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Guide for Bridge & Culvert Evaluation

A Supplement To The AASHTO Manual for Bridge Evaluation for Agency-Specific Information

2nd Edition (Draft)

2025

National Aeronautics and Space Administration

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SECTION 1: INTRODUCTION

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SECTION 1: INTRODUCTION

1.1 PURPOSE

1.1.1 General

In accordance with the requirements and guidance of the Federal Highway Administration (FHWA), The National Aeronautics and Space Administration (NASA) has developed the NASA Guide for Bridge and Culvert Evaluation (NGBCE). The NGBCE is intended as a supplement to the American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Evaluation (MBE), Third Edition 2018, and its 2019 and 2020 interim revisions. The MBE is incorporated by reference in part 650 (Bridges, Structures, and Hydraulics) of the Code of Federal Regulations (23 CFR, pt. 650). The NGBCE is not intended to supersede information in the MBE but rather to provide complementary, non-contradictory supplemental information, procedures, and requirements specific to NASA.

Only the specific sections and articles in which supplemental information has been added are included in this document. The reader is to refer directly to the AASHTO MBE for all other material. Culvert inventory and inspection were added in Sections 9 and 10 of this guide.

1.1.2 NASA Bridge Management Program (NBMP)

As part of Federal regulatory requirement 23 CFR, pt. 650, subpt. C, all Federal agencies with highway bridges on public roads that are located within that respective agency's responsibility or jurisdiction shall inspect or cause to be inspected such bridges and maintain a bridge management program in accordance with the National Bridge Inspection Standards (NBIS).

As part of this Federal requirement, NASA has established the NASA Bridge Management Program and concurrently developed the NASA Guide for Bridge and Culvert Evaluation (NGBCE) for use at all Centers and other NASA facilities where bridges and/or culverts are owned by NASA.

The Federal Highway Administration (FHWA) requires NBIS regulations to be applied to all publicly owned highway bridges longer than 20 feet located on public roads. A public road is defined in 23 U.S.C. 101(a)(27) as "any road or street under the jurisdiction of and maintained by a public authority and open to public travel." NASA owns both public and nonpublic bridges. A NASA bridge is considered nonpublic if only badged personnel have access to the bridge and the bridge is contained within a security-gated area.

1.2 SCOPE

1.2.1 NASA Bridge Inventory

NASA utilizes the guidance provided in the NBIS for all its bridges. However, only public bridges are reported to the FHWA. The Center Bridge Program Manager (CBPM) provides the Specification for the National Bridge Inventory (SNBI) dataset to the Agency Bridge Program Manager (ABPM) at Kennedy Space Center (KSC). The ABPM communicates the information to the FHWA. Changes to the inventory data should be entered into the agency inventory within 3 months after the month when the field portion of the inspection is completed. For modifications to existing bridges that alter previously recorded inventory data and for newly constructed bridges, enter the inventory data into the agency inventory within 3 months after the month of opening to traffic. For changes in load restriction or closure status, enter the revised inventory data into the agency inventory within 3 months after the month the change in load restriction or closure status of the bridge is implemented.

1.3 APPLICABILITY

Sections (1-6) and appendices (A-G) of this guide are applicable to highway structures owned by NASA and meeting the definition of a "bridge" per the current Rule of the FHWA NBIS. Where conflicts or inconsistencies exist between this Guide and the federal requirements specified in the NBIS, the FHWA Bridge Inspector's Reference Manual (BIRM), the NBIS and FHWA requirements shall govern. Sections (9-10) and Appendix F are applicable to culverts owned by NASA.

1.4 QUALITY MEASURES

1.4.1 Introduction

In order to ensure that NASA's bridges and culverts are being inspected and evaluated in an accurate and consistent manner, it is necessary to establish certain associated quality control (QC) and quality assurance (QA) measures. These QC/QA measures are integrated into the entire program to ensure systematic implementation.

The bridge inspection process is the foundation of the entire NASA Bridge Management Program. Therefore, accuracy and consistency of the data is very important. Skillful bridge and culvert inspections are vital in ensuring public safety and the process also directly impacts programming and funding appropriation.

These procedures are intended to maintain the quality of NASA bridge and culvert inspections and evaluations at a high level. The QC/QA functions are essential for all personnel involved with the NASA Bridge Management Program, including contractors and consultants, and will provide for accuracy and consistency among the numerous personnel responsible for bridge

safety inspections, culvert inspections, reporting, and load rating within and for the Agency. QC measures are generally intended to maintain the quality of the inspection program. While QA is intended to verify the adequacy of the established QC measures.

1.4.2 QC Measure

Qualifications of Personnel:

See Section 4.3 for detailed qualifications of personnel.

Required Submittals and Deliverables:

In addition to the standard safety and environmental submittals required at the location of the inspection, the inspection firm shall also provide qualifications certificates for the inspection team. The CBPM or their designated representative (Contractor Engineer(s) or inspection contract project manager) shall review these certificates for relevance and completeness.

The deliverables identified in Table 4.1 of this guide shall be provided to the CBPM for review and acceptance. The ABPM will be available to provide guidance in the review and acceptance process. Final deliverables will be provided to the ABPM.

On-Site QC:

Performance of an on-site review of inspections can be a highly effective quality control measure and can build a strong communication link between the inspectors and the reviewer(s). The CBPM and/or their designee (a Contractor Engineer or a Quality Control Manager) will conduct and document QC field reviews. For bridges, the field reviews will be performed at each center for at least one day every inspection cycle. The QC field reviews are to be included in the bridge file. For culverts, the field reviews will be performed as needed for culverts with concerning deteriorations or culverts with missing data

A priority in conducting a QC field review shall be given to bridges that are posted for weight restrictions, Structurally Deficient (SD) bridges, bridges programmed for rehab/replacement, critical findings bridges, bridges with unusual changes in condition ratings (e.g., more than one appraisal rating change from previous inspections), and bridges that require special inspections (underwater, NSTM, or other special conditions).

This QC field review will consist of the CBPM and/or their designee(s) assessing the correctness and completeness of the inspection, including field notes, sketches, coding, elements and quantities, maintenance recommendations, and photos as required by NASA's current procedures, as well as those needed to depict critical conditions, etc. QC field review may be delegated to the inspection firm. However, they should not be conducted by the same team performing the inspection. Significant findings will be brought to the CBPM attention. The QC field reviews are to be included in the bridge file.

Office QC:

The CBPM and/or NASA designee (i.e., someone who has completed a bridge inspection training and is familiar with inspection procedures and coding) will conduct a QC review of all bridge files in their respective office at least once every inspection cycle (24 months) to ensure the information collected during bridge inspections is accurate, consistent, of a high quality, and readily available. All documentation of inventory, inspection, and load rating information should be kept in an orderly and retrievable manner. The CBPM and/or Contractor Engineer(s) will review the files for completeness and accuracy and compare the files to previous inspection reports, noting any significant changes.

Among items to be reviewed are:

- Appropriateness of the identified bridge elements and their quantities
- Correlation between spread of MBE inspection elements condition states and the National Bridge Inventory (NBI) coding
- Load restrictions, if present, correlate with load rating and recommended posting
- All required photos are included
- All items necessary for accurate reporting to the FHWA are properly coded

The CBPM and Contractor Engineer(s) will compare new inspection reports to previous reports, noting any significant changes.

For culverts, the Contractor Engineer(s) will review the inspection findings and ensure the process and frequency are in accordance with Section 9 and 10 of this guide. The Contractor Engineer(s) shall bring any significant findings to the attention of the CBPM.

1.4.3 QA Measure

Routine QA Routine Meetings:

text

In-Brief and Out-Brief Review Meetings:

Text

Annual Site Visits:

Text

The ABPM shall meet the qualifications set forth in 23 CFR 650.309 for Program Managers. In addition, ABPM and CBPMs shall meet continued training requirements as described in Section 1.4.6. The ABPM and CBPMs will hold a bi-monthly conference call meeting to discuss quarterly updates and ensure program requirements are met.

Bridge inspection teams shall meet the requirements set forth by the FHWA for Inspection Team Leaders and Inspection Team Members. The responsible Contractor Engineer(s) shall review the qualifications of the inspection team personnel before every inspection cycle (typically once every 24 months)

QC Field Review

Performance of an in-field review of inspections by the CBPM can be a highly effective quality control measure and can build a strong communication link between the inspectors and the reviewer(s). The CBPM and/or NASA designee (i.e., someone who has completed a bridge inspection training course and is familiar with inspection procedures and coding) will conduct and document QC field reviews. For bridges, the field reviews will be performed on at least 25% of the bridges inspected every inspection cycle (24 months). The QC field reviews are to be included in the bridge file. For culverts, the field reviews will be performed as needed for culverts with concerning deteriorations or culverts with missing data

A priority in conducting a QC field review shall be given to bridges that are posted for weight restrictions, Structurally Deficient (SD) bridges, bridges programmed for rehab/replacement, critical findings bridges, bridges with unusual changes in condition ratings (e.g., more than one appraisal rating change from previous inspections), and bridges that require special inspections (underwater, NSTM, or other special conditions).

This QC field review will consist of the CBPM and/or Contractor Engineer(s)assessing the correctness and completeness of the inspection, including field notes, sketches, coding, elements and quantities, maintenance recommendations, and photos as required by NASA's current procedures, as well as those needed to depict critical conditions, etc. QC field review may be delegated to the inspection firm. However, they should not be conducted by the same team performing the inspection. The QC field reviews are to be included in the bridge file.

QC Office Review

The CBPM and/or NASA designee (i.e., someone who has completed the bridge inspection training and is familiar with inspection procedures and coding) will conduct a QC review of all bridge files in their respective office at least once every inspection cycle (24 months) to ensure the information collected during bridge inspections is accurate, consistent, of a high quality, and readily available. All documentation of inventory, inspection, and load rating information should be kept in an orderly and retrievable manner. The CBPM and/or Contractor Engineer(s) will review the files for completeness and accuracy and compare the files to previous inspection reports, noting any significant changes.

1.4.4 QC/QA Procedures for NASA Bridge Inspections Performed by Contractors

The CBPM may delegate the QC/QA procedures of Contractor Bridge Inspectors to the Contractor Engineer(s) to ensure the overall quality is of an acceptably high level. Designated Contractor Engineer(s) are responsible for QC/QA procedures and controls within their own organization. In addition, they are to follow the NBIS and NASA's current policies and procedures, including but not limited to the QC/QA procedures described in this guide

Quality Assurance

Bridge inspection teams shall meet the requirements set forth by the FHWA for Inspection Team Leaders and Inspection Team Members. The responsible Contractor Engineer(s) shall review the qualifications of the inspection team personnel before every inspection cycle (typically once every 24 months)

QC Field Review

On behalf of the CBPM, the Contractor Engineer(s) will conduct and document QC field reviews of Contractor Bridge Inspectors working in the field at least once every inspection cycle (24 months). The QC field reviews will be conducted for at least 25% of the bridges being inspected and the composition of these bridges will be such that they represent a cross-section of bridge types being inspected. The QC field reviews are to be included in the bridge file.

Bridges that are posted for weight restrictions are to have priority for spot checking. This field review will consist of the Contractor Engineer(s) assessing the correctness and completeness of the inspection, including coding, elements and quantities, maintenance recommendations, and photos as required by NASA's latest policies and procedures as well as those needed to depict critical conditions, etc. This review shall be done with the Contractor Bridge Inspector(s) present so that any improper coding or procedures can be discussed in the field and immediately corrected.

For culverts, the field reviews will be performed as needed for culverts with concerning deteriorations or culverts with missing data. Findings of the QC field review shall be documented in the comments section of the culverts file as described in Section 10 of this guide.

QC Office Review

The CBPM and Contractor Engineer(s) will perform a QC office review of all contractor bridge inspection reports to ensure the information collected during bridge inspections is accurate, consistent, and of high quality.

Among items to be reviewed are:

- Appropriateness of the identified bridge elements and their quantities
- Correlation between spread of MBE inspection elements condition states and the National Bridge Inventory (SNBI) dataset
- Load restrictions, if present, correlate with load rating and recommended posting
- All required photos are included
- Current wearing surface dead load as measured does not exceed “max wearing surface for load capacity” according to the bridge record drawings by more than ½ inch
- All items necessary for accurate reporting to the FHWA are properly coded

The CBPM and Contractor Engineer(s) will compare new inspection reports to previous reports, noting any significant changes.

For culverts, the Contractor Engineer(s) will review the inspection findings and ensure the process and frequency are in accordance with Section 9 and 10 of this guide. The Contractor Engineer(s) shall bring any significant findings to the attention of the CBPM.

Disqualification

When the inspection review indicates that a Contractor and/or Contractor Bridge Inspector continue to make the same or similar mistakes, omissions, etc., NASA may implement disqualification procedures as follows:

- Upon receiving notice of incorrect coding and significant findings, the Contractor Bridge Inspector is to address the findings and prepare a report that explains the steps that will be taken to correct the problems to ensure they will not be repeated in the future.
- If the same or similar mistakes are repeated, the Contractor Bridge Inspector is to be given notification that they will be disqualified if these problems are not corrected and avoided in the future.
- The Contractor Bridge Inspector will be reviewed again in their next assigned inspection contract. If the same or similar problems are found, the Contractor and/or Contractor

Bridge Inspector will be notified that they are hereby disqualified for a minimum of 4 years.

A disqualified Contractor and/or Contractor Bridge Inspector may be re-qualified after the 4-year period if they indicate in their term agreement proposal how they have corrected their deficiencies (e.g., refresher training, change in personnel).

Reasons for Disqualification

Typical reasons for disqualification can be, but are not limited to, the following:

- Lack of proper contact with the CBPM or their representative after finishing inspections in the area
- Lack of proper follow up with the CBPM or their representative for critical findings
- Failure to report significant deterioration or damage such as fractured load-carrying members, critical scour at foundations, and vehicular impacts
- Failure to perform bridge inspections and produce inspection reports on time
- Failure to attend in-brief or out-brief meetings if directed by NASA or its representative. If data or reporting appears to be erroneous and the Contractor and/or Contractor Bridge Inspector fails to justify and/or correct the issue

1.4.5 QC/QA Procedures for Load Rating

Load ratings of bridges within NASA jurisdiction are completed by a Rater, typically a professional engineer working for an inspection firm. For highway bridges that do not have a known load rating, an initial rating is to be completed based on the current as-built/as-inspected conditions and in accordance with the AASHTO MBE and Section 6 of this guide. Once an initial rating is established, the rating is to be recalculated and updated whenever necessary to reflect significant changes in condition, modifications, or applied loading to the bridge. More details on load rating frequency are presented in Section 6 of this guide.

Significant changes in load rating (e.g., a decrease of 25% or greater and/or derating below the legal load limits) are to be reported by the CBPM to the ABPM. An updated SNBI dataset shall be provided by the CBPM to the ABPM within 30 calendar days. The ABPM is to report the new SNBI dataset to the FHWA.

Rater

The rater is typically a load rating engineer working under a bridge inspection firm hired by NASA or its contractor during a routine inspection cycle. In some cases a rater may be hired to perform specific bridge load rating analysis for permitting or other types of bridge inspections. All available data for the structure to be load rated shall be collected and reviewed for completeness and accuracy. The inspection report(s) and accompanying photos should be compared to any plans or sketches to ensure they are, in fact, for the bridge under evaluation. The load rating is to be based on the current loads on the bridge. The rater will perform a structural analysis and prepare a full set of calculations in accordance with the *AASHTO Manual for Bridge Evaluation*. An accompanying Load Rating Summary (LRS) form is to be prepared for the bridge (see *G*). Collectively these engineering documents are considered the bridge load rating package.

Checker

The checker is typically a load rating engineer working for the same firm as the rater. The checker is responsible for reviewing all of the available data for the bridge and checks the rater's conclusions for current loads and capacity from the bridge load rating package. All structural analysis results and member capacity calculations prepared by the rater will be confirmed by the checker. All information on the LRS form will be checked for completeness and accuracy. Any comments by the checker are to be addressed and dispositioned prior to final submittal of the bridge load rating package. A marked-up copy of the bridge load rating package is to be returned to the rater for record purposes.

1.4.6 Qualification Requirements of Personnel

See Section 4.3 for detailed qualifications of personnel.

1.4.7 Continued Training Requirements

The ABPM shall complete an FHWA-approved comprehensive bridge inspection training course as described in the NBIS Title 23, Part 650.309 paragraph (h) and score 70 percent or greater on an end-of-course assessment. In addition, the ABPM shall complete a cumulative total of 18 hours of FHWA-approved bridge inspection refresher training over each 60-month period.

The CBPMs should take a bridge related refresher training over each 60-month period. Suggested topics for continued training include:

- Any National Highway Institute (NHI) training courses; these may be rotated over several inspection cycles to cover more topics.

- Bridge Inspection Refresher Training.
- Engineering Concepts for Bridge Inspectors.
- Safety Inspection of In-Service Bridges.
- NSTM Inspection Training.
- Inspection of Ancillary Highway Structures.
- Underwater bridge inspection.
- Specialized equipment training.

1.5 DEFINITIONS AND TERMINOLOGY

Refer to the current editions of the AASHTO Manual for Bridge Evaluation, the FHWA NBIS, and Appendix A of this guide for a list of Definitions and Terminology.

1.6 REFERENCE MANUALS AND PUBLICATIONS

Specific problems not covered in this Guide may be encountered. The following references are suggested for more information:

- FHWA. 2022 *Specifications for the National Bridge Inventory,* Federal Highway Administration, U.S. Department of Transportation*, Washington, DC.*
- FHWA*. 1995 Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Federal Highway Administration, U.S. Department of Transportation, Washington, DC.*
- U.S. Government. 2022. *National Bridge Inspection Standards (NBIS)*, Code of Federal Regulations. U.S. Government Printing Office, Washington, DC, Title 23, Part 650.
- AASHTO. 2018, *Manual for Bridge Evaluation (MBE),* Second Edition*.* Washington, DC: American Association of State Highway and Transportation Officials, Washington, DC.
- AASHTO. 2013, *Manual for Bridge Element Inspection,* First Edition. Washington, DC: American Association of State Highway and Transportation Officials, Washington, DC.
- FHWA. 2022 (Revised 2023). *Bridge Inspector's Reference Manual (BIRM) (2022 NBIS)*, Federal Highway Administration, U.S. Department of Transportation, Washington, DC.
- AASHTO. 2015, *Manual for Bridge Element Inspection with 2015 Interim Revisions,* First Edition. American Association of State Highway and Transportation Officials, Washington, DC.FHWA. 1986, *Inspection of Fracture Critical Bridge Members,* FHWA Report No. IP-86-26. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

- FHWA. 2010, *Underwater Bridge Inspection,* FHWA Report No. NHI-10-027. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.
- FHWA. 2012, *Evaluating Scour at Bridges,* Fifth Edition. FHWA Report No. HIF-12-003. Hydraulic Engineering Circular (HEC) No 18. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.
- FHWA. 2009, *Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance,* Third Edition. FHWA Report No. NHI-09-111. Hydraulic Engineering Circular (HEC) No 23. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.
- FHWA. 1986 *Culvert Inspection Manual,* Federal Highway Administration, U.S. Department of Transportation*, Washington, DC*
- NYSDOT. 2006 *Culvert Inventory and Inspection Manual,* New York Department of Transportation, Albany, NY.

SECTION 2: BRIDGE FILES AND DOCUMENTATION

SECTION 2: BRIDGE FILES AND DOCUMENTATION

2.1 GENERAL

2.1.1 NASA Agency Bridge Files

All Centers and other NASA facilities shall maintain a complete, accurate, and current record of each bridge under their jurisdiction in accordance with the AASHTO Manual for Bridge Evaluation, Section 2.1. The official electronic storage system available to each Center is to be utilized as the storage system for the bridge inspection reports, records, SNBI dataset, load rating calculations, and other related documents comprised in the overall bridge files. In addition, electronic copies are to be stored in the NASA centralized site. The CBPM at each Center is to maintain hard copies of the most recent bridge inspection reports. Previous inspection reports are to be stored on that Center's electronic storage system. The ABPM at NASA HQ and the Co-ABPM at KSC are both to receive electronic copies of new inspection reports of all NASA Centers. Each Center's CBPM is responsible for providing these electronic copies within 30 days of receiving the final signed electronic copy from their contractors.

2.2 INVENTORY DATA

2.2.1 NASA Bridge Inventory Data

The FHWA, in accordance with 23 CFR 650 Subpart C requires application of the NBIS to structures defined as highway bridges located on all public roads and sets the national standard for the proper safety inspection and evaluation of highway bridges. A public road is defined in 23 U.S.C. 101(a)(27) as "any road or street under the jurisdiction of and maintained by a public authority and open to public travel". NASA owns and maintains both public and non-public highway bridges. A NASA bridge is considered non-public if only badged personnel have access to such a bridge because the bridge is contained within a secured gated area.

An inventory of all NASA bridges is to be maintained in the NASA Bridge Inventory Master Data Sheet (see Appendix E). NASA applies the NBIS to all highway bridges in the NASA bridge inventory; however, only those bridges defined as public highway bridges are reported to the FHWA. The ABPM at HQ and Co-ABPM at KSC each retain an electronic copy of the NASA Bridge Inventory Master Data Sheet. Information that should be recorded as bridge inventory data is specified in the AASHTO MBE, Section 2.3. Bridge inventory data provides information about a bridge that is generally not subject to change. Each CBPM is responsible for providing the bridge inventory information to the ABPM and Co-ABPM.

An SNBI dataset is to be prepared following the Routine Inspection of any bridge. The SNBI format is to be in accordance with the current edition of the FHWA Specifications for the National Bridge Inventory. For a definition of Routine Inspection see Section 4.2.2 of this guide. The CBPM is responsible for providing SNBI dataset to the ABPM and Co-ABPM. The ABPM is to supply the SNBI dataset report to the FHWA as requested and by the specified date.

An SNBI dataset is to be prepared for any of the following situations: recent inspection, significant bridge modifications that alter previously recorded data, change in load restriction, change in closure status and new bridge. These datasets are to be recorded within 30 calendar days of the date of inspection or completion of the work.

2.3 REGISTRY OF CERTIFIED BRIDGE INSPECTOR PERSONNEL

NASA has developed a Registry of Certified Bridge Inspectors and maintains it in the primary bridge file. The database was developed per 23 CFR 650.307(e)(2) and provides data for all NASA Centers that have public access bridges and culverts. Page one of the registry is shown below for reference.

Registry of Certified Bridge Inspector Personnel-March 2025

Inspector Name	License Number	License Expiration Date	License State	Type of License (SAFETY/UW/NSTM)
James A Appler	76076 (P.E.)	2/28/2027	FL	SAFETY-Team Lead
Keith S Hoogland	CBI 00341		FL	UW-Team Lead
David Walker	CBI 00493		FL	SAFETY-Team Lead

NOTES:
SAFETY = Safety Inspection of In-Service Bridges
UW = Underwater
NSTM = Non-Redundant Steel Tension Member (formerly Fracture Critical Member)
This database per part B.IE.04 of SNBI Publication

Kennedy Space Center

SECTION 3: BRIDGE MANAGEMENT SYSTEMS

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SECTION 4: INSPECTION

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SECTION 4: INSPECTION

4.1 INSPECTION TYPES

4.1.1 Inventory (Initial) Inspection

The Inventory (Initial) Inspection is the first inspection conducted of a bridge by NASA. An Inventory Inspection shall meet all the requirements of a Routine Inspection (see Section 4.2.2) including an SNBI dataset to determine the baseline structural condition. Element level inspections are highly recommended.

An Inventory Inspection is to occur:

- Following the construction of a new bridge
- Following significant modification or rehabilitation of an existing bridge
- When a bridge previously under the jurisdiction of another agency is added to the NASA system

See Section 4.3.1 for frequency of Initial Inspections. The effort and intensity should be sufficient to accurately document the baseline of all bridge elements condition states and SNBI items. Traffic control and special access equipment, though not typically used for an Inventory Inspection, may be required.

The inspection team should have a set of as-built bridge drawings (if available) to refer to when performing the inventory inspection. When bridge plans are not available, the inspection team is to take field measurements to complete the inventory inspection.

4.1.2 Routine Inspection

A Routine Inspection is a regularly scheduled inspection that generally consists of visual observations and/or measurements that are needed to determine the following:

- The physical and functional condition of the bridge
- Changes from initial or previously recorded conditions, repairs, or other maintenance that may be needed

The inspection team is to provide all SNBI data needed to determine the structural condition in sufficient detail to clearly establish the bridge's condition and to ensure its continued safe operation.

The level of scrutiny and effort required to perform a Routine Inspection will vary according to the structure's type, size, design complexity, and existing conditions. To provide a reasonable level of confidence in the safety of the bridge, knowledge of the structure and good engineering judgment are necessary to determine those portions that are to receive close-up scrutiny during a Routine Inspection.

Photographs are to accompany the inspection reports showing at a minimum:

- Bridge deck level as viewed from roadway
- Each end of the bridge looking towards the approaches

- Both elevation views of bridge
- Any posting signs (if applicable)
- Any damage noted in the report
- Anything that warrants further review by the CBPM
- Representative overall photos of the deck, superstructure and substructure of the bridge

In general, the more severe the issue the more photographs, sketches, and written details that should be provided in the inspection report. A routine inspection report will include an SNBI dataset. See Section 4.2.2 for frequency of Routine Inspection.

4.1.3 Damage Inspection

Per the NBIS, a Damage Inspection is *an unscheduled inspection to assess structural damage resulting from environmental factors or human actions*. A damage inspection may be conducted by a Bridge Inspector, an inspection Team Leader, a NASA (or contractor) engineer, or other personnel with relevant experience. A damage that has the potential to impact the structural and/or the safety integrity of the bridge must be conducted by, or under the supervision of, a Professional Engineer.

A Damage Inspection can occur following:

- A vehicle, or boat, striking the bridge
- High water under the bridge
- A severe environmental event such as an earthquake or tornado
- Observed damage during a routine walk down by the CBPM or a Contractor Engineer

The scope of damage inspections varies widely depending on the extent of the damage, the volume of traffic encountered, the location of the damage on the structure, and documentation needs. At a minimum, photographs and measurements are to be taken to show the extent of damage.

The Contractor Inspector is to obtain sufficient information for the CBPM and the Contractor Engineer(s) to accurately document and assess the condition of the bridge and determine a course of action. Potential courses of action include but are not limited to:

- Repairs
- Placement of emergency load restrictions
- Partial or full closure of the bridge to traffic

For scour critical bridges, if it is determined that the bridge potentially has been subjected to high flow, an underwater damage inspection may be required to assess possible impact.

4.1.3.1 Damage Inspection Documentation

Measurements and/or photographs of damage may be required so that the CBPM can determine if the bridge should be closed or restricted until bridge inspectors can get to the site and inspect the damage.

NASA has adopted the Federal Lands Highway (FLH) Damage Inspection Report Form as an official form to document Damage Inspections (see Appendix H). Pictures and additional pages may be attached to the form as needed. The CBPM shall notify the ABPM and Co-ABPM via phone and e-mail as soon as possible. If items in the SNBI dataset are affected by the damage, the CBPM shall provide an updated SNBI dataset to the ABPM within 30 days of the incident. If the load rating of the bridge is changed, the CBPM shall provide an updated load rating calculations and results to the ABPM within 30 days of the incident. The ABPM shall communicate any changes in the SNBI dataset and/or the load rating of the bridge to the FHWA within 60 days of the damage incident.

4.1.4 In-Depth Inspection

An In-Depth Inspection is sometimes referred to as a hands-on inspection and should be conducted at an “arm’s length” distance from all elements being inspected. Typically, an under-bridge inspection vehicle (UBIV) is used during an In-Depth Inspection. Any time a bridge element or a portion of the bridge requires further evaluation, analysis, or investigation to accurately assess its condition, an In-Depth Inspection is to be performed. This inspection may involve testing, monitoring, or conducting specific analyses of select bridge elements.

The In-Depth Inspection is typically performed:

- To assess bridge elements not accessible during Routine Inspections
- To obtain more sophisticated data
- To perform special testing
- To bring in other experts to assess a particular problem

In-Depth Inspection reports generally contain sufficient details to understand what elements were inspected at an in-depth level, description of findings (including sketches and photos as appropriate), and any other pertinent information to facilitate future inspections such as equipment and/or methods used to analyze and assess elements.

4.1.5 Non-Redundant Steel Tension Member (NSTM) Inspection

Non-Redundant Steel Tension Member (NSTM) were previously referred to as Fraction Critical Members (FCMs). See Section 4.8 for a description. NSTM inspection includes identifying the location of all NSTMs in the bridge and recording any problems or potential problems at these locations in order to determine the safety of the structure. NSTM inspections provide a history of cracking (e.g., time of initiation, rate of growth) that can greatly assist the engineer in determining the need and priority of repairs, and in estimating the remaining service life of the bridge.

The inspection intensity of all NSTMs should be sufficient to discover the onset of fatigue cracking and should be conducted minimally at an “arm’s length” distance. At a minimum the inspector should have a magnifying glass and dye penetrant kits on site. Lighting to ensure details are clearly visible may also be critical on some bridges.

Factors that need to be considered include:

- The criticality of the detail
- Tension stress level
- Overall condition of the member
- ADTT (average daily truck traffic)
- Installed retrofits

Photographs or sketches taken over a series of inspections are recommended to document conditions' changing over time. Nondestructive testing may be required to properly inspect and assess certain NSTM details, as well as determine the full extent of any visibly observed cracking. Each bridge containing NSTMs is to have an inspection procedure that is unique to the bridge and that is discussed separately in the inspection report.

Procedures should minimally include:

- A schematic of the superstructure with all NSTMs and their stress categories identified
- Identification of applicable risk factors.
- Consideration of NDE methods and frequency.
- Qualifications for inspectors as needed.
- Equipment required to properly assess NSTMs
- Hazards or other challenges to properly access NSTMs
- Any unique features of the NSTMs
- Load limits, if applicable

See Section 4.2.5 for frequency of NSTM inspection.

4.1.6 Underwater Inspection

If the underwater portion of a bridge substructure or the surrounding stream channel cannot be inspected visually at low water by wading or probing, it will then require an Underwater Inspection using divers or other appropriate techniques to accomplish these tasks. An Inspection Team Leader shall be present for all Underwater Inspections. Each Underwater Inspection will have procedures that are unique to the bridge being inspected.

Procedures should at a minimum include:

- A list of all underwater elements to be inspected, level of inspection, and frequency.
- Location of inspection: Explain where the above water inspection ends and where the underwater inspection starts.
- Scour countermeasures, if any, to be inspected.

- Details of inspection procedure and scheduling considerations.
- Equipment needed for the inspection
- Access points
- Qualifications for inspectors.
- Scour countermeasures, if any, to be inspected
- Hydraulic features affecting the structure and/or inspection
- Risk factors

At the conclusion of every dive, the diver shall go over the inspection findings with the Inspection Team Leader to verify that the notes taken by staff on the surface are a correct representation of what the diver found. The diver should also go over all underwater photos, making sure that the photo numbers and descriptions are correct.

4.1.7 Special Inspection

Special Inspections are performed to monitor known or suspected deficiencies. Special Inspection reports are to clearly indicate what elements were looked at, what methods of inspection were used (e.g., visual, dye penetrant, ultrasonic, magnetic particle, hands-on), and what was found.

Special Inspection Criteria:

- Bridges meeting the following criteria shall have a special inspection:

  a. Load posted bridges: A special inspection of the element(s) controlling the load posting shall be performed minimally every 6 months.

- Bridges meeting the following criteria may need to have a special inspection based on the recommendation of the contractor inspection firm or the Contractor Engineer(s) and the approval of the CBPM:

  a. Fatigue-sensitive details (FSD) on steel girder bridges. FSDs are category E or E' details. Fatigue in these details is typically caused by out of plane bending. Generally, the procedures for an FSD-related Special Inspection are the same as those for a NSTM Inspection.
  b. Other significant defects where additional monitoring may be necessary. These defects should be documented in the inspection report and discussed with the CBPM for concurrence to perform the Special Inspections.

4.1.8 Complex Bridge Inspection

The 2022 NBIS defines Complex feature as *bridge component(s) or member(s) with advanced or unique structural members or operational characteristics, construction methods, and/or requiring specific inspection procedures. This includes mechanical and electrical elements of moveable spans and cable*

related members of suspension and cable-stayed superstructures. Complex Bridge Inspections are required for bridges that contain elements or systems such as moving parts, post-tensioning, or other sophisticated and unusual details. These complex systems or details require special and unique inspection procedures that are beyond the scope of what is included in a Routine Inspection. Complex Bridge Inspections may also require additional inspector training, experience, and special equipment. See Section 4.2.8 for frequency of Complex Bridge Inspection. Complex Bridge Inspection procedures should be documented in the inspection report and stored in the bridge file. These procedures should include:

- The description and location of complex features.
- Risk factors including:
    - Complex structural response.
    - Difficulty to access.
    - Specialized inspection equipment needs.
    - High ADT & ADTT.
    - Low redundancy.
    - History of past problems.
- Inspection procedure.
- Inspection frequency.
- Inspector experience and training.

4.2 FREQUENCY

4.2.1 Inventory (Initial) Inspection Frequency

An Inventory Inspection is to be conducted within 90 calendar days of opening bridge to traffic for new bridges, completion of a major rehabilitation or modification project on a bridge, or whenever a bridge previously under the jurisdiction of another agency is added to the NASA system. See Section 4.2.1 for a description of Initial Inspection.

4.2.2 Routine Inspection Frequency

Routine Inspections are to be conducted at regular intervals, using one of the risk-based methods outlined in the NBIS section 650.311. Default intervals for NASA bridges are **not to exceed 24 months.** Utilizing the extended intervals method, as outlined in the NBIS, requires proper documentation of the justification and/or the process used and a formal approval from the ABPM and the FHWA. See *Section 4.1.2* for a description of Routine Inspections.

Certain bridges require regular inspections **not to exceed 12 months**. These bridges fall into the following categories:

- A condition rating of 4 or less for at least one of the following NBI items:
  a. Deck (NBI Item 58 – SNBI Item B.C.01)
  b. Superstructure (NBI Item 59 – SNBI Item B.C.02)
  c. Substructure (NBI Item 60 – SNBI Item B.C.03)
  d. Culvert (NBI Item 62 – SNBI Item B.C.04)
  e. Structural Evaluation (NBI Item 67)
- Any bridge may have a shorter inspection frequency when recommended by the Inspection Team Leader or the Contractor Engineer(s) and approved by the CBPM. The reason(s) for recommending an increase in the frequency is to be clearly documented in the bridge inspection report. Some factors to consider are structure type, design, materials, age, condition ratings, scour, environment, annual average daily traffic and annual average daily truck traffic, history of vehicle impact damage, loads and safe load capacity, and other known deficiencies.
- All railroad bridges[1]

4.2.3 Damage Inspection Frequency

Damage Inspections or Assessments are scheduled as needed to assess damage to the bridge following an environmental or human-caused event. A damage inspection or assessment is to be conducted within 24 hours of the reported damage. See Section 4.2.3 for a description of damage inspections and Damage Assessments.

4.2.4 In-Depth Inspection Frequency

For those bridges identified as requiring such, In-Depth Inspections are typically conducted on a **48-month** interval. The in-depth inspection frequency may be increased to **12 months** or **24 months** at the recommendation of the Inspection Team Leader or the Contractor Engineer(s) with the approval of the CBPM. This increase in frequency should be based on the severity of deterioration in primary structural elements. See *Section 4.2.4* for a description of In-Depth Inspections.

4.2.5 Non-Redundant Steel Tension Member (NSTM) Inspection Frequency

First NSTM Inspection to be completed within 12 months of bridge opening (includes rehabilitated bridges when relevant). NSTM Inspections are to be conducted at regular intervals, using one of the risk-based methods outlined in the NBIS section 650.311. Default intervals for NASA bridges are **not to**

[1] Railroad bridges are to be inspected in accordance with 49 CFR Part 237 – Bridge Safety Standards and all applicable Federal Railroad Administration requirements as established therein.

exceed 24 months. Utilizing the extended intervals method, as outlined in the NBIS, requires proper documentation of the justification and/or the process used and a formal approval from the ABPM and the FHWA. See *Section 4.1.5* for a description of NSTM Inspections.

NSTM Inspections may be required at less than a 24-month (reduced interval). Criteria to consider when determining the necessary inspection interval of these members are type, design, materials, age, condition, environment, annual average daily traffic and annual average daily truck traffic, history of vehicle impact damage, loads and safe load capacity, and other known deficiencies. For bridges containing NSTM, if the superstructure has a coding of 4 or less (item 59 in the old NBI or items B.C.02 or B.C.14 in the new SNBI), the NSTM Inspection shall be performed at intervals of 12 months or less.

4.2.6 Underwater Inspection Frequency

First underwater inspection to be completed within 12 months of bridge opening (includes rehabilitated bridges when relevant). Underwater Inspections are then to be conducted at regular intervals, using one of the risk-based methods outlined in the NBIS section 650.311. Default intervals for NASA bridges are not to exceed 48 months (every other routine inspection). Intervals up to 60 months may be utilized with an approval from the ABPM. Utilizing the extended intervals method for up to 72 months, as outlined in the NBIS, requires proper documentation of the justification and/or the process used and a formal approval from the ABPM and the FHWA. See *Section 4.1.6* for a description of Underwater Inspections.

Bridges meeting one of the following criteria may require a reduced frequency interval:

- If the NBI item 113 is coded 3 or less (scour is critical), SNBI item B.C.11 is coded 3 or less (Major scour seriously affecting bridge stability), NBI item 60 (or SNBI item B.C.03) is coded 4 or less (due to scour concerns), or MBE scour element is coded condition state 3 or 4 , the Underwater Inspection frequency may be set to 6, 12, or 24 months. Upon completing a scour analysis of the bridge, this increased inspection frequency may be adjusted as needed.

- If the inspector observes conditions that warrant monitoring at an increased frequency, the Underwater Inspection frequency may be set to 6, 12, or 24 months upon approval from the CBPM. These conditions may include but are not limited to evidence of substructure movement, significant deterioration or undermining in a submerged primary substructure element, significant stream migration, significant bank sloughing, or debris buildup.

Any time the inspector determines the inspection frequency needs to be changed, the reason is to be documented in the underwater inspection report and discussed with the CBPM. The date of the inspection after which the frequency was changed shall be referenced in all future inspection reports until the change in frequency is lifted.

4.2.7 Special Inspection Frequency

Special Inspections fall into one or more of the following categories:

- Fatigue sensitive details on steel girder bridges: Inspections on fatigue sensitive details on steel girder bridges are typically conducted on a **48-month** interval. The inspection frequency may be increased to **12 months** or **24 months** at the recommendation of the Contractor Inspection Team Leader or the Contractor Engineer(s) with the approval of the CBPM. This increase in frequency depends on the severity of the defect or deterioration of the structural element(s) having fatigue sensitive details. See *Section 4.2.7* for a description of Special Inspections.

- Bridges requiring load posting (Item 41 = P or B) in fair or better condition (Items 58,59,60 > 4): These bridges with a Routine Inspection or NSTM Inspection scheduled at **24 months** also requires a Special Inspection at **6 months** to inspect one or more elements. The intent is to keep apprised of the ongoing condition of critical bridge elements on a shorter frequency without unnecessarily invoking a full Routine Inspection or NSTM Inspection.

- Other defects: With the approval of the CBPM, a Special Inspection may be conducted in between Routine Inspections to monitor a known defect.

4.2.8 Complex Bridge Inspection Frequency

See Section 4.1.8 for a description of Complex Bridge Inspections. Frequency of mechanical and electrical components is determined by the CBPM, not to exceed 48 months. Factors effecting the frequency of mechanical and electrical components inspection frequency include the age and condition of the equipment, redundancy, and routine preventative maintenance. The frequency and related justification shall be documented in the inspection report and the bridge file.

4.3 QUALIFICATION AND RESPONSIBILITIES OF INSPECTION PERSONNEL

4.3.1 Inspection Program Manager

The Agency Bridge Program Manager (ABPM) at KSC and Center Bridge Program Managers (CBPMs) at various NASA Centers form the management group responsible for administration of the NASA Bridge Management Program. The Co-ABPM shall meet the qualification requirements for program manager specified in 23 CFR 650.309. The ABPM has overall program responsibility including ensuring NASA's compliance with the National Bridge Inspection Standards. This includes the inspection, reporting, load rating, and inventory of all bridges owned, operated, and/or under the jurisdiction of NASA. The ABPM is also responsible for communications with the FHWA regarding the program.

The ABPM and Co-ABPM are responsible for the management and oversight of the Agency bridge inspection program. Each CBPM oversees the inspection, reporting, and load rating performed for the bridges at their respective Centers. Each CBPM reports to the ABPM and the Co-ABPM.

4.3.2 Contractor Inspection Team Leader

NASA contracts directly or through a prime contractor with second tier bridge inspection contractors. The bridge inspection contractor is to provide Inspection Team Leaders, all of whom meet the qualification requirements for Team Leader as specified in 23 CFR 650.309. The Inspection Team Leaders are responsible for all Inventory, Routine, NSTM, Underwater, Damage, and Special Inspections of the bridges included in their contract.

4.3.3 Contractor Bridge Inspector

The contractor Bridge Inspector position gives an individual the experience necessary to meet the requirements of Team Leader as specified in 23 CFR 650.309. See the Appendix A for the definition of bridge inspection experience.

4.3.4 Contractor Load Rating Engineer

All contractor personnel hired by NASA to act as Contractor Load Rating Engineer (CLRE) on behalf of NASA shall be professional engineers with a background in structural analysis and/or design and are responsible for the structural analysis and calculations necessary to determine the safe load-carrying capacity of a bridge in accordance with the AASHTO Manual for Bridge Evaluation. The CLRE may prepare posting letters if load posting is required. A CLRE may also perform structural analysis and calculations for overweight permit requests.

4.3.5 Underwater Bridge Inspection Diver

For bridges whose underwater substructure or foundation elements cannot be satisfactorily inspected by wading or probing an Underwater Inspection will be required. Underwater Inspections are typically performed by a specialty subcontractor hired by the bridge inspection contractor. All contractor personnel performing the work of an Underwater Bridge Inspection shall complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course as specified in 23 CFR 650.309.

Underwater Bridge Inspection Divers shall also meet the minimum diving qualifications required by the Occupational Safety and Health Administration (OSHA) regulations, Commercial Diving Operations (29 CFR 1910 Subpart T). In addition, the particular bridge to be inspected may dictate the inclusion of personnel with enhanced inspection and/or diving capabilities.

Underwater bridge inspections shall be performed in accordance with the current edition of the FHWA Underwater Bridge Inspection Manual.

4.4 Safety

The safety of the inspection team, NASA and contractor personal, and the public is paramount. The inspection contractor shall comply with MBE Section 4.5, NASA safety regulations, the safety regulations of the NASA Center where the inspection is taking place, The Manual on Uniform Traffic Control Devices (MUTCD), The Occupational Safety and Health Administration (OSHA) (29cfr1910 and 29cfr1926), and any other applicable safety regulations.

To minimize chances of injury, inspectors should adopt the following work habits:

- Never work alone
- Be well-rested and alert
- Stay in good health and maintain a level of good physical conditioning
- Use and be familiar with the proper tools

In general, the inspection firms are expected to submit a safety and health plan and a letter of appointee for a safety point of contact. They are also expected to attend a safety in-brief prior to beginning the inspection. Underwater inspection firms shall submit a diving safety and health plan including diver certificates and cardiopulmonary resuscitation (CPR) and First Aid certificates.

4.5 PROCEDURES

4.5.1 Inspection Guidelines and Condition Rating of Bridge Components

NASA Bridges are inspected to determine condition, identify deficiencies, and document results in an inspection report in accordance with the FHWA NBIS (Code of Federal Regulations 23 CFR, pt. 650) and the inspection procedures in Section 4.2, AASHTO Manual for Bridge Evaluation (MBE).

NASA Centers should prepare to utilize the 2022 Specifications for the National Bridge Inventory, for inspections scheduled in calendar year 2024. Starting from calendar year 2025, inspections for NASA bridges shall utilize the 2022 Specifications for the National Bridge Inventory for inspections. The FHWA will not accept submittals in accordance with the old 1995 Recording and Coding Guide starting from the March 2026 submittal period.

Element level inspections are conducted in accordance with the latest edition of the AASHTO Manual for Bridge Element Inspection.

4.5.2 Inspection Reporting

Following the completion of every bridge inspection, the bridge inspection contractor is to submit the findings and recommendations in a formal inspection report to the bridge owner/Center or through its representative within the time period specified in the contract. The inspection report shall include the SNBI dataset.

The CBPM shall provide the deliverables illustrated in Table 4.1 to the ABPM by their due date. The ABPM is responsible for providing the SNBI datasets for all NASA public bridges to the FHWA by their due date.

Table 4.1: Deliverable provided by CBPM to ABPM and Co-ABPM

Deliverables	**Due by**
Electronic Copy of inspection report	Within 30 days of the date CBPM receive electronic copies of the report from their contractors, or the end of the fiscal year (whichever comes first)
SNBI dataset	Within 30 days of the date CBPM receive electronic copies of the report from their contractors, or the end of the fiscal year (whichever comes first)
LRS sheet	Within 30 days of the date CBPM receive electronic copies of the report from their contractors, or the end of the fiscal year (whichever comes first)
Load rating calculation (if applicable)	Within 30 days of the date CBPM receive electronic copies of the load rating calculations from their contractors, or the end of the fiscal year (whichever comes first)

4.5.3 Critical Findings Procedures

4.5.3.1 Critical Finding Definition

A critical finding is defined in the BIRM as a *damage, deterioration, or a defect that requires immediate action to ensure public safety. This includes the possible closure of the structure or the affected area, for safety reasons until interim remedial measures can be implemented.* It also includes scour, damage, corrosion, section loss, settlement, cracking, deflection, distortion, delamination, loss of bearing, and any condition posing an imminent threat to public safety. Below are some examples:

- A maintenance recommendation with an emergency priority assigned by the bridge inspector
- The following bridge components rated 2 or less:
    a. Bridge Deck (NBI Item 58 – SNBI Item B.C.01).
    b. Bridge Superstructure (NBI Item 59 – SNBI Item B.C.02) when rating is not due to the condition of NSTM.
    c. Bridge Substructure (NBI Item 60 – SNBI Item B.C.03)
- The following bridge components rated 3 or less:

a. NSTM (SNBI Item B.C.14)
b. Bridge Superstructure (NBI Item 59 – SNBI Item B.C02) when rating is due to the condition of NSTM.
c. Channel (NBI Item 61 – SNBI Item B.C.09)
d. Channel Protection (NBI Item 61 – SNBI Item B.C.10)
e. Culverts (NBI Item 62 – SNBI Item B.C.04)

- A determination that a bridge closure or posting is required but not currently in place.
- Any event causing immediate concern or potential danger to the traveling public (e.g., a bridge strike, flood, earthquake)

4.5.3.2 Critical Finding Reporting

Upon discovering a condition on site that is determined to be a critical finding the Contractor Inspection Team Leader is to notify the bridge owner/Center or its delegated representative immediately either in person or by telephone. A written formal notification of the critical finding is to be submitted to the owner or their representative by the bridge inspection contractor.

The bridge owner/Center is to quickly and diligently investigate the findings and take any and all necessary actions and precautions. The bridge owner/Center is to notify the ABPM of the critical finding as soon as possible but no later than one week. The ABPM is to communicate the findings to the FHWA as soon as possible but no later than the next FHWA data call for Critical Findings.

In addition to completing a formal notification, the following information is to be documented in the final bridge inspection report:

- A summary of the critical finding
- Contact information for the bridge owner/Center (name, title, phone number, etc.)
- Date of notification of critical finding to the bridge owner/Center
- Brief summary of interim actions that were/are to be taken (e.g., bridge closure, lane restriction, speed restriction, load posting)
- Assign a timeline for follow up action as needed.

4.5.3.3 Emergency Notification to Police and Public

If the Inspection Team Leader determines on site that there is an immediate danger to the traveling public, the CBPM and state or local law enforcement are to be contacted immediately advising them of the situation. The CBPM shall immediately coordinate with state or local law enforcement and engage all Center resources necessary to mitigate the immediate danger including bridge closure, lane closure, speed restriction, etc. If bridge posting or closure occurs, the CBPM shall inform the ABPM as soon as possible.

4.5.4 Non-Redundant Steel Tension Member Inspection Procedures (NSTM)

NSTM is a primary steel member fully or partially in tension, and without load path redundancy, system redundancy or internal redundancy, whose failure may cause a portion of or the entire bridge to collapse. Fatigue related stresses is the most common cause of failure in NSTM and is of the highest importance during the inspection. Inspection procedures shall be developed for each bridge that includes NSTMs. The procedures shall comply with the requirements of the AASHTO Manual for Bridge Evaluation and the FHWA Inspection of Nonredundant Steel Tension Members Memorandum dated May 9, 2022.

At a minimum, NSTM inspection procedures should include:

- Applicable Risk Factors.
- Consideration of NDE methods.
- Frequency of inspection.
- Qualifications for inspectors.

For frequency of NSTM Inspection see *Section 4.2.5*.

4.5.5 Underwater Inspection Procedures (NSTM)

For bridges that cannot be inspected using wading and probing, identify the locations of underwater portions. Underwater inspection procedures shall be developed for each bridge in accordance with the requirements of the AASHTO Manual for Bridge Evaluation. These procedures should include at a minimum:

- Location of inspection: Explain where the above water inspection ends and where the underwater inspection starts.
- Detailed procedure of inspection.
- List of elements to be inspected.
- level of inspection and frequency.
- Qualifications for inspectors.

For frequency of UW Inspection see *Section 4.2.6*.

4.5.6 Special Structures (Complex Bridges) Inspection Procedures

CFR 650.313(g) requires Federal agencies to “develop and document inspection procedures for bridges which require NSTM, underwater, in-depth, and complex feature inspections in accordance with Section 4.2, AASHTO Manual. Specific procedures for unique and complex structural features must be developed for each bridge and contained in the bridge file.”

A special inspection plan shall be developed for each special/complex bridge to reflect the unique characteristics of the structure. Moveable bridges and their inspections are described in detail in the AASHTO Moveable Bridge Inspection, Evaluation, and Maintenance Manual.

Inspection reports for NASA complex bridges should be utilized to include the required inspection procedures. Inspectors training should also be documented.

Inspectors shall review the unique inspection plan and procedures specific to each special/complex bridge prior to completing an inspection of the bridge.

- Location of complex features
- Specific Risk Factors
- Inspection procedure
- Inspection frequency-
- Inspector experience and training.

4.5.7 Special In-Depth Inspection Procedures

When a Special In-Depth is required at a reduced interval, inspection procedures shall be documented.

4.6 Unknown Foundations

NASA utilizes all of its resources (e.g., plan archives, inspection files, design files, and local highway district contacts) to locate plans for each bridge in the inventory. However, in some cases plans cannot be located. Without foundation drawings appropriate calculations for scour evaluations cannot be made. Item 113 (Scour Critical Bridges) is coded as “U” for bridges with unknown foundations. This coding is primarily used when it cannot be determined if a bridge’s foundations are spread footings or piles. If the foundation type can be satisfactorily determined by routine or underwater inspection, Item 113 is to be changed to the appropriate code.

A bridge is categorized as low risk if it has performed well, has a low ADT (Average Daily Traffic) and short detour length, and has no history of significant scour-related issues. High risk infers that the bridge has performed satisfactorily, but because of NASA defined criteria and experiences, a higher level of scrutiny is needed.

The risk category for a bridge with unknown foundation details is based on the following NBI items:

- Item 71 - Waterway Adequacy
- Item 61 - Channel and Channel Protection
- Item 45 - Number of Main Spans
- Item 46 - Number of Approach Spans
- Item 19 - Detour Length
- Item 29 – ADT

The failure risk for bridges with unknown foundations comprised of four or more spans is to be determined on a case-by-case basis since potential risk factors for multispan bridges may not be

adequately represented in the NBI items listed above. An unknown foundation plan-of-action (POA) is to be developed for all bridges with unknown foundation details.

4.6.1 High-Risk

A bridge is to be categorized as high risk if:

- The bank and/or protection is undermined or if overtopping of the bridge deck is possible.
- The bridge has two or three spans, bank and/or protection is beginning to slump or erode, and overtopping is a slight possibility.
- The bridge has one span, bank and/or protection is beginning to slump or erode, overtopping is a slight possibility, ADT is greater than 100 vehicles and the detour length is greater than 10 miles.

High-risk unknown foundation bridges are to be closely monitored. Underwater inspection may be performed at a frequency less than 48 months if approved by the CBPM.

A high-risk unknown foundation POA is similar to those for bridges determined to be scour critical. Additional monitoring occurs during Routine and Underwater (if applicable) Inspections and after major flood events. The CBPM and the Contractor Engineer(s) are to review high risk bridge unknown foundation POAs at least once every 4 years, or more frequently if significant scour is observed during inspections. Contractor Bridge Inspectors are to review the current unknown foundation POA prior to inspection and take it into consideration as they perform the bridge inspection.

Based on information in the bridge inspection report and feedback from the Bridge Inspectors, Contractor Inspection Team Leader, and local Center maintenance personnel recommendations may be made for:

- Foundation investigation
- Countermeasure installation
- Programming for bridge replacement (usually if significant scour occurs or recurs frequently)

4.6.2 Low-Risk

Low-risk unknown foundation bridges are to be monitored by Routine and Underwater (if applicable) Inspections at frequencies specified in *Section 4.3.2—Routine Inspection Frequency* and *Section 4.3.6—Underwater Inspection Frequency*.

The unknown foundation POA for a low-risk bridge is to describe an ongoing monitoring plan. Monitoring typically occurs during routine biennial inspections and following major flood events.

Bridge Inspectors are to review the current unknown foundation POA prior to inspection and take it into consideration as they perform the bridge inspection. Inspectors may make a recommendation to the CBPM or the Contractor Engineer(s) to reassign a low-risk bridge to high risk if field conditions warrant. The inspection report is to document all findings and other pertinent information that should be considered as part of a reassignment.

Additional Information:

FHWA memo 1/9/2008: Technical Guidance for Bridges over Waterways with Unknown Foundations

FHWA memo 6/3/2009: Frequently Asked Questions - Bridges Over Waterways with Unknown Foundations

FHWA memo 10/29/2009: Additional Guidance for assessment of Bridges Over Waterways with Unknown Foundations

4.7 REFERENCES

- U.S. Government. 2022. *National Bridge Inspection Standards (NBIS)*, Code of Federal Regulations. U.S. Government Printing Office, Washington, DC, Title 23, Part 650.
- AASHTO. 2018, Manual for Bridge Evaluation (MBE), Third Edition. Washington, DC: American Association of State Highway and Transportation Officials, Washington, DC.
- AASHTO. 2013, Manual for Bridge Element Inspection, First Edition. Washington, DC: American Association of State Highway and Transportation Officials, Washington, DC.
- FLH. 2013, Bridge Inspection Manual, Federal Highway Administration (FHWA), Federal Lands Bridge Office, Sterling, Virginia.

AASHTO 1998. Moveable Bridge Inspection, Evaluation, and Maintenance Manual, First Edition, MBI-1. American Association of State Highway and Transportation Officials, Washington, DC.

FHWA. 1986, Inspection of Fracture Critical Bridge Members, FHWA Report No. IP-86-26. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

FHWA. 2010, Underwater Bridge Inspection Manual, FHWA Report No. NHI-10-027. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

FHWA. 1995 Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

U.S. Government. 2004. National Bridge Inspection Standards (NBIS), Code of Federal Regulations, Title 23, Part 650. U.S. Government Printing Office, Washington, DC.

FHWA. 2002 (Revised 2002). Bridge Inspector's Reference Manual (BIRM), Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

AASHTO. 2015, Manual for Bridge Element Inspection with 2015 Interim Revisions, First Edition. American Association of State Highway and Transportation Officials, Washington, DC.

FHWA. 2003, Manual on Uniform Traffic Control Devices. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

Additional references are available in Section 4.13 (References) in the 2011 Manual for Bridge Evaluation (MBE), Second Edition. If the Bridge Inspector is unable to find the guidance needed, the concern shall be brought to the attention of the CBPM. Contractor Bridge Inspectors should contact the Inspection Team Leader.

FHWA Inspection of Nonredundant Steel Tension Members Memorandum dated May 9, 2022

SECTION 5: MATERIAL TESTING

SECTION 5: MATERIAL TESTING*

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SECTION 6: LOAD RATING

SECTION 6: LOAD RATING

6.1 SCOPE

NASA follows the criteria set forth in Section 6 of the MBE for load rating its bridges.

6.1.1 Frequency of Load Rating

Per 23 CFR 650.313 "*Inspection procedures*", each bridge shall be rated as to its safe load-carrying capacity in accordance with the AASHTO Manual (incorporated by reference, *see* §650.317). Post or restrict the bridge in accordance with the AASHTO Manual or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor.

Below are general guidance to aid in making the determination on whether or not to load rate a bridge based on the type of inspection:

- Initial Inspection: An initial inspection must be accompanied with an analytical load rating analysis

- Damage Inspection: If the inspector suspects that the damage may have affected the structural capacity of the bridge the CBPM shall be notified immediately. The CBPM and/or NASA designee will evaluate the damage and determine if a load rating is needed

- Routine Inspection: The inspection firm shall make a recommendation to the CBPM and/or NASA designee when a new load rating analysis is deemed necessary based on the conditions of the bridge. In general, the following rules apply:

    a. A NASA bridge which does not have an assigned load rating shall be analyzed and assigned a load rating.

    b. A NASA bridge which does have load rating but the conditions of the bridge have changed, after the load rating was assigned, in a way that impacts the structural capacity of the bridge shall be re-analyzed and a new load rating assigned to represent the new conditions.

    c. A NASA bridge which does have a load rating assigned to it and the conditions of the bridge did not change, after the load rating was assigned, in a way that would impact the structural capacity of the bridge does not need to be re-analyzed.

- All other inspection types: The inspector shall notify the CBPM and/or NASA designee if he/she suspects the conditions of the bridge have deteriorated in a way that may affect the load rating. The CBPM and/or NASA designee will evaluate the damage and determine if a load rating is needed

6.1.2 Load Rating Requirements

A complete Load Rating Report will include the following:

- Summary: example of a Bridge Load Rating Summary Form is presented in Appendix G of this guide.
- Narrative: the load rater shall clearly state the methodology and assumptions used, including the inspection findings used in rating the bridge.
- Plans: the plan sheets required to perform the analysis should be included in the final load rating report. If the load rating is a part of a bridge inspection and the bridge inspection report includes the plans for the bridge, it is acceptable to not include them again in the load rating report.
- Calculations: the load rater's inputs and summarized outputs shall be clearly presented. Intermediate calculations should also be included in the report.
- Stamp and Seal: load rating calculations shall be stamped and sealed by a Professional Engineer (PE).

6.1.3 Posting of Bridges

NASA posts bridges (reduces the allowed load on bridges) under its jurisdiction in accordance with the AASHTO Manual for Bridge Evaluation. The Code of Federal Regulations requires posting or restricting a bridge when the maximum unrestricted legal load or state routine permit loads exceed that allowed under the operating rating or equivalent rating factor. NASA may also choose at its own discretion to post a bridge at the inventory rating limit dependent upon the particular circumstances and judgment of the CBPM and responsible load rating engineer.

The inventory rating level generally corresponds to the customary design level of stresses but reflects the existing bridge and material conditions with regard to deterioration and loss of section. Load ratings based on the inventory level allow comparisons with the capacity for new structures and, therefore, results in a live load, which can safely utilize an existing structure for an indefinite period of time. The operating rating level describes the maximum permissible vehicular live load to which the bridge may be subjected. Allowing unlimited number of vehicles to use the bridge at operating level may shorten the life of the bridge.

Permit vehicles that cause the bridge to resist loads beyond the inventory rating limit may be allowed at the judgment of the bridge permitting engineer; however, no vehicle that causes the bridge to resist loads beyond the operating rating limit may be permitted.

Regulatory signage related to the posting of bridges is to conform to the requirements of the FHWA Manual on Uniform Traffic Control Devices (MUTCD) and the AASHTO MBE.

The CBPM to inform the ABPM as soon as possible of a bridge posting status change. The CBPM shall work with the ABPM to update the NASA Inventory Datasheet within 60 days from changes in a bridge posting status. The ABPM is to communicate the findings to the FHWA as soon as possible but no later than the next FHWA data call for Critical Findings.

6.1.4 Closing of Bridges

NASA Centers should utilize the following guidelines to assist in the decision-making of closing a bridge. These guidelines are not intended to be inclusive. The inspector(s) or bridge load rating engineer should communicate a bridge closure recommendation to the CBPM when deemed necessary per their load rating calculations and/or their best professional judgment.

- After major impact damage compromising the safety of the bridge until a damage inspection can be performed.
- After a damage, or other type, inspection if deemed necessary by the responsible engineer.
- When the gross live load capacity is less than 3 tons

The CBPM to inform the ABPM as soon as possible of a closed bridge status change. The CBPM shall work with the ABPM and the to update the NASA Inventory Datasheet within 60 days from changes in a bridge closing status. The ABPM is to communicate the findings to the FHWA as soon as possible but no later than the next FHWA data call for Critical Findings.

SECTION 7: FATIGUE EVALUATION OF STEEL BRIDGES

SECTION 7: FATIGUE EVALUATION OF STEEL BRIDGES*

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SECTION 8: NONDESTRUCTIVE LOAD TESTING

SECTION 8: NONDESTRUCTIVE LOAD TESTING*

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END OF NASA SUPPLEMENTAL SECTIONS TO THE MBE

SECTION 9: CULVERT INVENTORY (RECORDS)

SECTION 9: CULVERT INVENTORY (RECORDS)**

9.1 PURPOSE

The purpose of the section is to differentiate between NASA culverts and bridges and define the requirements and parameters of culvert inventory. The primary intent of this guide is to ensure the safety of the motoring public, ensure the safety of NASA employees and contractors, and ensure the continued longevity of NASA's bridge and culvert infrastructure investment by implementing a good monitoring program, which leads to more informed maintenance, repair, or replacement decisions. Therefore, it is expected that good engineering judgment will be used alongside the recommendations of Section 9 and 10 to categorize culverts, identify inspection frequencies and level of inspection details. The limits set forth in the "Required Inventory Items" section are intended to highlight general practices. Engineering judgment shall supersede when culverts do not meet these limits but need to be inventoried and inspected. However, all culverts meeting or exceeding the limits identified in this guide shall be included in the inventory.

9.2 DIFFERENTIATION BETWEEN CULVERTS AND BRIDGES

Traditionally, span length has been used to distinguish culverts from bridges. Spans less than 20-feet (10-feet in case of railroad) are defined as culverts. The span is measured parallel to the centerline of the highway or railroad. NASA culverts with greater spans are defined as bridges, included in the NASA bridge inventory, and receive a routine inspection at a frequency not to exceed 24 months. For more information on the inspection rules for NASA bridges review Sections 1 through 8 of this guide.

Even though the guidance provided in Sections 9 and 10 of this guide is intended primarily for culvert structures with spans less than 20-feet, it is worth noting that the inspection section may be beneficial for all culverts. NASA culverts greater than 20-feet are inventoried as bridges. However, there are significant differences between culverts and bridges other than the span length. These differences can be categorized under hydraulic, structural, maintenance, traffic safety, construction, durability and inspection. For more details on the nature and extent of these differences refer to Section 1 of the Culvert Inspection Manual published by the Federal Highway Administration (FHWA) in 1986.

9.3 INVENTORY REQUIREMENTS

Required Inventory Items: NASA Centers will maintain an inventory of culverts owned and/or maintained by NASA which satisfy one or more of the following conditions.

- Culvert presently carries a paved road
- Culvert presently carries a railroad track
- Culvert is 12 inches or greater in diameter
- Culvert that recently satisfied one of the conditions above but is now closed or collapsed, shall also be considered an inventory culvert until it is physically removed

- NASA Centers may include a culvert which does not meet any of the above criteria in their inventory if it is deemed in the public's best interest based on engineering judgment.

- The file(s) shall also be stored in the NASA centralized site. The CBPM shall coordinate any updates to culvers inventory in the NASA centralized site with the ABPM and the Co-ABPM

9.4 INVENTORY DATA

This section serves as a guide for NASA Centers on what data should be collected and recorded in the Inventory. Under no circumstances, should the inspectors jeopardize their safety in pursuit of collecting any of the inventory information. Hazards to avoid include but are not limited to dangerous wild life and culverts fully submerged in water. When actual measures are not safely feasible, approximate or best guess values are acceptable. If an inventory item is estimated, it should be noted in the comments section. Electronic filing is acceptable.

1. Culvert Location: The location of each culvert should be recorded using latitude and longitude coordinates. NASA Centers may choose to use other coordinate systems. Centers are advised to remain consistent with the coordinate system they use for inventory and inspection of their culverts

2. Culvert Asset Number: An asset number should be assigned for each culvert for record keeping purposes

3. Inspection Date: The date on which the culvert was last inspected

4. Follow up Inspection Date: If a follow up inspection is needed, the date on which the follow up was conducted should be recorded

5. Next Inspection Date: The recommended date of the next inspection should be recorded. This decision is based on the recommended frequency of inspection for each culvert. The frequency of inspection should consider both conditions and the significance of the culvert along with any safety concerns. Culvert inspection frequencies should be based on engineering judgment and should not be assigned by the field inspectors

6. Culvert Type: Culverts may be categorized into one of five categories:

    a. Highway Culverts (Speed >=45 mph)

    b. Side (Road) Culverts (Speed <45 mph)

    c. Not Road Culvert: For example storm drain, flume or other

    d. Active Railroad Culvert

    e. Inactive Railroad Culvert

7. Diameter: Record the diameter of the culvert pipe in inches

8. Length: Record the length of the culvert in feet.

9. Span: For the purposes of the Culvert Inventory, the culvert span should be measured perpendicular to the centerline of the culvert. Record the span measured to the nearest inch See Figure 9-1. The following guidance shall be utilized in measuring culverts when applicable:

    a. Measurement should be made between inside faces of the barrel walls

    b. In the case of slab type culverts, span is measured from inside face to inside face of the abutment walls, perpendicular to the centerline of the culvert.

    c. In the case of multiple cell culverts, the culvert shall be considered one structure if the distance between adjacent barrels is less than 1/2 the diameter of the smaller barrel in the group.

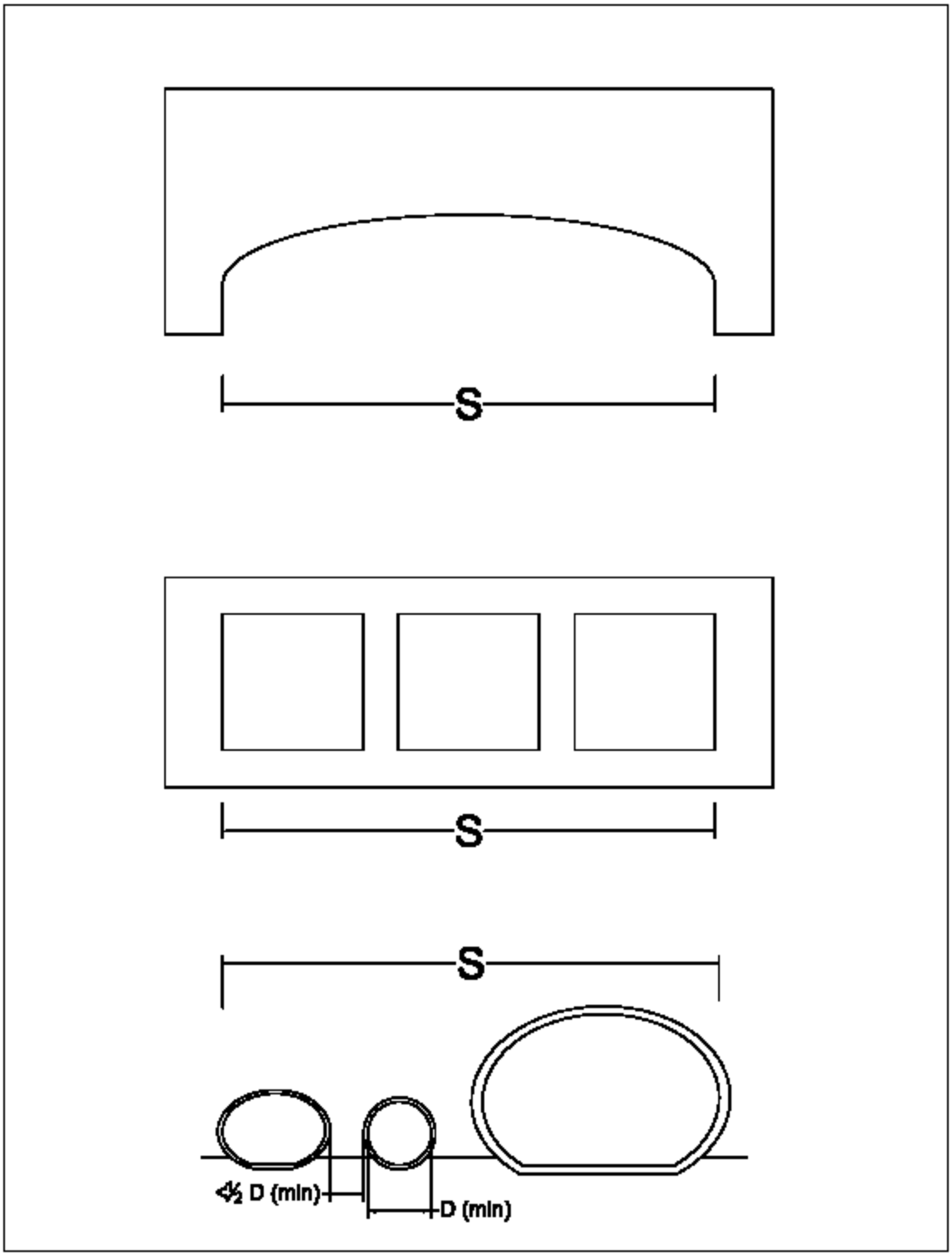

Figure 9-1: Culvert Span Insert Citation or replace

10. Year Built: If known, enter the year when the culvert was installed

11. Number of Cells

12. Shape: Enter the most predominate shape (excluding extensions):

    a. Circular

    b. Pipe Arch and Elliptical

    c. Arches (no culvert barrel material at the bottom)

    d. Box Sections (rectangular or square)

13. Material: Enter the most predominate material

    a. Concrete

    b. HDPE

    c. Metal

    d. PVC

    e. Other

14. Headwall Material: Centers should record this item twice, once for each end of the culvert. One end may be designated as A while the other is designated as B

    a. Formed Concrete

    b. Mitered End

    c. Rip-Rap

    d. Other

    e. None

15. Culvert End Type: Centers should record this item twice, once for each end of the culvert. Ends to the north or to the west should be designated as A while ends to the south or to the east should be designated as B

    a. Inlet

    b. Outlet

    c. Catch Basin

d. Other

16. Cover Condition:

    a. Under 2 feet pipe cover

    b. 2 to 5 feet pipe cover

    c. Over 5 feet pipe cover

Photos: Centers are encouraged to use photos to document the types of the inspected culverts and their surroundings.

SECTION 10: CULVERT INSPECTION

SECTION 10: CULVERT INSPECION

10.1 INSPECTION FREQUENCY

The frequency of inspection required for each culvert is determined by the responsible engineer(s) at each center. The recommendations outlined in this section are intended to aid in the process. The inspection frequency may be increased by the engineer(s) based on their professional judgment.

10.1.1 Culverts to Be Inspected a Frequency Not to Exceed 12 Months:

- Culverts with overall rating of 1 or 2
- Culverts under flight hardware transporting route
- Culvert with an overall rating of 3 and run under a paved road where speed is 45 mph or higher.
- Culverts under active railroad

10.1.2 Culverts to Be Inspected a Frequency Not To Exceed 24 Months:

- Culverts that do not meet criteria of 10.1.1 and have an overall rating of 3
- Culverts that do not meet criteria of 10.1.1 and run under a paved road where speed is 45 mph or higher.

10.1.3 Culverts to Be Inspected a Frequency Not to Exceed 48 Months:

- Culverts that do not meet criteria of 10.1.1 or 10.1.2 and have an overall rating of 4 or 5

10.2 INSPECTION PROCEDURES

10.2.1 Data Collection

Inspectors are encouraged to review available information prior to performing the actual inspection. This includes plans and most recent inspection reports. Inventory Data (Section 9-3) should be verified. If Inventory Data is updated, it should be noted in the comments section. If drop-down menus are utilized in a spreadsheet and more than one deficiency type exists for the culvert being inspected, select the worst case condition and describe the other conditions in a “comment” column. Each CBPM is required to maintain an inventory of all Center culverts in a NASA Culvert Inventory & Condition Datasheet (*see Appendix K)*.

10.2.2 Safety

Review Section 4.5 for safety requirements of culvert inspection. Individual centers may add safety requirements unique to their centers. Culvert inspections shall be performed in teams of two or more. Depending on the size and configuration of a culvert or a sewer, it may be considered a confined space per OSHA (29CFR1910.146). Because of the additional risk introduced by wild life in many of the NASA Centers, **inspectors shall not enter a culvert without an issued permit (even if the culvert does not qualify as a confined space).** A non-entry visual inspection should be used on any culvert where a good view of the entire barrel may be obtained from the culvert ends. For culverts where a non-entry inspection is not sufficient, inspection via electronic video equipment should be used.

10.3 CONDITION DATA

10.3.1 Condition Description of Elements

Guidance on the Condition Description of culvert elements is provided below in items 1 through 13. Condition Descriptions assist centers in preparing the proper repair or replacement projects. The comments section may be used if additional clarification is needed.

1. Roadway Condition: The condition of the roadway above the culvert should be recorded. Examples of the descriptions are:

    a. Roadway in good condition

    b. Roadway pavement cracks or other damage

    c. Settlement and cracks in roadway

    d. Major settlement and undermining

    e. Damage or misaligned guardrail

    f. Roadway settlement

2. Water condition: Centers should record this item twice, once for each end of the culvert. One end may be designated as A while the other is designated as B:

    a. Dry pipe

    b. Pipe filled with water

    c. Pipe partially filled with water

3. Erosion Condition: Centers should record this item twice, once for each end of the culvert. One end may be designated as A while the other is designated as B:

a. Scour or undermining at culvert end

b. Embankment erosion or settlement

c. Both scour and embankment erosion

d. Damaged or failed embankment protection

e. No visible erosion

4. Debris Condition at end: Centers should record this item twice, once for each end of the culvert. One end may be designated as A while the other is designated as B:

   a. Debris accumulation at pipe end

   b. Overgrown vegetation at pipe end

   c. Both debris accumulation and overgrown vegetation

   d. No debris accumulation or overgrown vegetation at pipe end

5. Headwall Condition: Centers should record this item twice, once for each end of the culvert. One end may be designated as A while the other is designated as B:

   a. Cracks or spalling at headwall or wingwall

   b. Erosion at headwall or wingwall

6. Sediment Buildup in pipe: Centers may record this item twice, once for each end of the culvert. One end may be designated as A while the other is designated as B:

   a. Heavy sediment buildup in pipe

   b. Moderate sediment buildup in pipe

   c. No sediment buildup in pipe

   d. Unknown

7. Pipe Condition:

   a. Cracks or spalling at pipe barrel

   b. Cracks or spalling at pipe end

   c. Crushed or flattened pipe

   d. Pipe joint separation or failure

e. Heavy corrosion of pipe

f. Moderate corrosion of pipe

g. Crushed pipe and heavy corrosion

h. Crushed pipe and moderate corrosion

i. No visible pipe damage

j. Unable to assess pipe

8. Comments: This section is for the inspectors or engineers to record any additional comments regarding the conditions or significance of the roadway or culvert. Examples of the comments could be:

   a. Debris at the entrance

   b. Cannot access culvert for measuring

   c. Erosion behind east wall

   d. Culvert under flight hardware route

9. Follow up Inspection Comments: This section is for the inspectors or engineers to record any additional comments during a follow up inspection Examples of the Follow up Comments are:

   a. Catch basin inlet inspected by structural engineer

   b. Culvert completely underwater or does not exist

10. Photos: Centers are encouraged to use photos to document the conditions of the inspected culverts and their surroundings.

11. Culvert Beneath Flight Hardware Route:

    a. Yes

    b. No

12. Culvert Beneath Active Railroad:

    a. Yes
    b. No

13. Culvert Beneath 45mph or higher road:

    a. Yes

b. No

10.3.2 Condition Code

The inspector shall assign condition code to some of the culvert elements. These codes are then used to generate an overall rating value of the culvert. A rating system from 1 to 5 is used where 5 represents an excellent condition while 1 represent a bad condition. A general explanation of the rating system is explained below. Applying these code values may vary based on the element being rated.

Condition Code Value:

5: Excellent condition. No work required. Good for at least 5 years.

4: Good condition. Only scheduled maintenance and/or condition monitoring required. Good for at least 5 years.

3: Fair condition. Minor repairs required. Repair or replace within 3-5 years.

2: Poor condition. Replacement or significant repairs required within 1-2 years.

1: Bad condition. Replacement required now.

Culvert Element Ratings:

1. Roadway Rating: A numerical rating between 1 and 5 is assigned to the roadway above the culvert
2. Erosion Rating: A numerical rating between 1 and 5 is assigned to represent erosion existence and magnitude. Use a rating of 5 if no erosion is present
3. Headwall Rating: A numerical rating between 1 and 5 is assigned to the Headwall of the culvert. Both headwalls should be considered for rating and the lowest rating controls
4. Pipe Rating: A numerical rating between 1 and 5 is assigned to the culvert pipe.

10.3.3 Culvert Overall Rating

The culvert overall rating is the lowest of (Roadway Rating, Erosion Rating, Headwall Rating, and Pipe Rating).

APPENDIX A: DEFINITIONS AND TERMINOLOGY

Active Railroad – A Railroad track that is being utilized for train transportation or will be utilized in the foreseeable future.

Agency Bridge Program Manager – NASA person, who meets the qualifications of program manager as specified in 23 CFR 650.309, in charge of the Agency's Bridge Management Program. The ABPM has the duties and overall responsibility for the inspection, reporting, load rating, and inventory of all bridges owned, operated, and/or under the jurisdiction of NASA. The ABPM provides overall leadership and coordinates with the Center Bridge Program Managers and the Federal Highway Administration's representatives to provide guidance and oversight.

Bridge – As defined in the 2022 NBIS, a bridge is *a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between under copings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it includes multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.*

Bridge inspection experience *– As defined in the 2022 NBIS, Active participation in bridge inspections, in either a field inspection, supervisory, or management role. Some of the experience may come from relevant bridge design, bridge load rating, bridge construction, and bridge maintenance experience provided it develops the skills necessary to properly perform a NBIS bridge inspection.*

Bridge Inspector's Reference Manual – An FHWA publication that explains the basic concepts of bridge inspection and requirements of the National Bridge Inspection Standards.

Center Bridge Program Manager – NASA person at a Center or other NASA facility with overall responsibility for the Bridge Management Program at their respective Center/facility. The CBPM will be available to maintenance contractors, bridge inspectors, load rating engineers, and the Center's project integration divisions. The CBPM ensures that required inspections are completed on time and in accordance with the NBIS and NASA's current policies and procedures. The CBPM reports to the ABPM and the Co-ABPM.

Complex Bridges – Bridges with complex features. Complex features are defined in the 2022 NBIS as: *bridge component(s) or member(s) with advanced or unique structural members or operational characteristics, construction methods, and/or requiring specific inspection procedures. This includes mechanical and electrical elements of moveable spans and cable related members of suspension and cable-stayed superstructures*.

Contractor Bridge Inspector – Contractor personnel hired by NASA, or their designee, to act as bridge inspectors on behalf of NASA for bridges under the jurisdiction of the Agency.

Contractor Engineer – Contractor personnel of various engineering disciplines (civil, structural, electrical, mechanical, etc.) hired by NASA to provide technical support and recommendations to the CBPM. Contractor engineers shall at all times ensure that their work related to the NBMP complies with the NBIS and NASA's current policies and procedures. The contractor engineers may perform tasks on behalf of the CBPM such as field oversight of bridge inspections.

Contractor engineers are responsible for documenting all their work and reporting to the CBPM.

Contractor Team Leader – Contractor personnel hired by NASA to act as Bridge Inspection Team Leaders on behalf of NASA at the various Centers and other NASA facilities who are in charge of an on-site bridge inspection team and responsible for planning, preparing, and performing bridge field inspections. The Team Leader is responsible for the overall management and supervision of a bridge inspection team composed of one or more inspectors. The Team Leader ensures that inspections performed by the team are completed in accordance with the NBIS, the NBMP, and all other current NASA policies and procedures.

Culvert – A culvert is a structure designed hydraulically to take advantage of submergence to increase water carrying capacity. Culverts, as distinguished from bridges, are usually covered with embankment and are composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert. Culverts may qualify to be considered “bridge” length.

Federal Railroad Administration –The Federal Railroad Administration was created by the Department of Transportation Act of 1966. It is one of ten agencies within the U.S. Department of Transportation concerned with intermodal transportation (49 CFR Chapter 2).

Highway Culvert – A culvert under a paved road for which the speed equals to or exceeds 45 mph.

Inactive Railroad – A Railroad track that is not being utilized for train transportation and does not have plans to be utilized in the foreseeable future.

Load Rating – The determination of the live-load carrying capacity of an existing bridge.

Manual for Bridge Evaluation – AASHTO publication that *serve as a resource for use in developing specific policy and procedures for the inspection and evaluation of existing in-service highway bridges. The MBE also includes the nationally recognized guidance for the load rating of highway bridges.*

Manual on Uniform Traffic Control Devices – FHWA publication that *establishes uniform national criteria for the use of traffic control devices that meet the needs and expectancy of road users on all streets, highways, pedestrian and bicycle facilities, and site roadways open to public travel.*

NASA Bridge Management Program – Agency-wide program established to meet the requirements of 23 CFR 650 Subpart C, in regard to the inspection, reporting, load rating, and inventory of highway bridges on public roads that are located within NASA’s responsibility or jurisdiction.

NASA Guide for Bridge and Culvert Evaluation – A supplement to the MBE, Third Edition, 2018. The NGBCE is not intended to supersede information in the MBE but rather to provide complementary, non-contradictory supplemental information, procedures, and requirements

specific to NASA.

National Bridge Inspection Inventory – The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards.

National Bridge Inspection Standards – Federal regulations that *sets the national minimum standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 144(h) and the requirements for preparing and maintaining an inventory in accordance with 23 U.S.C. 144(b). The NBIS establishes requirements for inspection procedures, frequency of inspections, a bridge inspection organization, qualifications of personnel, inspection reports, and preparation and maintenance of bridge inventory records. It applies to all structures defined as highway bridges located on all public roads, on and off Federal-aid highways, including tribally-owned and federally-owned bridges, private bridges that are connected to a public road on both ends of the bridge, temporary bridges, and bridges under construction with portions open to traffic.*

Paved Road – A road with a durable surface material, flexible (asphalt) or rigid (concrete), laid down on an area intended to sustain vehicular traffic. The primary function of a pavement is to transmit loads to the sub-base and underlying soil.

Railroad Track – A structure consisting of the rails, fasteners, railroad ties and ballast, plus the underlying subgrade. It enables trains to move by providing a dependable surface for their wheels to roll upon.

Posting –Post or restrict the bridge in accordance with the AASHTO MBE or in accordance with State law (where the NASA Center is located), when the maximum unrestricted legal loads or routine permit loads exceed that allowed under the operating rating or equivalent rating factor. Regulatory signage related to the posting of bridges is to conform to the requirements of the FHWA *Manual on Uniform Traffic Control Devices (MUTCD)* and the AASHTO *MBE*.

Public Road – As defined in 23 U.S.C. 101, a Public Road refers to *any road or street under the jurisdiction of and maintained by a public authority and open to public travel.*

Quality Assurance – In accordance with the NBIS, Quality Assurance refers to *the use of sampling and other measures to assure the adequacy of QC procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.*

Quality Control – In accordance with the NBIS, Quality Control refers to *Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level.*

Railroad Bridge – Any structure with a deck, regardless of length, that supports one or more railroad tracks or any other undergrade structure with an individual span length of 10 feet or more and located at such depth that it is affected by live loads.

Structurally Deficient – In accordance with the Pavement and Bridge Condition Performance Measures final rule, published in January of 2017, a classification of Structurally Deficient is

given to a bridge when it has any component [Item 58, 59, 60, or 62] in Poor or worse condition [code of 4 or less].

Underwater Bridge Inspection Diver – Contractor personnel responsible for inspecting underwater elements of bridges on behalf of NASA. Underwater Inspections are typically performed by a specialty subcontractor hired by the bridge inspection contractor. Underwater Bridge Inspection Divers shall complete an FHWA -approved, comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course as specified in 23 CFR 650.309. Divers shall also meet the minimum diving qualifications required by the Occupational Safety and Health Administration (OSHA) regulations, Commercial Diving Operations (29 CFR 1910 Subpart T).

APPENDIX B: Acronyms

AASHTO – American Association of State Highway and Transportation Officials, 444 North Capitol Street, NW, Suite 249, Washington, DC 20001.

ADT – average daily traffic

ABPM – Agency Bridge Program Agency

ADTT – average daily truck traffic

BIRM – *Bridge Inspector's Reference Manual*

CBPM – Center Bridge Program Manager

CFR – Code of Federal Regulations

FHWA – Federal Highway Administration, U.S. Department of Transportation

FRA – Federal Railroad Administration

KSC – Kennedy Space Center, SR 405, Florida 32899

MBE – *Manual for Bridge Evaluation*

MUTCD – *Manual on Uniform Traffic Control Devices*

NASA – National Aeronautics and Space Administration, 300 E Street SW, Washington, DC 20024–3210

NBIS – National Bridge Inspection Standards

NBMP – NASA Bridge Management Program

NGBE – NASA Guide for Bridge Evaluation

POA – Plan of action

SD –Structurally Deficient

Appendix C: EXAMPLE OF BRIDGE LOAD RATING SUMMARY FORM

BRIDGE LOAD RATING SUMMARY FORM

BRIDGE DATA	
Bridge Number:	703004
Struct. Type Main [Item 43] @:	3 16
Struct. Type Appr. [Item 44] @:	
Select Construction Cont.	

POSTING DATA	
Current Restrictions	
Item 41 @:	Open, No Restrictions
Is Posting Needed:	No
Proposed Restrictions	
Item 70 @:	At/Above Legal Loads

PROGRAM USED
STAAD, BARS

BASIS FOR ANALYSIS	
Design Drawings:	No
As-Built Drawings:	Yes
Shop Drawings:	No
Field Measurements:	No
Coupon Testing:	No
Other:	Inspection Report

LIVE LOAD DISTRIBUTION	
AASHTO LFD:	X
AASHTO LRFD:	
SALOD:	
BRUFEM:	
Finite Element on Grillage:	

LONGITUDINAL GOVERNING COMPONENT	
Main/Approach Span:	Main
Description:	Movable
Material:	Steel
Simple/Continuous Span:	Simple
Span Length:	17.58'
Flexure, Shear or Principal Tension:	Flexure

TRANSVERSE GOVERNING COMPONENT	
Main/Approach Span:	Main
Description:	Movable
Material:	Steel
Deck, Box or Substructure:	
Flexure, Shear or Principal Tension:	Flexure

OTHER SPAN OF INTEREST (If Applicable)

OTHER SPAN OF INTEREST (If Applicable)

PONTIS DATABASE INPUT

PONTIS APPRAISAL TAB

Description (NBIS Code)	Value
Design Load (31) @	MS18 (HS20)
HL93, M9 (H10), M13.5 ((H15), M13.5 (HS15), M18 (H20), MS18 (HS20), MS18 (HS20)+Mod, Pedestrian, Railroad, MS22.5 (HS25), Unknown (NBI), Unknown (P), Not Applicable (P)	
Operating Type (63) @	Allowable Stress
Unknown, Load Factor, Allowable Stress, Load & Resistance Factor, Load Test, No Rating, Unknown (NBI) Not Applicable (P)	
Operating Rating (64)* @ ( )	47.7 (M) Tons
Inventory Type (65) @	Allowable Stress
Unknown, Load Factor, Allowable Stress, Load & Resistance Factor, Load Test, No Rating, Unknown (NBI) Not Applicable (P)	
Inventory Rating (66)* @ ( )	34.6 (M) Tons

LEGEND

* If rating is provided as a factor from an LRFR analysis, multiply the rating factor by 36 tons
** If not calculated, enter "-1"
LRFR Rating Only
If Posting is not required, enter "99"
@ BMS Coding Manual available on the FDOT Office of Maintenance website

PONTIS LOAD RATING 1 TAB

Description (NBIS Code)	Value	
HS 20/HL 93 Governing Span Length	17.58	FT
Load Rating Origination	As-Built Plans	
Unknown, Design Plans, As-Built Plans, Field Measurements		
Load Rating Date	09-Aug-13	
Method Calculation	AASHTO Formula	
Unknown, AASHTO Formula, SALOD, BRUFEM, Other		
Load Distribution Factor		
Impact Factor	30.00	
Design Method	Working Stress	
Unknown, Working Stress, Load Factor, LRFD, Others		
Design Measure	English	
Unknown, English, Systeme International		

TRUCK OPERATING RATINGS

SU 2**	Bascule Span Stringer	M	32.8	Tons
SU 3**	Bascule Span Stringer	M	41.7	Tons
SU 4**	Bascule Span Stringer	M	38.7	Tons
C 3**	Bascule Span Stringer	M	54.0	Tons
C 4**	Bascule Span Stringer	M	46.3	Tons
C 5**	Bascule Span Stringer	M	50.5	Tons
ST 5**	Bascule Span Stringer	M	61.0	Tons
Recommended SU Posting ##			99	Tons
Recommended C Posting ##			99	Tons
Recommended ST Posting ##			99	Tons

PONTIS LOAD RATING 2 TAB

Description (NBIS Code)	Value	
FL 120 Longitudinal Governing Span Rating	-1.0	Tons
SEGMENTAL		
FL 120 Transverse Rating (Segmental)**	-1.0	Tons
Single Axle Transverse Rating**	-1.0	Tons
Tandem Axle Transverse Rating**	-1.0	Tons
Wing Span**	-1.00	FT
Web-to-Web Span**	-1.00	FT
MAXIMUM SPAN		
HS 20 Operating Rating Maximum Span**	62.1	Tons
FL 120 Longitudinal Maximum Span #	-1.0	Tons
FLOOR BEAM		
Floor Beam Present	No = Stop Yes = Continue	
Governing Floor Beam Span**	26.54	FT
Governing Floor Beam Spacing**	17.58	FT
Floor Beam HS 20 Rating**	54.9	Tons
Floor Beam SU 4 Rating**	42.3	Tons

COMMENTS BY ENGINEER

The interior beam and cross girder at Flanking Spans 1 and 3 and the main girders, floorbeams and stringers in the bascule span were rated. The Bascule Span stringers control the rating.

Responsible Engineer:
FL P.E. #:
Date:
Address:

Engineering Sign and Seal

COMPUTATIONS

Performed By:
Checked By:
Reviewed By:

G:\FL13\0016\Bridge\703004\Load Rating\703004_LR Summary Sheet.xlsx

Appendix D: Damage Assessment Form

U.S. Department of Transportation
Federal Highway Administration

FEDERAL LANDS HIGHWAY
DAMAGE INSPECTION REPORT

Sheet No: 1 of

Structure Information

Structure No.: _____ Park/Agency: _____
Structure Name: _____

Incident Report Information

Reported By: _____ Date: _____
Description of Issue: _____

Response Team Information

Team Members: _____ Arrival Date: _____
Inspection Findings: _____

Recommendations/ Follow-up Procedures

Follow up be required?: ☐ No ☐ Yes
Recommendations: _____

Cost Estimate for Repairs

Quantity	Unit	Item Description	Unit Price	Cost

Team Leader: _____
Printed
_____ Date: _____
Signature

Appendix E: NASA INVENTORY MASTER DATASHEET

NASA Center	Bridge Name	Structure #	Facility #					Year Built	Public	Year Re-constructed	Current Inspection - Overall NBI Ratings						Status	Posted (Item 70)	Load Restrict.	Scour (Item 113)	Qtrly Updates / Changes
				2022	2023	2024	2025				Deck	Super-structure	Sub-structure	Channnel	Culvert	Suffic. Rating					
Kennedy Space Center (KSC)	Banana River Bridge	703003	M7-1150		Jun			1965		N.A.	6	5	5	5	N/A	55.10	0	5		6	
	Haulover Canal Bridge	703004	E4-2414		Jun			1965	P	N.A.	7	5	6	7	N/A	69.3	0	5		5	
	SR 405 over SR 3 Bridge WB	703005	M6-0232		Jun			1964		N.A.	7	7	7	N/A	N/A	74	2	5		N	
	SR 405 over SR 3 Bridge EB	703006	M6-0232		Jun			1965		N.A.	7	7	7	N/A	N/A	74	2	5		N	
	Bannana River Relief Bridge	703007	M8-2230		Jun			1965		N.A.	7	5	5	6	N/A	68.1	0	5		6	
	Jay Jay RR Bridge	H2-1198	H2-1198		Jun			1963		N.A.	6	5	6	5	N/A	N/A	0			5	
	Box Culvert NB over Banana Crk	K6-0588	K6-0588		Jun			1996		N.A.	N.A.	N.A.	N.A.	7	6	96.9	0	5		6	
	Box Culvert SB over Banana Crk	K6-0588A	K6-0588A		Jun			1980		N.A.	7	7	7	6	N.A.	95.9	0	5		6	
	RR Box Culvert over Banana Cre	K6-0589	KSC-11150		Jun			1964		N.A.	N/A	N/A	N/A	7	7	N/A	0	5		6	
Stennis Space Center (SSC)	Bascule Bridge			Sep				1969			5	6	7	8	N.A.	67	0	5		8	
	SB Turtleskin Creek Bridge			Sep				1970	P		6	6	5	7	N.A.	67.3	2	5		U	
	NB Turtleskin Creek Bridge			Sep				2012	P		7	7	7	7	N.A.	99.9	0	5		8	
	NAVO Culvert Bridge	NAVO Culvert		Sep				2000			N.A.	N.A.	N.A.	5	7	91.5	0	5		8	
	NRL Culvert Bridge	NRL Culvert		Sep				2000			N.A.	N.A.	N.A.	5	7	94	0	5		5	
	Trent Lott Parkway Culvert	Trent Lott Culvert		Sep				2012			N.A.	N.A.	N.A.	6	6	68	0	5		8	
	KDT Road Culvert Bridge	KDT Culvert		Sep				1984			N.A.	N.A.	N.A.	6	5	73.2	0	5		8	
WFF	Wallops Island Bridge	188008030		Aug				1959			5	5	5	8	N.A.	66	0	5		6	
JPL	Arroyo SECO Bridge	JPLFACILITY0285	285	Apr				1971	P		6	7	7	8	N.A.	82	0	R		5	
Johnson Space Center (JSC)	3rd Street Entrance Bridge		832	Mar				1963	P		6	6	5	6	N.A.	72.22	2	5		8	
	3rd Street Exit Bridge		831	Mar				1963	P		6	6	6	6	N.A.	83.22	2			8	
	West Side Culvert Bridge		851	Mar				1965			N.A.	N.A.	N.A.	7	7	81.91	0	5		8	
GSFC	GSFC	2170001P0000000		Apr				1966	P	2004	6	5	5	7	N.A.	86	0	K		5	Bridge Closed in Sep 16, 2025 due to collision damage
																					Estimated reopening after repairs in Spring 2025
GRC	West Area Road Culvert Bridge	158000000		Aug				1995			N.A.	N.A.	N.A.	7	8	83.5	2	5		7	
	Cedar Point Road Culvert Bridge			Aug				1950			N.A.	N.A.	N.A.	7	4	46.2	1	5		7	
	PBS-Pentolite Rd Culvert-Bridge			Aug				1941			N.A.	N.A.	N.A.	6	4		1	5		U	
	PBS-Taylor Road Culvert-Bridge			Aug				1941			N.A.	N.A.	N.A.	5	6		0	5		U	
WSTF	Apollo Blvd Culvert Bridge				Jul			1988													
	STGT Road Culvert Bridge				Jul			1963													

Appendix F: EXAMPLE CULVERT & CONDITION DATASHEET

Site-Center	MapLi	CulvXCoo	CulvYCoo	ASSET_NO	Inspection Date	FollowupDate	Next Insp Date	Culvert Type
KSC	map	759461	1529556	CULV00001	6/27/2016		6/27/2020	Side (Road) Culvert

DIAMET	GIS_Leng	Span	Year Built	# of Cell	Shape	Material	CA_HeadwallMaterial
18	22	1.5	Unknown	1	Circular	HDPE	None

CB_HeadwallMateria	CA_EndType	CB_EndType	CA_CoverCondition	CB_CoverCondition
None	Other	Other	2 to 5 foot pipe cover	2 to 5 foot pipe cover

Roadway Condition	CA_WaterCondition	CB_WaterCondition	CA_ErosionCondition
Roadway in good condition	Pipe partially filled with water	Pipe partially filled with water	No visible erosion

CB_ErosionCondition	CA_DebrisCondition	CB_DebrisCondition	CA_HeadwallCondition	CB_HeadwallCondition
No visible erosion	Overgrown vegetation at pipe ends	Overgrown vegetation at pipe ends	No headwall	No headwall

CA_Sediment Buildup in pipe	CB_Sediment Buildup in pipe	CA_PipeCondition	CB_PipeCondition
No sediment buildup in pipe	No sediment buildup in pipe	No visible pipe damage	No visible pipe damage

Comments	Follow up Inspection Comments	Culvert Beneath Flight Hardware Route	Culvert Beneath Active Railroad
		No	No

Culvert Beneath 45mph or higher road	Roadway Rating	Erosion Rating	Headwall Rating
No	4	5	N.A.

Pipe Rating	Culvert Overall Rating	CA_VegClearingNeede	CB_VegClearNeede	Phot	Phot	Phot
4	4	No	No	photo		

CA_Photo	CA_Photo	CA_Photo	CA_Photo	CA_Photo	CB_Photo	CB_Photo	CB_Photo
					photo	photo	

Appendix G: Registry of Certified Bridge Inspector Personnel

Inspector Name	License Number	License Expiration Date	License State	Type of License (SAFETY/UW/NSTM)
James A Appler	76076 (P.E.)	2/28/2027	FL	SAFETY-Team Lead
Keith S Hoogland	CBI 00341		FL	UW-Team Lead
David Walker	CBI 00493		FL	SAFETY-Team Lead
Patrick D Huff	61124 (P.E.)	2/28/2027	FL	DAMAGE
Doug A Czerwinski	40088 (P.E.)	2/28/2027	FL	SAFETY-Team Lead, DAMAGE
Michael F Landry	43800 (P.E.)	2/28/2027	FL	SAFETY-Team Lead, DAMAGE

NOTES:
SAFETY = Safety Inspection of In-Service Bridges
UW = Underwater
NSTM = Non-Redundant Steel Tension Member (formerly Fracture Critical Member)
DAMAGE = Inspection after damage event
This database per part B.IE.04 of SNBI Publication

Kennedy Space Center | Stennis Space Center | Jet Propulsion Laboratory | Johnson Space Center | Goddard Space Flight Center