - 7.3.1 Enter the Available Resources
  - 7.3.2 Calculate the Initial Weighted Priority
  - 7.3.3 Review Project Information
  - 7.3.4 Enter Scheduled Contract Work
  - 7.3.5 Schedule Projects
  - 7.3.6 Review In-house Scheduled Projects
  - 7.3.7 Review Contract Scheduled Projects
- 7.4 Returning to the Main Menu

Input and Output Examples—Grimes demonstrates a culvert input and output example or specific portions of different culvert inputs and outputs as is required to reinforce the lecture demonstration

Classroom Exercise— Participants are given a specific exercise or exercises with follow-up questions that require the utilization of several features of each module. At least 10 minutes of this session are devoted to reviewing exercises and answering participant questions.

## **AFTERNOON BREAK**

## **FOURTH SESSION**

Vendor Technical Presentations—Invited vendors present participants with handouts and brief explanations of their products and services. Each vendor may generate comments and questions from the participants.

Class Summary, Evaluations, Certificates—Davidson fields questions from the participants, restates course goals, hands out participant evaluation forms, and presents certificates to participants.

## **DISMISSAL**

## **REVIEW AND DEBRIEF**

Davidson and Grimes review evaluations, conduct trainer evaluations, discuss issues that have been recognized during the session, and prepare the room for the next presentation or clean up following the final presentation.

## APPENDIX D

### Classroom Exercises



University Transportation Center for Alabama  
FHWA Culvert Management System  
ALDOT Computer Training Center  
Montgomery, Alabama

#### Classroom Exercise 1

Last week, you completed inspections on eight culverts on County Road 17. It's Monday morning, and you have just poured your first cup of coffee. The County Engineer would like to receive a report on last week's inspection in time for the evening County Commission meeting. Since there is a slight drizzle outside, you decide that there is no better time than now to get working on the inspection report.

1. In the **inventory module**, run a **select query** to find the eight structures located on **CR 17**.
2. Run a **detailed culvert description report** to quickly review the eight records for the structure that serves **Indian Valley Lake**. **DO NOT PRINT THIS REPORT!**
3. Return to the **inventory module**.

The GPS reading for this culvert indicates that the location of the center point on this culvert is: **N 33° 17.172', E 086° 49.975'**. The existing culvert was constructed in **1973** under Project Number **S-833**. On August 15, 1997, the structure received an inventory rating of **21 tons** but and was posted for this load.

4. Enter the data given above into the appropriate data entry boxes. Check the rest of the detailed inventory data for this record for misspellings and typographical error.

Exit from the Condition Module.

Exit from the Program.

Questions and Comments

## Classroom Exercise 2

A recent inspection was performed on an existing culvert located on County Road 17 in Shelby County, Alabama. Your thorough inspection indicates that the following condition codes are appropriate:

|                   |               |                 |             |               |             |
|-------------------|---------------|-----------------|-------------|---------------|-------------|
| <b>PAVEMENT</b>   | <b>Normal</b> | <b>HEADWALL</b> | <b>Good</b> | <b>DEBRIS</b> | <b>Fair</b> |
| <b>SHOULDER</b>   | <b>Good</b>   | <b>WINGWALL</b> | <b>Good</b> |               |             |
| <b>SETTLEMENT</b> | <b>Fair</b>   | <b>EROSION</b>  | <b>Fair</b> |               |             |
| <b>ABUTMENT</b>   | <b>Good</b>   | <b>CHANNEL</b>  | <b>Good</b> |               |             |

Don't forget to adjust the **General Rating Codes** using normal NBIS coding practices.

Next, you wish to request that a few maintenance items be addressed. Add the following **MR Activity Codes** and **Amounts** in their appropriate data entry boxes.

100 Square Yards of Pavement Patching

250 Linear Feet of Added Guardrail (includes anchors)

15 Square Feet of Patching Spalls (for separations in barrels that may contribute to the settlement noted in the roadway)

Exit from the Condition Module.

Exit from the Program.

Questions and Comments

**APPENDIX E**  
**UTCA Seminar Evaluation Data**

**UTCA Seminar Evaluation Form**  
**PROFESSIONAL DEVELOPMENT PROGRAM EVALUATION**

*Implementation of the Federal Highway Administration's Culvert Management System*

Presented by: Tom Grimes and Jim Davidson, March 2006

*To provide us your assessment of this continuing education program, please read each item and then rate the questions by circling the appropriate response.*

|  |           |              |      |
|--|-----------|--------------|------|
| <b>Overall quality and usefulness of the program</b>         | Excellent | Satisfactory | Poor |
| <b>Instructor's expertise in this topic</b>                  | Excellent | Satisfactory | Poor |
| <b>Presentation of course materials, ideas, and concepts</b> | Excellent | Satisfactory | Poor |
| <b>Responsiveness to questions</b>                           | Excellent | Satisfactory | Poor |
| <b>Course description in brochure</b>                        | Excellent | Satisfactory | Poor |
| <b>Would you recommend this class for other colleagues?</b>  | Excellent | Satisfactory | Poor |

**Comments about this program:**



**Table E.1. UTCA seminar participant evaluation data**

|  |           |        |    |              |
|--|-----------|--------|----|--------------|
| Number of Participants                           | 32        |        |    |              |
| Number of Responses                              | 31        |        |    |              |
| Program quality & usefulness                     | 48        | out of | 62 | possible 77% |
| Instructor expertise                             | 58        |        | 62 | 94%          |
| Presentation of material, ideas & concepts       | 49        |        | 62 | 79%          |
| Responsiveness to questions                      | 59        |        | 62 | 95%          |
| Course brochure                                  | 44        |        | 62 | 71%          |
| Recommendation to colleague (Yes = 1, No/NR = 0) | 30        |        | 31 | <u>97%</u>   |
| Composite Score =                                |           |        |    | 85%          |
| RATING SCALE                                     | Raw Score |        |    |              |
| Excellent = 75 to 100%                           | 2         |        |    |              |
| Satisfactory = 40 to 74%                         | 1         |        |    |              |
| Poor = 0 to 40%                                  | 0         |        |    |              |

**Positive Participant Comments.**

“It [FHWA CMS] seems like a very useful tool. I am not sure if it will be implemented on a voluntary basis.”

“Very helpful! We will try to use [it].”

“Very informative.”

**Neutral Participant Comments.**

“I’m not sure that our county has the manpower for tracking this information on structures not required by ABIMS and in addition to CIMS.”

“Shorten pipe presentation. Also have plastic pipe demo.”

**Negative Participant Comments.**

“The computer program itself needs some bug and user adjustments.”

“Should have been a 4 hour course. [The brochure was] to [sic] wordy.”

# APPENDIX F

## Seminar Brochure

### *Implementation of FHWA Culvert Management System*

#### SEMINAR OUTLINE

So you think you want to manage your culverts!  
(Introduction)

Standards of practice in culvert management

An example CMS database

Culvert inspections and data entry

Culvert management applications

    Basic maintenance operations

    Advanced system-wide prioritization

What do I do with all this data?

    GIS applications

    State-of-practice replacement solutions

Choosing a replacement technology

    Presentation of available industry solutions

    Design aids, technical papers, case studies

#### INSTRUCTORS

Thomas C. Grimes, P.E., Chief Engineer, Shelby County  
Highway Department

James S. Davidson, PhD, Department of Civil and Environ-  
mental Engineering, The University of Alabama at Bir-  
mingham.

#### LOCATION

Alabama Department of Transportation's Computer Train-  
ing Center at Gunter Industrial Park.

#### REGISTRATION

The course fee is \$50. Pre-registration is required as  
there are a limited number of seats.

#### FOR MORE INFORMATION AND TO REGISTER ELECTRONI- CALLY

(Tom) Thomas C. Grimes, Chief Engineer, Shelby County  
Highway Department, 205-669-3880,  
tgrimes@shelbycountyalabama.net

(Jim) James S. Davidson, Associate Professor, Department  
of Civil and Environmental Engineering, The University of  
Alabama at Birmingham, 205-934-8435, jdavidso@uab.edu

INVOICING IS AVAILABLE UPON REQUEST.

# UTCA

University Transportation Center for Alabama

## *Implementation of the Federal Highway Administration's Culvert Management System*

University of Alabama at Birmingham  
School of Civil & Environmental Engineering  
1075 13th Street South  
Hoenn Building 130B  
Birmingham, AL 35294  
Phone: 205-934-8430  
Fax: 205-934-9855  
E-mail: jdavidso@uab.edu

THE UNIVERSITY OF  
**ALABAMA** **UAB** **UAH**

Management  
and Safety of  
Transportation  
Systems

Figure F-1. FHWA CMS seminar brochure, page 1.

## Implementation of the FHWA Culvert Management System

Rural roads constitute the majority of roadway network in Alabama. Much of this network is maintained by the State, but the majority is managed and maintained by County Highway Departments. Within these rural roadways are thousands of short span bridges and culverts. Recent studies at both the Federal and State levels have emphasized the vast number of these structures that are deficient and in need of replacement. Although this dollar amount is significant by itself, it does not account for indirect user costs such as damage to vehicles, lost time from detours, and lost revenue due to low load capacities. Although the need for replacing these structures is widely recognized, there is often a lack of management expertise in making informed decisions regarding the replacement order for LT20 projects.

This seminar provides a broad practical overview of culvert replacement and rehabilitation issues and technologies encountered by today's culvert designers and maintenance personnel. It starts with a brief overview of the need for management applications in government agencies and a primer on digital management technology that is available today. You will receive hands-on treatment in the practical application of one "off-the-shelf" culvert management system that has been developed through the Local Technical Assistance Program of the Federal Highway Administration.

The seminar reviews the essential steps in implementing and completing a system-wide culvert inspection and rating program using the FHWA CMS database tool. Also, the seminar includes value-added technologies to assist in planning replacement and rehabilitation work and system-wide prioritization and work plans. Common solutions to culvert replacement and rehabilitation are discussed by experts in the field of culvert and bridge replacement. Unique, state-of-practice design templates and construction materials are presented and discussed.

An overview of challenges facing today's design and maintenance teams follows. You will learn how to deal with budget constraints, engineering problems, construction on poor material, and how to limit public involvement and impact in the design and construction process. An in-depth discussion of various design aids, solutions, and case studies concludes this seminar.

### SEMINAR BENEFITS

- Learn how to build a system-wide database of small bridge structures or culverts including structural assessment, rating

data, maintenance records, maintenance costs, and replacement prioritization.

- Discover how to quickly choose replacement alternatives and to specify their proper application to your unique project requirements.
- Discuss various design philosophies and applications including the latest high-tech culvert replacement and rehab solutions such as flowable fill and fiber reinforced shotcrete for in situ replacement and strengthening. Learn the "how-to's" from experts who have developed and field-tested the applications.
- Receive up-to-date technical papers, design aids, specifications, and case studies from industry leaders in culvert replacement including Sherman Concrete, Hanson Pipe, and Contech-CPI.
- Examine ongoing research in environmentally friendly culvert rehabilitation through recycling of industrial waste byproducts.
- Receive your free copy of Report No. FHWA-LT-02-001, "Culvert Management System (CMS)" in CD-ROM format so that you can begin your system-wide culvert management database today.

### SPECIAL FEATURES

Each participant will receive a copy of the FHWA Culvert Management System (CMS) Program disk and the CMS Users Manual. Each participant may also receive numerous design aids, technical papers, design manuals, and case study reports from various industry leaders in culvert and material technology.

### CONTINUING EDUCATION CREDIT

Each seminar participant qualifies for 0.55 Continuing Education Units (CEU's). (0.1 CEU = 1 Professional Development Hour.)

### WHO SHOULD ATTEND

Structural and civil engineers, ALDOT employees, county engineers, city engineers, maintenance personnel, and competent contractors seeking to broaden their knowledge of culvert management technology, culvert replacement and rehabilitation research, culvert design, and construction techniques. While most of the discussion topics are technical in nature, those who are not engineers will not be overwhelmed because the instruction is an enjoyable mix of hands-on practice and group participatory discussion.

| Sign up for:                                      | Time      | Price   |
|---|-----------|---------|
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
| <input type="checkbox"/> Type the event name here | 00:00     | \$00.00 |
|   | Subtotal: | _____   |
|   | Tax:      | _____   |
|   | Total:    | _____   |

Name \_\_\_\_\_  
Address \_\_\_\_\_  
\_\_\_\_\_

Phone \_\_\_\_\_

Method of Payment  
 Check  
 Bill Me  
 Visa  
 MasterCard  
 American Express

Credit Card # \_\_\_\_\_ Exp. date \_\_\_\_\_

Signature \_\_\_\_\_

University Transportation Center of Alabama

University of Alabama at Birmingham  
School of Civil & Environmental Engineering  
1075 12th Street South  
Hoenn Building 1308  
Birmingham, AL 35294

Phone: 205 934 9430  
Fax: 205 934 9895  
E-mail: jkavids@uab.edu



Figure F-2. FHWA CMS seminar brochure, page 2.

**APPENDIX G**  
**Shelby County FHWA CMS Inspection Form**

# FHWA CMS Inspection Report

**Structure Number:** \_\_\_\_\_ **Location:** \_\_\_\_\_

**Date of Inspection:** \_\_\_\_\_ **Type:** Routine \_\_\_ Interim \_\_\_

**Inspector Initials:** \_\_\_\_\_ **Latitude:** \_\_\_\_\_

**Longitude:** \_\_\_\_\_

**Condition Code    Description**

**Pavement:** \_\_\_\_\_

**Shoulder:** \_\_\_\_\_

**Guardrail:** \_\_\_\_\_

**Settlement:** \_\_\_\_\_

**Embankment:** \_\_\_\_\_

**Overall roadway rating:** \_\_\_\_\_

**Abutment:** \_\_\_\_\_

**Pier:** \_\_\_\_\_

**Span:** \_\_\_\_\_

**Coating:** \_\_\_\_\_

**Headwall:** \_\_\_\_\_

**Wingwall:** \_\_\_\_\_

**Overall structure rating:** \_\_\_\_\_

**Opening:** \_\_\_\_\_

**Alignment:** \_\_\_\_\_

**Scour:** \_\_\_\_\_

**Erosion:** \_\_\_\_\_

**Debris:** \_\_\_\_\_

**Condition of vegetation:** \_\_\_\_\_

**Overall channel rating:** \_\_\_\_\_

**Additional remarks**

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**Data Entry Date:** \_\_\_\_\_

**Reviewer:** \_\_\_\_\_

**Title:** \_\_\_\_\_