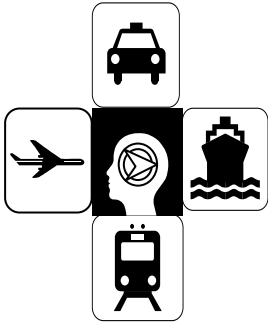


JERSEY DOT'S

"TURNING PROBLEMS INTO SOLUTIONS"



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Tech Brief

CULVERT INFORMATION MANAGEMENT SYSTEM – DEMONSTRATION PROJECT

FHWA-NJ-2009-017

August 2009

THE PROBLEM

Culvert pipes play a vital role in transportation infrastructure by facilitating safe drainage. The ramifications of culvert failures range from a temporary roadway closure to a catastrophic event with the attendant loss of human life. In that regard, the decision making process for preventative maintenance, i.e., to inspect, repair, replace, or no-action is key for both safety and cost savings considerations. However, the current inspection method is very expensive and time consuming. Hence, a new and properly developed Infrastructure Information Management System was developed to address these issues and to meet the Governmental Accounting Standards Bureau (GASB-34) requirements, as well as, saving tax payers' money.



**Collapse of New York State Thruway (I-88) due to culvert failure on June 28, 2006
(New York State Police Photo)**

OUR SOLUTION

We analyzed the condition of culverts in NJ, and based on material type, age and expected life and cost of replacement or repair, we can make recommendations to NJDOT for the decision process. The Culvert Information Management System (CIMS) provides fast and accurate information for NJDOT to make decisions on when and how to rehabilitate them.

OUR RESEARCH

The following information was used to make recommendations to Repair, Rehabilitate, Replace or to Do-Nothing at Project as well as Network levels.

- Number of pipes in the network
- Age or date of installation
- Fiscal year to be considered
- Condition State of some of the pipes based on prior inspection
- Expected life and variance for each pipe.
- Current value of the pipe after do-nothing/rehabilitation/replacement
- Cost of additional travel due to road closing
- Cost of inspection for each pipe
- Cost of pipe replacement
- Maximum rehabilitation for each, which includes user cost of failure, new construction cost plus damages associated with pipe failure
- Expected user cost for each pipe

We also enhanced the CIMS by adding the following modules:

The Culvert Assessment Module, a module developed to perform financial analysis by summarizing the pipe's material type, current condition, treatment cost, and relevant date. The Culvert Assessment Module also allows users to modify/update data at any time and automatically make a judgment to save the data by comparing the old and new information.

The screenshot shows the 'Culvert Data Form' interface. At the top, there are dropdown menus for 'Location' (R.T 1 SOUTH, EDISON, N.J.), 'Milepost' (30), 'MH_Start' (AMH 22.3555E), and 'MH_End' (AMH 22.4555). Below this, there are fields for 'Record ID' (U-504-1051-106-100), 'Project Name' (U-504-1051), and 'DP Number'. Further down, there are fields for 'Street' (R.T 1 SOUTH), 'City' (EDISON, N.J.), 'Location_code' (A Main Highway - Urban), 'Section_Number' (0), 'Condition' (0), 'MH1_id' (AMH 22.3555E), and 'MH2_id' (AMH 22.4555E). The 'Material Type' is 'DIP Ductile Iron Pipe', 'Inv_date' is '107.15', and 'Clean Date' is '107.15'. Other fields include 'Segment Length', 'Pipe Diameter' (C Circular 18" / 18"), 'Pipe Thickness' (0), 'Use_of_Sewer' (SW Stormwater), 'Survey Customer', 'DOT Inspector' (D. SALAZAR), 'Inspection Date' (09/14/2005), 'Inspection Reason' (F Routine Assessment), 'Video ID' (DVID02), 'Video Direction' (D), 'Video Operator', 'Report File', and 'Remarks'. A photo of a culvert interior is shown on the right. At the bottom, there is a table with columns 'Rec_id', 'Position', 'Counter', 'DVD File', 'Photo File', and 'Photo ID'. The table contains three rows of data. Below the table are buttons for 'Update', 'Report Preview', 'Structure Form', 'Assessment Form', 'Storm Water Form', and 'Close Me'. At the very bottom, it says 'Record: 1 of 151'.

Rec_id	Position	Counter	DVD File	Photo File	Photo ID
DVID02-261-1	0	00:45:14	AMH 22.3555E_AMH 22.4555E_D_051409-nA_NJD001-23_261a.jpg		261a
DVID02-261-2	0	00:45:14			General
DVID02-262-1	107.15	00:51:40			General

Screen Shot of CIMS

Optimization Module. After determining the treatment techniques for the culvert/pipe

segments under consideration, the user can define project groups and search for the optimal or near optimal solutions for budget allocation. This will be done by the CIMS optimization module.

Culvert Project Optimization Form

Culvert Project Optimization

Project Group id: Total Budget available (\$):

The project 'NJDOT_010108' contains 22 culvert/pipe segments to be considered in the optimization program. The total treatment expense is estimated as \$81843. Among these jobs, 1 must be included in the solution with minimum required budget \$22000. Please enter the available total budget for the plan in the textbox above. Click 'Search Optimal Solution' button to obtain the best budget allocation that maximizes the total capital expense of the network subject to the budget constraint.

Project Input Dataset

Pipe id	Group id	Pipe Sequence#	Selected	Pre-Fixed	Present worth	Improved worth	Treatment category	Treatment cost
U-504-1051-104-106	NJDOT_010108	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	\$250,000.00	\$500,000.00	Replacement	\$22,000.00
U-504-1051-127-130	NJDOT_010108	12	<input checked="" type="checkbox"/>	<input type="checkbox"/>	\$0.00	\$0.00	Inspection	\$9,786.00
U-504-1051-1-1	NJDOT_010108	8	<input checked="" type="checkbox"/>	<input type="checkbox"/>	\$491,317.00	\$500,000.00	Rehabilitation	\$5,000.00
U-504-1051-103-105	NJDOT_010108	4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	\$0.00	\$500,000.00	Rehabilitation	\$4,800.00
U-504-1051-101-103	NJDOT_010108	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	\$0.00	\$500,000.00	Rehabilitation	\$4,500.00

Record: 1 of 22

ILP Model Solution

Pipe id	Group id	Pipe #	Decision Variable	Pre-Fixed	Treatment category	Treatment cost	Improved worth	Total Budget	Total pipe # in network
U-504-1051-104-106	NJDOT_010108	1	1	<input checked="" type="checkbox"/>	Replacement	\$22,000.00	\$500,000.00	\$81,000.00	22
U-504-1051-127-130	NJDOT_010108	12	1	<input type="checkbox"/>	Inspection	\$9,786.00	\$0.00	\$81,000.00	22
U-504-1051-1-1	NJDOT_010108	8	1	<input type="checkbox"/>	Rehabilitation	\$5,000.00	\$500,000.00	\$81,000.00	22
U-504-1051-103-105	NJDOT_010108	4	1	<input type="checkbox"/>	Rehabilitation	\$4,800.00	\$500,000.00	\$81,000.00	22
U-504-1051-101-103	NJDOT_010108	3	1	<input type="checkbox"/>	Rehabilitation	\$4,500.00	\$500,000.00	\$81,000.00	22

Record: 1 of 22

Solution Summary: The solution includes 21 out of 22 jobs. OBJ_value = \$58967; and \$33 budget left (0-1 algorithm).

Additional Screen Shot of CIMS

Other components of CIMS:

- Determination of Critical Sections of the Culvert
- Inspection Frequency
- Inspection
- Condition State
- Prediction of Remaining Service Life
- Rehabilitation options and determining service life of the rehabilitated pipes
- Financial Analysis

FOR MORE INFORMATION CONTACT:

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A final report is available online at
<http://www.state.nj.us/transportation/refdata/research/>

If you would like a copy of the full report, please call the NJDOT, Bureau of Research at (609) 530-5637 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for: Culvert Information Management System – Demonstration Project
NJDOT Research Report No: FHWA-NJ-2009-017