AASHTOWare Bridge Management

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and Taylor Gilmore
Bentley Systems
Agenda

• Overview of AASHTOWare Bridge Management/Pontis
• Basics of Version 5.2
• Planned phases/features
• New options available
  – Hosting/SaaS options
  – Bentley InspectTech modules
• Questions
Pontis Basics

- Development started in the early 1990s under FHWA guidance
- Result of many millions invested by states and FHWA
- Part of AASHTOWARE – BRIDGEmWare software
- Licensed by more than 40 states
- Supports AASHTO element level inspection and management
Overview of Pontis 5.2

- AASHTOWare Product being developed under contract by Bentley
- Next generation of Bridge Management
- New Web interface/architecture
- National Bridge Elements
- Licensed by over 40 state DOTs
  - Also utilized by local and international agencies
Solicitation

- States were asked to voluntarily help support 5.2 development
- **Significant advantages to participating states:**
  - TRT participation
  - Onsite training/assistance
  - Early knowledge and implementation
  - Staff expertise considerably increased

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Project Proposal & Business Case for Developing the Next Generation of Pontis Bridge Management Software

Prepared by: AASHTO Pontis® Task Force

February 2012

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Thank You!
Pontis — AASHTOWare Bridge Management

• Pontis 5.2 is funded by a voluntary $5M pool from more than 20 state DOTs, under DOT guidance and expertise

• Tools that are easier to use and understand:
  – Planning
  – Deterioration
  – Risk
  – Multi-objective analysis
  – Lifecycle costs
  – Project models
  – Dashboards
  – Corridor planning
Advantages of Pontis as a BMS

• Full support and maintenance provided by AASHTO
• Developed over the past 20 years through extensive research and user feedback
• Enhancements and features are fully coordinated with AASHTO guidelines
• Incorporation of FHWA regulatory requirements
• Software created by DOTs for DOTs
  – Development administered and overseen by task force of state DOT representatives.
What’s in a Number?

4.5

5.1.0.3

5.1.2

5.2
What’s in a Number?

• Version 4.5
  – C++ based
  – Standalone or Client/Server Windows Application
  – CoRe Elements
  – Management and Inspection software

• Version 5.1.2/5.1.3
  – Microsoft .NET
  – Standalone (.NET) or Enterprise Web Based Application
  – NBEs/BMEs
  – Only Inventory/Inspection software
  – Management depends on 5.2

• Version 5.2
  – Microsoft .NET
  – Standalone (.NET) or Enterprise Web Based Application
  – NBEs/BMEs
  – Advanced Bridge Management Software
Basic Approach of BrM 5.2

• Utilize extensive research and lessons learned over past 20 years
  • Continue to evaluate best approach and layout
  • Give Task Force recommendations
  • TRT Expert Panel of State Representatives

• Develop the trunk of 5.2 and outward functionality at each level

• Multiple-phased implementation
Full Support of MAP-21 Requirements

Bridge Management System that is:

- Risk based
- Data Driven
- Performance measures
- Supports National Bridge and Tunnel Elements
Pontis 5.2 Phases

• Development on 5.2 in full swing

• Phased releases
  – Version 5.1.3
    • Support for NBE/BME Elements and numerous user requests
  – Version 5.2.1
    • Core program framework, risk assessments, integrated utility functions, network corridors
  – Version 5.2.2
    • Implementation of new deterioration models and multi-objective analysis
  – Version 5.2.3
    • Integrated project and program planning
    • All administrative features
Pontis 5.2.1

- Actively being developed
- Three Main Parts
  - Bridge Groups - 5.2.1(a)  \(\checkmark\) Done
  - Risk Assessments - 5.2.1(b)  \(\checkmark\) Done
  - Utility Functions - 5.2.1(c)  In Progress

Incorporation of user requests:
- Addressing tickets and incorporating as we go
- New features - advanced filters/Excel output
Bridge Groups

- Easy to use, new Web interface
- Network Corridors or user-defined groups of bridges
- Ability to group bridges based on a variety of factors
  - Simple creation list of common fields
  - Advanced fields
- Ability to group bridges allows for easier management and planning
Bridge Groups

Setup Corridors Wizard

Go to Corridor: I-70 Glenwood Canyon

Corridor | Bridges | County | Description
---|---|---|---
I-70 T-Rex Corridor | 21 | Denver | I-75
I-70 Northern | 32 | Larimer | I-75 / US-287
I-70 Grand Jct West | 14 | Mesa | I-70 miles to 0 to 54
I-70 Glenwood Canyon | 30 | Garfield | I-70
I-70 Divide | 16 | Summit | I-70
I-70 Denver West | 45 | Jefferson | I-70
I-70 Denver East | 42 | Arapahoe | I-70
I-70 Plains | 41 | Lincoln | I-70
I-70 Plains | 24 | Washington | I-70

Selected Corridors: 1 Selected
Risk Assessments

- Incorporation of Risk Assessments
  - Creation of new database data structures
  - Interface for creation of new Risk Assessments
  - Directly supports MAP-21
### Risk Assessment Table

<table>
<thead>
<tr>
<th>Vulnerability</th>
<th>Date</th>
<th>Status</th>
<th>Likelihood</th>
<th>Conseq</th>
<th>Assessment Value</th>
<th>Next Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic</td>
<td>1/2/2005</td>
<td>Calculated</td>
<td>5</td>
<td>50</td>
<td>100</td>
<td>1/2/2011</td>
</tr>
<tr>
<td>Scour</td>
<td>5/12/2012</td>
<td>Verified</td>
<td>7</td>
<td>50</td>
<td>6</td>
<td>5/12/2014</td>
</tr>
<tr>
<td>Fatigue</td>
<td>12/2/2009</td>
<td>Verification Pending</td>
<td>5</td>
<td>50</td>
<td>6</td>
<td>12/2/2014</td>
</tr>
</tbody>
</table>

### Risk Assessment Value

<table>
<thead>
<tr>
<th>Likelihood of Hazard</th>
<th>Consequence to Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
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<td></td>
<td>15</td>
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<td></td>
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<td>25</td>
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<td></td>
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<td></td>
<td>35</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>

**Vulnerability Type:** Scour

**Assessment Date:** 7/5/2012

**Assessment Key/Date:** 7/5/2012 (NNGR)

**Workflow Status:** Verified

**Affected Deck Area (Sq. Ft.):** 6,000

**Affected AADT:** 26,000

**Hazard Class:** 3

**Description:** Lots of scour here.
Risk Assessment Types

- Ability to have user-defined risk assessment types
- Support for agency-specified scales and formulas
- No limit to the number of assets created
Work Accomplishments/Requests

- Work Requests/Accomplishments
- Allow for setting Agency priority, cost, assignment and whether work is programmed
- Interface for external work accomplishments
- Better able to integrate with maintenance management systems
Improved Decision Making Tools

Better Tradeoff Analysis

- Mobility
- Life cycle cost
- Condition
- Risk and vulnerability

Tradeoff and Balance

New functionality:
- Balance multiple objectives
- More control of results
- More transparency

Eventual added consideration:
- Risk
- Time-sensitive deterioration
- Indirect cost

Better fit for agency workflow and business processes
Implementing Utility Functions

• Create a multi-objective framework that can be used to show the value (utility) of an action for a bridge

• Utility will also be shown for each sub-area
  – Mobility
  – Lifecycle cost
  – Condition
  – Risk items

• Work candidates are evaluated for how they contribute to mobility, lifecycle cost, condition and risk weightings
Multi-Objective Analysis Framework

- The model will score each work candidate identified.

[Diagram showing the Multi-Objective Analysis Framework with various hazard categories, performance measures, and scaling functions leading to a utility function.]
Utility Function Admin Page

View / Edit Mode

Utility Criterion Properties:
- Name: Bridge Health Index
- Formula: single or multiple fields
- When Excluded: N/A
- Assigned Weight: 50

Scaling:

<table>
<thead>
<tr>
<th>Original Value</th>
<th>Scaled Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>51</td>
</tr>
<tr>
<td>8</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>84</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

Auto-Generated Utility Scaling Equation:

Manual Utility Scaling Equation:
Utility Rating View

Overall Utility Rating: 67

Condition:
- Bridge Health Index: 75
- Deck Rating: 6
- Culvert Rating: N

Adjusted Condition Value: 77 x Weight: 50% = Final Condition Value: 38

Risk / Assessment:
- Scour: 5
- Seismic: 7
- Fatigue: 3

Adjusted Risk Value: 60 x Weight: 30% = Final Assessment Value: 18

Mobility:
- Adjusted Mobility Value: 40 x Weight: 10% = Final Mobility Value: 4

Life Cycle Cost:
- Adjusted LCC Value: 70 x Weight: 10% = Final LCC Value: 7
# Recommended Actions

![Recommendations for Plum Creek Bridge](image)

**Bridges**

<table>
<thead>
<tr>
<th>Work Candidates</th>
<th>Inspection</th>
<th>Analysis</th>
<th>Reports</th>
<th>Gateway</th>
<th>Admin</th>
</tr>
</thead>
</table>

**Bridge:** 1234567

**Name:** Plum Creek Bridge

**Facility:** 1-25

**Feature:** East Fork Plum Creek

- **Route:** 30025
- **Milepoint:** 181.50
- **District:** 1 - Metro
- **County:** Douglas
- **Func:** 11 - Urban interstate
- **Area:** 23 - Castle Rock
- **Owner:** 1 - State Hwy agency
- **Reap:** 1 - State Hwy
- **Material:** 6 - PYS Continuous
- **Design:** 05 - Multiple Box Beam
- **Source:** 7 - Countermeasures

<table>
<thead>
<tr>
<th>History - Geometry</th>
<th>Mobility - Safety</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built: 1968</td>
<td>Operating: 53.5</td>
<td>NB1: Deck: 4</td>
</tr>
<tr>
<td>Recentstr: 1996</td>
<td>Inventory: 32.6</td>
<td>Deck HL (calculated)</td>
</tr>
<tr>
<td>Length: 150 ft.</td>
<td>Geometry: 9</td>
<td>Superstr: 7</td>
</tr>
<tr>
<td>Width: 60 ft.</td>
<td>Approch: 8</td>
<td>Substr: 6</td>
</tr>
<tr>
<td>Span: 100 ft.</td>
<td>Waterway: 6</td>
<td>Substr HL (calculated)</td>
</tr>
</tbody>
</table>

**Current Scaled Performance**

- **Health:** 63.2
- **Risk:** 60.0
- **LC Cost:** 75.5
- **Mobility:** 100.0
- **Rating:** 72.5
- **SDPCO:** 50

**All Available Work Candidates**

<table>
<thead>
<tr>
<th>Work Candidate</th>
<th>Utility Value</th>
<th>Utility Change</th>
<th>Cost (est)</th>
<th>Benefit/Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do Nothing</td>
<td>70.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Candidate 1</td>
<td>78.4</td>
<td>8.1</td>
<td>$5000</td>
<td>1.62</td>
</tr>
<tr>
<td>Work Candidate 2</td>
<td>90.3</td>
<td>20.0</td>
<td>$10000</td>
<td>2.00</td>
</tr>
<tr>
<td>Work Candidate 3</td>
<td>84.2</td>
<td>13.4</td>
<td>$9600</td>
<td>0.87</td>
</tr>
<tr>
<td>Work Candidate 4</td>
<td>60.8</td>
<td>5.5</td>
<td>$14500</td>
<td>0.72</td>
</tr>
<tr>
<td>Work Candidate 5</td>
<td>71.3</td>
<td>1.0</td>
<td>$6000</td>
<td>1.86</td>
</tr>
<tr>
<td>Work Candidate 6</td>
<td>70.3</td>
<td>0.0</td>
<td>$3000</td>
<td>0.00</td>
</tr>
<tr>
<td>Work Candidate 7</td>
<td>76.6</td>
<td>6.2</td>
<td>$2750</td>
<td>2.25</td>
</tr>
<tr>
<td>Work Candidate 8</td>
<td>77.2</td>
<td>7.0</td>
<td>$2200</td>
<td>3.16</td>
</tr>
</tbody>
</table>

**Recent Completed Work**

- **Year:** 2006
- **Cost:** $30,000

- Deck Overlay
Needs List

![Diagram of Needs List interface with filters and data entries for bridge work candidates.]

- **Work Candidate Filter**: Bridge ID, 0407598, Flex Action, Corridor, Flex Action, Custom.
- **Bridge Characteristics**: Owner: State Highway Agency, Custodian: State Highway Agency.
- **Bridge Details Table**:
  - **Bridge ID**: 04 07598, Facility: Interstate 25, Flex Action: Repair Deck, Cost ($k): 30.0, Year: 2012, Benefit/Cost: 1.34.
  - **Bridge ID**: 04 07598, Facility: Interstate 25, Flex Action: Spot Point, Cost ($k): 30.0, Year: 2012, Benefit/Cost: 1.34.
  - **Bridge ID**: 04 07640, Facility: US 285, Flex Action: Repair Deck, Cost ($k): 30.0, Year: 2013, Benefit/Cost: 1.34.
  - **Bridge ID**: 04 08923, Facility: US 285, Flex Action: Spot Point, Cost ($k): 30.0, Year: 2013, Benefit/Cost: 1.34.
  - **Bridge ID**: 04 10967, Facility: Main Street, Flex Action: Repair Deck, Cost ($k): 30.0, Year: 2012, Benefit/Cost: 1.34.
  - **Bridge ID**: 04 26553, Facility: Wiber Way, Flex Action: Do nothing, Cost ($k): 30.0, Year: 2012, Benefit/Cost: 1.34.
Phase II (5.2.2)

- Complete Bridge Analysis Module
  - Bridge Analysis Dashboard
  - Work Candidate Dashboard
  - Replacement Bridge/Culvert page

- Deterioration Models

- Completion of Multi-Objective Analysis
## Bridge Analysis Dashboard

**Work Candidates**

- **Bridge**: 1234567
- **Name**: Plum Creek Bridge
- **Facility**: I-25
- **Feature**: East Fork Plum Creek

**Route**: 00028  **Milepost**: 181.50

**District**: 1 - Metro  **County**: Douglas
**Fnd**: 11 - Urban Interstate  **Area**: 23 - Castle Rock
**Owner**: 1 - State Hwy agency  **Resp**: 1 - State Hwy
**Material**: 6 - P/S Continuous  **Design**: 06 - Multiple Box Beam
**Scour**: 7 - Countermeasures

### History - Geometry

- **Built**: 1968
- **Reconstr**: 1995
- **Length**: 160 ft
- **Width**: 60 ft
- **Span**: 100 ft

### Mobility - Safety

- **Operating**: 53.5
- **Inventory**: 32.6
- **Approach**: 8
- **Way**: 6

### Health Index

- **NBI**: 2
- **Deck**: 4
- **Super**: 7
- **Substr**: 5
- **Column**: 5
- **Structure**: 4

### Current Scaled Performance

- **Health**: 63.2
- **Rail**: 50.0

### Sufficiency

- **LC Cost**: 75.5
- **Mobility**: 100.0
- **Racing**: 72.5
- **SD/FI**: 80

### Recent Completed Work

- **Year**: 2006
- **Cost ($k)**: 200.0

### Effect on Scope and Timing

<table>
<thead>
<tr>
<th>Work Candidate</th>
<th>Utility</th>
<th>Utility Change</th>
<th>Cost</th>
<th>Benefit / Cost ($k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-Netting</td>
<td>60.1</td>
<td>-</td>
<td>$0</td>
<td>0</td>
</tr>
<tr>
<td>Work Candidate 1</td>
<td>63.1</td>
<td>3</td>
<td>$500</td>
<td>6</td>
</tr>
<tr>
<td>Work Candidate 2</td>
<td>64.1</td>
<td>4</td>
<td>$1000</td>
<td>4</td>
</tr>
<tr>
<td>Work Candidate 3</td>
<td>62.1</td>
<td>2</td>
<td>$200</td>
<td>10</td>
</tr>
<tr>
<td>Work Candidate 4</td>
<td>41.5</td>
<td>11.6</td>
<td>$2000</td>
<td>5.7</td>
</tr>
</tbody>
</table>

### Effects on Each Utility Criterion

<table>
<thead>
<tr>
<th>Before WC</th>
<th>After WC</th>
<th>Condition</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scour</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Seismic</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>BHI</td>
<td>72</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Deck Cond</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

### Effects on Each Element

- 12 - SPC/other bridge
- 20 - Steel girder
- 30 - Concrete deck
- 50 - Concrete approach slab
- 70 - Other bridge railing
Improved Deterioration Models

- Allow for evaluating future condition at the detail and summary level
- Implement new deterioration model logic
  - Weibull approach to include time factor
- Easy to construct/new elicitation process
- Utilize NBE elements
  - Protective systems
  - Defect flags
- Allow for multi-path deterioration
Phase III (5.2.3)

- Completion of programming module
  - Projects
  - Programs
- Scenario Creation
- Results Browsing/Dashboards
- Additional administration features
- Complete Project Planning module
Project List
Network Level Planning

This graph compares the performance of the inventory subsets. If any are underperforming, you can increase their share of the budget to bring them up. Target performance is set on the Tradeoff Analysis Dashboard.

This graph shows the maximum achievable utility at any given budget level, given the project list and utility weights developed elsewhere in the system. Since the program is optimized, it will always be at one point along this frontier, indicated by the triangle.
 Significant Progress Being Made

• Completion of Pontis 5.1.2
• Imminent Release of Pontis 5.1.3
• Code complete of Pontis 5.2.1(a) and 5.2.1(b)
• Designing Pontis 5.2.1(c)
• Initial work on Pontis 5.2.2

• Solid experienced team moving forward
Current Activities

• Bi-weekly Task Force Meetings (webinar)
• Quarterly Task Force Meetings (in person)
• Development of Phase 1C – Utility Functions
• Coordinate with TRT
• Launch Phase 2
• Continue update webinars to the user community
• Expanding overall team
New Features

• Advanced filters
• Integrated mapping
• Excel outputs
• Improved interface
  – Less clicks
  – Latest web controls
• Performance/speed improvements
• Hosting/SaaS option
• Coordination with optional Bentley InspectTech modules
Integrated Mapping
Excel/PDF Outputs
Available to Smaller Agencies

• New pricing model will be piloted by AASHTO to allow easier usage by smaller (non-DOT) agencies

• Tiered by number of bridges:
  – 250 or less
  – 251-500
  – 501-1000

• Hosted-only solution

• Limited support hours

• User group attendance add-on

• Contingent on final AASHTO approvals
Planned Bentley Add-Ons And Services

• AASHTO / Bentley Agreement supports new add-ons in coordination with Task Force:
  – Hosting/SaaS
  – Mobile applications
  – Workflow
  – 3D interactive inspection models
  – ProjectWise linkage
  – User credentialing
  ….
Hosting / SaaS Solutions

- Bentley able to provide reliable and secure hosting environment for Pontis solutions
- Bentley applies all patches and updates needed to Pontis
- Storage, processing and servers tuned for Pontis maximum performance
- Can result in significant cost savings to DOT and performance/satisfaction improvement
Complex Structure Add-On

• Solution designed to support large assets
• Turns thousands of pages into useful information
• Data can be viewed and linked on interactive 3D model accessible via the Web
• Information directly linked to individual elements
• Interactive dashboards, maintenance planning, and trend analysis quickly identify problems and needs
Complex Structure Add-On
Interactive Inspections

Delaware River Port Authority
Bridge and Structure Inspection Management System

StructureSuite
inspecttech

U45-L45 (Main Thru Span > Verticals > North Truss)

Rating: 6 - Satisfactory Condition (minor deterioration)

Remarks:
- Rubber pads attached to all stainless steel retrofit rods are generally cracked, dry and worn.
- The northwest retrofit stainless steel rod vibrates more than the others. Also, the 1st retaining U-bolt above the roadway is missing one lock nut.
- Truss vertical southeast flange has horizontal gouges throughout the edge of the flange.

Photos: 64, 65, 66
ProjectWise Add-On
## Work Flow

### Report Review Progression:

<table>
<thead>
<tr>
<th>Date Submitted</th>
<th>Submitted By</th>
<th>Submitted To</th>
<th>Action</th>
<th>Action Completed?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/11/2012</td>
<td>Patel, Rajesh</td>
<td>Patel, Rajesh</td>
<td>Moved to state on review 1</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>09/27/2012</td>
<td>Patel, Rajesh C. (Admin)</td>
<td>Paola, Nicholas</td>
<td>Yes</td>
<td></td>
<td>This report is for your review.</td>
</tr>
<tr>
<td>09/15/2012</td>
<td>Patel, Rajesh C. (Admin)</td>
<td>Koil, Joseph</td>
<td>Yes</td>
<td></td>
<td>Joe You must Assign to County person</td>
</tr>
<tr>
<td>08/09/2012</td>
<td>Koil, Joseph</td>
<td>[not assigned]</td>
<td>Moved to bridge owner review</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>08/09/2012</td>
<td>Mansour, Hussein</td>
<td>Koil, Joseph</td>
<td>Moved to consultant review</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
Mobile App Version for Pontis Field Usage

Advanced mobility for users of **InspectTech**: 
**InspectTech Collector Mobile**

- Sleek, graphical interface
- Custom inspection workflow
- Capture photos, video, and audio
- Calculations based on NBI and other codes
- Built-in historical asset information
- Rapid pinpointing of assets using mapping/GPS
- Cloud service synchronization with SaaS
  InspectTech solution
Tracking Dashboards
Conclusion

- Pontis 5.2 (AASHTOWare Bridge Management 5.2) is rapidly being developed
- BrM will be an easier to use and more powerful tool defining new standard of Bridge Management
- Version 5.1.3 with Migrator Support available soon
- Pontis 5.2 will be released in three main phases
- New AASHTO / Bentley agreement provides greater coordination and new optional features for Pontis users
- Offered as SaaS solution that provides an anywhere, anytime secure one-stop location for all data
Questions

Upcoming Webcasts:
Visit www.bentley.com or www.roadsandbridges.com

Contact us!
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