



**RESEARCH & DEVELOPMENT**

# **Communicate Lessons, Exchange Advice, Record (CLEAR) Database Development**

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# **Communicate Lessons, Exchange Advice, Record (CLEAR) Database Development**

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<p>Valuable lessons learned and best practices gleaned from construction projects often do not transfer to future generations due to the lack of a formalized process. This ongoing issue gives rise to the need to impart fresh training to new North Carolina Department of Transportation (NCDOT) employees once the aging workforce retires or in the event of turnover. In addition, a platform for personnel to record pertinent project information about projects' successes and failures is needed. Such information can help solve problems and avoid repeated mistakes. The aim of this research project is to create a new program for lessons learned/best practices called Communicate Lessons, Exchange Advice, Record (CLEAR). The North Carolina State University (NCSU) researchers used a Six Sigma approach to identify, define, develop, optimize, and verify lessons learned/best practices to create the CLEAR database. The database fields were selected based on end-user input as well as a review of existing data, such as claims and supplemental agreements, within NCDOT data repositories. The NC Department of Information Technology created this internal-only web-based database on its Connect NCDOT SharePoint portal with MS Access as the backend. Training materials, including videos and standard operating procedures, were created to disseminate information about this new program. The CLEAR program will help the NCDOT to institutionalize knowledge and is expected to improve project cost variability and scheduling.</p>			
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## EXECUTIVE SUMMARY

This research project was undertaken to develop and establish an internal-only Connect NCDOT SharePoint-based database to collect and share lessons learned/best practices about North Carolina Department of Transportation (NCDOT) projects. This database project is referred to as CLEAR (Communicate Lessons, Exchange Advice, Record). “A lesson learned is defined as knowledge gained from experience, successful or otherwise, for the purpose of improving future performance” (Construction Industry Institute, 2017). For this project, ‘lessons learned’ signifies the process of collating data during a project’s lifecycle about activities that may be useful for future NCDOT projects. This repository for storing and retrieving data for future projects will help the NCDOT to achieve better project control and consider suggestions for innovative ideas, thereby adding value to the state of North Carolina.

Previous research efforts (e.g., CII 2017 and the International Atomic Energy Agency Construction Workshop 2011) have explored various approaches to access and utilize lessons learned experiences in the construction industry. Also, the Kentucky Transportation Cabinet funded a study to develop a constructability lessons learned tool to be used during the design phase to improve project outcomes (Stamatiadis et al. 2012). In contrast, this NCDOT research project incorporates the collection and dissemination of both lessons learned and best practices at each concurrence point during the preconstruction phase, execution phase (considering detailed design and construction), and maintenance and operations, thereby essentially covering all aspects of a project’s lifecycle. North Carolina State University (NCSU) researchers have helped create the user-friendly database, CLEAR, to gather, record, and communicate the lessons learned and best practices. The database is sortable by major trends, such as by keywords and/or by division, region, county, cost/schedule impacts, project type, and project phase, for the various groups within the NCDOT.

This report also presents a preliminary analysis of claims data that pertain to utilities. These data, obtained from the Highway Construction and Materials System (HiCAMS), are for 1994 through 2018. In its initial data gathering stages, the NCSU research team observed a frequent trend with regard to utilities claims and found from data analysis that one in every five projects is impacted by utility issues-related claims that delay the schedule by about 70 days and increases project costs by about 2%. In addition, the quality of input within HiCAMS needs to ensure that missing/unknown cases are addressed appropriately for better data analysis in the future. This analysis of utility claims should help the NCDOT identify avenues for improvement and generate a customized list of best management practices to handle such issues.

The success of the CLEAR program is heavily reliant on the end-users. Therefore, their willingness to participate in this program and enter relevant knowledge gained at project sites is imperative. To this end, the NCSU research team developed a survey instrument to help determine the training requirements of NCDOT personnel and develop training materials that would provide the most meaningful impact and encourage participation in the CLEAR program. Based on the survey results, the research team developed training materials in the form of short videos using commercially available video-making software, VideoScribe. In addition to the video materials, the research team also prepared standard operating procedures (SOPs) for the various stakeholders in this program, i.e., end-users, the gatekeeper, and the Expert Review

Panel. These SOPs are intended to serve as a guide for entering information into the appropriate forms and searching for lessons learned/best practices based on relevant search criteria, and for the experts to review entered information.

The final research product is a comprehensive, lessons learned/best practice resource repository that can be used to improve performance for future projects. The future scope include developing a data dashboard for visualizing data (both text and otherwise) to provide useful insights on the content uploaded within the CLEAR database. In addition, the data dashboard will also serve as a success metric for this program in monitoring entries based on divisions and counties. It is also envisioned to automatically push relevant lessons to end-users based on an artificial intelligence model to automatically disseminate information to the end-users. The NCDOT will greatly benefit from CLEAR, thereby improving project management and operational performance.

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## **List of Definitions Related to CLEAR (Communicate Lessons, Exchange Advice, Record)**

**Accepted:** A lesson learned or best practice submission has been reviewed by an expert and, with the expert opinion applied, has been placed on the ‘Accepted Submissions’ list on the CLEAR SharePoint homepage for reference or next steps.

**Applicable discipline:** Areas of work within the North Carolina Department of Transportation (NCDOT), such as Construction, Erosion Control, Geotech, Hydraulics, etc. The applicable discipline has a specialized person or group to evaluate and review the submission. This person or group is different from the person or group who would benefit from learning from the submission. The applicable discipline selected should reflect the person or group whose expertise is required to vet the submission. The applicable discipline also can be selected by the gatekeeper. See the list of Applicable Disciplines posted on the CLEAR homepage for a description of each.

**Best practice:** Methods or techniques that have been found to be the most effective and practical means to achieve an objective while making the optimal use of the State's resources.

**Expert Review Panel (ERP):** Experts in domains within the NCDOT who have extensive knowledge within their area of work. Whereas the taskforce consists of experts who cover all disciplines of work, the ERP is selected by the gatekeeper from this pool of experts as those who can offer the most relevance and expertise to the entered lesson.

**Gatekeeper:** The person/team that is responsible for reviewing submissions, communicating with appropriate ERP members about the submissions, and facilitating the inclusion of valid lessons learned/best practices in the CLEAR database. The Value Management Office team at the NCDOT will act as the gatekeeper for the CLEAR database.

**Idea:** A creative thought that can help improve processes and bring about change in routine work practices.

**Innovation:** The introduction of ideas, methods, devices, or emerging technologies that are new to the operations of an agency. For state DOTs, these innovations could involve the introduction of new processes, materials, methods, technologies, and/or tools to improve results and outcomes. These innovations may be entirely new and require validation and testing or they may already have been tested or proven at other agencies or in another business unit within the agency and are ready for adoption in this application.

**Innovation Coordinator:** A person who is highly motivated in encouraging his or her unit or office to participate in the CLEAR program, thereby supporting innovation.

**Lean Six Sigma:** Proven methodology to drive outstanding business performance by improving processes and enhancing customer value through systemically eliminating waste.

**Lessons learned:** The knowledge gained from one’s own project experiences as well as experiences of others (Project Management Institute, 2004).

**Location:** Description of where the relevant issue/lesson learned/best practice took place. Possible examples could be 1 South Wilmington St., Raleigh, or Western Blvd. at Gorman St., or the mile marker in the project (if applicable).

**Next steps:** Future course of action that possibly could bring about policy, procedural, or organizational changes within the NCDOT.

**Office:** The submitter's office or unit within the NCDOT.

**Project:** The NCDOT project in the Construction or Maintenance Division.

**Rejected:** The submission or the lesson learned was incomplete and the submitter did not accept the Request for Information, or the submission was deemed unsuitable for the CLEAR database.

**Subject Matter Expert (SME):** Former name for an ERP member. Some historical data may use 'SME'.

**Solution Needed:** Information is solicited about how to solve problems encountered on projects and in routine work practices.

**Submitter:** An NCDOT employee who is willing to share lessons learned/best practices or requests a solution to a problem as part of his/her assigned tasks.

**Technical Advisory Group (TAG):** A group of ERP members who focus on specific topics and collectively review submissions through the NCDOT and establish goals for collecting or soliciting solutions.

**Technical Coordination Committee (TCC):** A group composed of upper management, multidisciplinary and multi-modal representatives, and external partners that provides guidance and reviews from a high-level/industry perspective.

## 1. INTRODUCTION

The need to document and institutionalize firsthand knowledge gained by construction personnel has expanded over the past several decades. The construction industry is a knowledge-based industry that relies heavily on knowledge input by various participants within a project team environment (Carrillo & Anumba, 2002). Construction project management involves coordinating teams from all phases of the project's lifecycle (i.e., planning, design, construction, and maintenance). Despite taking sound precautions, external uncontrolled factors, such as utility coordination, right-of-way acquisition, project funding, and interagency communication, can lead to delays and claims (Plotch, 2015). In fact, one in three capital projects risks being delayed, over-budget, and/or fails to achieve its profit objective (Anderson & Tucker, 1994). One of the primary reasons that organizations repeat their past mistakes is failure to document experiential knowledge (Anderson & Tucker, 1994). As a remedy, lessons learned can serve as a valuable resource for planning and design teams to help identify potential problems in advance and thus to be proactive in mitigating possible schedule and cost overrun issues.

Lessons learned is one of the 17 best practices recognized by the Construction Industry Institute (CII) for enhanced project performance. The CII report on lessons learned (Gibson et al. 2008) is an invaluable resource in the field of knowledge management. It highlights the three main phases of a lessons learned exercise as collection, analysis, and implementation. The CII report also notes that, in any organizational structure, knowing the information to document and where to document it can impact the effectiveness of a designed lessons learned tool. Therefore, lessons learned databases are an effective means to record and retrieve appropriate information to apprise users about past experiences, both good and bad. Establishing the right culture and upper management support is also essential to establishing a successful lessons learned program. Most organizations have now started to realize the full potential of a lessons learned program within their organizations.

The Value Management Office at the North Carolina Department of Transportation (NCDOT) performed a study in 2014 as an initial step towards building a lessons learned database. The intent of this exercise was to create a meaningful interface between preconstruction units and field personnel and to document useful information about previous projects to act as a reference for future project planning. The study was referred to originally as the Post Construction Assessment Program (PCAP) because its primary aim at that time was to capture information about issues that arose post-construction in addition to responses from the pre-construction phases such as planning and design. As part of the PCAP, NCDOT personnel across various divisions were asked to provide their input about the concept of a unique database that would serve as a knowledge repository about previous projects. The identified need was to have a simple yet robust tool that could be used for gathering data, indexing the data correctly, and retrieving the most relevant files based on key search terms and phrases.

For this research project, the North Carolina State University (NCSU) research team sought to develop a new robust tool to institutionalize construction project knowledge for the NCDOT in consultation with the North Carolina Department of Information Technology (NC DIT). This report describes the effort to assist in the design and implementation of a lessons learned/best practices database named CLEAR (Communicate Lessons, Exchange Advice, Record) for the

NCDOT. CLEAR is a Connect NCDOT SharePoint-based internal-only database that is intended for use mainly by personnel who are associated with any project phase within the NCDOT. Personnel from various project phases can now record information related to issues (both good and bad) that emerged in a particular project and avoid repeating mistakes. As an example of this need, during the data gathering phase of this project, the NCSU research team learned that no formal process was available for the design team to know if any issues or problems related to their designs had arisen during construction or whether any delays had occurred and/or additional monies were involved. CLEAR is intended to communicate experiences among personnel so that successes and failures can be shared, recorded, and hopefully addressed.

The research approach used here is to utilize the rich knowledge and experiences of NCDOT personnel that can be harnessed effectively in the form of an efficient lessons learned tool (Hansen, Nohria, & Tierney, 1999). The NCSU research team employed a Six Sigma approach to accomplish this goal. The concept that underlies CLEAR is to improve coordination among all divisions and units and act as a knowledge repository, best practices guide, and readiness indicator for future projects. The lessons learned database is intended to be used by personnel from all 14 highways divisions throughout North Carolina as well as the central units. CLEAR thus provides a platform for interagency communication and for personnel to revisit past experiences that are rich in data.

Figure 1 presents a chart that is found on the NCDOT's Value Management Office website that succinctly explains CLEAR to NCDOT personnel (Fullerton, 2020). As shown, CLEAR aims to collect lessons learned and best management practices from NCDOT personnel and share that information with others. These lessons learned and practices are vetted by an Expert Review Panel (ERP) that is composed of NCDOT personnel who are leaders in their respective fields and have the ability to inform and make policy changes relevant to their units or offices. To initiate a submission of a lesson learned or best practice, an NCDOT employee would go to the Connect NCDOT CLEAR SharePoint site and fill out the necessary and relevant information online. The program can autofill some project information, and attachments such as photos or documents can be included in the submission. Once the information is complete, the submission goes to the gatekeeper in the Value Management Office. The gatekeeper reviews the submission to ensure that it is complete and relevant and then forwards the submission to the ERP for thorough review and vetting. Once the lessons learned/best practice is approved, the ERP populates the database. The database is searchable by keywords and other functions such as filtering by county, division, project type, etc. CLEAR aims to create feedback loops within the department for all project phases, disciplines, units, offices, and locations. This program is also expected to bring organizational changes to improve processes within the NCDOT. The NCDOT will greatly benefit from this knowledge repository, thereby aiding in achieving better project performance.

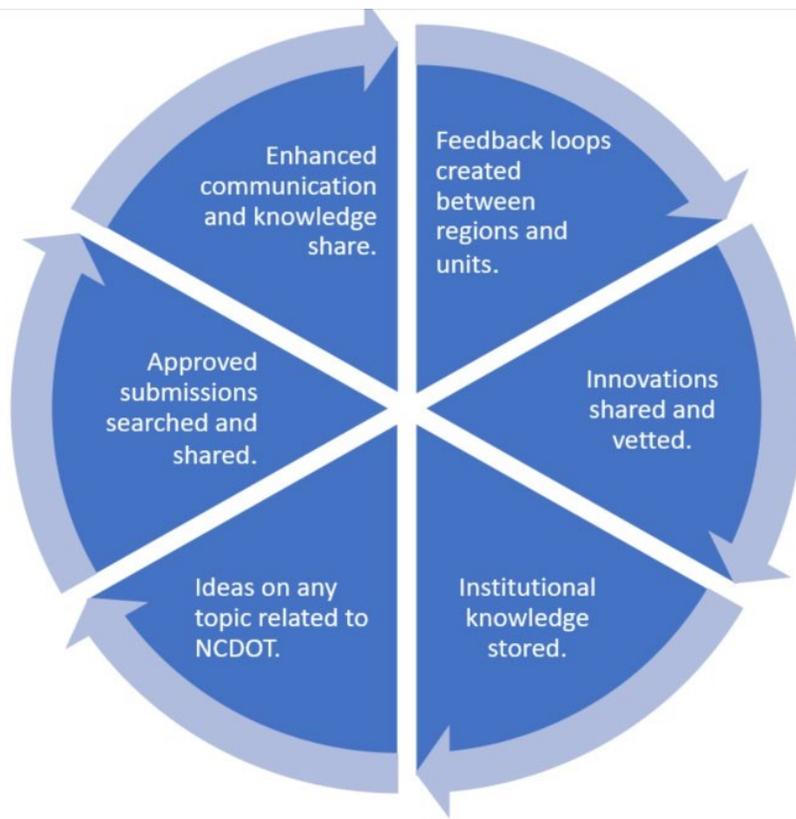


Figure 1. ‘What You Need to Know’ (Fullerton, 2020).

## 2. LITERATURE REVIEW

### 2.1. Previous Work Regarding Lessons Learned at Other Organizations and Departments of Transportation

Numerous organizations have benefited from lessons learned tools and programs in order to tap past experiences and make informed decisions. For example, the National Aeronautics and Space Administration has both a public lessons learned system as well as an internal lessons learned system. The United States Army’s Construction Engineering Research Laboratories uses DrChecks, which utilizes client-server architecture for online comment sharing among various parties for discussions that pertain to design documents. In addition, “the CROSS-US [Confidential Reporting on Structural Safety – United States] is a confidential reporting system to capture and share lessons learned from structural safety issues which might not otherwise have had public recognition, with the aim of preventing future failures” (CROSS-US, 2020). The CROSS-US database is open access to the public and includes a search feature that is based on a construction taxonomy that has not been shared hitherto as public knowledge.

With regard to transportation organizations, the Indiana Department of Transportation (INDOT) was an early adopter of a lessons learned database. McCullouch and Patty (1994), researchers at Purdue University, conducted a series of interviews with INDOT personnel to improve coordination between the design and construction teams with the ultimate aim to achieve a better

constructability review program. To this end, the Purdue team developed a windows-based constructability lessons learned software application using Visual Basic. Folio Views is the software that contains the constructability lessons learned in text form and is used to store, index, and retrieve the lessons (McCullouch and Patty, 1994).

The Kentucky Transportation Center at the University of Kentucky conducted a similar research activity to develop a web-based lessons learned database that could accept files both in text format and image format. Goodrum et al. (2003) surveyed resident engineers, contractors, and consultants to obtain an initial understanding of their vision of a perfect lessons learned database. Each user associated with the database was classified into three categories, i.e., end user, gatekeeper, or administrator, with each of their functions clearly stated. The database was structured in two parts, one for users to enter new lessons learned and the other for storing and retrieving cleaned-up lessons. MS Access was implemented for data storage and retrieval and MS FrontPage was used to accept lessons learned input from users. The database also had provisions to search for specific terms within the database fields to yield specific results that would be helpful for design teams during a constructability review. However, this effort did not fulfill its intended purpose as the lessons learned database became defunct once its 2,000-row limit was reached. The main failure to ensure proper functioning of this database was caused by not mitigating the risk of running out of space beyond the permissible 2,000-row limit.

Fong and Yip (2006) assessed the level of readiness of construction professionals in Hong Kong to implement lessons learned systems within their organizations. One of their key research findings was that construction personnel preferred not to record lessons learned while the project was ongoing, which could lead to the loss of important knowledge.

More recently, other transportation organizations and DOTs also have developed knowledge repositories in the form of databases. For example, the Kentucky Transportation Cabinet funded a study to develop a constructability lessons learned tool for use during the design phase to improve project outcomes (Stamatiadis, Goodrum, Shocklee, Sturgill, & Wang, 2013). Also, the Federal Highway Administration (FHWA) has compiled a list of lessons learned from various transportation-related projects from DOTs throughout the United States (FHWA, 2018). This database is open access for the public and contains lessons learned in text format from various projects as well as project phases. The USDOT has a lessons learned database for its Intelligent Transportation Systems (ITS) called ITS Lessons Learned Knowledge Resource (LLKR) (ITS Joint Program Office, 2020). The LLKR database captures knowledge from users who are involved in planning, deployment, operations, maintenance, and evaluation of ITS throughout the United States. This database is heavily reliant on gathering information from other related databases, such as ITS case studies, the ITS Electronic Document Library, the Transportation Research Board (TRB) Transportation Research Information Services, international transportation literature databases, and TRB conference proceedings. The LLKR is open access to the public and can be searched for lessons learned using keywords or by filtering based on location and/or categories.

The Colorado DOT (CDOT) created a program called Lean Ideas Everyday to encourage users to upload innovative suggestions and adopted practices to improve existing methodologies by clicking on 'I fixed It!' and 'I Suggest!' respectively. Although this database accepts information

entry by authorized personnel only, the public has open access to Idea Cards that provide details about a few select innovations and how their use has helped the CDOT to improve its workflow processes. The Lean Ideas Everyday database was developed primarily using Google products, such as Google sheets and slides (CDOT, 2018).

## **2.2. Lessons Learned from Previous Lessons Learned Database Designs**

Goodrum et al. (2003) devised a list of suggestions for successfully designing and implementing a lessons learned database, as follows.

1. Lessons learned systems require a champion. A champion should be assigned to promote and manage the system. The champion should be experienced and capable of dedicating resources when needed. Other characteristics of a champion include that he/she:
  - a) Is knowledgeable about organizational work processes.
  - b) Is visible at the management level of the training and orientation of the lessons learned system.
  - c) Can establish accountability and authority.
  - d) Has exceptional people and communication skills.
  - e) Is respected in the organization for fairness and impartiality.
2. A submitter's input into a lessons learned system must be recognized. Recognition needs to be given to the submitter in the form of either a letter or email within ten days of receipt of a lesson learned.
3. Lessons learned systems should not be used to criticize mistakes.
4. Lessons learned systems should be designed for simplicity.
5. The most significant factors for the success of lessons learned systems are:
  - a) Quantity of the stored lessons learned.
  - b) Quality of the stored lessons learned.
  - c) Diversity of the lessons learned.
  - d) Availability of resources that are required to maintain and update the system.
6. The most common deficiencies of lessons learned systems include that they are:
  - a) Too expensive to maintain.
  - b) Too complex to be used effectively.
  - c) The skills required are beyond that available within the organization to operate and maintain.

Most of the above points were validated by a research survey conducted by Knoco, Ltd. (Knoco, 2009) whose aim was to ascertain the degree of usefulness of existing lessons learned systems within organizations. Knoco, Ltd. prepared an online questionnaire and received 74 responses from organizations that represented a wide range of functionalities. The respondents reported success factors and barriers to implementing an ideal lessons learned database, and the responses seemed to concur with the points in Goodrum et al.'s (2003) list of suggestions. The barriers were classified into the following categories: senior management, culture within the organization, lack of follow-through and application, time issues, and other barriers. Figure 2 presents the results of the survey conducted by Knoco, Ltd. where respondents were asked to indicate whether or not they implemented certain components in their lessons learned database. Few respondents stated that they rewarded/incentivized submission of lessons learned. Encouragement from senior management in the form of nominal awards can encourage people to

enter lessons learned in a positive manner and thus aid in achieving a more effective lessons learned database.

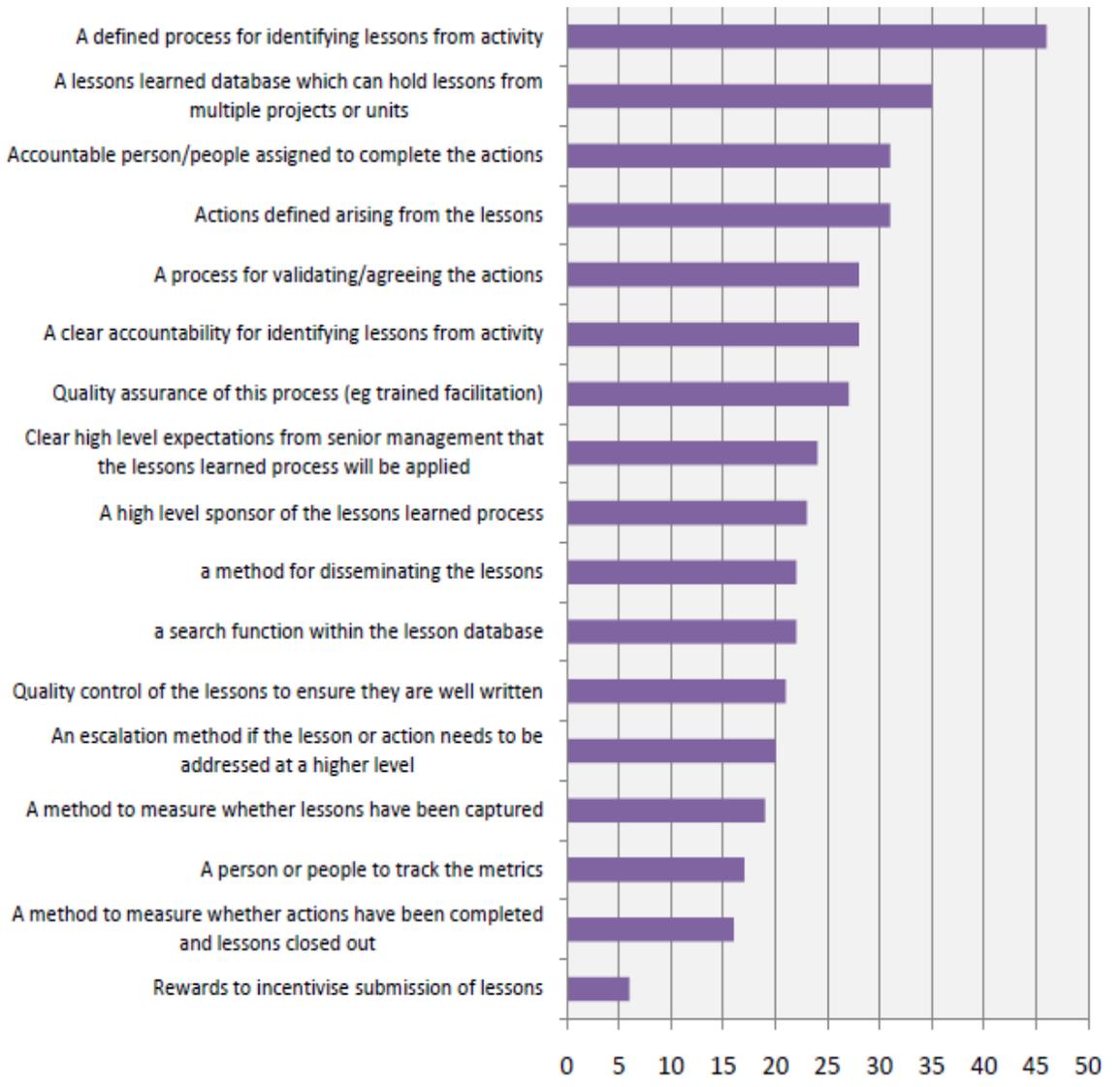


Figure 2. Preferred lessons learned components (Knoco, 2009).

### 3. METHODOLOGY

#### 3.1. Introduction

The initial background study that was performed by the NCDOT’s Value Management Office in 2014 identified the need for a formal medium to communicate information about projects within the NCDOT. The results indicated the lack of a medium to store knowledge that was gained on project sites and led to the PCAP in 2017, which in turn led to NCSU researchers being contracted to help develop a new lessons learned database for the NCDOT. During the ongoing

research efforts, the PCAP was renamed CLEAR in 2018 because the CLEAR database was intended to make sure the content was captured from all project phases and not just the post-construction period as initially envisioned. The NCSU research team consulted the literature that focused on earlier lessons learned databases to ensure that CLEAR was user-friendly in order to ensure its longevity. The research team took precautions to avoid the snags that had been experienced in earlier research efforts. To this end, the NCSU researchers employed a Design for Six Sigma (DFSS) approach to design and create the new and robust lessons learned database. The five stages of the DFSS methodology, i.e., identify, define, develop, optimize, and verify (IDDOV), form the basis of the final research outcomes (Banerjee, Jaselskis, & Alsharif, 2020).

### 3.2. Design for Six Sigma (DFSS)

The DFSS methodology is a systematic and disciplined problem prevention approach that is widely used to design robust engineering systems. Many models in addition to the IDDOV model utilize DFSS for generic technology development, such as I<sup>2</sup>DOV (invent, innovate, develop, optimize, verify), CDOV (concept, design, optimize, verify), and DMADV (define, measure, analyze, design and verify), to name a few. Although these models have their own benefits and drawbacks, the NCSU research team decided to utilize the concepts of the closed-loop IDDOV model that starts and ends with the customers. The research team first explored various other models and then selected the IDDOV model, which appeared to be the most suitable of the various DFSS options, to design and build an error-free robust lessons learned database. Figure 3 shows pictorially the five steps of the IDDOV model as applied to the CLEAR database. The following subsections provide brief descriptions of the five components of the selected DFSS IDDOV model.

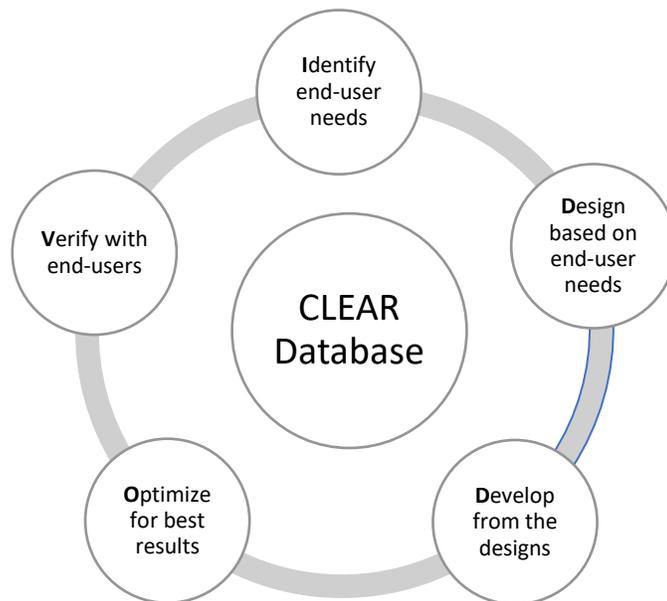


Figure 3. Design for Six Sigma model approach applied to CLEAR database.

#### **Identify end-user requirements.**

The first phase of the development of the CLEAR database involved gathering end-user needs

from NCDOT personnel and understanding the features that they envisaged as being incorporated into an ideal lessons learned database. The focus was to learn the current practices of sharing lessons learned and to obtain detailed information about the end-users' needs. For this purpose, the NCSU research team created an interview guide to obtain responses regarding current needs. The questions were classified into three categories: basic respondent information, current practices, and database requirements. Appendix A presents this interview guide.

#### **Design the database based on end-user needs.**

The NCSU research team performed simple qualitative analysis of the respondents' inputs, including frequently recurring trends/keywords and content analysis, to extract the most relevant information. In addition, the team prepared a risk sheet that listed possible caveats that the end-users anticipated for the CLEAR database. Based on these inputs, the research team devised three initial segments of user input for the lessons learned database: (1) a description of existing conditions, (2) lessons learned or best management practice, and (3) project information. Appendix B presents these database fields that are based on the preliminary inputs received from the respondents.

#### **Develop the database from designs.**

The final database designs were submitted to the NC DIT for database development. The CLEAR database is housed within the Connect NCDOT portal and uses SharePoint to display the lessons learned entry form and uses MS Access database as its backend. The Connect NCDOT portal covers a wide array of products used by NCDOT personnel for their daily work and hence was the natural choice to host the lessons learned database.

#### **Optimize the database for best results.**

The Value Management Office identified a select group of experts within each applicable discipline based on their NCDOT experience as well as their knowledge about addressing issues within these disciplines. These experts, also known as taskforce members, were trained both in person and via video calls to use the CLEAR database. Their feedback, including whether they felt that any features were missing and hindered the ability to record lessons learned, served both to validate the database design and development and to glean their opinions. With regard to space constraints within the database, the lessons learned should be able to be archived in an ever-expanding repository for the future. Such data would pertain primarily to obsolete technologies, implemented organizational changes, or other suitable subjects determined by the taskforce.

#### **Verify with end-users for completeness.**

The final phase of the IDDOV cycle is the end-users testing the database and informing the research team about any possible modifications or additions that are needed. The Value Management Office conducted a risk assessment study of the CLEAR program to determine any potential risks and appropriate mitigation measures. The CLEAR lessons learned/best practices database was rolled out first as a pilot program to a select group of NCDOT units and divisions before expanding its reach to the entire organization in March 2020. The Value Management Office will be the gatekeeper of this database and is responsible for ensuring the completeness and quality of submitted lessons learned/best practices and for the final uploading of these lessons learned into the database.

## 4. FINDINGS

The following section provides insights into the findings obtained using the IDDOV approach mentioned above. Each subsection within this heading pertains to how the IDDOV stages tie-in with the CLEAR program and the findings at each of these five stages.

### 4.1. Identifying Trends and Database Fields

The NCDOT Value Management Office provided contact information for potential interview respondents to the NCSU research team. The research team then sent interview requests to 66 potential respondents at the NCDOT. During this phase of information gathering, 32 interviews were conducted with 46 personnel who had a total of 813 years of work experience. Figures 4 and 5 present details regarding the interview process by project phase and personnel designation, respectively. The interviews were conducted both in person and by phone with personnel from multiple project phases, such as preconstruction, design (e.g., safety and structures), construction, and maintenance. NCDOT personnel in areas of materials, design-build, and facilities management also were interviewed. In addition to being in various project phases and areas, the respondents belonged to multiple levels of work, starting as high as the state-level engineer to assistant resident engineers. This variety of the NCDOT workforce afforded the research team opportunities to explore diverse perspectives from within the NCDOT. Overall, this interview process helped the research team to obtain in-depth feedback about extant processes of information exchange and to determine the fields to include in the new lessons learned database.

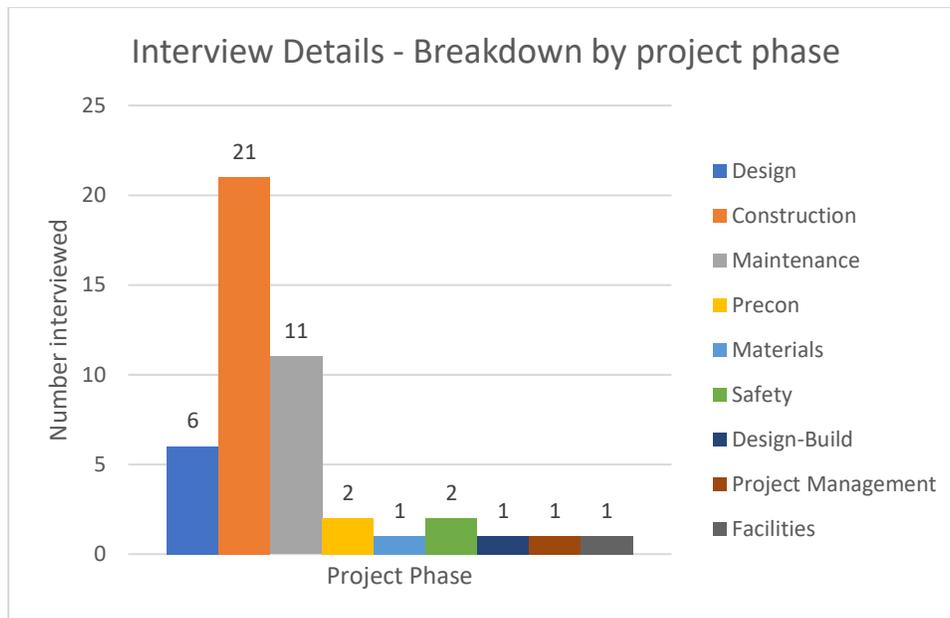


Figure 4. Interview details by project phase.

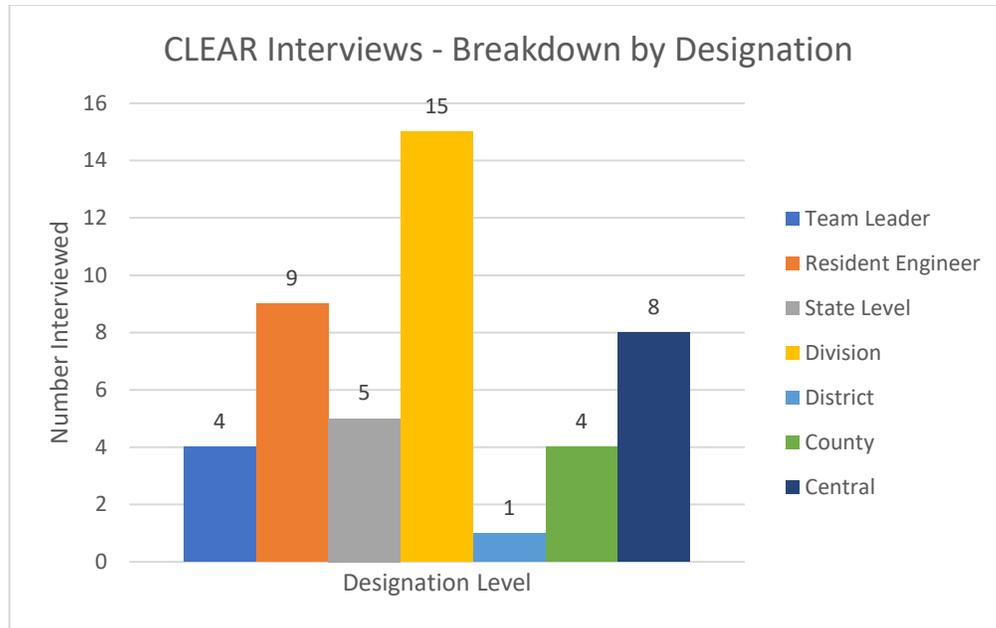


Figure 5. Respondent details by personnel designation.

The NCSU research team carefully documented the inputs from these interviews so not to miss any important piece of information. For each interview, the research team prepared at least two sets of notes and entered the information into a MS Word file for each interview, whether obtained in person or by phone. Following each interview, the notes from all the research team members were combined to prepare a comprehensive list of responses. By the end of this phase, the research team had gained a good sense of current organizational practices to communicate lessons learned within the NCDOT and determined the proper direction to proceed with designing the lessons learned database fields. Based on the interview responses, the research team considered the following points for designing the database.

#### 4.1.1. Database Design Considerations

- Software
  - Microsoft Access is well known but respondents had concerns that it might not function very well as the size of the database increases.
  - The database needs the capability to populate fields using data from other sources (to mitigate the double entry of data).
- Structure

In general, respondents liked the fields in the preliminary database, e.g., description of existing conditions, lessons learned/best practice, reference, project name, project number, contract number, project size, etc. Suggestions for improvements included:

- Add an impact or severity rating for each lessons learned/best practice.
- Identify the beneficiary(ies) of the lessons learned/best practice.
- Use keywords found in *Roadway Standard Drawings, Specifications, and Special Provisions*, e.g., earthworks, pipe culverts, contract time, liquidated damages, etc.

- Design a short version rather than detailed descriptions because users will know where to go for more information.
- Include links to standard NCDOT documents, e.g., specifications, design details, contract documents, claims, and supplemental agreements, to make it easier for users to find this information.
- Provide the name of the unit as contact information for additional inquiries rather than the name of a contact person.
- Provide photos or links to photos.
- Data Entry
  - For larger and longer duration projects, enter lessons learned during the construction phase. For smaller projects, lessons learned can be assessed at the end of the project.
  - Try to make the amount of time for data entry less than five minutes, as entering data should not be a large time commitment.
  - Avoid having to enter the same data twice.
  - Use drop-down menus as much as possible to reduce the amount of manual data entry.
  - Populate certain fields automatically from other sources, e.g., the Highway Construction and Materials System (HiCAMS), where possible.
  - Start by entering the more impactful lessons learned, e.g., ones that resulted in claims and supplemental agreements.
- Search Capability
  - Provide a keyword search capability that is similar to Google searches. The current NCDOT search capability could be improved.

#### **4.1.2. General Observations**

- The current approach to sharing lessons learned/best practices from one project to another is informal (word of mouth).
- Groups tend to be in silos in that they do not communicate with those outside their division.
- The NCDOT has experienced significant turnover in all departments. A new database could help serve as a training resource for new staff.
- Better project coordination is needed. Maintenance should apprise the design team of problems faced so that such issues can be addressed during the design phase.

## 4.2. Database Design

The initial version of the developed database had a single lessons learned/best practices form that was based on inputs gathered during the first phase and was divided into three segments (see Appendix B). The first segment recorded basic user information such as name and division and office information including email and telephone number. This information was not intended to be displayed while showing the lesson learned in appropriate search results, but was only for the gatekeeper (defined in Section 5.2.1) to be able to contact the end-user in case any missing/additional information was needed. The second segment input information about the issue and solution that were entered. Users could include attachments such as pictures, PDFs, revised contract language, and other relevant files to make it contextually easy to understand. The third segment recorded project information that pertained to the lesson learned or best practice. A few fields in this segment were intended to be populated from other internally linked databases to expedite data entry and encourage participation. However, based on Value Management Office's input and other studies such as the Risk Assessment study (described later in section 4.5), this initial common form for lessons learned/best practices formed the basis for the now existing three forms for lessons learned, best practices, and solutions needed.

### 4.2.1. Principal Stakeholders

The principal stakeholders involved with the CLEAR database are as follows:

*End-users:* End-users are NCDOT personnel who are responsible for entering useful lessons learned and best practices based on knowledge gained at project sites. They also are responsible for searching for relevant knowledge to understand previous circumstances in order to avoid repetition of problems.

*Gatekeeper:* The Value Management Office at the NCDOT serves as the gatekeeper for CLEAR and is responsible for checking for completeness of the submissions, forwarding the submissions to taskforce members, and subsequently approving the submissions after receiving the go-ahead from taskforce members.

*Taskforce:* The taskforce is composed of experts within various disciplines who are responsible for ensuring the quality of the content that is uploaded to the database. Based on its review of each submission, the taskforce will inform the gatekeeper of its decision to accept or reject the submission. Note that, whereas the taskforce consists of experts who cover all disciplines of work, the ERP is selected by the gatekeeper from this pool of experts as those who can offer the most relevance and expertise for submission.

*Innovation Coordinators:* These coordinators are highly motivated in encouraging their units or offices to participate in the CLEAR program, thereby supporting innovation.

*Technical Advisory Group (TAG):* The TAG is composed of taskforce/ERP members who focus on specific topics or areas and collectively review lessons learned/best practices submissions through the NCDOT and establish goals for solutions.

*Technical Coordination Committee (TCC):* The TCC is composed of upper management, multi-disciplinary and multi-modal representatives, and external partners who provide guidance and review from a high-level/industry perspective.



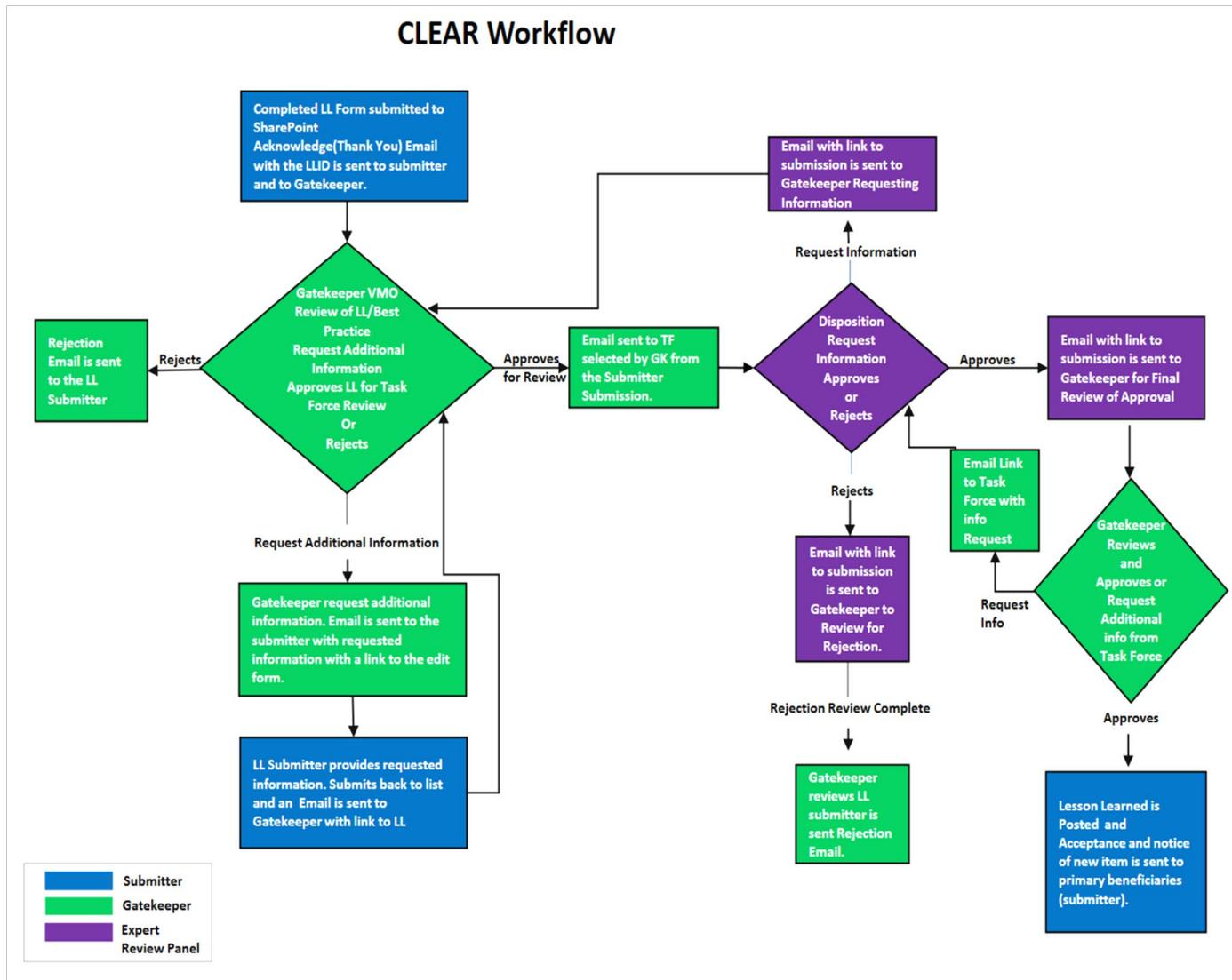


Figure 7. CLEAR workflow process.

### **4.3. Database Development and Respondent Feedback**

In the initial effort, the NCSU research team gathered 42 lessons learned and best practices from 19 end-users and from two pilot projects. The research team contacted NCDOT personnel who had participated during the data gathering phase to build the lessons learned repository. The 19 respondents provided their lessons learned/best practices over the telephone. In addition to gathering these telephone data, the research team also visited two pilot projects and gathered lessons learned and best practices by observing the project sites and talking with site personnel. The two pilot projects were the East-end Connector project in Durham, NC and Pitt County's Resident Engineers office in Division 2. The effort to solicit as many high-quality lessons learned as possible from end-users, such as site engineers, inspectors, resident engineers, and other project personnel, is ongoing whereby users can enter information in the CLEAR database within the Connect portal.

#### **4.3.1. General Comments Based on Project Phase**

A few general trends emerged based on project phase, risks associated with a new system, and user incentives extracted from the lessons learned and data gathering phase, as follows.

- **Preconstruction**
  - Planning
    - Changes that take place after design completion and are due to scope creep indicate missing initial goals and give the perception that “you did not deliver”.
  - Design
    - Drainage
      - Design culverts with above-grade fill that is more than 4 feet (otherwise a thicker top slab is required/grade must be raised).
    - Structures
      - Provide additional clearance to the top set of deck reinforcing bars on heavily skewed bridges to add ‘a little more play’ with the screed (add half-inch additional clearance).
    - Erosion Control
      - Because the design and field conditions frequently differ (more so on smaller projects), hold more face-to-face meetings and encourage field visits by designers to discuss solutions.
    - Other
      - Provide feedback to designers about how new products perform in the field.
  - Project Management
    - Improve utility (sewer, water, gas, power, communication) relocation process with third-party owners, which is a “constant battle we deal with on every project.”
    - Address right-of-way issues prior to construction (timing of access and size of right-of-way).

- Provide project management training to designers who are given project management responsibilities.
- **Construction**
  - Drainage/Erosion Control
    - Ensure that inspectors are properly performing their duties, especially with regard to washed-out shoulders and ditches (which perhaps were washed away because they were not compacted properly).
    - Allow grass and other vegetation to mature to prevent erosion.
  - Structure
    - Request that NCDOT personnel review current standards and specs to see if NCDOT personnel can be more flexible with contractors, especially with regard to bridge deck pours where contractors prefer to pour more at the same time and the NCDOT wants them to pour less.
  - Paving
    - Address any foreign material found in asphalt (e.g., mud flaps).
    - Provide a better way to predict actual quantities that are needed because, e.g., for bridge rehabilitation projects, often the actual quantities are greater than those specified in the design.
  - Other
    - Request inspectors to provide more detail when writing their diaries.
    - Invite the maintenance engineer to assist with the punch list.
    - Resolve issues found during construction so they do not become a maintenance problem.
- **Post Construction**
  - Erosion
    - Consider extending the shoulder berm gutter to address bridge water runoff issues that lead to excessive slope bank erosion.
  - Structures
    - Address cracking in pre-stressed continuous for live load bent diaphragm-girders.
  - Pavement/Subgrade
    - Require resurfacing when subgrade quality is poor.
  - Other
    - Improve continuous quality improvement (CQI) rating approach because:
      - It is subjective (e.g., what is the difference between a 4 and 5 rating?)
      - Resident engineers might be inclined to rate an item above a 6 just to avoid spending time writing a detailed report.
      - Some resident engineers have not completed a CQI assessment for projects before.
      - A binary rating might be better (needs fixing or not).
- **Others**
  - Consultants
    - Require (or consider requiring) consultants to follow an updated checklist (e.g., roadway checklist), because the NCDOT is still having issues with the quality of the work performed by some private consulting firms.

- Address the current problem of not enough consultants to deliver the amount of work required by the NCDOT (“lag in what the industry can provide”).
- Standardization
  - Provide a standard for divisions to follow, because currently each division is managing projects in its own way.
  - Provide a manual (or playbook) for Project Development to follow or a place to go to for answers to questions.
- Knowledge Management
  - Provide training. Transferring knowledge from one project to another is important. Webinars are a good place to disseminate best practices. Having a lessons learned database is a good idea.
  - Find a better way to track the root cause of problems. The HiCAMS User Manual is good for materials data but not for integrating other data (e.g., from diaries, weather, etc.)
  - Improve communication by “going electronic” (using SharePoint) instead of relying on manual approaches.
  - Alleviate redundant work; e.g., currently, both iPad and HiCAMS data are required to be entered.
  - Provide a mechanism for passing information from construction to design teams to rectify errors.

#### **4.3.2. Risks Associated with Database Creation**

- Legal issues
  - Avoid potential increase in liability to the NCDOT for problems (identified by lessons learned) that are not corrected in a timely manner.
  - Be mindful of the types of records that can be made public (as some might be deemed sensitive).
- Willingness to participate
  - Consider that some personnel might not be willing to spend time documenting lessons learned and best practices for their projects.
  - Consider that some personnel might be more likely to provide best practices as opposed to potentially embarrassing lessons learned.
- Technical
  - Address slow performance issues; e.g., Excel files ~10 MB tend to hang up for pay items.
- Quality of lessons learned
  - Heads of units should review each lesson learned to validate its suitability and worthiness for incorporation into the database.
- Avoid creating another software maintenance requirement where additional time is needed to follow up with any software problem, which is typical with new programs.

### **4.3.3. Participation Incentives**

- Obtain upper management support/buy-in and encourage others in the organization to use the database.
- Make the entering/submission of lessons learned and best practices part of employees' annual performance reviews.
- Consider focusing initially on lessons learned/best practices that are related to claims and supplemental agreements. Consider including specific questions related to lessons learned and best practices within the HiCAMS manual.

## **4.4. Optimize for Best Results**

CLEAR is envisioned to be “a program to support internal communication, knowledge sharing, creativity, and innovation” (Fullerton, 2020). The success of this program hinges on the end-users' willingness to embrace and enter useful knowledge into the database in the form of lessons learned, best practices, or solutions needed. In order to achieve this goal, the NCSU research team devised a strategy to promote the use of the CLEAR program among NCDOT personnel. This strategy was aimed to develop the best possible ways to encourage participation by incorporating user preferences and possible incentives. With this strategy in mind, The NCSU team developed a survey that was sent out to NCDOT employees. The survey and its results are discussed in the following subsections.

### **4.4.1. Methodology: The CLEAR Program Survey**

When designing this survey, the NCSU research team gave priority to minimizing the time needed to complete it. The team created the survey online using Qualtrics and sent a link to NCDOT employees through the Value Management Office. The survey started with an introduction that provided a brief description of the CLEAR program and the goal of the survey, followed by instructions, a confidentiality statement, and a consent to participate statement (see Appendix C). The survey consisted of three sections: (A) the respondent's background information, (B), the respondent's preferences for training method, and (C), the respondent's user preferences. These three sections are described in the following paragraphs.

Section A: Respondent's background.

The goal of Section A was to glean a general idea about the respondent in order to link this information to the respondent's preferences later. The NCSU research team discussed the possibility of a multi-faceted strategy where different audiences were targeted by different approaches. Given the high retirement rate at the NCDOT, the research team decided to make the first question of this section about the respondent's age group. Respondents were given five options for a range of birth dates: 1945 and before, 1946 to 1964, 1965 to 1980, 1981 to 1997, and 1998 and after. The second question inquired about the number of years of experience the respondent had with the NCDOT. The third question was about the respondent's current job function. The next three questions were aimed at understanding the respondent's work-hour distribution (jobsite vs. office), type of devices used during work hours (laptop, phones, PCs, etc.), and how much time the respondent has access to the internet during work hours.

#### Section B: Training preferences.

The goal of Section B was to determine the NCDOT employee's preferences for ways to learn about new technologies, applications, and services. In the first question, the respondent was given five options and asked to rate them on a scale from 1 (least favorable) to 5 (most favorable). A write-in option was also given for this question. The options were devised based on a review of common training solutions and were checked with the NCDOT Value Management Office for approval. The next three questions focused on the characteristics of videos that might be used to train employees to use the CLEAR program.

#### Section C: User incentives.

The goal of Section C was to discover possible ways to create incentives and motivations for the employees to contribute knowledge and retrieve lessons learned from the CLEAR database. The first question was: "During work, how often do you face a problem, situation, or opportunity for improvement that you think having previous knowledge about would have helped save time, money, or generally improved the outcome?" Respondents were given five options: (a) daily basis, (b) weekly basis, (c) monthly basis, (d) when starting a new position or job function, and (e) when starting a new project. The goal of this question was to identify possible times when use of the CLEAR program could be mandated or highly recommended. The last question of this section (and the entire survey) was: "*You would most likely provide input and retrieve data and experiences from the knowledge sharing program if....*" This question was open-ended and without options in order to provide space for respondents to suggest possible incentives or identify factors that were important to them and that would impact their utilization of the CLEAR program database.

#### **4.4.2. Results**

The survey was sent out to NCDOT employees through the Value Management Office. Each respondent's anonymity was guaranteed and no identifiers were collected. Answers were recorded between May 25, 2019 and August 21, 2019. The total number of responses was 58. The respondents were given the option to skip questions they did not wish to answer. On average, each question was answered 49 times.

Figure 8 presents the results from the age group question: 46% of respondents were 39 to 54 years old, 28% were in the millennial age group of 22 to 38 years old, and 26% were 55 to 73 years old.

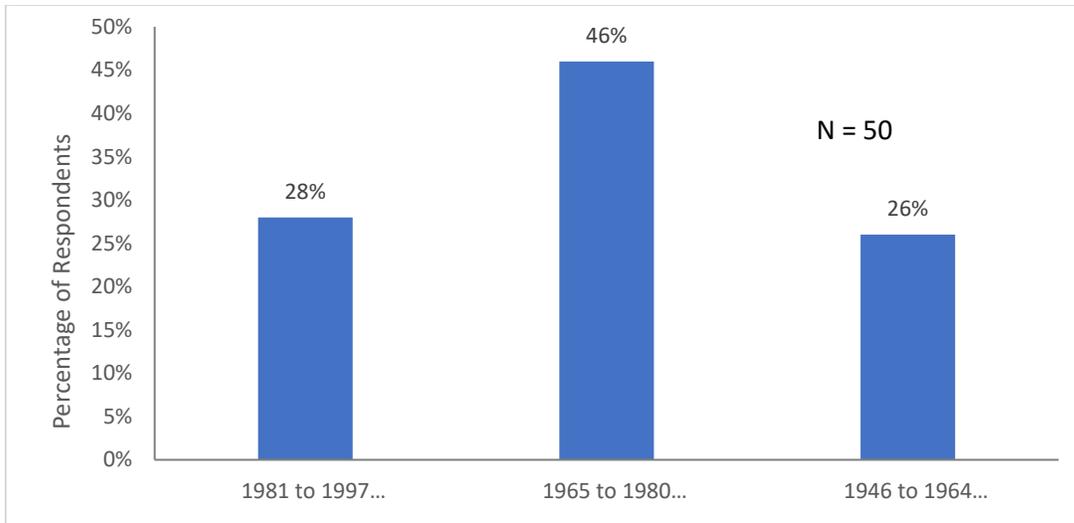


Figure 8. Age group distribution within NCDOT.

In terms of experience, 34.8% had 5 years or less experience with the NCDOT, 13% had 25 years or more experience, and 19.6% had 21 to 25 years of experience. Figure 9 shows all the results.

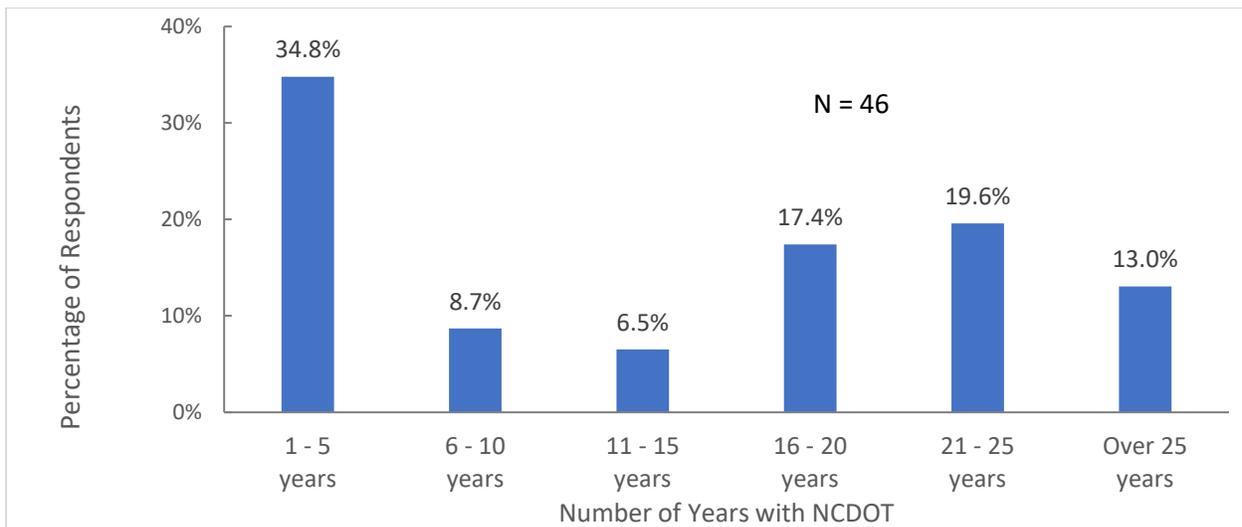


Figure 9. Years of experience with NCDOT.

Figures 10 through 13 show the current job functions, work-hour distribution, types of devices used during work hours, and access to the internet during work hours, respectively.

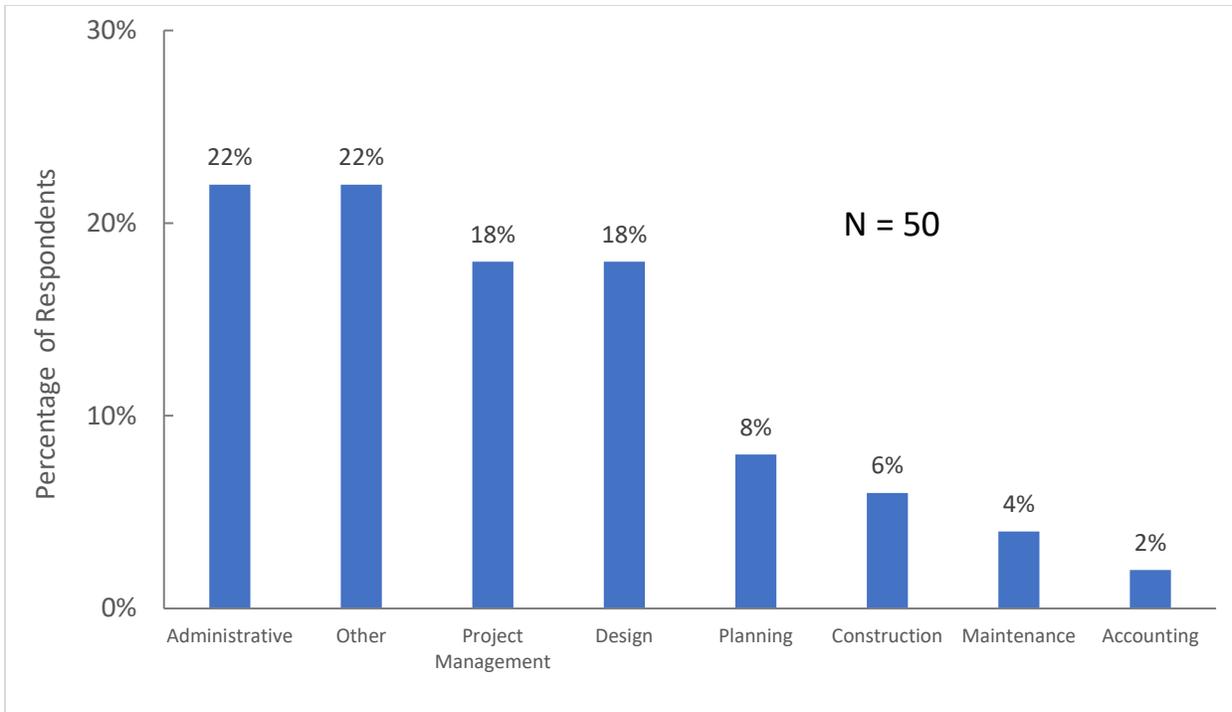


Figure 10. Current job function distribution within NCDOT.

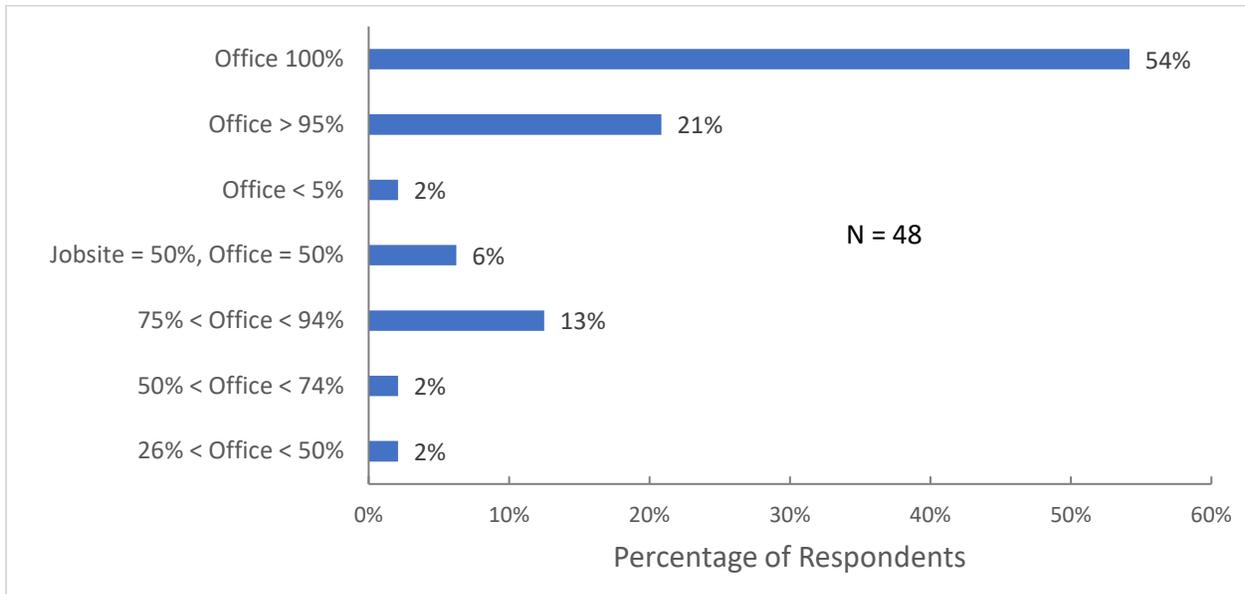


Figure 11. Work-hour distribution within NCDOT: Office vs. job site.

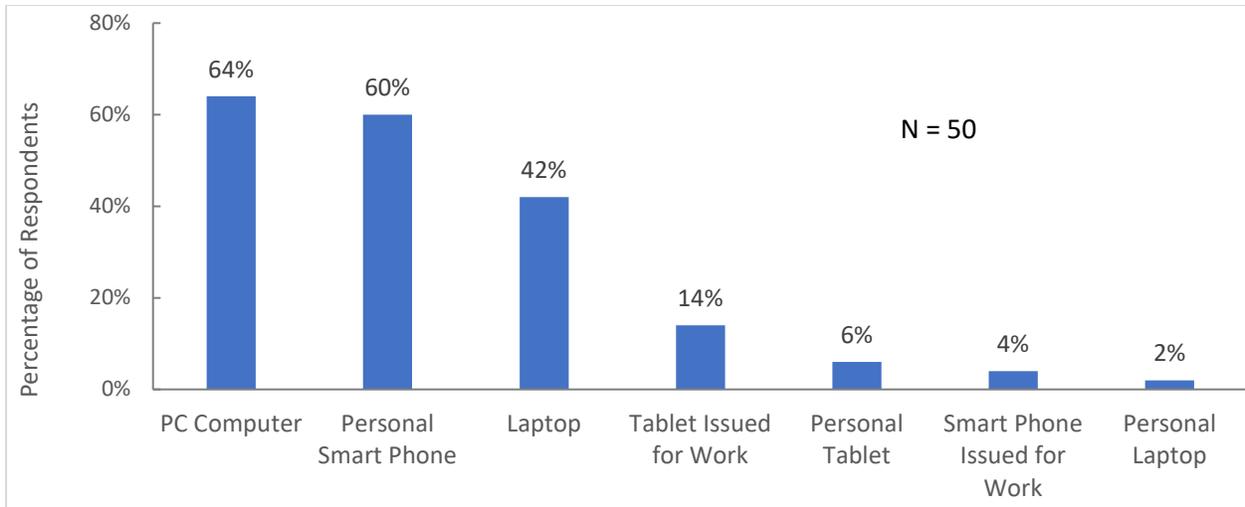


Figure 12. Type of devices used during work hours at NCDOT.

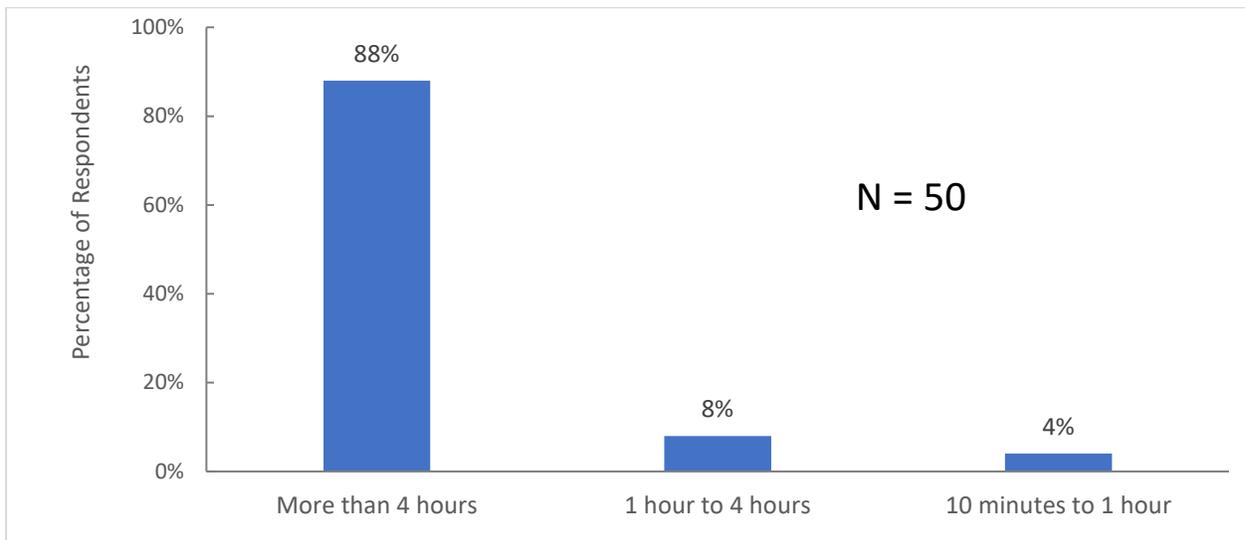


Figure 13. Time of access to the internet during work hours at NCDOT.

In terms of learning preferences, the overall majority of respondents gave high favorability scores to ‘Combination of practical training and online videos’. Figure 14 presents the overall scores. The research team performed further analysis to link the training preferences to age group but no significant correlations could be established. The ‘Combination of practical training and online videos’ and ‘Video or series of videos’ remained the highest scoring options across categories. Figures 15 through 20 show the distribution of scores across the three age groups and three job functions, respectively.

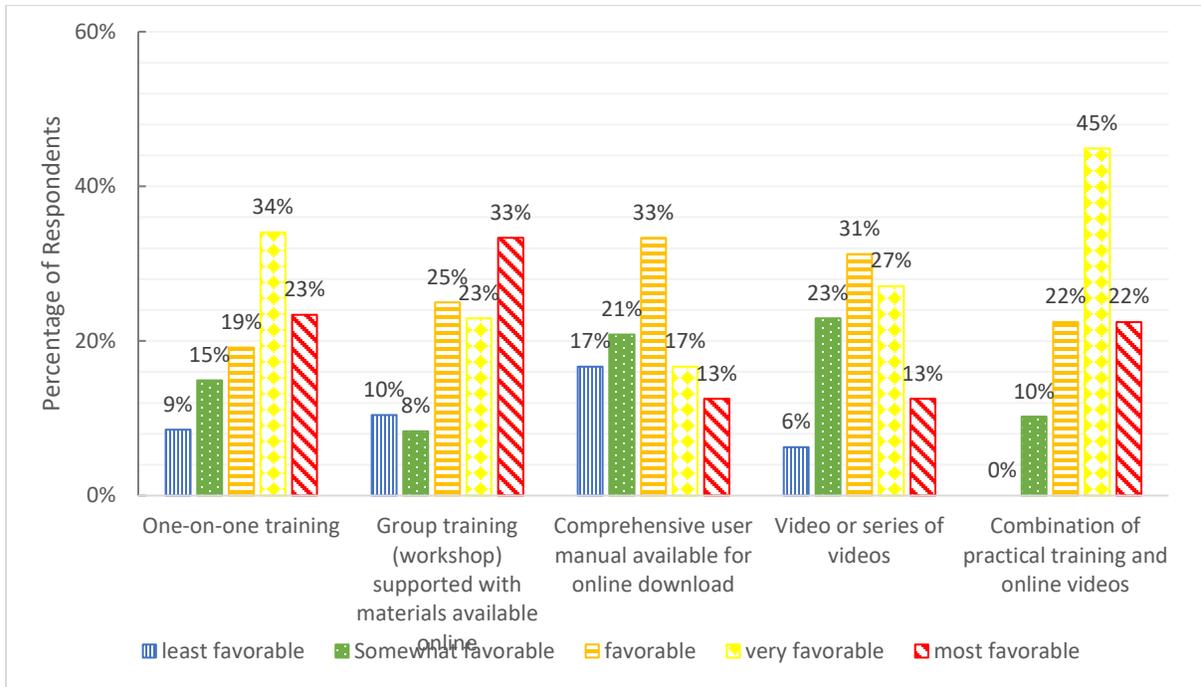


Figure 14. Overall learning preferences of NCDOT employees.

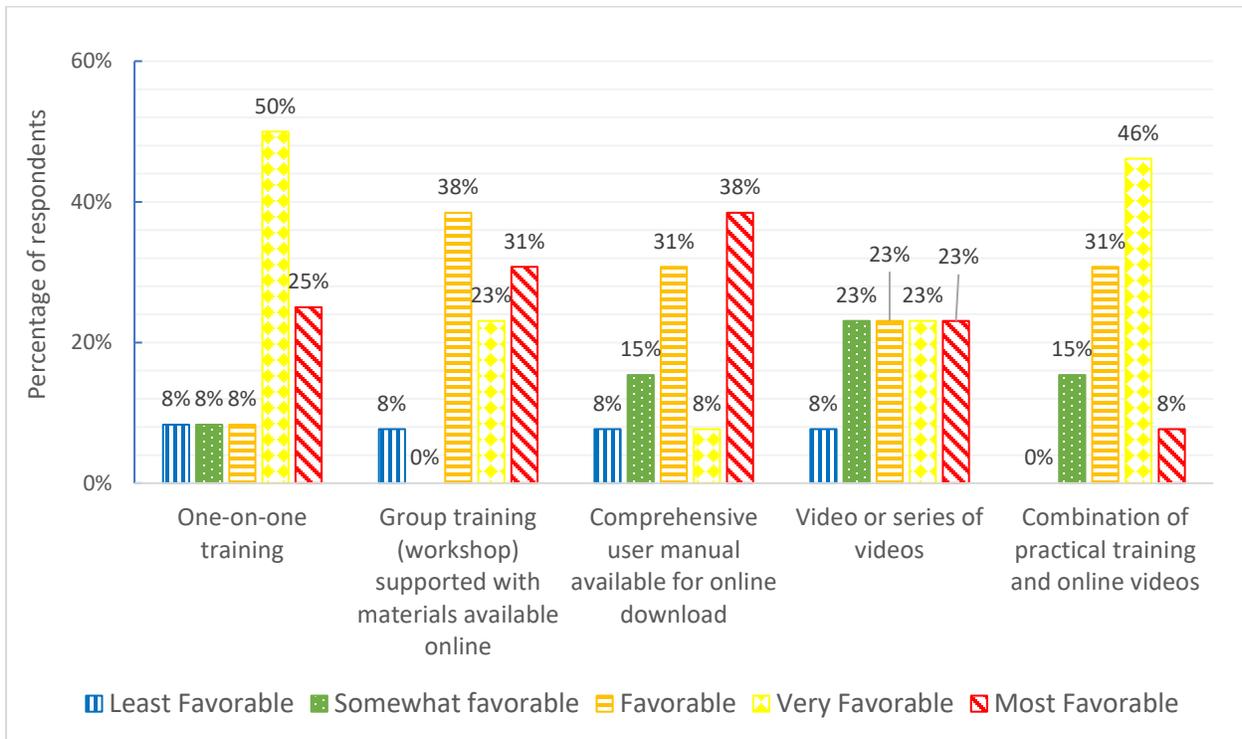


Figure 15. Preferred learning approaches in the 55 to 73 year old age group.

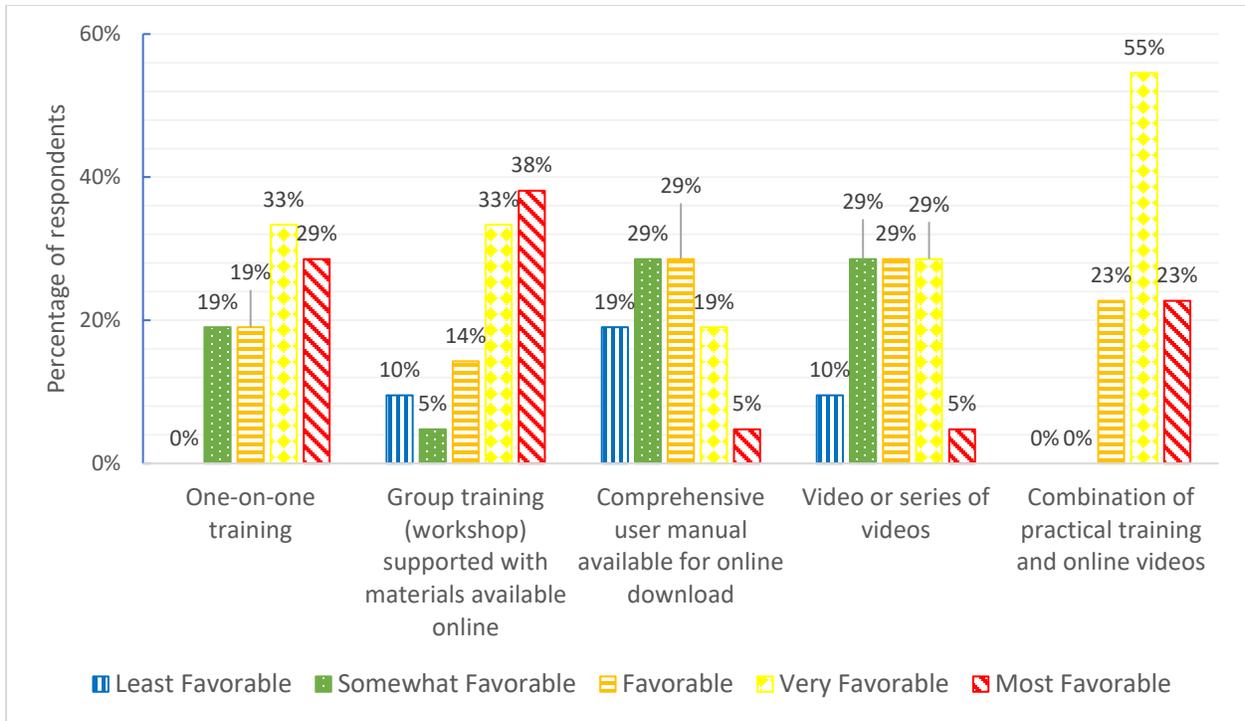


Figure 16. Preferred learning approaches in the 39 to 54 year old age group.

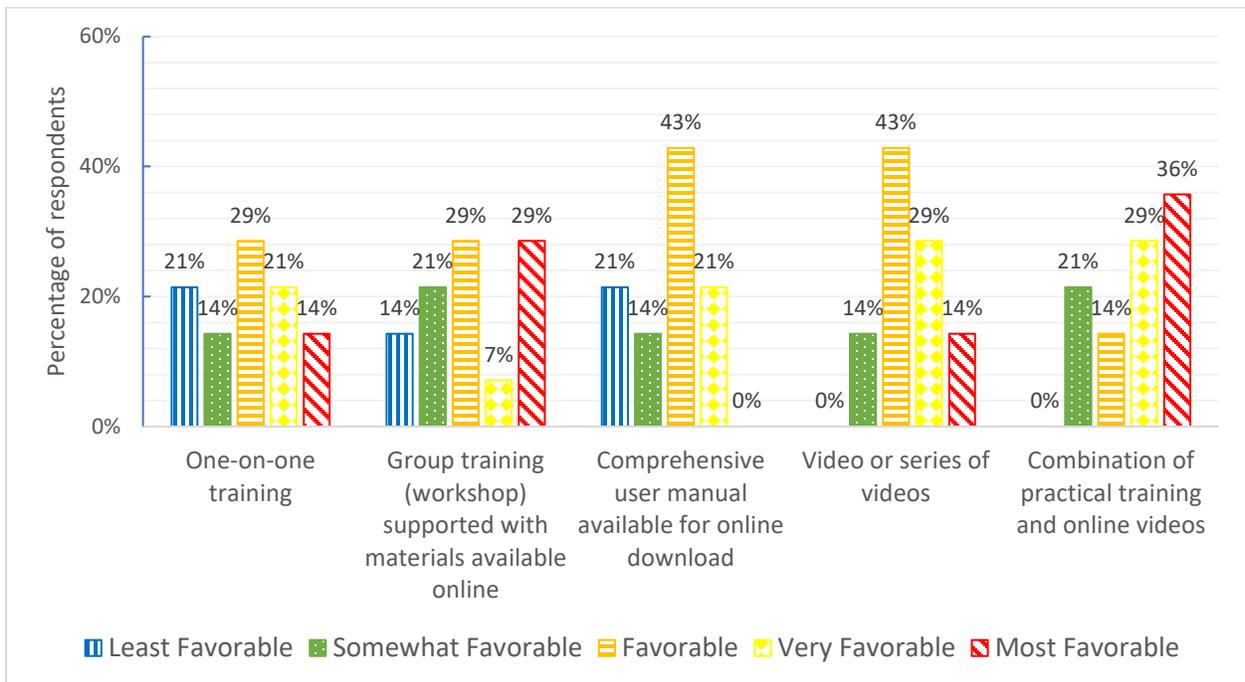


Figure 17. Preferred learning approaches in the 22 to 38 year old age group.

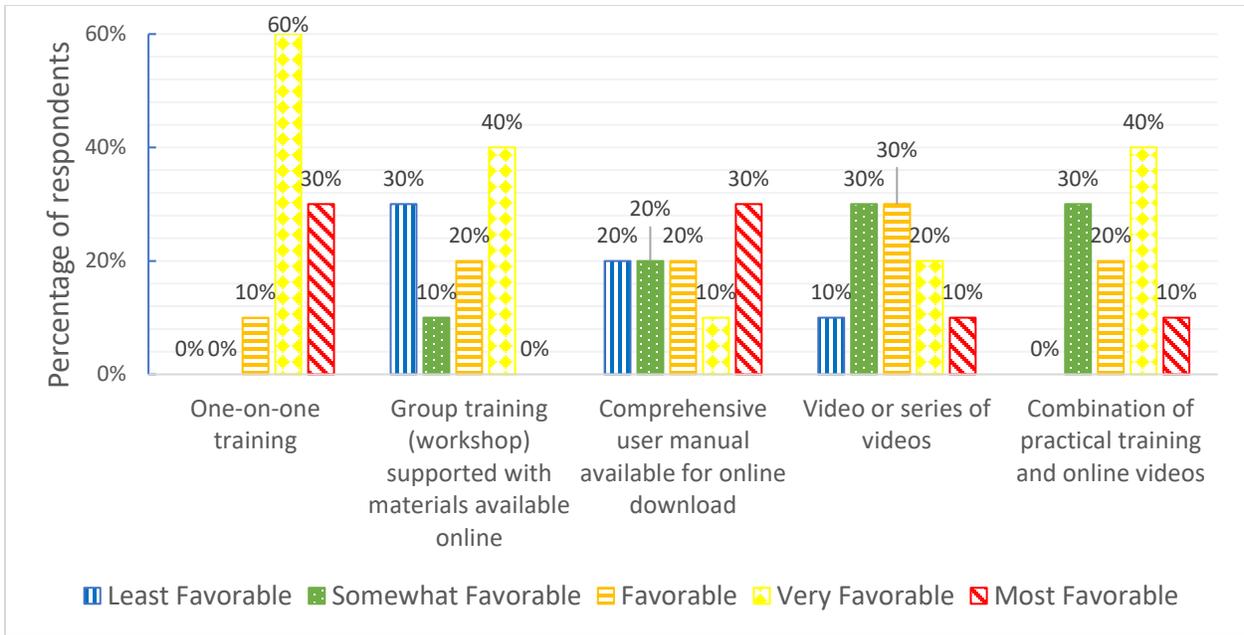


Figure 18. Preferred learning approaches in the administrative job function.

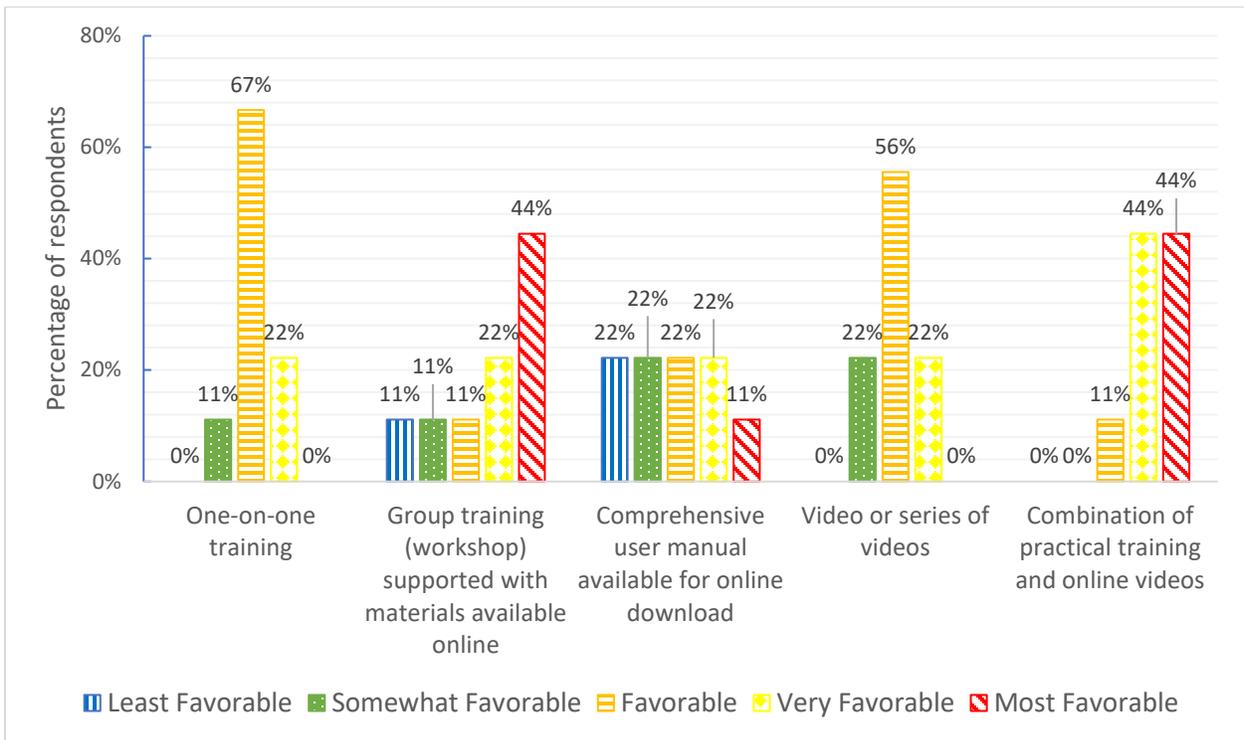


Figure 19. Preferred learning approaches in the project management job function.

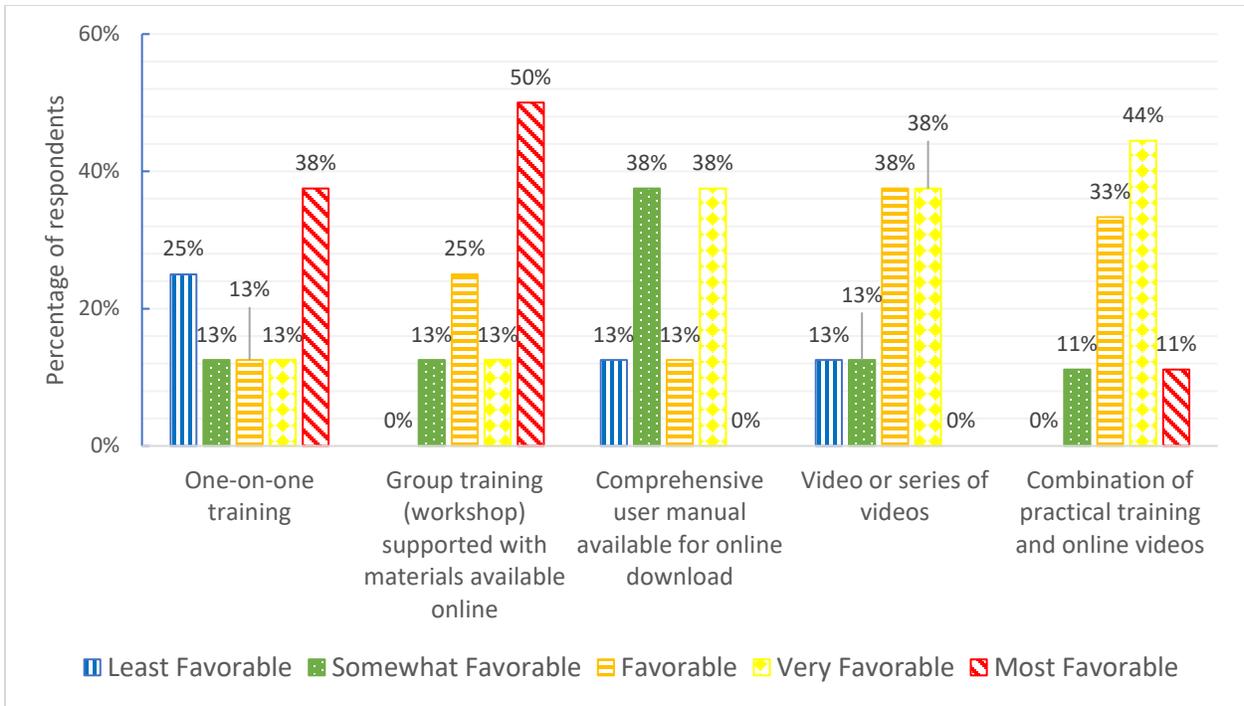


Figure 20. Preferred learning approaches in the design job function.

No clear majority of responses was evident in terms of type of training videos or type of instruction in the videos. Figures 21 and 22 indicate that the percentages were close.

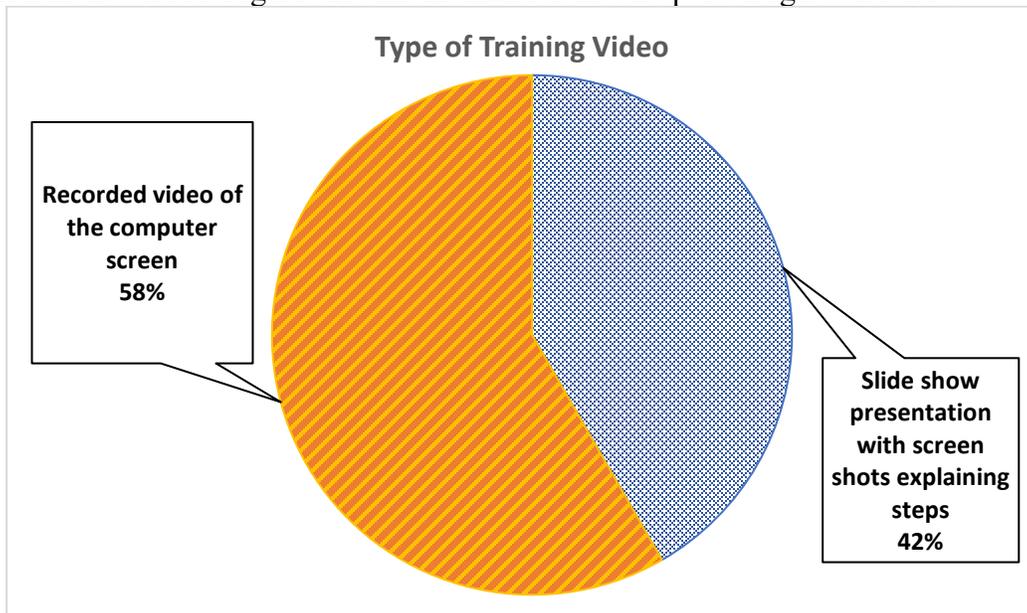


Figure 21. Preferred type of training video.

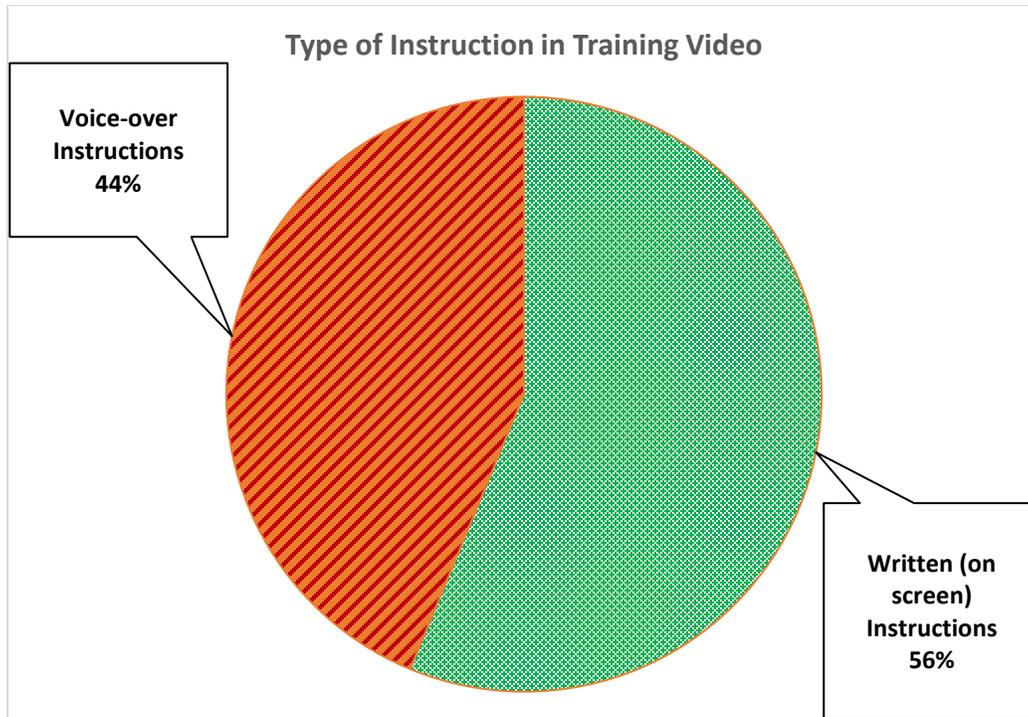


Figure 22. Preferred type of instruction in training video.

Finally, more than 70% of respondents reported that they had faced a problem, situation, or opportunity for improvement that they think having previous knowledge about would have helped save time, money, or generally improved the outcome on a weekly or monthly basis. Figure 23 shows that 29% of respondents reported that they faced such issues at the beginning of a new job function, position, or project. The answers to the last question, ‘You would most likely provide input and retrieve data and experiences from the knowledge sharing program if . . .’ included a variety of factors and suggestions. The research team reviewed and classified these factors into categories, some of which are shown in Figure 24.

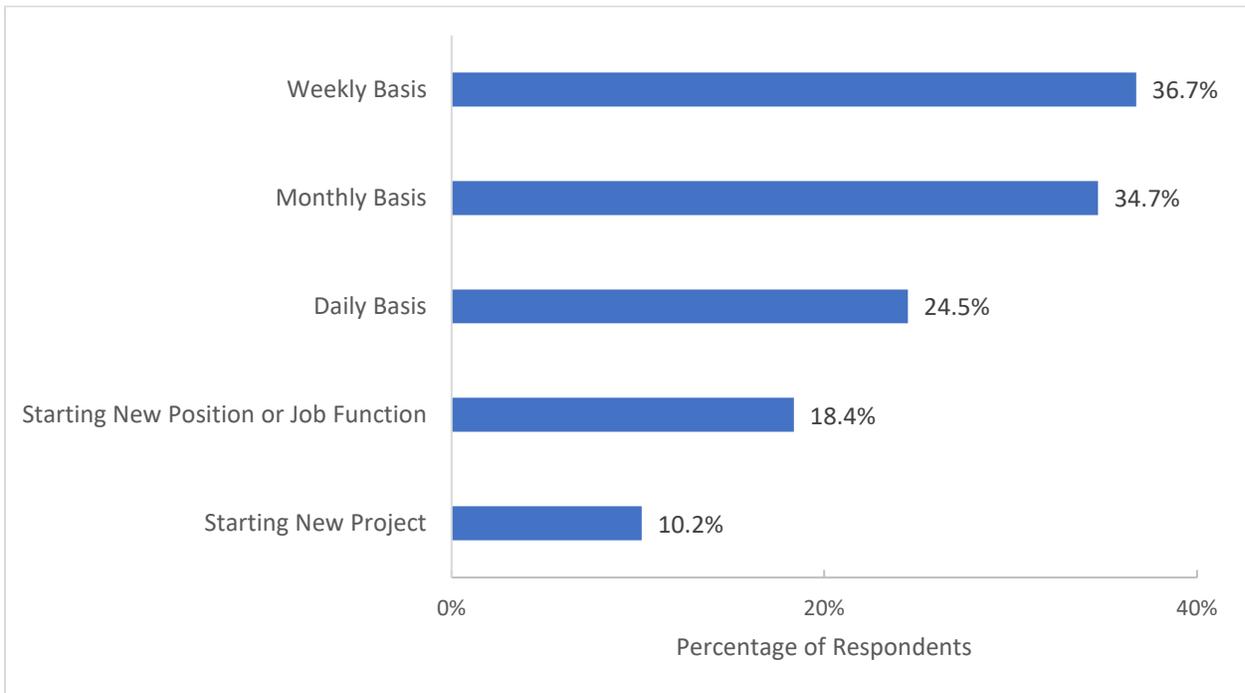


Figure 23. Frequency of encountering issues that CLEAR program database might be able to help address.

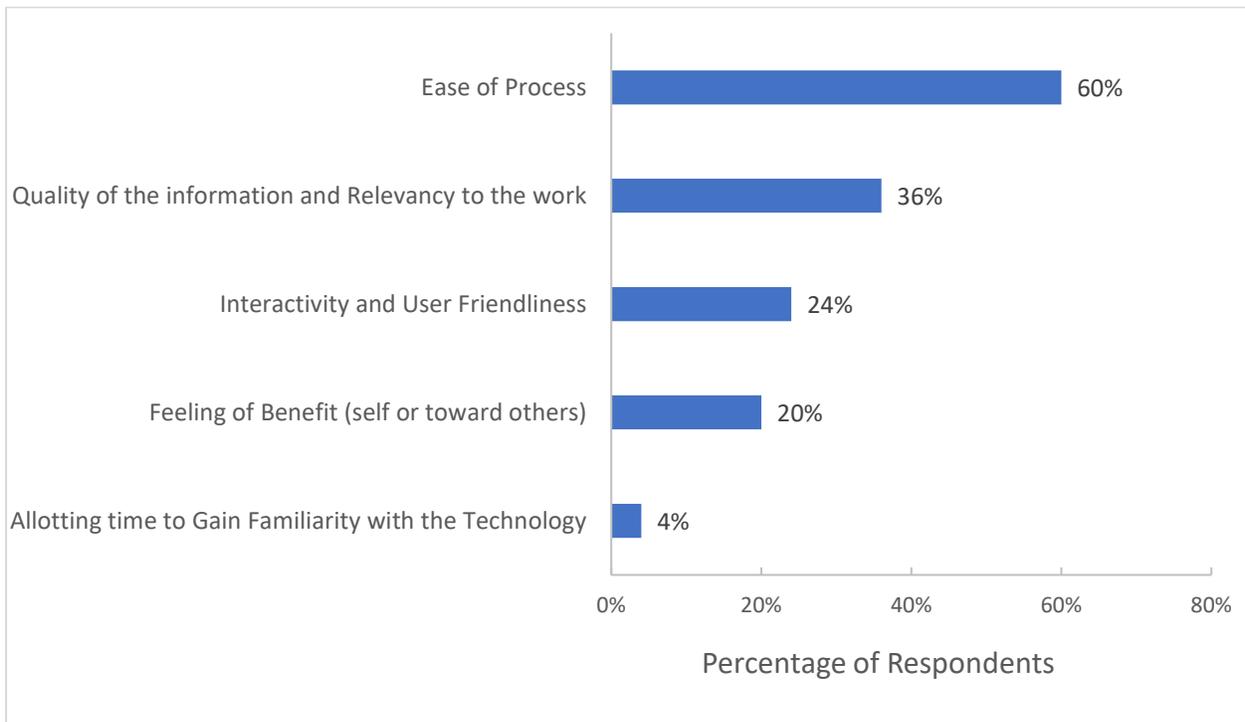


Figure 24. Possible factors that might encourage personnel to use the CLEAR database.

#### **4.4.3. Analysis**

As Figure 2 suggests, the percentage of respondents with less than five years of experience with the NCDOT (34.8%) is comparable to those with more than 20 years of experience (32.6%). In terms of age groups, the percentage of respondents between 55 and 73 years old (26%) who are nearing retirement is close to the percentage of respondents 22 to 38 years old (28%). The CLEAR program, among its other objectives, is designed to facilitate the sharing of knowledge and practical experience between the most and least experienced groups. With regard to training preferences, overall, 'Combination of practical training and supporting videos to be available online' is the most preferred approach for the 22 to 38 and 39 to 54 year old age groups. The 55 to 73 year old age group preferred group training supported by material available online. Based on these results, and given that most of the respondents spent a large portion of their work hours in an office with access to a PC and to the internet, the CLEAR program was recommended to be promoted through a series of videos available online. The series includes an introductory video about the CLEAR program and its objectives and benefits to the NCDOT and its employees. Other videos were created to show how to access the database, submit lessons, and troubleshoot. Also, the videos longer than five minutes each were not preferable.

This online education approach was tested by Zou (2007) for construction management education. Among the advantages Zou found were efficiency and flexibility as well as the ability to cater to large numbers and allow part-time students to be enrolled. At the end of Zou's three-year study, 67% of the students surveyed after enrolling in an online construction class showed preference for a combination of face-to-face and online learning (Zou, 2007). These findings in the field of construction management academic education concur with the findings of this study as they pertain to the professional environment at the NCDOT.

#### **4.4.4. Recommendations**

By far the most important feature of the program that respondents reported in the incentives section of the survey was ease of process. Respondents recommended that the CLEAR program developers keep all the submission and retrieval processes as simple as possible.

Based on the survey results, the respondents also recommended creating a series of videos that describe the CLEAR program and explain how to submit and retrieve lessons as well as how to troubleshoot. The NCSU research team made a special effort to keep the 'how to' videos short and simple based on the users' preferences and recommendations. At the time of data analysis for this survey, the research team had created four videos that were planned to be shown at workshops and NCDOT divisions meetings. Appendix D presents screenshots of these videos. The topics of the four videos are:

1. How to submit a lesson learned to the CLEAR program database.
2. How to submit a best practice or an idea to the CLEAR program database.
3. How to request a solution to an issue or challenge faced on projects using the CLEAR program database.
4. How to submit a solution to a problem or a best practice using the kiosk form.

In addition to videos, respondents suggested workshops to introduce the CLEAR program to employees across the NCDOT divisions and central unit. These workshops could be held as part of regular meetings or conferences.

#### 4.5. Verify Database Based on User Feedback

##### 4.5.1. Risk Assessment Study

Once the NC DIT had set up the CLEAR database in the SharePoint portal, the database needed to be validated by the end-users. For this task, the Value Management Office at the NCDOT conducted a one-day risk assessment study of the CLEAR program in November 2019. The aim of this study was to understand the possible risks that could arise out of this program and possible mitigation measures. The study had 21 participants who identified 65 risks, of which 51 risks were deemed to require mitigation. Figure 25 provides a breakdown of the severity of the risks.

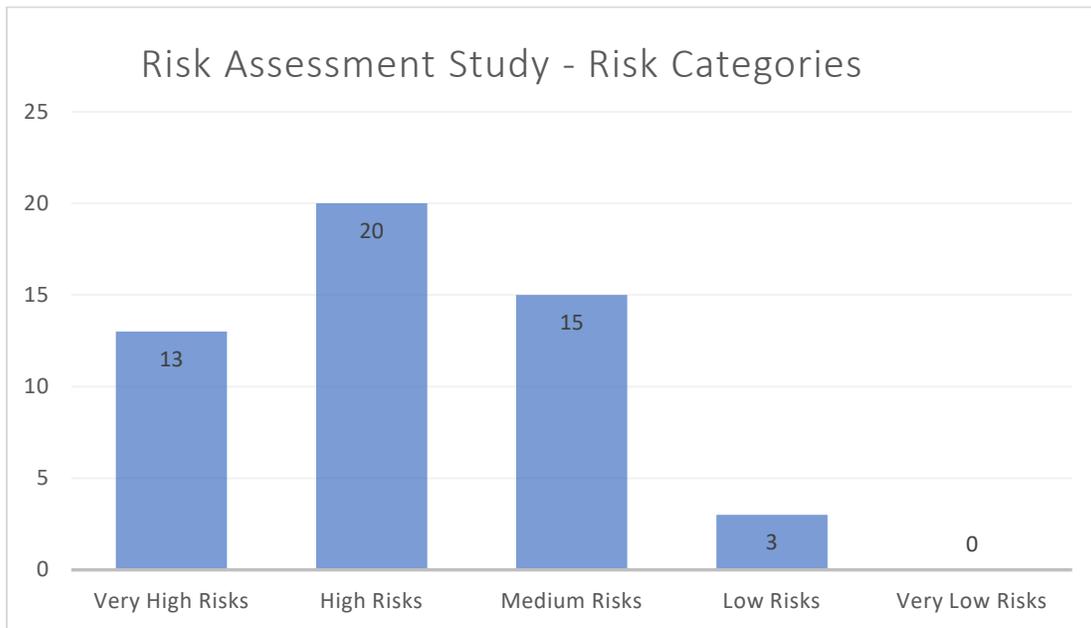


Figure 25. Risk classifications identified from CLEAR risk assessment study.

All the identified risks were categorized based on topics such as search, collection, integration, sharing, and recognition. The Value Management Office in consultation with the study participants devised proposed mitigation strategies for these risks and, subsequently delegated these risks to the appropriate authorities to implement proper mitigation measures. More information on this study and the identified risks can be found on the NCDOT website (Fullerton, 2020).

Based on the risks identified from the risk assessment study and work done by other DOTs, such as the CDOT, the NCSU research team developed three forms (presented in Appendices E, F,

and G) to replace the existing single form in CLEAR. These three forms were used to input information about (1) lessons learned, (2) best practices/ideas, and (3) solutions (or control measures) that are needed to address obstacles/challenges faced at project sites. The research team also developed a set of standard operating procedures (SOPs) for end-users and to provide taskforce members with information about how to use the appropriate functionality (see Appendices H-K). For end-users, the SOPs explain how to enter information in the Lessons Learned, Best Practices, and Solution Needed forms and to search for content in the database. In addition to these forms, the research team also developed ‘how to’ videos that describe the steps to enter information in the CLEAR database (see Appendix D). These videos are intended to act primarily as a training resource for first-time users of this database although users can also use them as reference material when using CLEAR. The NCSU research team, in consultation with the Value Management Office also prepared a list of definitions (presented at the starting of this report) and frequently asked questions (FAQ) (see Appendix L) to be uploaded in the CLEAR website. All stakeholders related to the CLEAR program can make use of these documents to familiarize themselves with relevant terminologies and obtaining information from the FAQs.

#### **4.5.2. Lessons Learned to Lessons Remembered**

In line with the organizational goal of the CLEAR program to institutionalize knowledge, the NCSU research team prepared a sequence of steps to make the lessons learned easy for users to remember. The data gathering phase analysis results revealed that utilities-related issues were the problems that most affected NCDOT personnel. Therefore, the research team developed possible interventions that are based on the literature, personnel responses from interviews, and HiCAMS data provided by the Value Management Office regarding utilities claims. Appendix M provides an example of these steps to remember lessons learned with regard to utilities claims and Section 5 is focused exclusively on information regarding utilities claims.

#### **4.5.3. Training Materials**

The NCSU research team developed training videos using the video-making software VideoScribe (see Appendix D). These training videos were created for all three forms and describe how an end-user can enter information in the appropriate forms. The research team also prepared training materials as ‘kiosk’ forms that are designed for maintenance personnel who do not have access to the Connect NCDOT portal to enter information. All the training materials, including the videos, have been uploaded to the CLEAR portal so that end-users can become familiar with ways to share information using the CLEAR program.

#### **4.5.4. Online Training**

The Value Management Office organized the first online training session using Microsoft Teams for participants from Wake County in the Hydraulics and Aviation Divisions. This session was planned initially to be a face-to-face gathering, but due to the Covid-19 situation, the training session was converted to an online format. The purpose of this training session was to introduce CLEAR to a pilot group of NCDOT employees (approximately 30 participants) and to explain CLEAR’s potential benefits to both the participants and the NCDOT as a whole. The research team worked closely with the Value Management Office in preparing the training materials and

providing support in order to obtain feedback about the presentation materials. A feedback form (see Appendix N) provided at the end of the presentation allowed the participants to share their opinions about the CLEAR program and the efficacy of the presentation.

Data analysis of the feedback survey revealed the following information:

- 16 valid responses were received, of which 15 were complete in all aspects.
- The total NCDOT work experience of the users was 187.5 years, which is an average of ~11.72 years.
- The users ranked the order of usage preference for the CLEAR forms as Lessons Learned, Best Practices, and Solutions Needed, as indicated in Figure 26.
- A majority of the respondents strongly agreed that the training met their needs and that they would be willing to contribute to the CLEAR program.

Figure 27 presents the data analysis results for the various questions in the feedback survey.

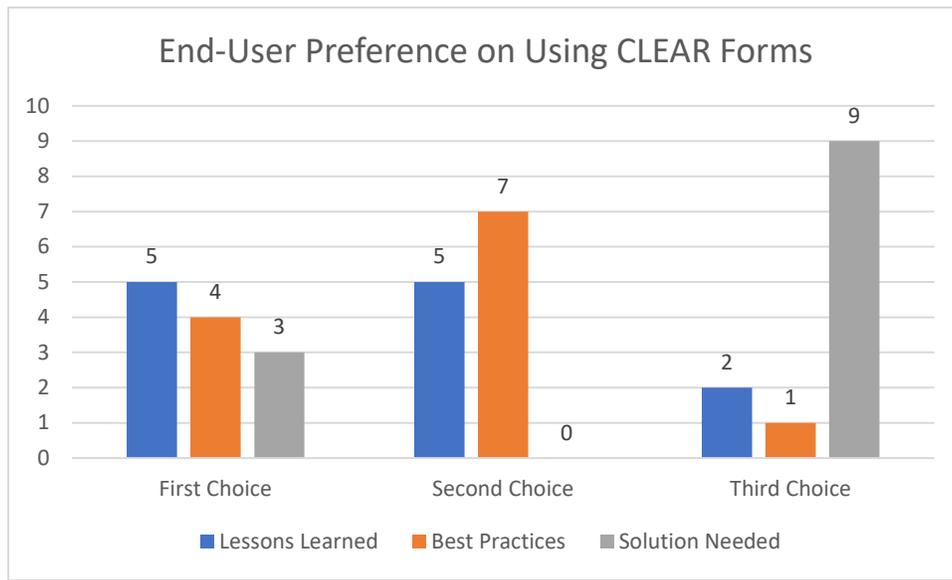


Figure 26. Ranking of three CLEAR forms based on user feedback.

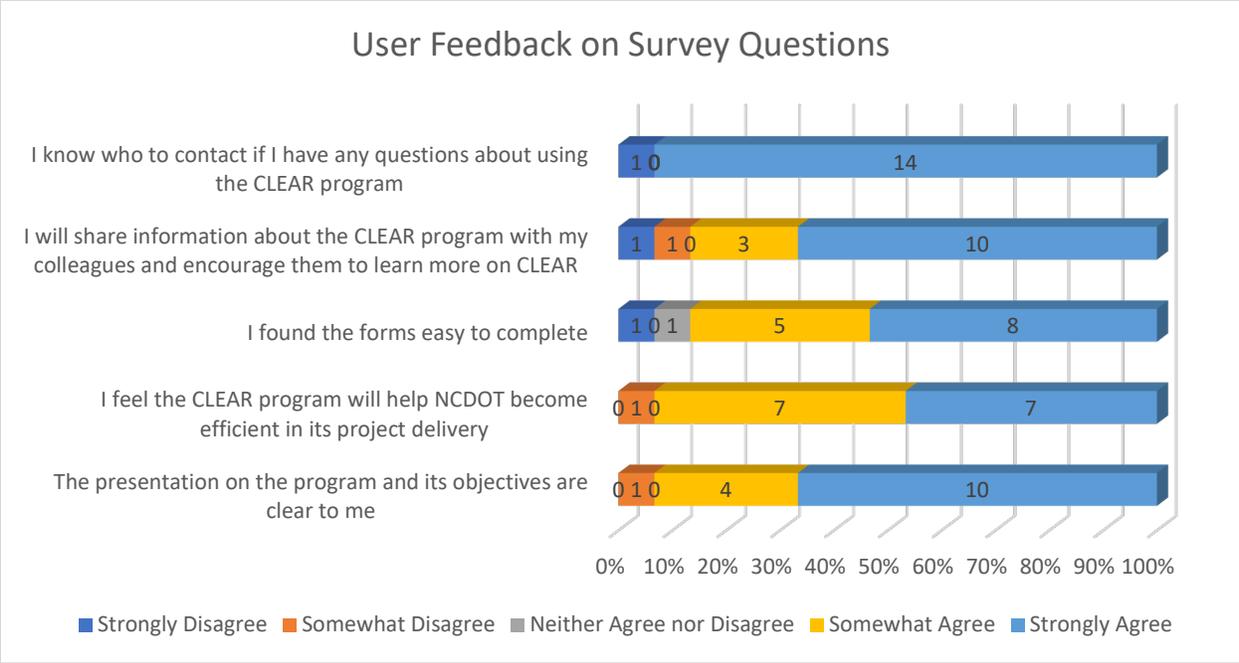


Figure 27. Data analysis of user feedback obtained from survey questionnaire.

**5. ANALYSIS OF NCDOT CLAIMS RELATED TO UTILITIES**

This section presents the analysis for a sample of NCDOT utilities-related claims. The analysis was conducted because NCDOT survey respondents and personnel consistently reported several issues related to utilities. Dealing with utilities seems to be one of the most challenging and ongoing issues for the survey respondents.

**5.1. Introduction**

Transportation projects share the right of way with utilities-related infrastructure. Therefore, transportation agencies must coordinate with several different utility agencies to accommodate different types of utilities, such as electricity, water, telecommunications, and gas. The space-sharing of public roads and bridges with utilities often complicates the efficient delivery of transportation projects and increases the risk of utilities conflicts (Goodrum et al., 2008; Quiroga et al., 2019). According to Quiroga et al. (2011), transportation agencies often lack adequate and updated information about their facilities, which can lead to damage to existing utilities during construction and create environmental and safety incidents as well as time and cost overruns. In short, managing utilities and transportation projects is challenging.

Transportation agencies have investigated best management practices for dealing with utilities and utilities providers. For example, the Illinois Department of Transportation (IDOT) surveyed state DOTs and IDOT districts about top effective best management practices and found that coordination, cooperation, communication (or ‘CCC’) and subsurface utility engineering (SUE) are among the most utilized practices to manage utilities in the context of transportation projects

(El-Rayes et al., 2017). The Kentucky Transportation Cabinet also assessed risks associated with utilities and investigated best practices to minimize those risks. Mitigation strategies include early utilities involvement in the design phase (30% or earlier) and effective utilities investigations that utilize SUE.

Nonetheless, utilities continue to impact the performance and outcomes of transportation projects. A past research effort identified numerous reasons for disruptions caused by utilities-related issues and dealing with utilities providers, including design and communication issues (El-Rayes et al., 2017; Quiroga et al., 2011, 2019; Sturgill Jr, 2018). However, no comprehensive assessment was undertaken in that study to target the impacts of utilities on transportation projects by investigating construction claims records. Construction claims data provide rich information that can be leveraged for this purpose. The objectives of this study of NCDOT utilities claims are to:

- Assess the impact of utilities-related claims on construction costs.
- Assess the effect of utilities-related claims on construction schedules.
- Assess the characteristics of utilities-related claims in terms of project type, project size, and utility type.
- Understand the sequence of events that led to a utilities-related claim.
- Report the relevant lessons learned that have been collected for the CLEAR database.

The following sections review the research methodology and present the findings.

## **5.2. Utilities Claims Database and Research Methodologies**

The research methodology used for this investigation followed qualitative and quantitative approaches to studying claims associated with utilities. The analyzed utilities claims database includes a total of 1,144 valid claims related to utilities in North Carolina. These claims occurred on 707 NCDOT projects that were let between 1994 and 2018. Figure 28 shows the number of projects that were impacted by utilities claims across the years in which the studied projects were let.

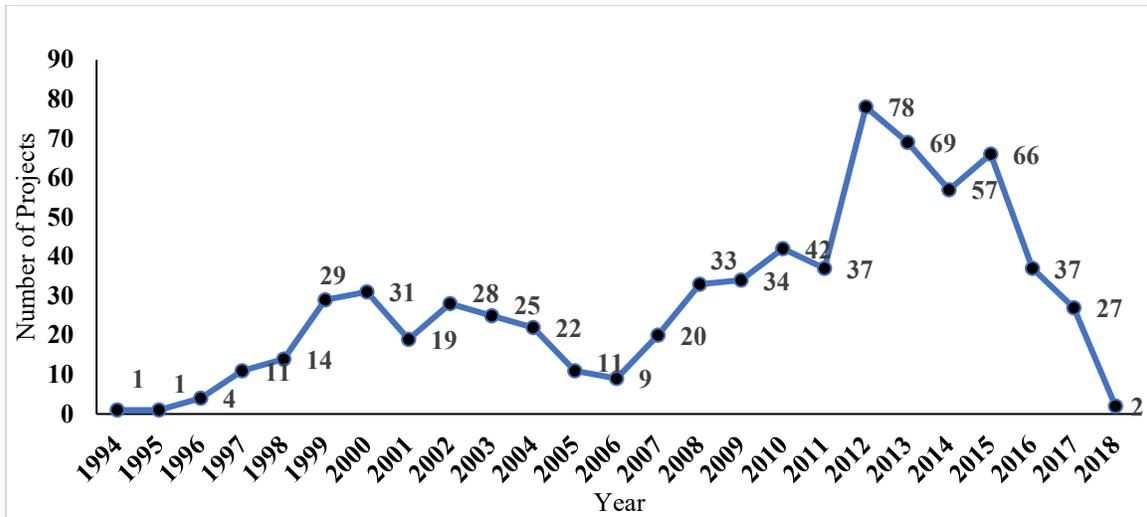


Figure 28. Number of projects influenced by utilities claims, by letting year.

The database of claims that are related to utilities is part of a massive database of overall construction claims and supplementals. The claim database was obtained by utilizing search word capabilities in the ‘claim description’ field. The claim description provides a narrative of the reason(s) for submitting the claim. The searched keywords include ‘utility’, ‘lane’, ‘sewer’, ‘power’, and ‘utility providers’. The keywords mentioned earlier are examples of the utilized keywords in searching. The returned results were inspected manually by the research team to obtain claims associated specifically with utilities and to discard claims not related to utilities. The claims associated with utilities represent nearly 13% of the construction claims database. These claims occurred in 707 out of the total 3,335 projects. That is, almost 21% of all projects were affected by at least one utility claim.

The claims descriptions provide a rich source of unstructured data and explain the events that led to submitting the claim as well the utility type (e.g., electricity, water, gas, or telecommunications). The research team conducted comprehensive content analysis of the claims narratives to structure and summarize the reports. Content analysis is a common qualitative research approach that categorizes unstructured text into structured categories (Neuendorf & Kumar, 2015; Saldana, 2015). Following this approach, the research team obtained the following insights from the claims data: (1) utility type, (2) utility location (e.g., underground or above-ground), and (3) the scenario in which the utility claim occurred. In coding the scenarios, the research team followed the domino effect coding approach suggested by Saldana (2015). The premise of the domino effect approach, as the name suggests, is creating a flow of events that would lead to the utility claim. Figure 29 describes this method using an example from the claims database.

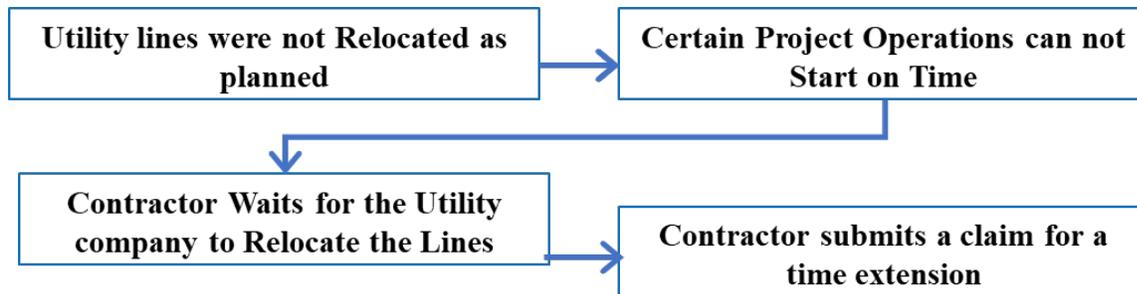


Figure 29. Example of domino effect coding approach using claims data.

Next, the NCSU research team established frequency and descriptive statistics for the following attributes:

- Project location (by division)
- Project size
- Project type
- Number of utilities claims for each project
- Cause(s) for delay (labeled in the database by NCDOT project managers)
- Delays due to utilities claims
- Cost increase due to utilities claims
- Utility type
- Utility location
- Events that led to the claim

Note that, in numerous cases, the provided claim descriptions lacked some substantial information about the events that occurred before submission of the claim(s). Also, the research team encountered claims records with missing data. Lastly, the research team reported the lesson(s) learned regarding utilities that had been submitted to the CLEAR database.

### 5.3. Analysis Findings

This section discusses the frequency and statistical analyses of the utilities claims records. The following subsections report the findings.

#### 5.3.1. Number of Projects Affected by Utilities Claims, by Division

Figure 30 shows the distribution of the studied affected projects that had utilities claims. These results indirectly suggest the divisions where the agency should focus on managing and controlling utilities-related issues. Most of the projects that were impacted by utilities claims are in Division 10, which includes projects that are let in Mecklenburg County, the largest county in the State in terms of population.

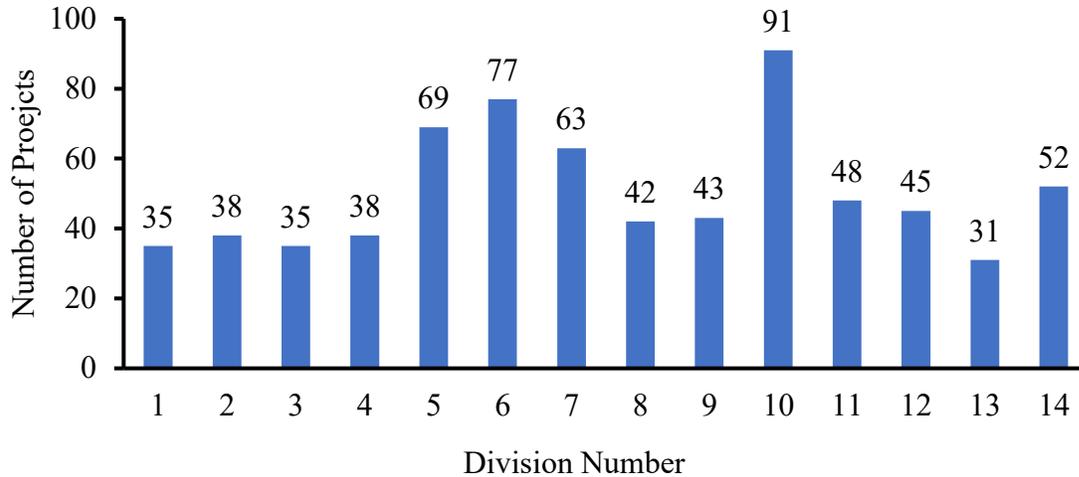


Figure 30. Number of projects affected by utilities claims, by division.

### 5.3.2. Size of Projects Affected by Utilities Claims

The bid amount determines the size of the project. Alsharif (2015) classified transportation projects into the following categories (in USD): less than \$1 million, \$1 to \$5 million, \$5 to \$20 million, and above \$50 million (the latter known as megaprojects) (Alsharif, 2015). Figure 31 shows the frequency of projects impacted by utilities claims clustered by project size. Most of the projects impacted by utilities claims tend to be small. One possible explanation for this finding is that smaller projects tend to have fewer coordination efforts compared to larger projects.

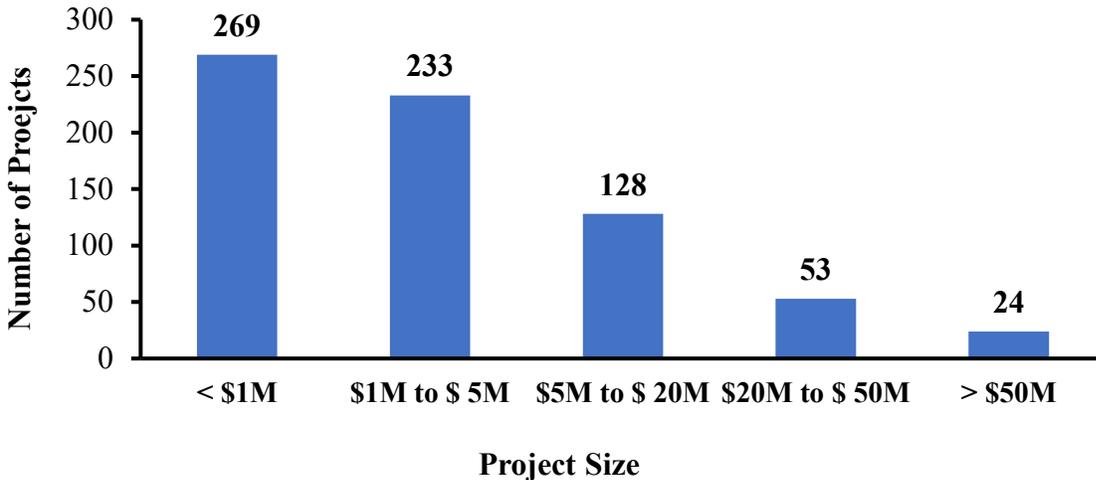


Figure 31. Number of projects with utilities claims based on project size.

### 5.3.3. Project Type

Figure 32 reports the number of claims related to utilities for each project type. The analysis is for 907 out of the total 1,144 claims records because the project type is missing for 234 utilities

claims. Not surprisingly, the highest number of claims occurred in urban projects, followed by bridge projects. The reason for this outcome might be that urban areas are characterized by congested and intertwined utilities infrastructure (Quiroga, et al., 2019).

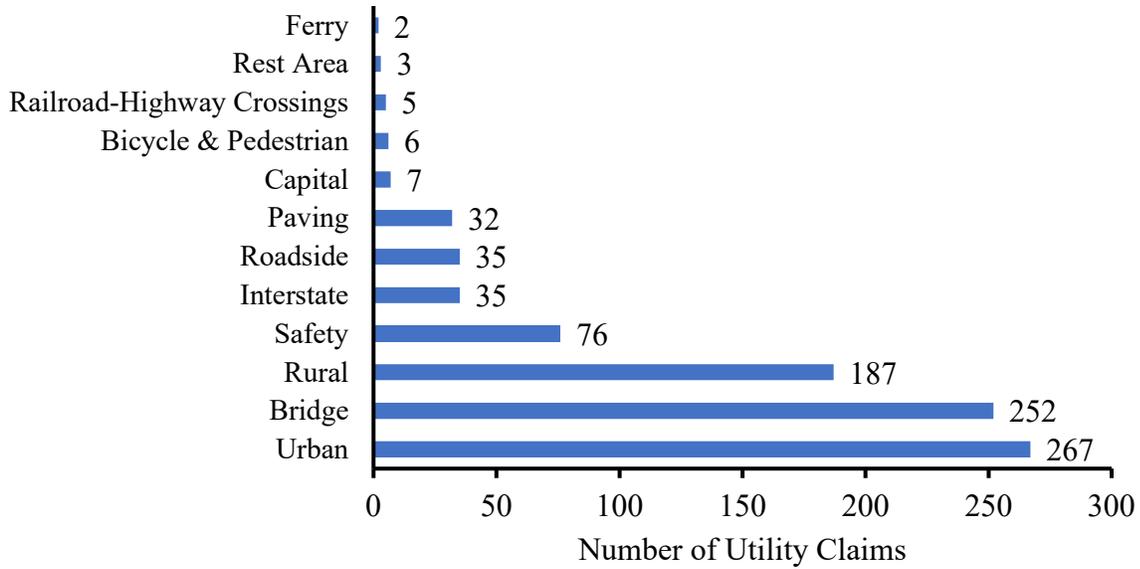


Figure 32. Number of utilities claims per project type.

### 5.3.4. Number of Utilities Claims per Project

Figure 33 reports the number of utilities claims per project. The figure shows that 492 projects had one utility claim and one project had 19 utilities-related claims. The one project with 13 utilities claims and the one project with 19 utilities claims are both megaprojects (projects with bid amounts greater than \$50 million). Table 1 presents summary statistics for the number of claims per project.

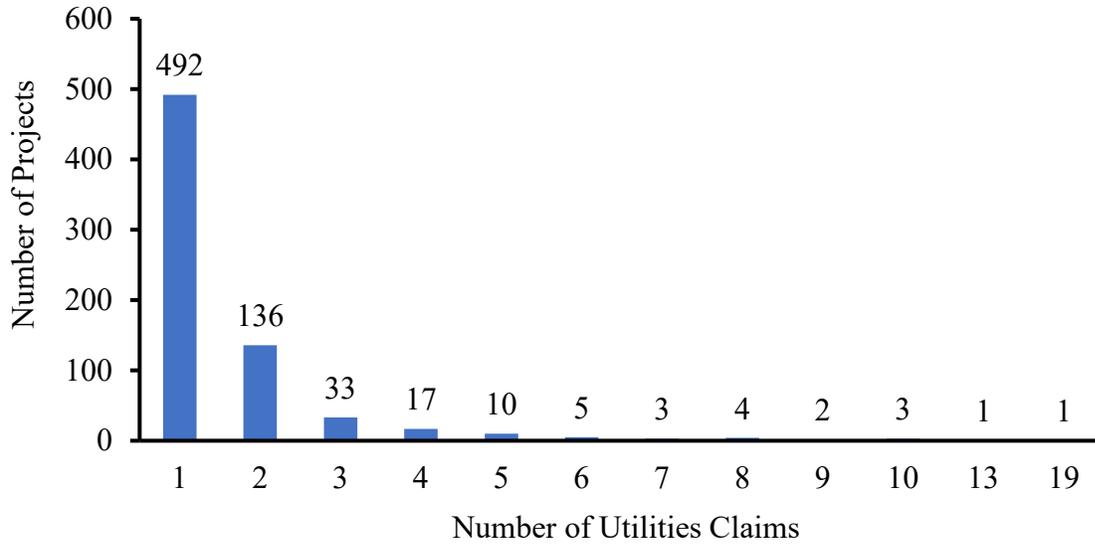


Figure 33. Number of utilities claims per project.

Table 1. Summary Statistics for Number of Utilities Claims per Project

Number of Projects	707
Average	1.62
Median	1
Standard Deviation	1.5
Mode	1

### 5.3.5. Analysis of Project Delays Due to Utilities Claims

The goal of this analysis is to assess the impact of claims related to utilities on the project's duration/schedule. In many cases, the contractor requested an extension of time due to a utility conflict that impeded the construction progress. Figure 34 shows the frequency of the time extensions that resulted from claims related to utilities. On average, such claims would extend the project completion by nearly 70 days. Table 2 provides summary statistics for delays caused by utilities claims.

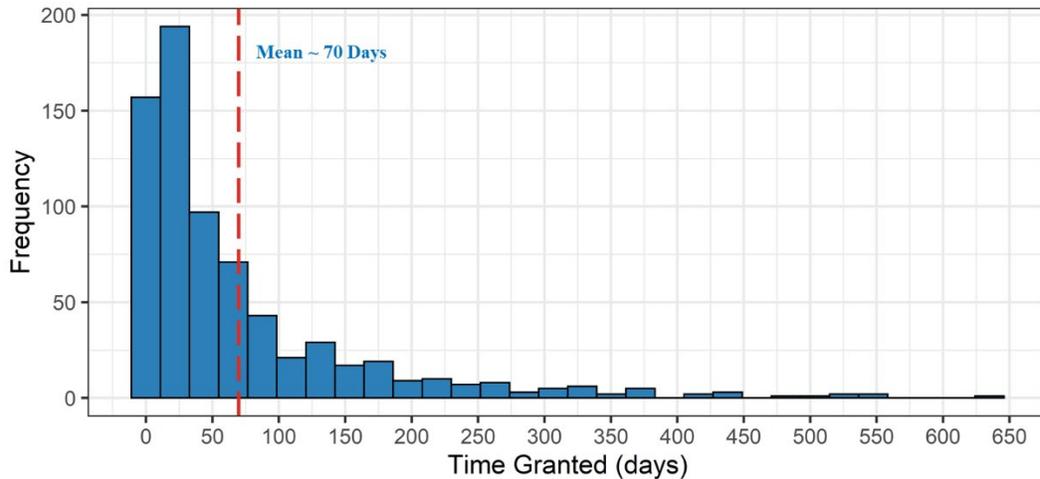


Figure 34. Frequency of delays due to claims associated with utilities-related delays.

Table 2. Summary Statistics for Number of Utilities Claims per Project

Number of Claims	715
Average	69.75
Median	34
Standard Deviation	92.45
Mode	7

### 5.3.6. Causes of Utilities Claims Delays

In the utilities claims database, each cause for delay is labeled by the person who entered the claims record. Out of 931 utilities claims, nearly 57% of the delays were caused by utilities-related conflicts (see Figure 35). In one claim, the contractor requested a time extension due to delays associated with relocating utilities. The contractor mobilized to the job site and was not able to start the project because the relocation work had not been completed in a timely matter. Design issues also seem to cause project disruption. In one project, the contractor attempted to install the proposed sewer and water lines. However, an unknown underground utility was encountered that halted the construction progress and resulted in submitting a claim.

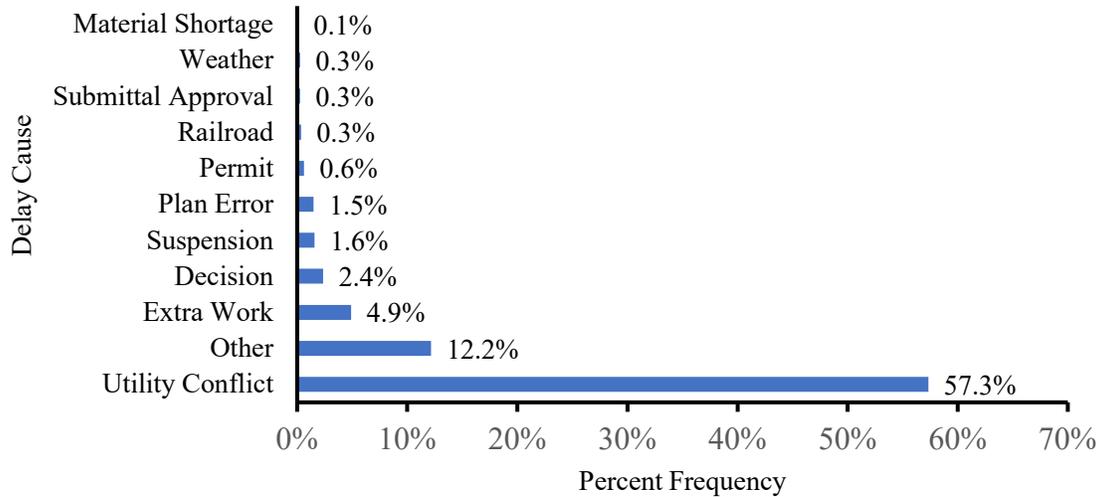


Figure 35. Percentage frequency of causes of utilities claims delays.

### 5.3.7. Cost Increase Due to Utilities Claims

Projects can vary in size, and thus, the cost of claims related to utilities can be normalized based on the bid amount, as shown in Equation (1).

$$Utility\ Claim\ Cost\ (\%) = \frac{Claim\ Amount\ Granted\ (\$)}{Bid\ Amount\ (\$)} \quad (1)$$

The claims database contains 125 records of the amount granted that was due to claims related to utilities. Table 3 reports the statistics of these records and indicates that the associated cost of a utilities claim would increase the project's bid amount by 2.4% on average. Nevertheless, the standard deviation is around 10%, which indicates a broad spread of data with several outliers. In one claim, the contractor requested compensation due to additional work. The contractor had constructed a detour and installed additional traffic control and safety items, including sandbags. In another claim, the contractor was delayed due to a utility conflict and requested a time extension. The contractor also asked for additional compensation for idle equipment and laborers during the utility relocation period.

Table 3. Cost Increase Due to Utilities Claims

Number of Claims	125
Average	2.4%
Median	0.26%
Standard Deviation	10.27%
Mode	0.005%

### 5.3.8. Utility Type Analysis

The utility type (i.e., power, gas, water, or electrical) was investigated via content analysis. Figure 36 shows the percentage frequency for each utility type. Water-related utilities are the most frequent type of utility involved in claims. In many instances, water line utilities are not shown on the construction drawings and are encountered during project execution. For example, a contractor was performing earthwork when the contractor encountered a water line. While the conflict was being investigated, the contractor was delayed from completing the remaining work and submitted a time extension claim. In numerous cases, however, the claim description lacks information about the utility type. For instance, one claim stated that the project completion date was extended by 228 days due to an availability date delay as a result of several utility conflicts. In this claim, the availability date was delayed because of utility conflicts, but the utility types were not mentioned.

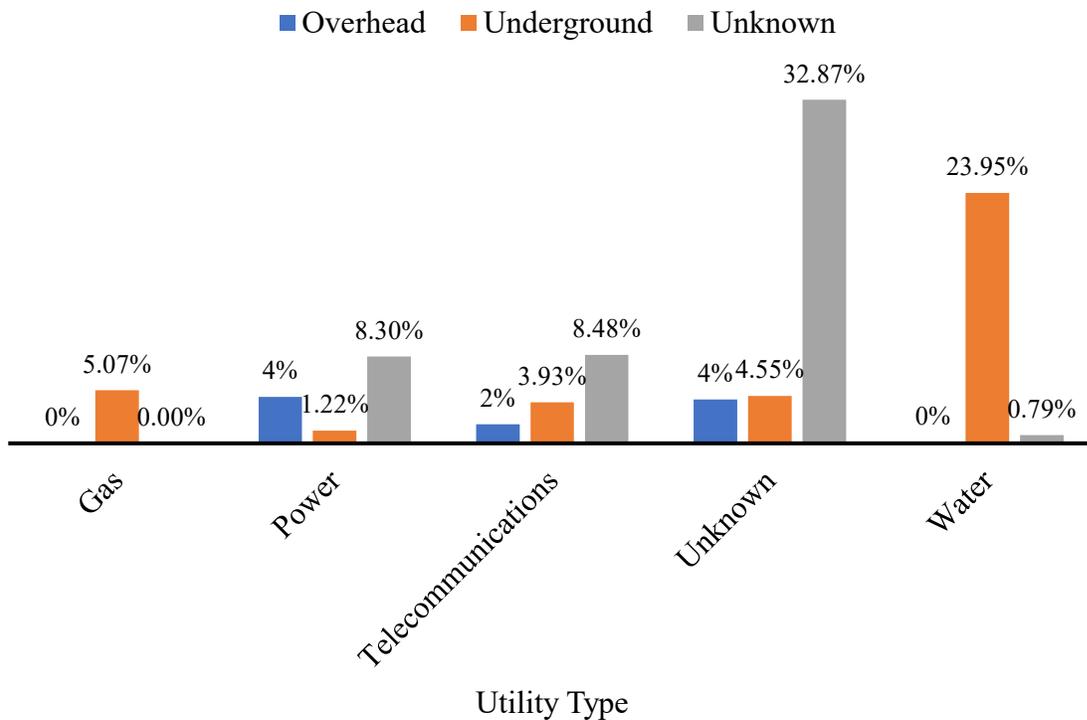


Figure 36. Percentage frequency of utility type, by location.

### 5.3.9. Utilities Claims Scenarios

In order to understand the events that led to utilities-related claims, the research team classified the claims into four categories: (1) expected, (2) no physical conflict, (3), unforeseen, and (4) unspecified. The ‘expected’ claims group includes delays due to utility relocation or improper relocation. The ‘no physical conflict’ category includes delays that were not due to physical issues but were caused by, for example, waiting for a new design or permit issues. The ‘unforeseen’ category includes cases where the existence of the utility infrastructure was not known or included in the project’s scope or drawings. Lastly, ‘unspecified’ includes claims records with limited or no information about the events that led to the claim. Figure 37 presents

the proportions of the utilities claims categories. Table 4 presents the most frequently reported scenarios that led to utilities-related claims.

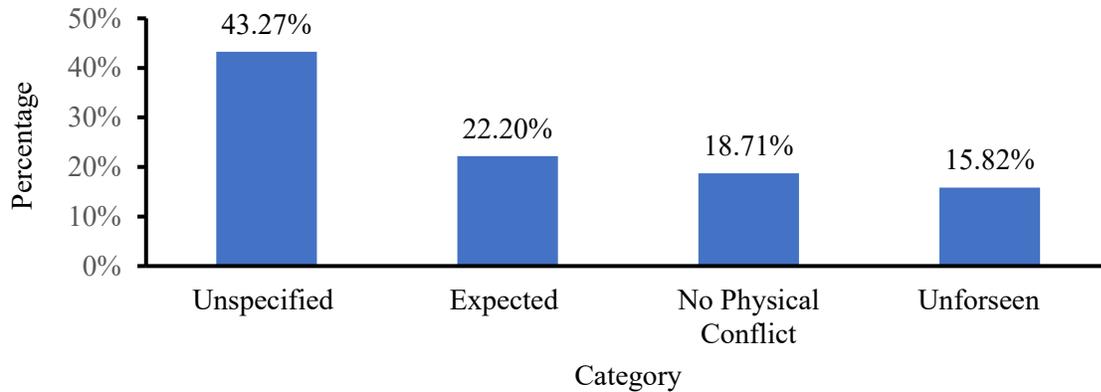


Figure 37. Proportions of utilities claims categories.

Table 4. Frequency of Events Leading to Utilities-Related Claims

Scenario	Frequency
<i>Expected</i>	
Delayed or Improper Relocation of Utility Lines → Delay in Project Availability/Mobilization	36
Delayed or Improper Relocation of Utility Lines → Delay in Project Availability/Mobilization → Delay in Structure Construction	20
Delayed or Improper Relocation of Utility Lines → Delay in Project Availability/Mobilization → Delay in Earthwork	17
Delayed or Improper Relocation of Utility Lines → Work Suspension → Delay in Earthwork	17
<i>Unforeseen</i>	
Design Error/Change → Work Suspension → Delay in Earthwork	14
Design Error/Change → Extra Cost/Overhead Cost	10
Design Error/Change → Work Suspension → Delay in Structure Construction	10
Design Error/Change → Work Suspension → Delay in Utility Construction	10
<i>No Physical Conflict</i>	
Delay in Connecting Utility Lines by the Provider → Work Suspension → Delay in Sign Installation/Activation	32
Concurrent Utility Project by Different Entity → Work Suspension → Delay in Paving/Resurfacing Operation	20
Permit Issues → Work Suspension → Delay in Utility Construction	10

## **5.4. Recommendations**

This study of utilities-related issues and resultant claims provided an opportunity for the NCSU research team to investigate the causes of claims that often arise due to utilities-related problems and to provide insights to the Value Management Office and top personnel in the Utilities unit. The research team was unable to analyze many claims because the utility type was either unknown or unspecified. Efforts should be made to encourage submitters to provide adequate information as more data can help provide better analysis results in the future. In addition, the NCDOT could consider implementing some of the best management practices and incentives that are reported in the literature. Finally, the NCDOT can partner with the NCSU research team to conduct a thorough study to develop a list of tailored best practices and incentives to aid in better utilities coordination and improve project success where utilities are involved. Appendix O lists a few sample lessons gathered from end-users that relate to utilities issues.

## **6. CONCLUSIONS**

Lessons learned can be an effective mechanism to document and retrieve wisdom gained from previous projects and to apply this knowledge to future projects to attain best practices and find solutions. The CLEAR lessons learned/best practices database within the NCDOT will facilitate improved coordination between inter- and intra-departmental personnel. The overall aims of this database are to achieve superior design performance and thus reduce the frequency and impacts of change orders, enhance cooperation, and ultimately accomplish improved operational performance. Two important considerations here are that (1) project teams are dynamic and seldom repeat themselves in different projects and (2) the aging workforce will retire before their knowledge can be documented. In either case, a significant amount of wisdom would be lost if this information were not documented in a proper lessons learned/best practice database. The CLEAR program will provide scope for the next generation to implement these lessons learned/best practices to realize desired project goals.

This research effort resulted in an internal-only web-based database that is housed within the Connect NCDOT SharePoint portal and contains information about lessons learned and best practices from ongoing or previous projects. Authorized personnel now have the ability to input data as well as search for information through this web-based database. The CLEAR training materials, including SOPs and training videos, will assist NCDOT personnel to contribute effectively to this program. The CLEAR program is expected to encourage end-users to share knowledge gained on projects and search for relevant lessons using the search function. Project teams across divisions, units, and departments at the NCDOT will greatly benefit from this rich and robust knowledge database.

## **7. FUTURE SCOPE**

The ultimate success of the CLEAR program will depend on the extent to which end-users are proactive about entering and searching for relevant lessons to be applied to their projects. A data dashboard is envisioned to ensure timely intervention by the experts (e.g., upper management



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## Appendix A. Interview Guide to Identify Trends and Database Fields

### North Carolina Department of Transportation Post Construction Assessment Program Data Collection Guide

**Introduction:** The purpose of this data collection guide is to gather information that pertains to trends, lessons learned, and end-user preferences for the design of a lessons learned/best practices database for the North Carolina Department of Transportation (NCDOT). The ultimate goal of this database, referred to as CLEAR (Communicate Lessons, Exchange Advice, Record), is to improve future project design, construction, and maintenance performance. The information provided in this database will be used to adjust future cost estimates, update standards, and change policies in an effort to improve the NCDOT as an effective and efficient organization to serve the public.

**Confidentiality Statement:** This research strictly follows North Carolina State University's (NCSU's) policy for data confidentiality. All data provided to NCSU in support of research activities by participating organizations are to be considered confidential information. The data provided by participants will not be communicated in any form to any party other than the NCSU researchers affiliated with this project.

**Consent:** Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, or to stop participating at any time. You can choose to skip any question that makes you feel uncomfortable. Minimal risks are associated with participation in this research. The results of this interview guide will be kept confidential. Your participation will give the NCSU research team valuable information that will help the team identify key trends and lessons learned that will be helpful in improving the performance of future NCDOT projects. By providing answers, you are consenting to be a part of this research project.

I agree

**Contact information for follow-up questions:** If you have any questions or require further information about this questionnaire or the research project, please contact one of the academic researchers: Dr. Edward Jaselskis (ejjasels@ncsu.edu) (Principal Investigator), Siddharth Banerjee (sbaner22@ncsu.edu) (NCSU doctoral student), or Abdullah Alsharif (afalshar@ncsu.edu) (NCSU doctoral student).

#### Definitions:

- **Gatekeeper:** The gatekeeper is the person who is responsible for reviewing and approving valid lessons to be included in the lessons learned/best practices database. For this project, the Value Management Office at the NCDOT will act as the gatekeeper.
- **Administrator:** The administrator of the database is responsible for uploading the verified lessons learned files from the Value Management Office into the database and periodically removing unnecessary information.
- **End-user:** An end-user is responsible for making use of the lessons learned and providing perspectives on the new lessons learned based on experience.

- **Lessons learned:** Lessons learned is the knowledge gained from one’s own project experiences as well as the experience of others (Project Management Institute, 2004)
- **Lessons learned database:** A lessons learned database is a comprehensive collection of lessons learned data that is organized for convenient access for improving future project performance (Dictionary.com--partial).
- **Trends:** Trends are used to identify potential areas where process improvements would be beneficial (Post Construction Assessment Program document).

## I. Respondent Background

1. Please identify yourself as an NCDOT employee or Consultant.
2. If you are an NCDOT employee, please provide your title (name not required) and Division.
3. How many years have you been working with the NCDOT? Non-NCDOT?
4. Which department are you affiliated with? What is your role within this department?
5. Have you worked in other departments within the NCDOT?
6. Which County, Division, and District have you worked with?

## II. Trends and Lessons Learned

1. Please identify any trends or recurring issues within your specific area of responsibility that, if addressed, could improve NCDOT project performance.
2. Are there any best practices that you would like to share that could improve planning, design, construction, or maintenance procedures?
3. In order for the research team to explore trends and lessons learned, we would like to review documentation from past projects that include, but are not limited to, construction quality index reports, claims, supplemental agreements, pay items/quantities, diaries, and monthly project reports. Would you be able to provide the research team with such information? Specific information to be collected includes the following:
  - a. Continuous quality improvement: Rating and comments for all parameters.
  - b. Claims: Claim Description, Claim ID, Claim Status, Claim Type, Contract Bid Amount, Contract Number, Contract Status, Contract Type, Delay Cause, Federal Highway Administration (FHWA) Authorized Representative, FHWA Date, Issue Description, Issue ID, Issue Reason, Issue Specification, Issue Status, Issue Type, Resident Engineer, Time Granted, Time Requested, Time Unit.
  - c. Supplemental agreements/contract adjustments: Contract Number, Contract Status, Contract Type, Deciding Job Title, Deciding Staff, Decision, Decision Comment, Decision Date, Description, FHWA Authorized Representative, Justification, Resident Engineer, Status, Total Amount, Type of Work.
4. Would your department or unit effectively use information obtained from similar completed projects?
5. What is your department’s current practice for obtaining best practices regarding previous projects?

6. Is the current practice for obtaining useful information from similar completed projects effective? If not, how would you recommend improving the current practice for capturing information from completed projects?
7. Please share any additional thoughts regarding trends and lessons learned that could improve NCDOT project performance.

### **Lessons Learned Database End-User Preferences**

Note: To facilitate the identification of preferences, the research team plans to show examples of other lessons learned databases (e.g., USDOT and Kentucky DOT).

1. The proposed lessons learned database is intended to capture and store lessons learned information and to allow NCDOT employees and consultants to search various lessons learned from the perspective of planners, designers, construction engineers, contractor engineers, and maintenance engineers.
  - a. Please provide comments regarding your preferences for a lessons learned database to maximize its use.
  - b. What would you like to see included that would increase your participation and use of a lessons learned database?
  - c. What information that describes the lessons learned would be helpful (e.g., type and size of project, short or long version of the lessons learned, etc.)?
  - d. What level of detail should be provided?
  - e. The research team proposes to have searchable lessons learned displayed in a manner such that the end-user will be able to read through multiple initial descriptions based on search criteria (e.g., project size, location, trends, etc.). Once the end-user feels that a particular lesson is relevant, he/she will have the option to explore the full content. Does this approach seem appropriate or should the research team consider another approach?
  - f. Would you prefer to arrive at lessons learned using drop-down menus under each category? If so, what categories or filters should be used? Alternatively, would you prefer another method (e.g., select project size → select project location → trends → and so on...)?
2. Please provide any other ideas or suggestions for creating the lessons learned database.
3. How familiar are you with MS Access and SharePoint? Do you find these platforms easy to use? What are some of the drawbacks of these platforms?

### **Information Technology (IT) Department**

- Database specifications
  - What is the most appropriate software to use to develop the lessons learned database?
  - What are the steps involved in developing and implementing such a software application for the NCDOT website and server implementation? How long does this process usually take?
  - If photos or videos are used in the lessons learned database, would the user be restricted to an upper limit for the size of images that can be uploaded?

- Could hyperlink text within entries be provided for users entering lessons into the lessons learned database?
  - Has the IT Department built and published similar databases?
  - Are these databases still functioning? If not, what are the reasons?
- Access for non-NCDOT employees
  - How will design consultants and other non-NCDOT personnel, including contractors, be able to gain access to this database?
  - How can outside consultants enter their own lessons learned to the database?
- Support
  - What kind of support can the NCDOT Value Management Office team expect from the NCDOT IT Department during the development phase, piloting phase, and long-term implementation phase?
  - What kind of assistance can the research team expect from the IT Department as the lessons learned database is developed and piloted?
  - What level of training support can the IT Department provide?
  - What are the procedures for upgrading the platform for the database after a certain number of years (e.g., upgrade to a new version of a software product)?

## Appendix B. Initial CLEAR Program Data Entry Fields

The initial information gathered from end-users helped the North Carolina State University research team prepare the first draft of database fields to collect information about lessons learned/best practices. These fields are as shown.

### CLEAR Lessons Learned/Best Practices

Date Observed

*If occurred multiple times, choose one date of occurrence*

Location \*

*(Example: Intersection of HWY109 and US14 or 1 South Wilmington Raleigh NC or Near Exit 70 on I-85)*

Division

County

Office \*

Name \*

Email \*

*(Name, Phone, Email id) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.*

Phone \*

Calendar Date

Populated based on the Division Selected above

#### **Description of Existing Condition**

Description of Issue (what was discovered – unforeseen condition?, key factors involved, uniqueness of the situation) – 200 characters.  
Add photos describing the existing condition

#### **[Attach Issue Reference Documents and Photos](#)**

Reference documents: pertinent drawing standards, plan details, correspondence, contract language, etc. (important to tie this description to tangible project documents)

Issue Details - Provide more details and any project cost/schedule impacts

**Lessons Learned or Best Management Practice**

Solution to Solve Issue - Short description of the solution used to solve the problem - 200 characters. Add photos describing the lesson learned/best practice/solution to the problem



[Attach Solution Reference Documents and Photos](#)

Reference documents: pertinent revised plan details, correspondence, Revised contract language, etc.

Select Disciplines (Check box to select Applicable Disciplines)

Applicable Disciplines

- Business Opportunity & Workforce Development (BOWD)
- Construction
- Design-Build
- Aviation
- Division of Motor Vehicles (DMV)
- Environmental Analysis
- Erosion Control
- Facilities Management
- Ferry
- Geotech
- Hydraulics
- Information Technology (IT)
- Local Projects
- Location & Surveys
- Materials & Tests
- Pavement Design & Collection
- Photogrammetry
- Procurement
- Project Management

- Public Transportation
- Rail
- Right Of Way
- Roadside Environmental
- Roadway Design
- Safety & Risk
- Maintenance
- Structures
- Transportation Mobility and Safety
- Turnpike Authority
- Utilities
- Equipment
- Project Development

Occurrences encountered  
*(Approximate number of occurrences or frequency this problem was encountered earlier)*

Select Rating - Check box for Impact Rating  
 Impact Rating COST-Percentage of initial authorized amount

- A - Financial Loss > 50%
- B - 25%<Financial Loss>50%
- C - 10%<Financial Loss>25%
- D - 1%<Finaical Loss>10%
- E - No change in Finances
- F - Financial Gain > 50%
- G - 25%<Financial Gain>50%
- H - 10%<Financial Gain>25%
- I - 1%<Finaical Gain>10%

Impact Rating SCHEDULE-Percentage of initial schedule

- a - Schedule Addition > 50%
- b - 25%<Schedule Addition>50%
- c - 10%<Schedule Add>25%
- d - 1%<Schedule Add>10%

- e - No change in schedule
- f - Schedule Improvement >50%
- g - 25%<Schedule Improvement>50%
- h - 10%<Schedule Improvement>25%
- i - 1%<Schedule Improvement>10%

Qualitative Impact

- negative press
- community impact
- safety issues
- innovative idea
- third party impact
- MPO/RPO impact
- Other

Check all that apply.

If Other selected fill in response below.

*Other Qualitative Impact - Please fill this box*

**Project Information**

Project Number

Dropdown list

Project No. If Not Available

Contract Number

Dropdown list

Contract No. If Not Available

Project Name If Available

Dropdown list

Project Name If Not Available

Project Delivery

Central Let or Division Let design?

Supplementary Agreement Involved (If yes, please enter amount in terms of additional time and cost – obtain from supplementary agreement form)

Specification Year  
Mile Marker

*If applicable. If not, type in N/A.*

Project Type  
*e.g. bridges, road widening, maintenance, DOT Facilities etc.*  
Project Phase  
*Planning, Design, Bid letting, Construction, Maintenance etc.*  
Project Cost

*Initial authorized \$ amount.*  
Project Size

*Initial number of miles*  
Project Schedule

*Initial number of months*  
Claim Involved (if yes, please enter amount in terms of cost and schedule - determine from Active Claim Resolution Form.)

<i>Supplementary Agreement Form Info- Please fill details if Yes</i>
<i>If Yes, please enter Active Claim Resolution Info</i>

## **Appendix C. CLEAR Program Survey Questionnaire: Promoting the Use of the NCDOT CLEAR Lessons Learned Program**

### **Introduction**

The North Carolina Department of Transportation's (NCDOT's) Value Management Office is developing a knowledge and experience-sharing lessons learned database through the CLEAR (Communicate Lessons, Exchange Advice, Record) program that will allow you to provide input and retrieve valuable lessons and experiences from past projects and experiences. The purpose of this survey is to determine how best to prepare training materials for this new application and understand your motivation to use such a database. This survey is part of a research project collaboration between the NCDOT and North Carolina State University (NCSU).

### **Instructions**

This survey is divided into three sections: (A) Respondent Background, (B) Training Preferences, and (C) Incentives to Use and Contribute to This Database. The survey is estimated to take approximately 5 to 10 minutes to complete. If you have any questions, please contact Omar Kadour Alainieh ([okadour@ncsu.edu](mailto:okadour@ncsu.edu)) or Dr. Edward Jaselskis ([ejjasels@ncsu.edu](mailto:ejjasels@ncsu.edu)).

### **Confidentiality statement**

This research strictly follows NCSU's policy for data confidentiality. All data provided to NCSU in support of research activities by participating individuals are considered confidential information. The data provided by participating individuals will not be communicated in any form to any party other than NCSU authorized academic researchers and designated NCSU staff members.

### **Consent**

Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, or to stop participating at any time. You can skip any question if you so choose. Minimal risks are associated with participation in this research. The results of the survey will be kept confidential. Your participation will give the research team valuable information and the results will help the team address your training needs and long-term use of this program. By clicking 'I Agree', you consent that you are willing to answer the questions in this survey.

### **Section A: Respondent Background**

A.1 In what year were you born (please select from the following ranges)?

- a) 1945 and before
- b) 1946 to 1964
- c) 1965 to 1980
- d) 1981 to 1997
- e) 1998 and after

A.2 How many years have you worked for the NCDOT (Type in this information)?

A.3 What is your current job function?

- a) Project Management
- b) Design
- c) Construction
- d) Maintenance
- e) Planning
- f) Accounting
- g) Administrative
- h) Other (Please specify)

A.4 What is your current work-hour distribution (jobsite vs. home office)? Please select one response.

- a) Office 100%
- b) Office > 95%
- c) 75% < Office < 94%
- d) 50% < Office < 74%
- e) Jobsite = 50%, Office = 50%
- f) 26% < Office < 50%
- g) 6% < Office < 25%
- h) Office < 5%

A.5 What type of devices (if any) do you use during work hours? Select all that apply.

- a) Smart phone issued for work
- b) Tablet issued for work
- c) PC computer
- d) Laptop
- e) Personal smart phone
- f) Personal tablet
- g) Personal laptop
- h) None

A.6 How much time during the work day do you have access to the internet?

- a) Less than 10 minutes
- b) 10 minutes to 1 hour
- c) 1 hour to 4 hours
- d) More than 4 hours

## **Section B: Training Preference**

B.1 What is your preferred approach to learn about new technologies, applications, or services? Rate the following approaches on a scale of 1 (least favorable) to 5 (most favorable).

- a) One-on-one training
- b) Group training (workshop) supported with materials available online
- c) Comprehensive user manual available for online download
- d) Video or series of videos
- e) Combination of practical training and online videos
- f) Other (please specify)

B.2 What is your preferred length of time when watching instructional videos online?  
Please select one response.

- a) Less than 2 minutes
- b) 2 to 10 minutes
- c) 10 to 20 minutes
- d) As long as it takes to cover the topic

B.3 For a training video, which option would you prefer? Please select one response.

- a) Slide show presentation with screen shots from the program that explain the steps or different components
- b) Recorded video of the computer screen as the steps are being applied

B.4 For the instructions in the training video, which option would you prefer? Please select one response.

- a) Written (on screen) instructions
- b) Voice-over instructions

### **Section C: User Incentives**

C.1 During work, how often do you face a problem, situation, or opportunity for improvement that you think having previous knowledge about would have helped save time, money, or generally improved the outcome?

- a) Daily basis
- b) Weekly basis
- c) Monthly basis
- d) When starting a new position or job function
- e) When starting a new project

C.2 You would most likely provide input and retrieve data from the knowledge sharing program if. . . .:

Thank you for completing this survey.

## Appendix D. Screenshots from the CLEAR Program ‘How-to’ Videos

From the video ‘How to submit a lesson learned to the CLEAR program database’:

### Meaningful lessons learned

-  Encourages positive outcomes
-  Reduces potential for



### Step 1: Login

<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>



### Step 2

#### Complete Basic Respondent Information

**CLEAR Lesson Learned**

Access denied. You do not have permission to perform this action or access this resource.

Name: \*

Office: \*

Email: \*

Phone: \*

\*Name, Office, Email, Phone – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.

Division: 03

Region: Eastern

County:

Described the circumstances surrounding the obstacle or challenge you faced

Solution to solve the problem:

Has this impacted the cost, schedule, and/or quality of your overall work or project?

Open Impact:

### Step 4

#### Solution to the issue

**Describe the solution provided for obstacle or challenge you faced**

Solution to solve the problem:

Provide a description of the solution used to deal with the issue described above.

#### CLEAR Lesson Learned - Submitter's Form

Name: Testing

Office: Test

Email: jwerner@ncdot.gov

Phone: Test

**Describe the circumstances surrounding the obstacle or challenge you faced**

Describe the issue, problem, or obstacle you encountered: This is a test

Date Observed: 2020-02-12T05:00:00Z

Occurrences Encountered: test

Location: test

Division: 01

Region: Eastern

County: Camden

**Describe the Solution you used to solve the issue described above**

Solution to solve the problem: test

**Has this impacted the cost, schedule, and/or quality of your overall work or project?**

Open Impact: Yes

Is there a cost impact? Financial Loss

From the video ‘How to submit a best practice or an idea to the CLEAR program database’:

## Best Practice/Idea

 Effective procedure to obtain optimal results  
 Cost/Schedule savings adopting innovative strategies

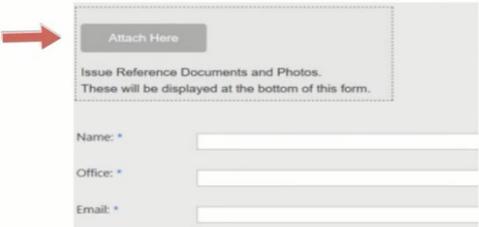
## Step 1: Login

<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>



## Step 2

### Attach Supporting Documents



Attach Here

Issue Reference Documents and Photos. These will be displayed at the bottom of this form.

Name: \*

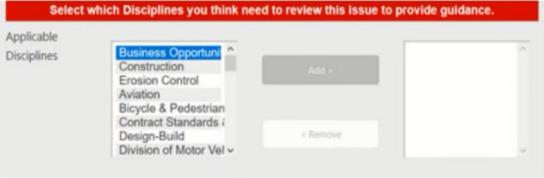
Office: \*

Email: \*

## Step 5

### Identify Applicable Disciplines

Select which Disciplines you think need to review this issue to provide guidance.



Applicable Disciplines

- Business Opportun
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestrian
- Contract Standards /
- Design-Build
- Division of Motor Veh

Buttons: Add, Remove

## Step 6

### Next Steps



**Next Steps Results**

Next Steps

- May result in a policy update;
- May require Specification Change or Special Provision;
- Possible New Product;
- Could be developed with a Lean Six Sigma Project;
- Additional research would further develop this submission;

Other

## Step 7

### Do you wish to be involved in further development (if needed)?

Should this lesson require additional development and implementation - do you wish to be a part of this effort?



Do you wish to be a part of this effort?

Select

Yes

No

Submit

From the video 'How to request a solution to an issue or challenge faced on projects using the CLEAR program database':

## Solution Needed

 Reach out to other users

 Overcame similar challenges



## Step 1: Login

<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>



## Step 2

### Attach Supporting Documents



Issue Reference Documents and Photos.  
These will be displayed at the bottom of this form.

Name: \*

Office: \*

Email: \*

**Describe the technical issue, problem, or obstacle you need assistance in solving.**

Describe the technical issue, problem, or obstacle you encountered

Date Observed

If occurred multiple times, choose one date of occurrence and indicate number or frequency below

Occurrence encountered   
(Approximate number of occurrences or frequency this problem was encountered earlier)

Location

Division

## Step 5

### Identify Applicable Disciplines

**Select which Disciplines you think need to review this issue to provide guidance.**

Applicable Disciplines

- Business Opportunity
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestrian
- Contract Standards
- Design-Build
- Division of Motor Veh



## THANK YOU FOR YOUR CONTRIBUTION

For more information regarding CLEAR, please contact: [CLEAR@ncdot.gov](mailto:CLEAR@ncdot.gov) or the Value Management Office at (919) 874-3333



## Appendix E. Final CLEAR Lessons Learned Data Entry Form

### CLEAR Lesson Learned

Access denied. You do not have permission to perform this action or access this resource.

Name: \*

Office: \*

Email: \*

Phone: \*

\*(Name, Office, Email, Phone) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.

**Describe the circumstances surrounding the obstacle or challenge you faced**

Describe the issue, problem, or obstacle you encountered

Date Observed  

If occurred multiple times, choose one date of occurrence and indicate number or frequency below

Occurrences Encountered   
(Approximate number of occurrences or frequency this problem was encountered earlier)

Location   
(Example: Intersection of HWY109 and US14 or 1 South Wilmington Raleigh NC or Near Exit 70 on I-85)

Division  

**Describe the solution provided for obstacle or challenge you faced**

Solution to solve the problem

Provide a description of the solution used to deal with the issue described above.

**Has this impacted the cost, schedule, and/or quality of your overall work or project?**

Open Impact

**Is this issue related to a construction or maintenance project?**

Open related issue

**Select which Disciplines you think need to review this issue to provide guidance.**

Applicable Disciplines

- Business Opportur
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestria
- Contract Standards
- Design-Build
- Disaster Recovery

**Do you have an idea on what next steps the Department should take to implement this submission?**

Open next steps

**Should this lesson require additional development and implementation - do you wish to be a part of this effort?**

Do you wish to be a part of this effort?

Title

**Appendix F. Final CLEAR Best Practice/Idea Data Entry Form**

**CLEAR Best Practice or Idea**

---

**Attach Here**

Issue Reference Documents and Photos.  
These will be displayed at the bottom of this form.

Name: \*

Office: \*

Email: \*

Phone: \*

\*(Name, Office, Email, Phone, ) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.

**Describe the Best Practice or Idea**

Best Practice description or idea   
Describe a best management practice or idea that could be used in the department

Examples of solution in practice   
Have you seen this in practice in the Department? Have you seen this elsewhere in North Carolina? Have you seen this elsewhere in the Industry? Explain where and how, provide reference details.

**Select which Disciplines you think need to review this issue to provide guidance.**

Applicable  
Disciplines

- Business Opportur
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestria
- Contract Standards
- Design-Build
- Disaster Recovery

Add >

< Remove

**Next Steps Results**

Next Steps

- May result in a policy update;
- May require Specification Change or Special Provision;
- Possible New Product;
- Could be developed with a Lean Six Sigma Project;
- Additional research would further develop this submission;

Other

**Should this lesson require additional development and implementation - do you wish to be a part of this effort?**

Do you wish to be  
a part of this  
effort?

Select ▼

Submit

## Appendix G. Final CLEAR Solution Needed Data Entry Form

### CLEAR Solution Needed

Issue Reference Documents and Photos.  
These will be displayed at the bottom of this form.

Name: \*

Office: \*

Email: \*

Phone: \*

(Name, Office, Email, Phone) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.

**Describe the technical issue, problem, or obstacle you need assistance in solving.**

Describe the technical issue, problem, or obstacle you encountered

Date Observed

If occurred multiple times, choose one date of occurrence and indicate number or frequency below

Occurrence encountered   
(Approximate number of occurrences or frequency this problem was encountered earlier)

Location

Division

**Select which Disciplines you think need to review this issue to provide guidance.**

Applicable Disciplines

- Business Opportur
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestria
- Contract Standards
- Design-Build
- Disaster Recovery

Title

## Appendix H. Standard Operating Procedures for End-Users to Enter Lessons Learned:

The following guidelines provide direction for end-users to submit a lesson learned to the North Carolina Department of Transportation (NCDOT) CLEAR (Communicate Lessons, Exchange Advice, Record) database. A meaningful lesson learned promotes or reinforces positive outcomes and reduces or eliminates the potential for mishaps and failures in future projects. Only items with an asterisk are required, but providing more complete information will provide a more robust database. Thank you for your support of this important program.

The following steps will help guide you through the submission process.

**Step 1: Log in.** Click on the following link which will bring you to the log-in screen.

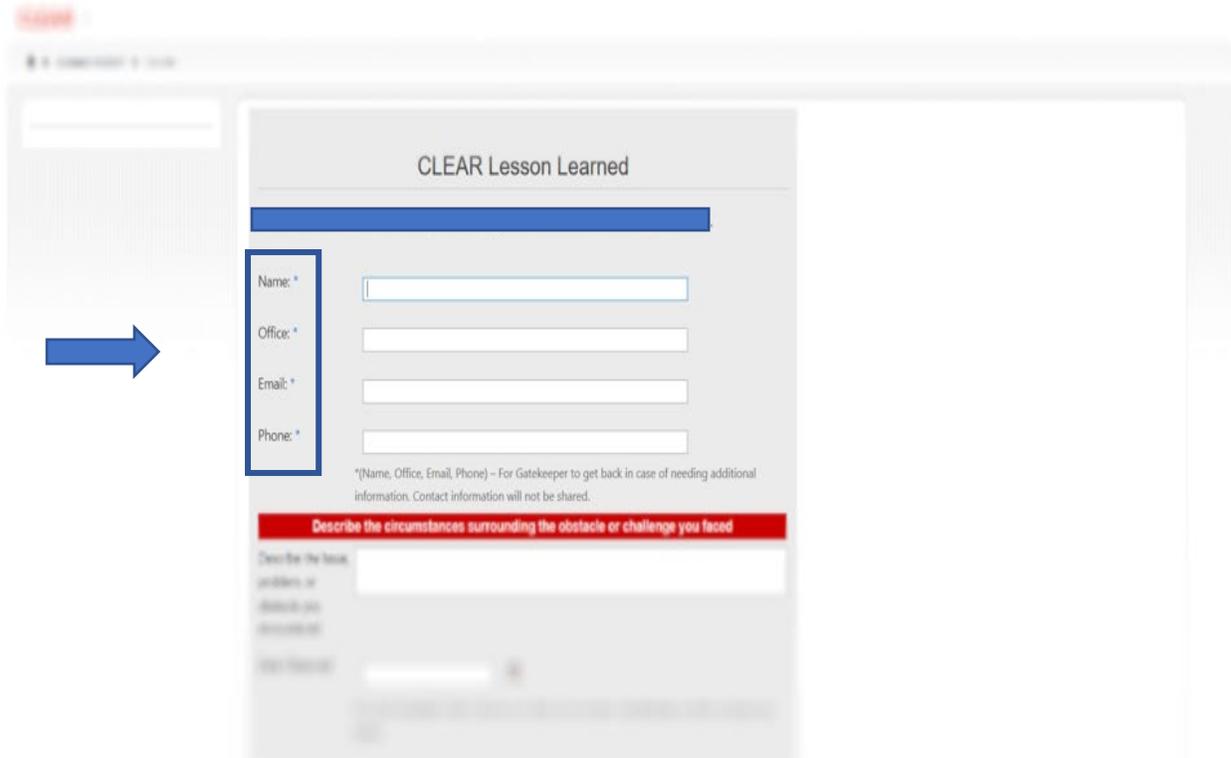
<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>

Log in with required credentials (you may bypass this part of the log-in process if you are already logged into the NCDOT network) and click on ‘Share Lessons Learned’ to start entering information.

Once a submission has been initiated, it cannot be saved to retrieve later. The submission must be submitted at the end of the submission process.

The screenshot shows the CLEAR portal interface. At the top, there is a navigation bar for 'Connect NCDOT BUSINESS PARTNER RESOURCES' with links for Home, Help, Team Sites, and Site Map. Below this is a search bar and a menu with categories like 'Doing Business', 'Bidding & Letting', 'Projects', 'Resources', and 'Municipalities'. The main content area is titled 'CLEAR · CLEAR' and 'Communicate Lessons, Exchange Advice, Record'. A central banner reads 'Welcome To CLEAR' and states: 'This online portal is open to all NCDOT Employees with an NCDOT Email. It is used as a tool to learn from colleagues on past questions that have been asked or recommendations that have been found. Some of the submissions may have been implemented, others are in development, and others are solutions to questions from our expert review panel. Turn around time is up to 30 days from submission.' Below the banner are three main action buttons: 'Share Lessons Learned', 'Share Best Practice/Idea', and 'Request Assistance with an Obstacle'. A blue arrow points to the 'Share Lessons Learned' button. The right sidebar contains 'Questions about CLEAR?' with contact info for Clare Fullerton, PE (CLEAR@ncdot.gov), 'Training Dates' for Division 14 and 13 Maintenance Training (March 19, 2020), and 'Links to Contacts' for Safety, HR, and IT concerns.

**Step 2: Complete basic respondent information.** The first part of the Lessons Learned form requires basic respondent information, such as your name, office, email address, and office phone number. This information is solely for the purpose of the gatekeeper to contact you in case additional information or clarification is necessary.



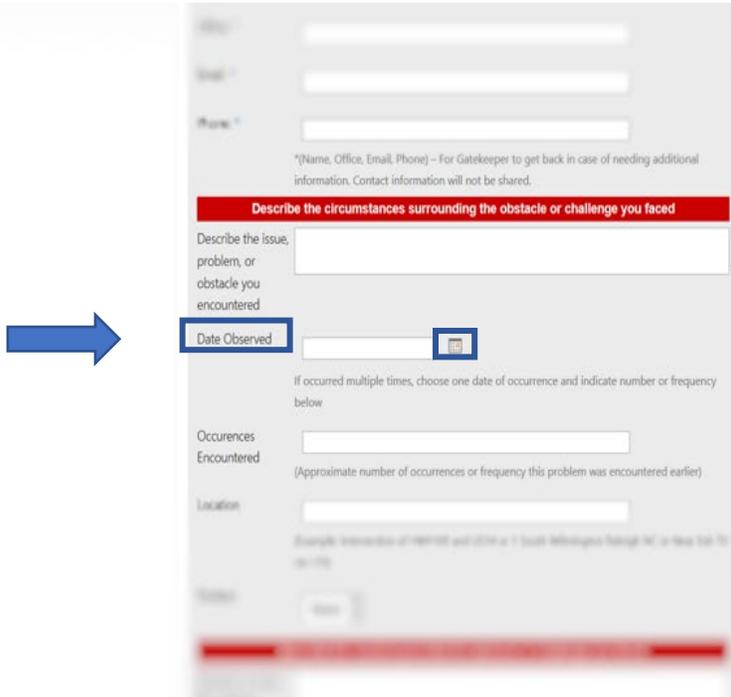
The image shows a screenshot of a web-based form titled "CLEAR Lesson Learned". The form is divided into several sections. At the top, there is a blue header bar. Below this, the form is organized into a grid. The first column contains labels for "Name: \*", "Office: \*", "Email: \*", and "Phone: \*". The second column contains corresponding text input fields. A blue arrow points from the left towards the "Name: \*" field. Below the input fields, there is a red banner with the text "Describe the circumstances surrounding the obstacle or challenge you faced". Underneath the banner, there is a large text area for describing the issue, followed by a "Date Reported" field and a "Submit" button. At the bottom, there is a small disclaimer: "(Name, Office, Email, Phone) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared."

**Step 3: Describe the circumstances surrounding the obstacle or challenge you faced.** This step captures information about the obstacle or challenge you faced on a project.

**Step 3 a: Describe the issue, problem, or obstacle you encountered.** Enter a description of the issue and a summary of the lesson learned that provides an overview of the issue.

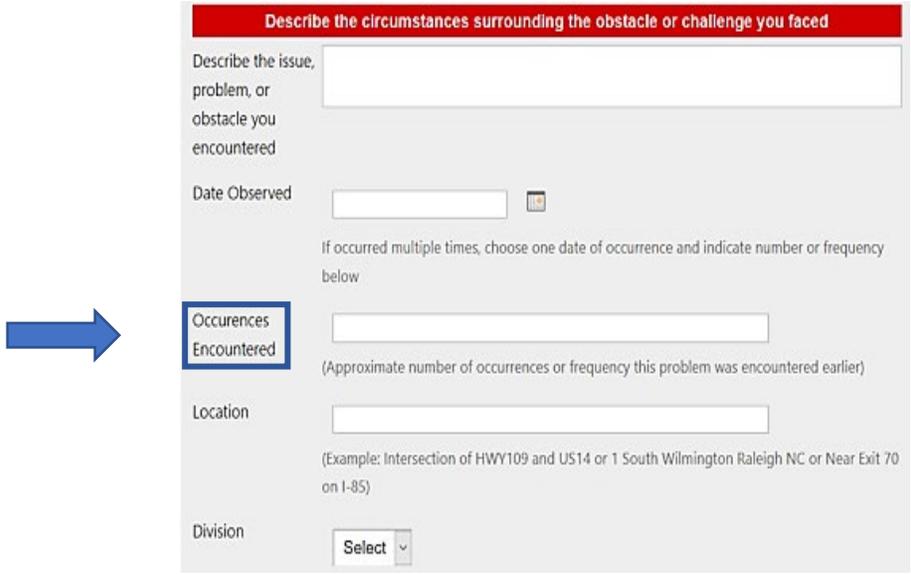
The image shows a screenshot of a web form. At the top, there are three input fields labeled 'Name', 'Email', and 'Phone'. Below these is a note: '\*[Name, Office, Email, Phone] - For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.' A red header bar contains the text 'Describe the circumstances surrounding the obstacle or challenge you faced'. Below this is a large text area with the prompt 'Describe the issue, problem, or obstacle you encountered'. A blue arrow points to this text area. Further down, there is a 'Date Observed' field with a calendar icon, followed by the instruction 'If occurred multiple times, choose one date of occurrence and indicate number or frequency below'. Below that is an 'Occurrences Encountered' field with the note '(Approximate number of occurrences or frequency this problem was encountered earlier)'. A 'Location' field follows, with an example: 'Example: Intersection of I-95/101 and 27th St in South Wilmington, Delaware, DE or New York, NY'. At the bottom, there is a 'Submit' button and another red header bar.

**Step 3 b: Select date observed.** To enter the date that you observed the issue, click on the calendar button and select the approximate date that you observed this issue. If the issue frequently occurs, then enter the most recent date observed and provide details about that particular observation.



The image shows a screenshot of a web form. A blue arrow points from the left towards the 'Date Observed' field, which is highlighted with a blue box. The form includes several input fields: 'Name', 'Email', and 'Phone'. Below these is a red header with the text 'Describe the circumstances surrounding the obstacle or challenge you faced'. This is followed by a large text area for describing the issue. The 'Date Observed' field is a date picker, and a small calendar icon is visible next to it. Below the date field is a section for 'Occurrences Encountered' with a text input and a note '(Approximate number of occurrences or frequency this problem was encountered earlier)'. There is also a 'Location' field with a text input and a small example text below it. At the bottom, there is a 'Submit' button and a red bar.

**Step 3 c: Indicate issue frequency.** Using the drop-down menu, indicate the number of times that you have encountered this issue.



**Describe the circumstances surrounding the obstacle or challenge you faced**

Describe the issue, problem, or obstacle you encountered

Date Observed

If occurred multiple times, choose one date of occurrence and indicate number or frequency below

**Occurrences Encountered**

(Approximate number of occurrences or frequency this problem was encountered earlier)

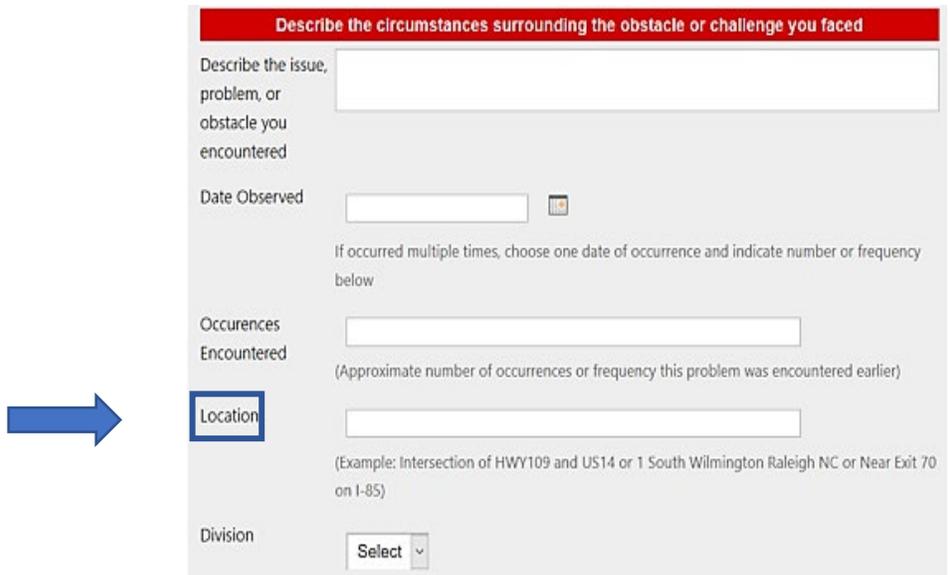
Location

(Example: Intersection of HWY109 and US14 or 1 South Wilmington Raleigh NC or Near Exit 70 on I-85)

Division

Select

**Step 3 d: Identify location of observation.** Enter the location where you observed the issue/best practice. If you observed it at multiple locations, enter the most recent occurrence location.



**Describe the circumstances surrounding the obstacle or challenge you faced**

Describe the issue, problem, or obstacle you encountered

Date Observed

If occurred multiple times, choose one date of occurrence and indicate number or frequency below

Occurrences Encountered

(Approximate number of occurrences or frequency this problem was encountered earlier)

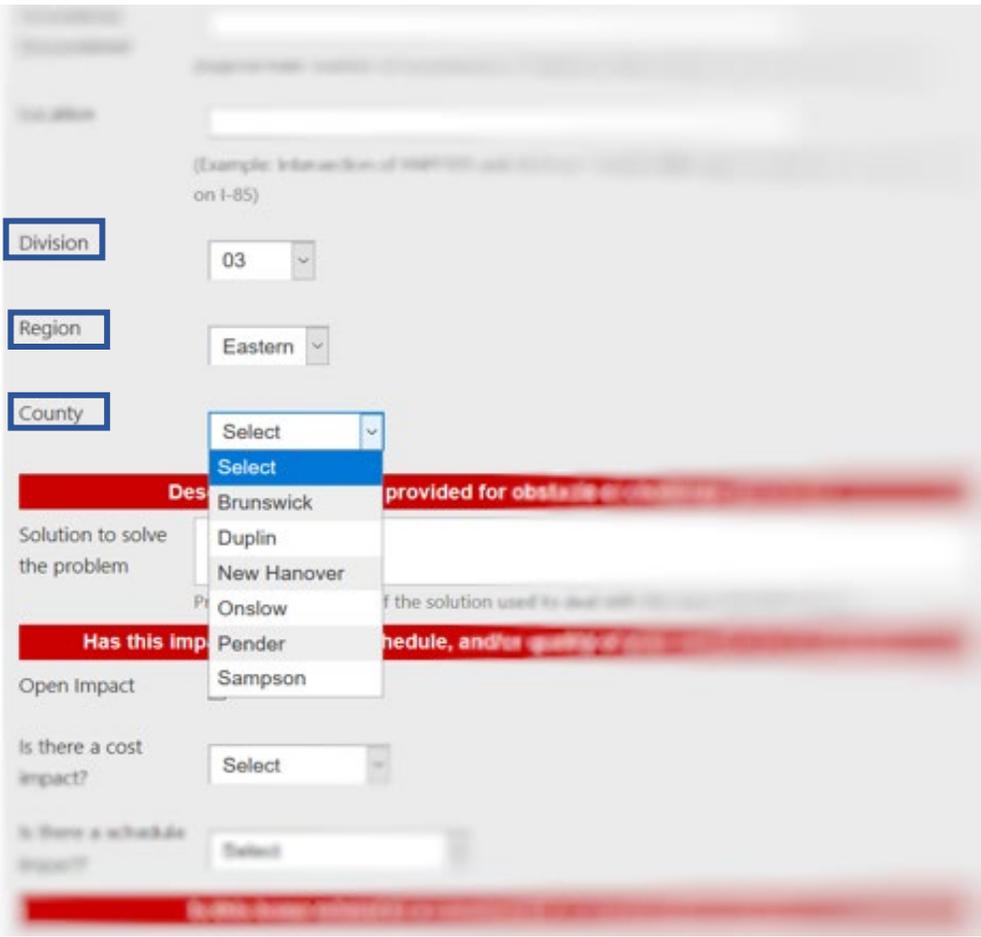
**Location**

(Example: Intersection of HWY109 and US14 or 1 South Wilmington Raleigh NC or Near Exit 70 on I-85)

Division

Select

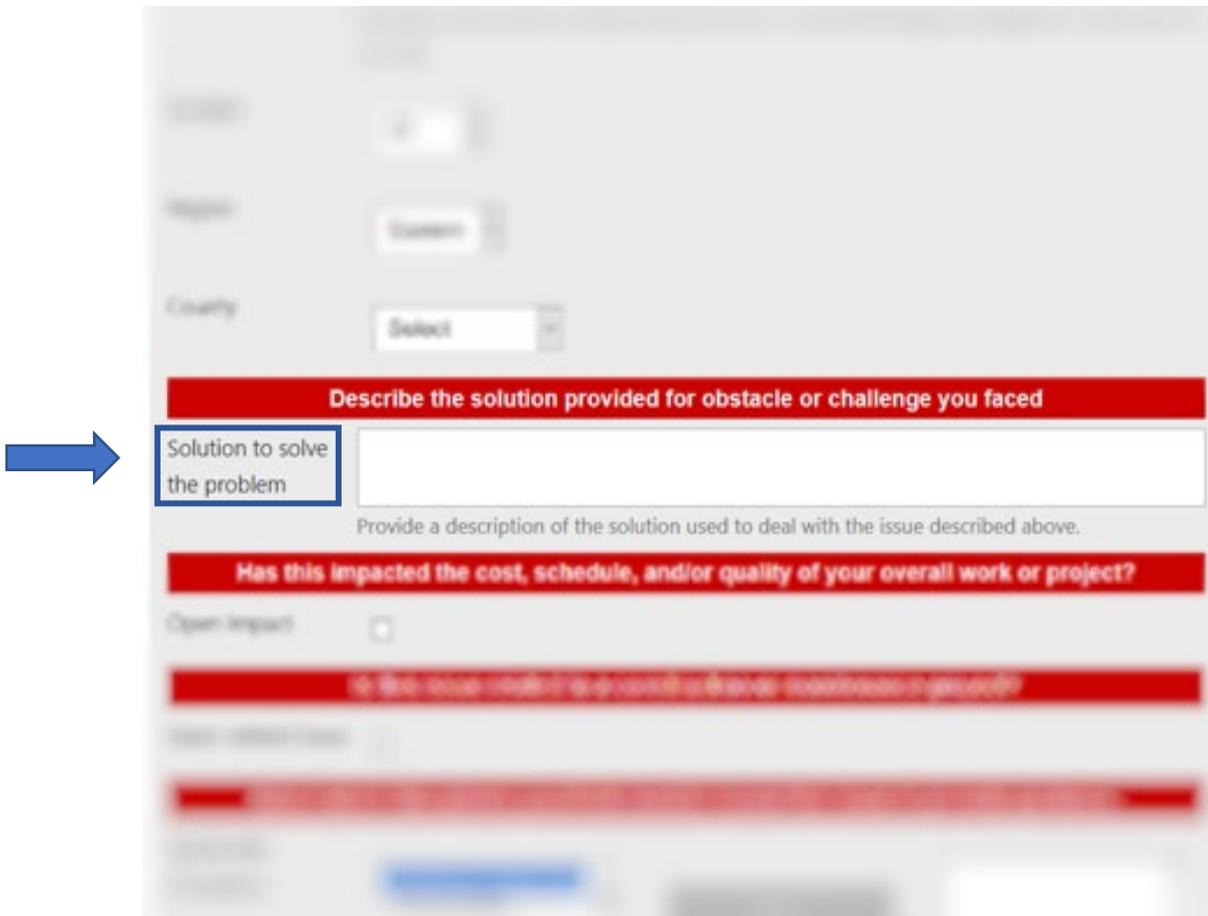
**Step 3 e: Division and County.** Using the drop-down options, select the Division and County related to the issue. Both Region and County will automatically populate based on the Division selected, and thus, Division must always be selected prior to selecting the county from the drop-down list.



The image shows a screenshot of a web form with several fields. The 'Division' field is highlighted with a blue box and contains the value '03'. The 'Region' field is also highlighted with a blue box and contains the value 'Eastern'. A blue arrow points to the 'Region' field. The 'County' field is highlighted with a blue box and has a dropdown menu open, showing the following options: 'Select', 'Brunswick', 'Duplin', 'New Hanover', 'Onslow', 'Pender', and 'Sampson'. The 'Select' option is highlighted in blue. Below the 'County' field, there are several red horizontal bars, likely representing redacted text or error messages. Other fields in the form include 'Solution to solve the problem', 'Has this impact?', 'Open Impact', 'Is there a cost impact?', and 'Is there a schedule impact?'. The 'Is there a cost impact?' field has a dropdown menu with 'Select' as the only visible option. The 'Is there a schedule impact?' field has a dropdown menu with 'Select' as the only visible option.

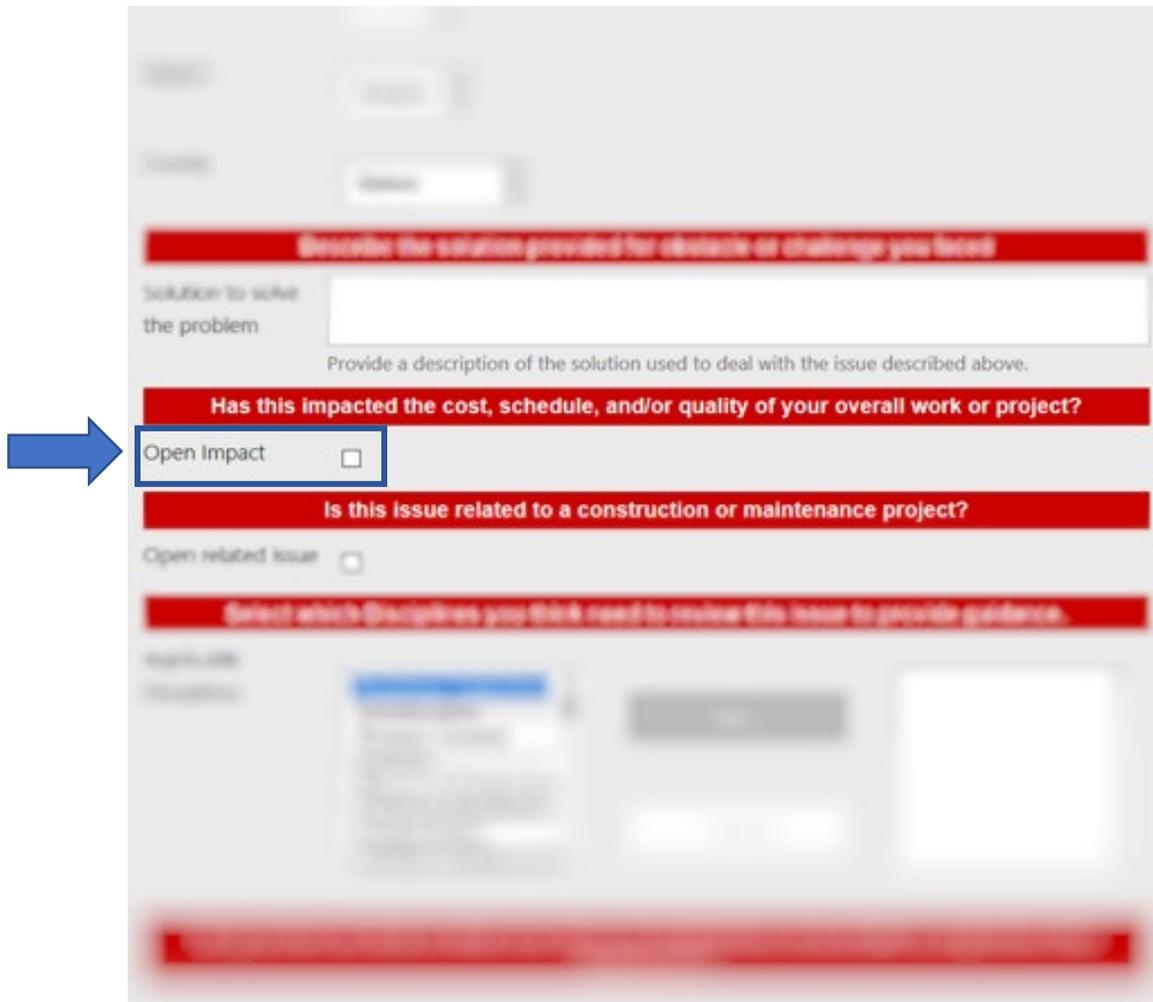
**Step 4: Describe solution(s) to the issue.** Provide details about if and how the issue was resolved in the ‘Solution to solve the problem’ field. Also, if you have determined the solution to this problem in another DOT or any other relevant source, please provide such examples in the box provided.

If you are looking for assistance to find a solution and do not have any suggestions at the time of submission, then use the Solution Needed form to solicit a solution to an issue. Similarly, use the Best Practices form to share a best practice/innovative idea that you might have used in a project.



The image shows a screenshot of a web form. At the top, there are three dropdown menus labeled 'State', 'Region', and 'County'. Below these is a red header bar with the text 'Describe the solution provided for obstacle or challenge you faced'. Underneath this header is a text input field with the label 'Solution to solve the problem'. A blue arrow points to this label. Below the input field is a smaller line of text: 'Provide a description of the solution used to deal with the issue described above.' Below this is another red header bar with the text 'Has this impacted the cost, schedule, and/or quality of your overall work or project?'. Underneath this is a radio button labeled 'Open Impact'. Below that is another red header bar with the text 'Is this issue related to a project or a specific business or agency?'. Below this is a radio button labeled 'Yes' and a radio button labeled 'No'. At the bottom, there are two buttons: a blue button labeled 'Submit' and a white button labeled 'Cancel'.

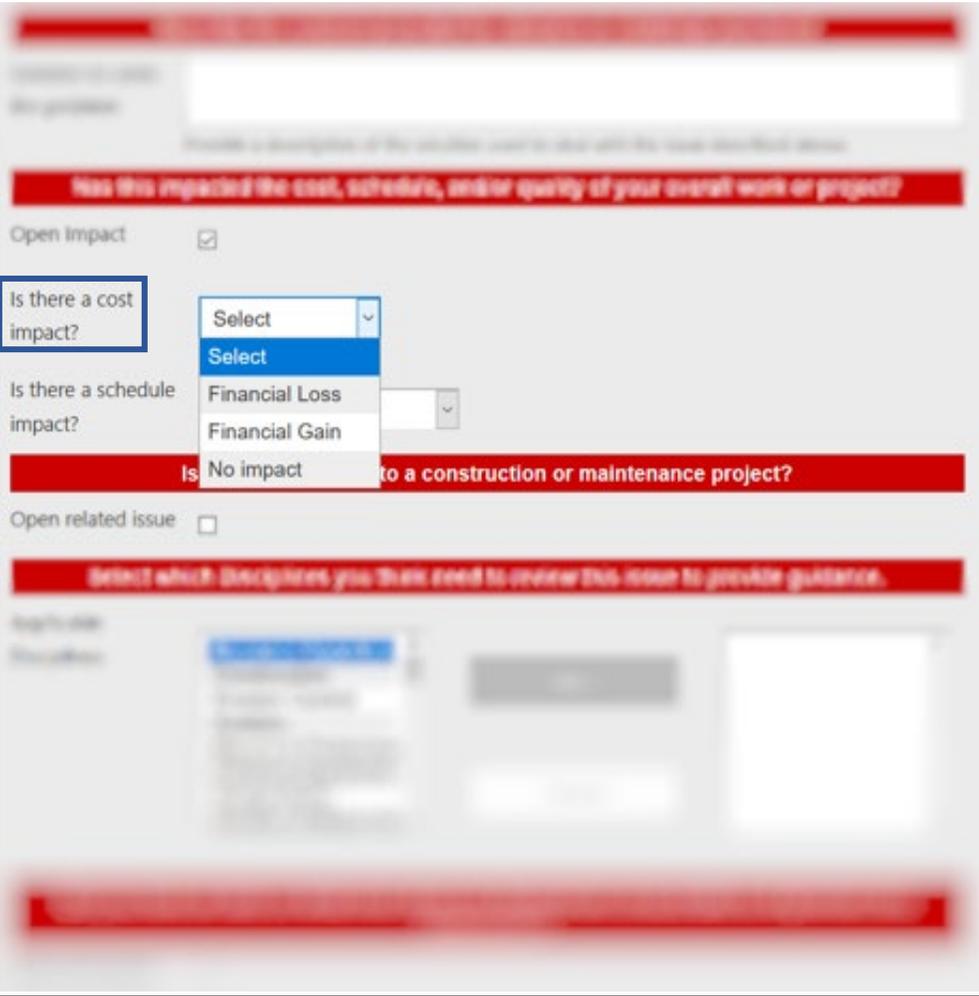
**Step 5: Cost and schedule impacts.** If the lesson learned/issue impacted the cost and/or schedule of the project, then click on the ‘Radio’ button to enter relevant information. If the lesson learned/issue did not impact cost and schedule, skip to Step 6.



The image shows a screenshot of a web form with several sections. A blue arrow points to the 'Open Impact' radio button. The form includes the following elements:

- A red header bar with the text: "Describe the solution provided for obstacles or challenges you faced".
- A text input field labeled "Solution to solve the problem" with a placeholder text: "Provide a description of the solution used to deal with the issue described above."
- A red header bar with the text: "Has this impacted the cost, schedule, and/or quality of your overall work or project?".
- A radio button labeled "Open Impact" which is selected.
- A red header bar with the text: "Is this issue related to a construction or maintenance project?".
- A radio button labeled "Open related issue".
- A red header bar with the text: "Select which Disciplines you think need to resolve this issue to provide guidance."
- A dropdown menu for "Disciplines" with a list of options.
- A text input field for "Additional comments".
- A red footer bar.

**Step 5 a: Impact on cost.** Select the appropriate cost impact from the drop-down menu.



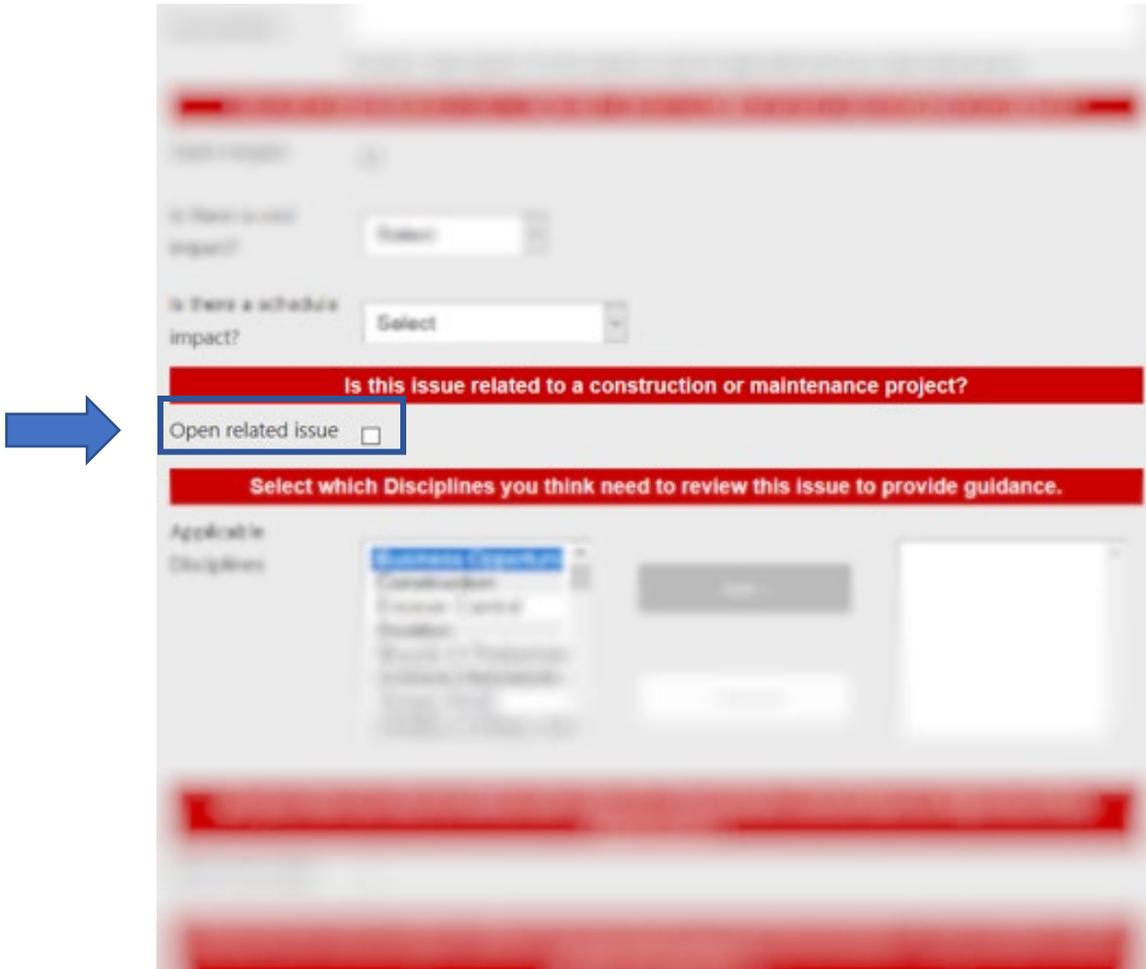
The image shows a screenshot of a web form with a red header. The form contains several sections:

- A text input field for a problem description.
- A red banner with the text: "Has this impacted the cost, schedule, and/or quality of your overall work or project?"
- A checkbox labeled "Open Impact" which is checked.
- A question "Is there a cost impact?" with a dropdown menu open. The dropdown options are: "Select", "Financial Loss", "Financial Gain", and "No impact". A blue arrow points to this question.
- A question "Is there a schedule impact?" with a dropdown menu.
- A red banner with the text: "Is No impact to a construction or maintenance project?"
- A checkbox labeled "Open related issue" which is unchecked.
- A red banner with the text: "Select which disciplines you think need to review this issue to provide guidance."
- A section for "Applicable Disciplines" with a list of options and a "Select All" button.

**Step 5 b: Impact on schedule.** Select the appropriate schedule impact from the drop-down menu.

The screenshot shows a software interface with several sections. A blue arrow points to a dropdown menu for the question "Is there a schedule impact?". The dropdown menu is open, showing the following options: "Select", "Addition to schedule", "Schedule improvement", and "No impact". Below this, there is a section titled "Applicable Disciplines" with a list of options: "Business Opportunity", "Construction", "Emission Control", "Reliable", "Energy & Production", "Process Remediation", "Safety", and "Water & Wastewater". There are also buttons for "Add" and "Remove" next to the disciplines list. The interface has a red header bar at the top and bottom.

**Step 6: Is this issue related to construction or maintenance?** If yes, click on the ‘Radio’ button to enter relevant project information. If this issue does not relate to construction or maintenance, skip to Step 7.



The image shows a screenshot of a web form with several sections. At the top, there is a red header bar. Below it, there are two dropdown menus labeled "Is there a schedule impact?" and "Is there a schedule impact?". Below these is another red header bar with the text "Is this issue related to a construction or maintenance project?". Underneath this bar is a radio button labeled "Open related issue". A blue arrow points to this radio button. Below the radio button is another red header bar with the text "Select which Disciplines you think need to review this issue to provide guidance.". Underneath this bar is a section titled "Applicable Disciplines" which contains a list of disciplines, a "Add" button, and a "Remove" button. The list of disciplines includes "Construction", "Civil Engineering", "Mechanical", "Structural Engineering", "Electrical Engineering", "Environmental Engineering", "Industrial Engineering", "Information Systems", and "Other".

**Step 6 a: Enter project details.** Select the Project Type, Project Phase, Project Cost, Project Size, and Project Schedule from the respective drop-down menus. The Project Number must then be selected from the drop-down menu prior to selecting the Contract Number. These fields are populated from the Highway Construction and Materials System (HiCAMS) database, and the Contract Number is populated based on the Project Number selected.

If the Project Number is not available from the drop-down menu, then fill in the fields manually.

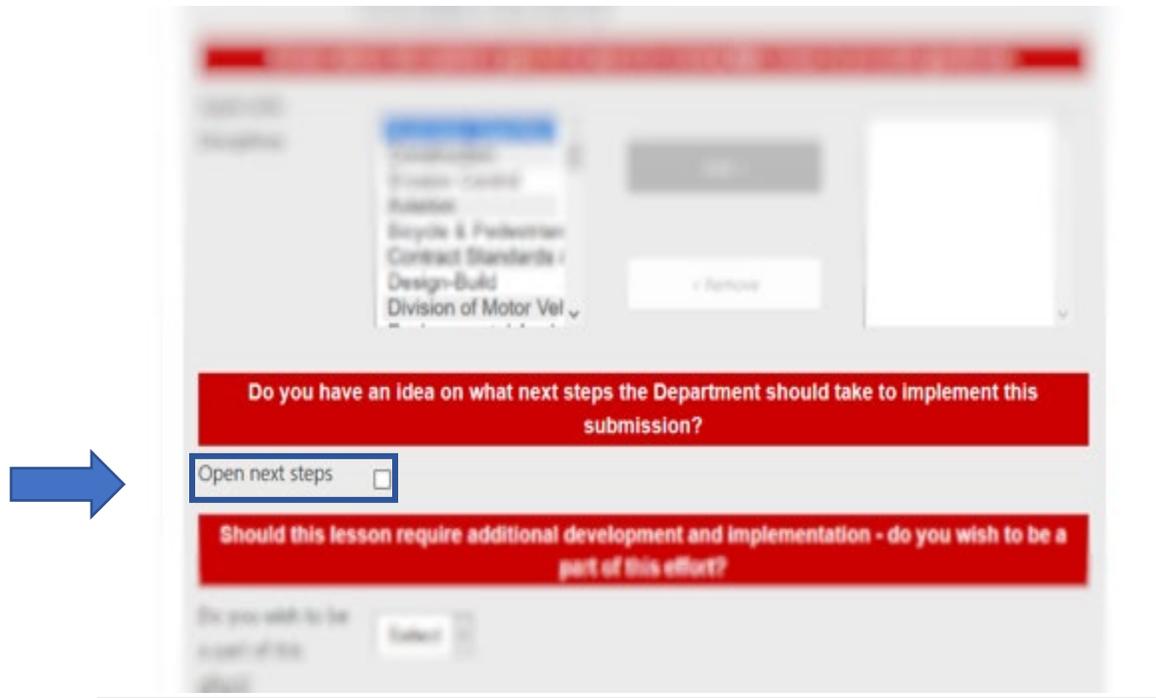
The screenshot shows a web form with a red header bar containing the text "Is this issue related to a construction or maintenance project?". Below the header, there is a checkbox labeled "Open related issue" which is checked. The form contains several fields:

- Project Type:** A dropdown menu with "Select" as the current value.
- Project Phase:** A dropdown menu with "Select" as the current value.
- Project Cost:** A dropdown menu with "Select" as the current value.
- Project Size:** A dropdown menu with "Select" as the current value.
- Project Schedule:** A dropdown menu with "Select" as the current value.
- Project Number Available:** A wide dropdown menu with "Select" as the current value.
- Provide Project Number:** A text input field. Below it, the text "If not available in drop-down list" is displayed.
- Contract Number Available:** A dropdown menu with "Select" as the current value.
- Provide Contract Number:** A text input field. Below it, the text "If not available in drop-down list" is displayed.

**Step 7: Identify applicable disciplines.** Select the Applicable Disciplines for this lesson; 38 disciplines are possible within the scope of this project. Although the number of applicable disciplines is not limited, please select only the most pertinent or applicable discipline(s). You can scroll down and view all 38 applicable disciplines. For multiple selections, press and hold the Ctrl button on the keyboard to select all the applicable disciplines using a mouse-click. Once you have made all possible selections, click on 'Add' to finalize the selections. If you added an option by mistake or want to remove selection(s), you can select the discipline to be removed from the list and press the 'Remove' button.

The screenshot shows a web form interface. At the top, there is a grey box with the text "Number" and "if not available in drop-down list". Below this is a red banner with the instruction "Select which Disciplines you think need to review this issue to provide guidance." Underneath the banner, the label "Applicable Disciplines" is positioned to the left of a scrollable list box. The list box contains several items: "Business Opportuni" (highlighted in blue), "Construction", "Erosion Control", "Aviation", "Bicycle & Pedestrian", "Contract Standards i", "Design-Build", and "Division of Motor Vel". To the right of the list box are two buttons: "Add >" and "< Remove". To the right of these buttons is an empty scrollable box. Below the list and buttons is another red banner with the question "Do you have an idea on what next steps the Department should take to implement this submission?". At the bottom left, there is a label "Open next steps" followed by a radio button. At the very bottom, there is a partially visible red banner with some text.

**Step 8: Open next steps.** If you have a recommendation about how this issue and/or solution could be developed further or integrated into the department, then click on the ‘Radio’ button that reads ‘Open next steps’.



The image shows a screenshot of a web form. At the top, there is a red header bar. Below it, there is a search bar and a list of categories including 'Transportation', 'Energy - Nuclear', 'Health', 'Bicycle & Pedestrian', 'Contract Standards', 'Design-Build', and 'Division of Motor Veh'. To the right of the search bar is a 'Remove' button. Below the categories, there is a red box with the text: 'Do you have an idea on what next steps the Department should take to implement this submission?'. Underneath this box is a radio button labeled 'Open next steps'. A blue arrow points to this radio button. Below the radio button is another red box with the text: 'Should this lesson require additional development and implementation - do you wish to be a part of this effort?'. At the bottom of the form, there is a 'Submit' button.

**Step 8 a: Next step results.** Select the appropriate boxes that you feel match the impact of the lesson learned on the organization as a whole.



Do you have an idea on what next steps the Department should take to implement this submission?

Open next steps

**Next Steps Results**  May result in a policy update;

May require Specification Change or Special Provision;

Possible New Product;

Could be developed with a Lean Six Sigma Project;

Additional research would further develop this submission;

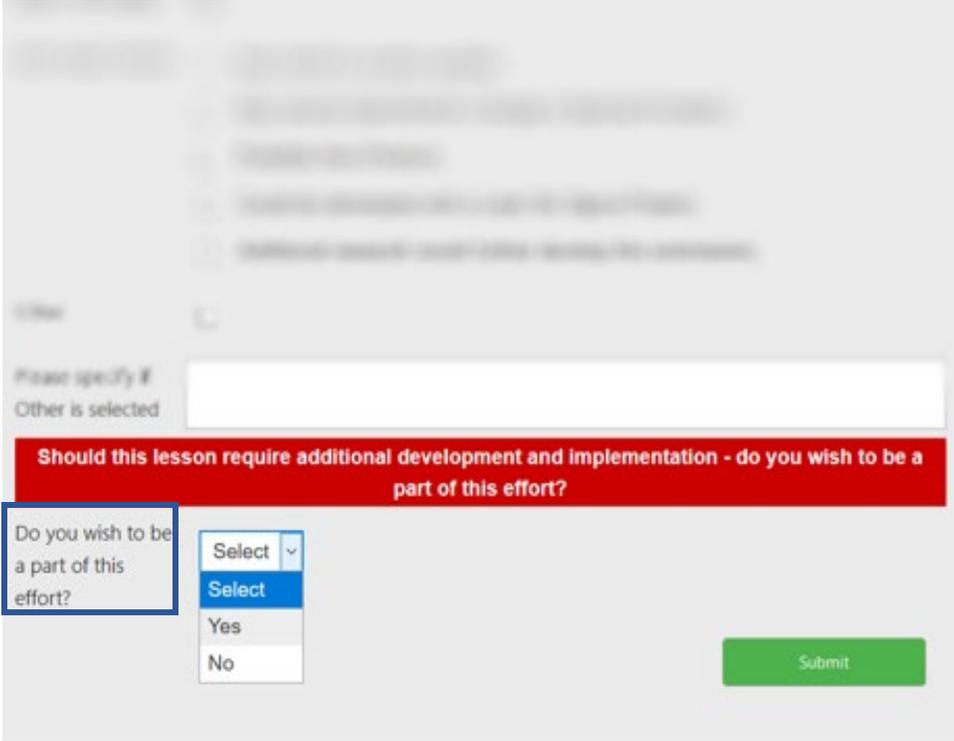
Other

Please specify if Other is selected

Should this lesson require additional development and implementation - do you wish to be a part of this effort?

Do you wish to be a part of this effort?

**Step 9: Additional development and implementation.** If you wish to be part of the development and possible implementation of this lesson learned to benefit the organization as a whole, then select 'Yes' from the drop-down menu.



The image shows a screenshot of a web form. A red banner contains the question: "Should this lesson require additional development and implementation - do you wish to be a part of this effort?". Below this banner, a blue-bordered box highlights the text "Do you wish to be a part of this effort?". To the right of this box is a dropdown menu with the following options: "Select", "Select", "Yes", and "No". A blue arrow points from the left towards the highlighted text. A green "Submit" button is located at the bottom right of the form area.

**Step 10: Check fields and submit.** Upon completing the form, kindly go through all the fields to check for any missing fields. Once you are satisfied that the form is complete, submit the lesson learned. It will be sent to the gatekeeper in the Value Management Office for review. Once you have clicked on the ‘Submit’ button, no further changes can be made to the form.

The image shows a portion of a web form. At the top, there is a 'Title' field with a small icon to its right. Below this is a text input field with the label 'Please specify if Other is selected'. A prominent red banner contains the question: 'Should this lesson require additional development and implementation - do you wish to be a part of this effort?'. Below the banner is another question: 'Do you wish to be a part of this effort?' with a dropdown menu. The dropdown menu is open, showing the following options: 'Select' (with a downward arrow), 'Select' (highlighted in blue), 'Yes', and 'No'. To the right of the dropdown menu is a green rectangular button with the text 'Submit' inside it, which is highlighted with a blue border.

**NOTE:** Once the form has been submitted, a weblink will be emailed to you automatically. This link will let you see your responses and you can bookmark this link or print a copy of your responses for future reference. Please note that no changes can be made to the entries once the form has been submitted. A typical lesson learned entered will look as shown below.

CLEAR

Home > Connect NCDOT > CLEAR

CLEAR

- [SDP to Submit Lessons Learned Best Management Practices](#)
- [Accepted Lessons Learned](#)
- [Accepted Best Practices](#)
- [Recent](#)

CLEAR Lesson Learned - Submitter's Form

Name: Testing  
 Office: Test  
 Email: jamerth@ncdot.gov  
 Phone: Test

**Describe the circumstances surrounding the obstacle or challenge you faced**

Describe the issue, problem, or obstacle you encountered: This is a test  
 Date Observed: 2020-02-12T05:00:00Z  
 Occurrences Encountered: test  
 Location: test  
 Division: 01  
 Region: Eastern  
 County: Camden

**Describe the Solution you used to solve the issue described above.**

Solution to solve the problem: test

**Has this impacted the cost, schedule, and/or quality of your overall work or project?**

Open Impact: Yes  
 Is there a cost impact?: Financial Loss  
 Cost Impact: between 25% - 50%  
 Is there a schedule impact?: Addition to schedule  
 Schedule Impact: between 25% - 50%

**Is this issue related to a construction or maintenance project?**

Open related issue: Yes  
 Project Type: - Highway  
 Project Phase: - Design  
 Project Cost: 50,000 - 250,000  
 Project Size: 1 mile - 10 miles  
 Project Schedule: 1 month - 6 months  
 Project Number Available: 0-3673  
 Provide Project Number: test  
 Contract Number Available: C200962  
 Provide Contract Number: test

**Select which Disciplines you think need to review this issue to provide guidance.**

Applicable Disciplines: Testing

**Do you have an idea on what next steps the Department should take to implement this submission?**

Open next steps: No

Next Steps Results:

Other: No

Please specify if Other is selected

**Should this lesson require additional development and implementation - do you wish to be a part of this effort?**

Do you wish to be a part of this effort?: Yes  
 Provide Email Address: jamerth@ncdot.gov

Version: 1.0  
 Created at 2/13/2020 12:07 PM by W. Meritt  
 Last modified at 2/13/2020 12:07 PM by W. Meritt

You can bookmark the online link to your lesson learned submission in your web browser or print a record of your responses by right-clicking anywhere on the form and selecting the 'Print' option; see below.

**CLEAR Lesson Learned - Submitter's Form**

Name:	Testing
Office:	Test
Email:	jwmerritt@ncdot.gov
Phone:	Test
<b>Describe the circumstances surrounding the obstacle or challenge you faced</b>	
Describe the issue, problem, or obstacle you encountered	This is a test
Date Observed	2020-02-12T05:00:00Z
Occurrences Encountered	test
Location	test
Division	01
Region	Eastern
County	Camden
<b>Describe the Solution you used to solve the issue described</b>	
Solution to solve the problem	test
<b>Has this impacted the cost, schedule, and/or quality of your organization's operations?</b>	
Open Impact	Yes
Is there a cost impact?	Financial Loss

Back	Alt+Left Arrow
Forward	Alt+Right Arrow
Reload	Ctrl+R
Save as...	Ctrl+S
Print...	Ctrl+P
Cast	
Translate to English	
View page source	Ctrl+U
Inspect	Ctrl+Shift+I



**Thank you for your contribution.**

## Appendix I. Standard Operating Procedures for End-Users to Enter Best Practices/Ideas:

The following guidelines provide direction for end-users to submit a best practice or an innovative idea to the North Carolina Department of Transportation (NCDOT) CLEAR (Communicate Lessons, Exchange Advice, Record) database. A best practice is an effective procedure that has been used in a project to obtain optimal results and can be proposed for widespread adoption throughout the organization. An example of a best practice includes cost/schedule savings by adopting innovative strategies. Only items with an asterisk are required, but providing more complete information will provide a more robust database. Thank you for your support of this important program.

The following steps will help guide you through the submission process.

**Step 1: Log in.** Click on the following link which will bring you to the log-in screen.

<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>

Log in with required credentials (you may bypass this part of the log-in process if you are already logged into the NCDOT network) and click on 'Share Best Practices/Idea' as shown in the screenshot below.

Once a submission has been initiated, it cannot be saved to retrieve later. The submission must be submitted at the end of the submission process.

Connect NCDOT  
BUSINESS PARTNER RESOURCES

Home Help Team Sites Site Map

Doing Business Bidding & Letting Projects Resources Municipalities

Search

**CLEAR · CLEAR**

Connect NCDOT · CLEAR

**CLEAR**

- [SDP to Submit Lessons Learned Best Management Practices](#)
- [Accepted Lessons Learned](#)
- [Accepted Best Practices](#)

### Communicate Lessons, Exchange Advice, Record

Connect NCDOT · CLEAR

## Welcome To CLEAR

This online portal is open to all NCDOT Employees with an NCDOT Email. It is used as a tool to learn from colleagues on past questions that have been asked or recommendations that have been found. Some of the submissions may have been implemented, others are in development, and others are solutions to questions from our expert review panel. Turn around time is up to 30 days from submission.

Share Lessons Learned   Share Best Practice/Idea   Request Assistance with an Obstacle

Do you have a Lesson Learned to share? Have you met an obstacle and solved the issue?

Do you have a best practice to share with the Department? Do you have an idea of something that could be used in the Department?

This review will be completed within 2 weeks. Do you have an issue, problem, or obstacle that you need assistance in solving?

Share Lessons Learned

Share Best Practice/Idea

Request Assistance with an Obstacle

### Questions about CLEAR?

Email Clare Fullerton, PE  
CLEAR@ncdot.gov

#### Training Dates

**Division 14 Maintenance Training**  
March 19, 2020

**Division 13 Maintenance Training**  
March 19, 2020

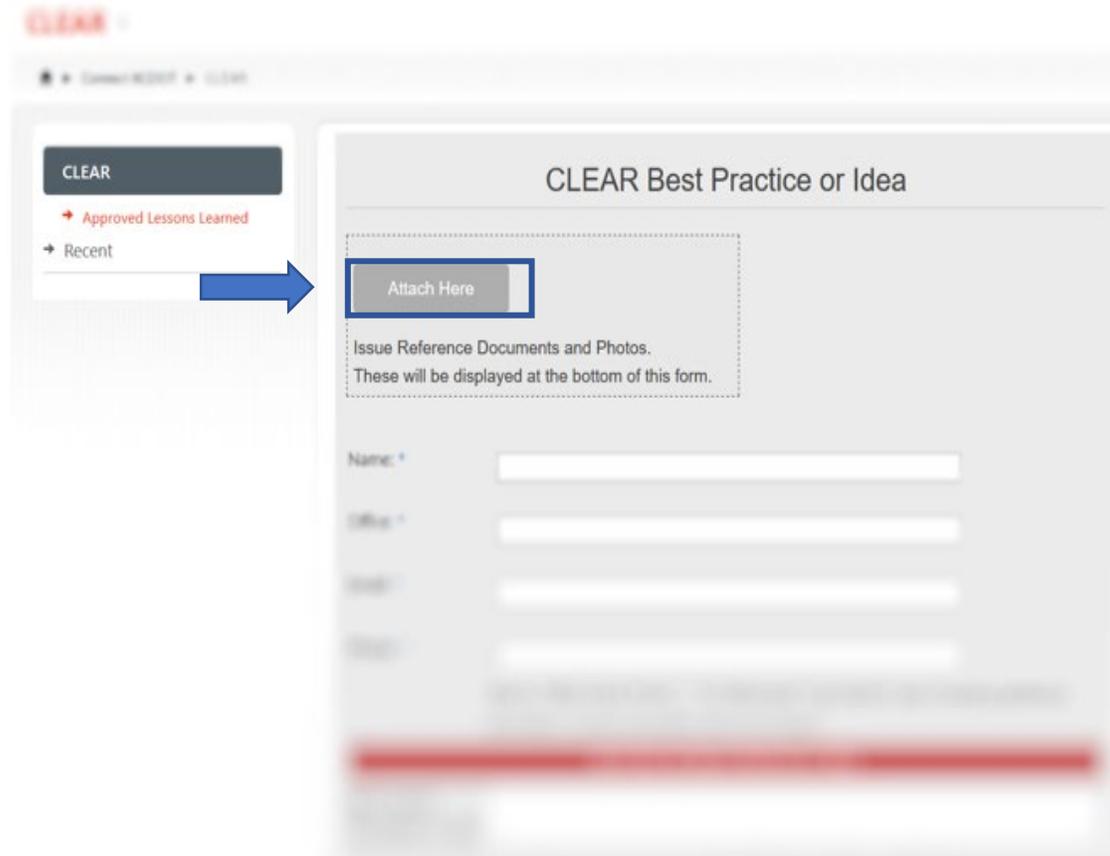
#### Links to Contacts

To contact safety with a Safety Concern please contact ANYRISK:  
<https://connect.ncdot.gov/anyrisk/Pages/default.aspx>

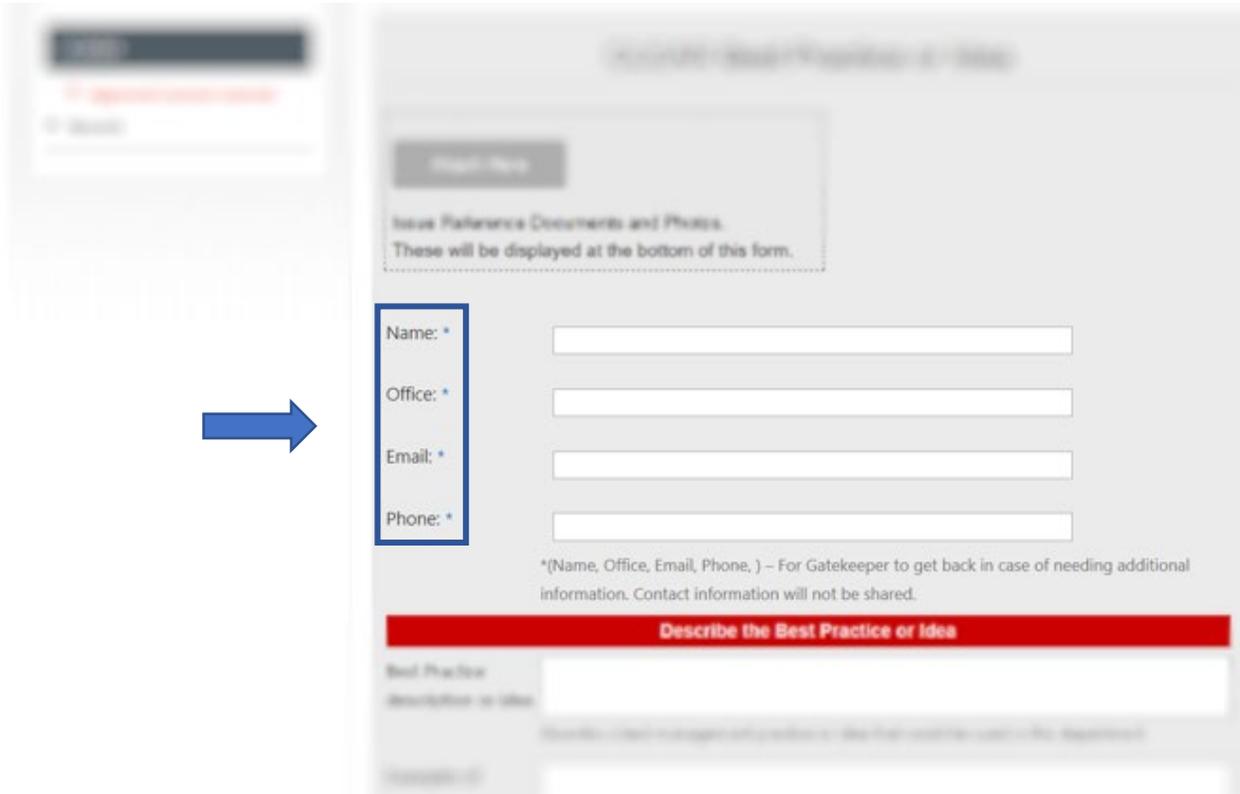
To contact HR with an HR Concern please contact your HR representative: <https://apps.ncdot.gov/directorioauthenticated/JoinPage.aspx?hd=22>

To contact IT with a Help Desk Item please contact the HELP Desk:  
[dot@ncdot.gov](mailto:dot@ncdot.gov)

**Step 2: Attach supporting documents.** The first part of the Best Practices or Idea form allows you to include pertinent reference documents, such as images, emails, PDFs, standard drawings, contract language, or other files, to make the best practice/idea clear and easy to understand. The attached files will be visible to you before submission to ensure that the appropriate files are attached.



**Step 3: Complete basic respondent information.** The next part of the Best Practice or Idea form requires basic respondent information, such as your name, office, email address, and office phone number. This information is solely for the purpose of the gatekeeper to contact you in case additional information or clarification is necessary.



The image shows a screenshot of a web form. On the left, a blue arrow points towards the contact information fields. The form has a header area with a 'Submit Now' button. Below this, there is a section for 'Issue Reference Documents and Photos' with a note that these will be displayed at the bottom of the form. The contact information section includes four input fields: 'Name: \*', 'Office: \*', 'Email: \*', and 'Phone: \*'. Below these fields is a note: '\* (Name, Office, Email, Phone, ) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.' A red horizontal bar with the text 'Describe the Best Practice or Idea' is positioned below the contact fields. The bottom of the form contains a 'Best Practice' section with a text area for 'Description or Idea' and a 'Submit' button.



**Step 4 b: Describe examples of solution in practice.** If this best practice/idea has been implemented in your department or elsewhere in North Carolina or another DOT, provide details about its implementation and its possible benefits for the NCDOT. Consider including relevant images/documents as attachments (refer to Step 1) to provide clarity regarding the feasibility of implementation throughout the organization.



Name:

Phone:

\*Name, Office, Email, Phone, } – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.

**Describe the Best Practice or Idea**

Best Practice description or idea

Describe a best management practice or idea that could be used in the department

**Examples of solution in practice**

Have you seen this in practice in the Department? Have you seen this elsewhere in North Carolina? Have you seen this elsewhere in the Industry? Explain where and how, provide reference details.

**Select which Disciplines you think need to review this issue to provide guidance.**

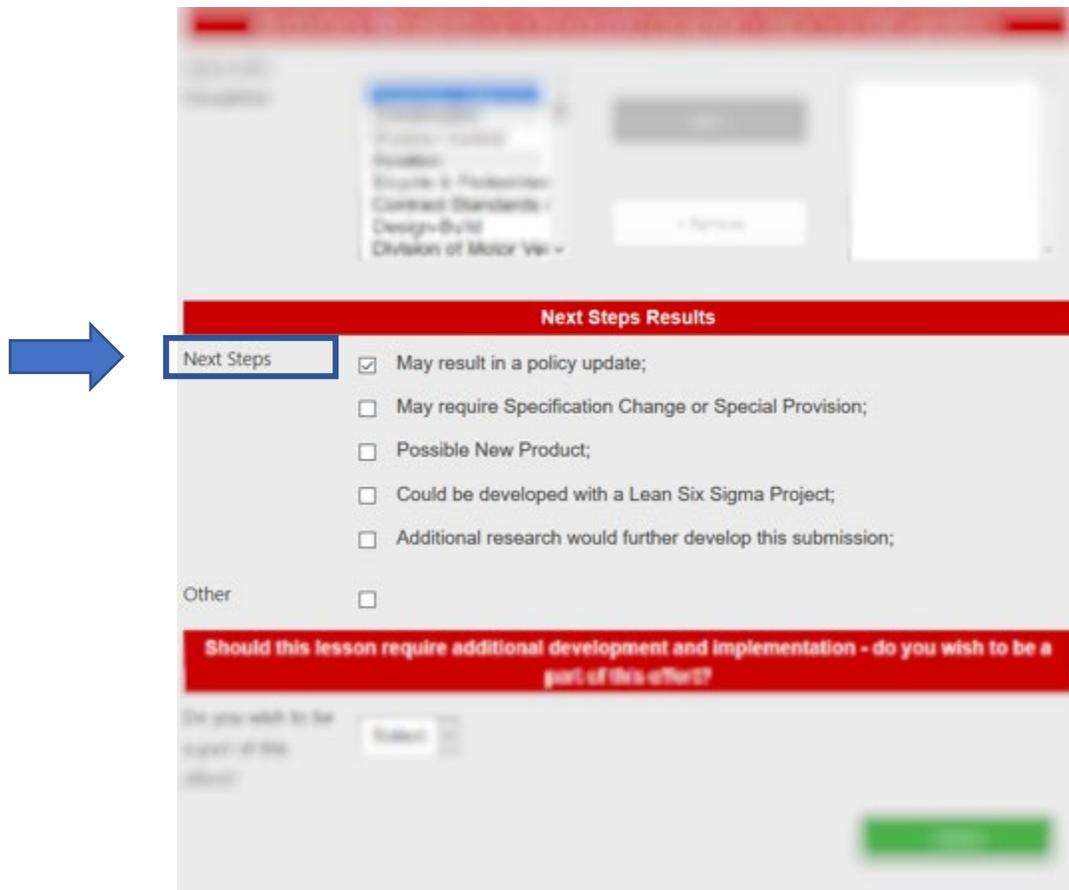
Application Disciplines

- Administration
- Finance
- Planning
- Safety
- Technology
- Training
- Other

**Step 5: Identify applicable disciplines.** Select the Applicable Disciplines for this lesson; 38 disciplines are possible within the scope of this project. Although the number of applicable disciplines is not limited, please select only the most pertinent or applicable discipline(s). You can scroll down and view all 38 applicable disciplines. For multiple selections, press and hold the Ctrl button on the keyboard to select all the applicable disciplines using a mouse-click. Once you have made all possible selections, click on 'Add' to finalize the selections. If you added an option by mistake or want to remove selection(s), you can select the discipline to be removed from the list and press the 'Remove' button.

The screenshot shows a web form with a red header bar containing the text "Select which Disciplines you think need to review this issue to provide guidance." Below the header, on the left, is a label "Applicable Disciplines" next to a scrollable list box. The list box contains the following items: "Business Opportuni", "Construction", "Erosion Control", "Aviation", "Bicycle & Pedestrian", "Contract Standards i", "Design-Build", and "Division of Motor Vel". To the right of the list box are two buttons: "Add >" and "< Remove". Further to the right is an empty scrollable box. Below this section is another red header bar with the text "Do you have an idea on what next steps the Department should take to implement this submission?". Underneath this bar is a label "Open next steps" followed by a radio button.

**Step 6: Next step results.** Select the appropriate boxes that you feel match the impact of the best practice or idea on the organization as a whole.

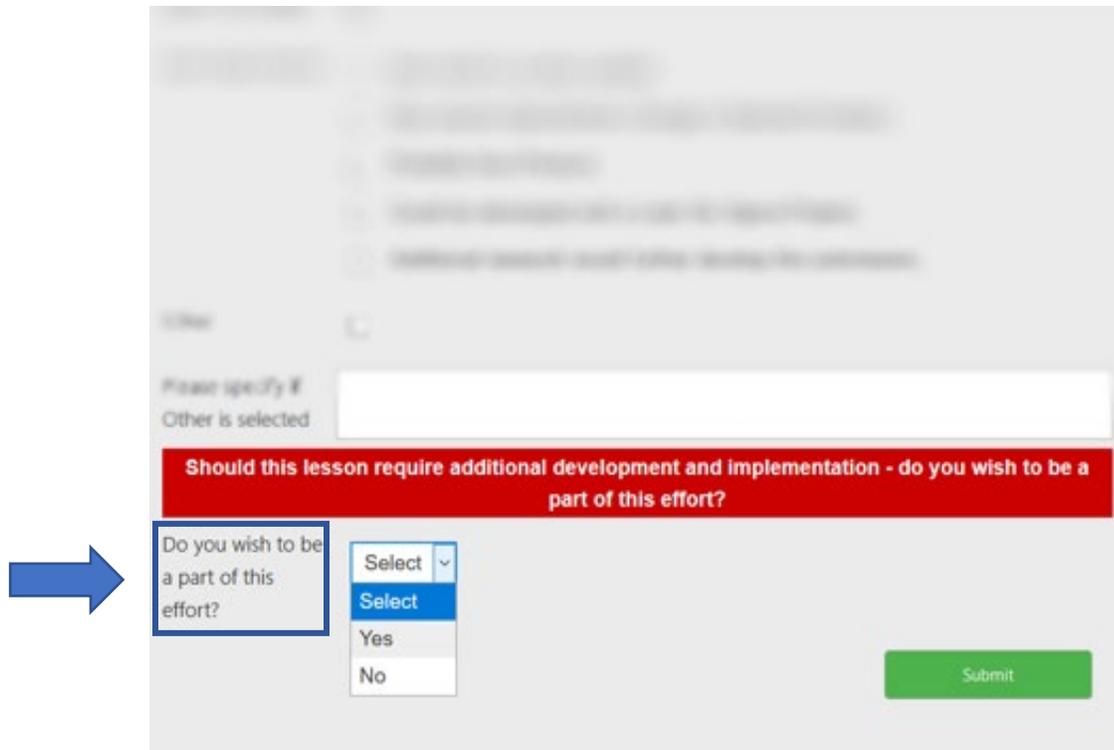


The image shows a screenshot of a survey form. At the top, there is a red header bar with the text "Next Steps Results". Below this, there is a section titled "Next Steps" which is highlighted with a blue box and a blue arrow pointing to it from the left. This section contains a list of five options, each with a checkbox:

- May result in a policy update;
- May require Specification Change or Special Provision;
- Possible New Product;
- Could be developed with a Lean Six Sigma Project;
- Additional research would further develop this submission;

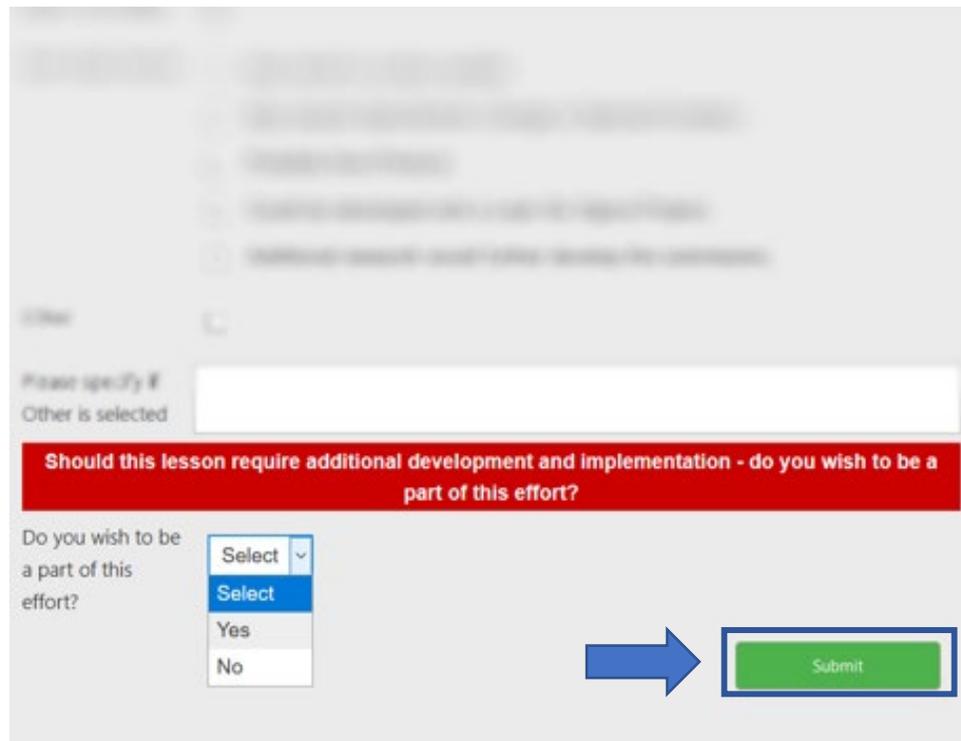
Below these options is an "Other" label with an empty checkbox. At the bottom of the form, there is a red bar with the text "Should this lesson require additional development and implementation - do you wish to be a part of this effort?". Below this bar, there is a question "Do you wish to be a part of this effort?" with a "Submit" button and a green "Next" button at the bottom right.

**Step 7: Additional development and implementation.** If you wish to be a part of developing and possibly implementing this best practice or idea to benefit the organization as a whole, then select 'Yes' from the drop-down menu.



The image shows a portion of a survey form. At the top, there is a section with a title and several bullet points, which are mostly blurred. Below this is a text input field with the label "Please specify if Other is selected". A prominent red banner contains the question: "Should this lesson require additional development and implementation - do you wish to be a part of this effort?". Below the banner, the question is repeated: "Do you wish to be a part of this effort?". To the right of this question is a dropdown menu with the following options: "Select", "Select", "Yes", and "No". A blue arrow points from the left towards the "Yes" option. To the right of the dropdown menu is a green "Submit" button.

**Step 8: Check fields and submit.** Upon completing the form, kindly go through all the fields to check for any missing fields. Once you are satisfied that the form is complete, then click on 'Submit'. Your submission will be sent to the gatekeeper in the Value Management Office for review. Once the 'Submit' button is clicked, no further changes can be made to the form.



The image shows a portion of a web form. At the top, there are several blurred text fields. Below them is a red rectangular box containing the text: "Should this lesson require additional development and implementation - do you wish to be a part of this effort?". Underneath the red box is a dropdown menu with the label "Do you wish to be a part of this effort?". The dropdown menu is open, showing options: "Select", "Select", "Yes", and "No". To the right of the dropdown menu is a blue arrow pointing towards a green "Submit" button. The "Submit" button is highlighted with a blue border.

**Thank you for your contribution.**

## Appendix J. Standard Operating Procedures for End-Users for Solution Needed:

The following guidelines provide direction about how to request information using the North Carolina Department of Transportation (NCDOT) CLEAR (Communicate Lessons, Exchange Advice, Record) database for solutions that are needed for issues or challenges faced. Soliciting information about ways to solve problems will allow the user to obtain relevant ideas from other users who have overcome similar challenges. Only items with an asterisk are required, but providing more complete information will provide a more robust database. Thank you for your support of this important program.

The following steps will help guide you through the submission process.

**Step 1: Log in.** Click on the following link which will bring you to the log-in screen.

<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>

Log in with required credentials (you may bypass this part of the log-in process if you are already logged into the NCDOT network) and click on 'Request Assistance with an Obstacle' as shown in the figure below.

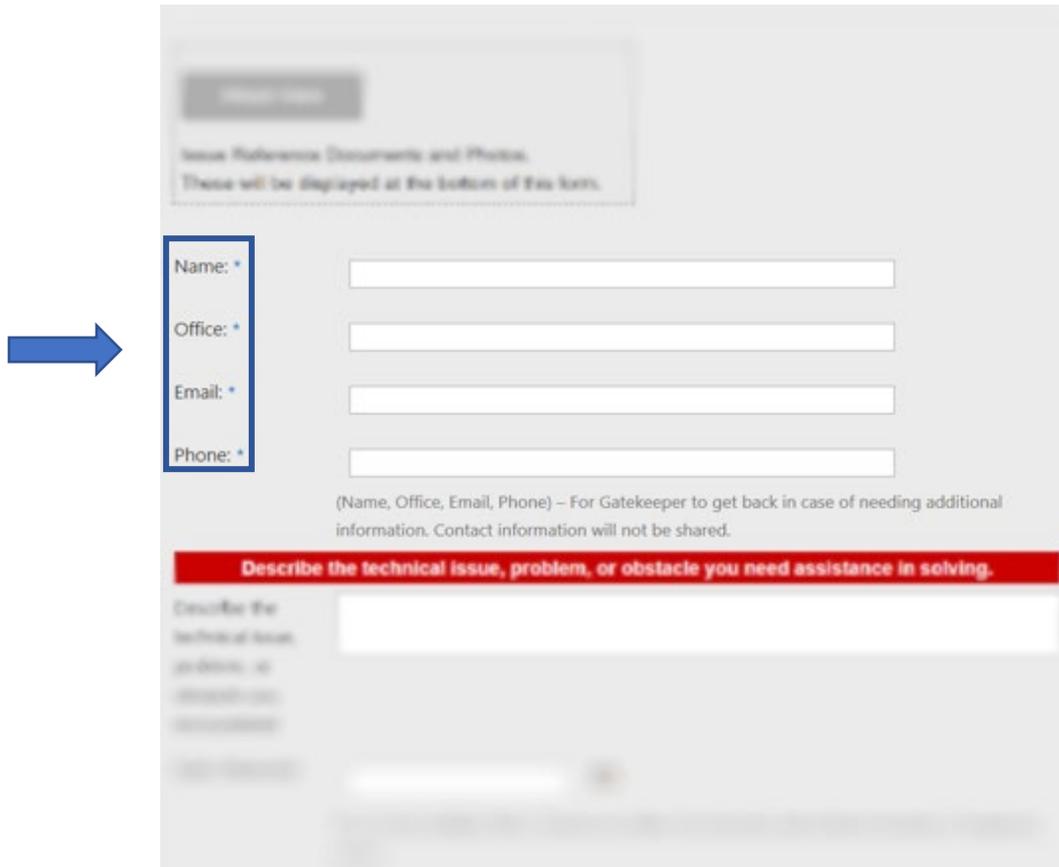
Once a submission has been initiated, it cannot be saved to retrieve later. The submission must be submitted at the end of the submission process.

The screenshot shows the CLEAR web portal interface. At the top, there is a navigation bar with links for 'Home', 'Help', 'Team Sites', and 'Site Map'. Below this is a search bar. The main content area is titled 'Communicate Lessons, Exchange Advice, Record' and features a 'Welcome To CLEAR' banner. The banner text states: 'This online portal is open to all NCDOT Employees with an NCDOT Email. It is used as a tool to learn from colleagues on past questions that have been asked or recommendations that have been found. Some of the submissions may have been implemented, others are in development, and others are solutions to questions from our expert review panel. Turn around time is up to 30 days from submission.' Below the banner are three columns: 'Share Lessons Learned', 'Share Best Practice/Idea', and 'Request Assistance with an Obstacle'. The 'Request Assistance with an Obstacle' button is highlighted with a blue box and a blue arrow pointing to it. On the right side, there are sections for 'Questions about CLEAR?' (Email: Clare.Futterton, PE; CLEAR@ncdot.gov), 'Training Dates' (Division 14 Maintenance Training: March 19, 2020; Division 13 Maintenance Training: March 19, 2020), and 'Links to Contacts' (Safety Concern: ANWRISK; HR Concern: HR representative; Help Desk: HELP Desk).

**Step 2: Attach supporting documents.** The first part of the Solution Needed form allows you to include pertinent reference documents, such as images, emails, PDFs, standard drawings, contract language, or other files, that relate to a search for the intended solution. The attached files will be visible to you before submission to ensure appropriate files are attached.

The image shows a screenshot of a web application interface for 'CLEAR Solution Needed'. On the left side, there is a sidebar with a 'CLEAR' button, a red plus icon followed by 'Approved Lessons Learned', and a right-pointing arrow followed by 'Recent'. A blue arrow points from the 'Recent' link to a dashed rectangular box in the main content area. This box contains the text 'Attach Here' and 'Issue Reference Documents and Photos. These will be displayed at the bottom of this form.' Below this box are several input fields labeled 'Name: \*', 'Office: \*', 'Email: \*', and 'Phone: \*'. At the bottom of the page, there is a red horizontal bar.

**Step 3: Complete basic respondent information.** The next part of the Solution Needed form requires basic respondent information, such as your name, office, email address, and office phone number. This information is solely for the purpose of the gatekeeper to contact you in case additional information or clarification is necessary.



The image shows a screenshot of a web form titled "Solution Needed". At the top, there is a section for "Issue Reference Documents and Photos" with a note that these will be displayed at the bottom of the form. Below this, there are four input fields for contact information: "Name: \*", "Office: \*", "Email: \*", and "Phone: \*". A blue arrow points to the "Name" field. Below the input fields, there is a note: "(Name, Office, Email, Phone) – For Gatekeeper to get back in case of needing additional information. Contact information will not be shared." Below this note is a red header bar with the text "Describe the technical issue, problem, or obstacle you need assistance in solving." followed by a large text area for describing the issue.

**Step 4: Describe the technical issue, problem, or obstacle for which a solution is needed.** This part captures information about the technical issue or challenge for which a solution is needed.

**Step 4 a: Describe the issue, problem, or obstacle you encountered.** Enter the problem description as a summary of the challenge that needs resolving.

The image shows a screenshot of a web form. At the top, there are input fields for 'Name' and 'Phone'. Below these is a note: '(Name, Office, Email, Phone) - For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.' A prominent red banner contains the text: 'Describe the technical issue, problem, or obstacle you need assistance in solving.' Below this banner is a large text input area. A blue arrow points to this input area, which is also highlighted with a blue border and contains the text: 'Describe the technical issue, problem, or obstacle you encountered'. Below the text area is a 'Date Observed' field with a calendar icon. A note below the date field says: 'If occurred multiple times, choose one date of occurrence and indicate number or frequency below.' There are several other blurred input fields and a red bar at the bottom of the form.

**Step 4 b: Select date observed.** For the date observed, click on the calendar button as shown and select the approximate date that this issue that requires a solution was observed. If the issue ‘frequently occurs’, then enter the most recent date observed and provide details regarding that particular observation.



Name:

Phone:

(Name, Office, Email, Phone) - For Gatekeeper to get back in case of needing additional information. Contact information will not be shared.

**Describe the technical issue, problem, or obstacle you need assistance in solving.**

Describe the technical issue, problem, or obstacle you encountered

**Date Observed**  

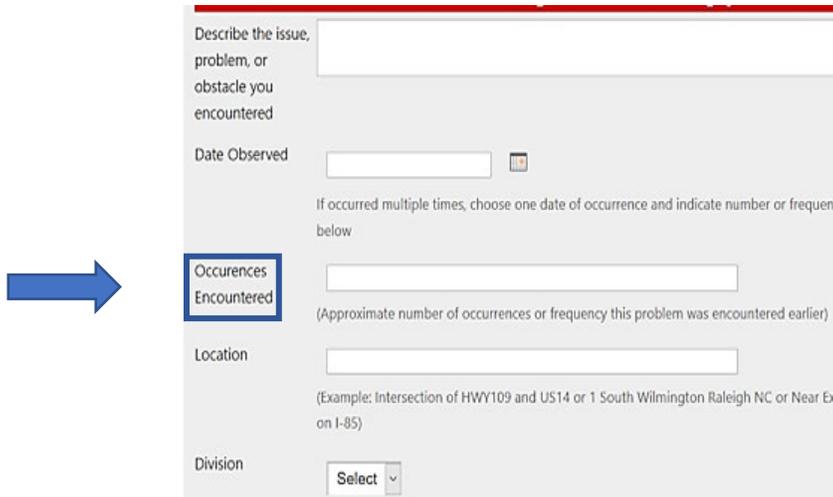
If occurred multiple times, choose one date of occurrence and indicate number or frequency below

Frequency

Number of occurrences

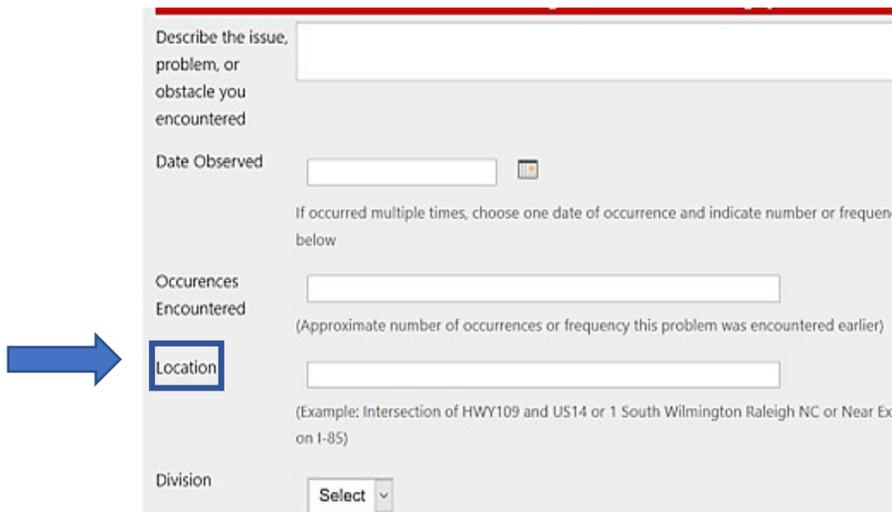
Notes

**Step 4 c: Indicate issue frequency.** Using the drop-down menu, indicate the number of occurrences that you have experienced or observed this issue.



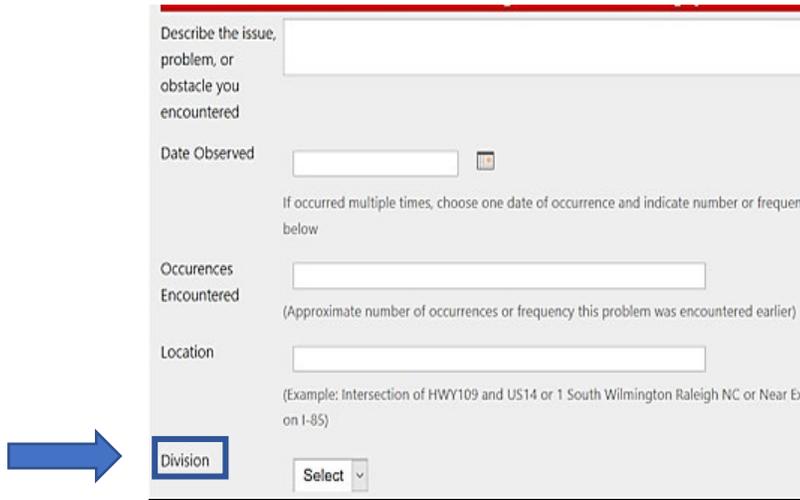
A screenshot of a web form with a light gray background. At the top, there is a text input field labeled "Describe the issue, problem, or obstacle you encountered". Below it is a "Date Observed" field with a calendar icon. A note below the date field says "If occurred multiple times, choose one date of occurrence and indicate number or frequency below". The "Occurrences Encountered" field is a text input box, and a blue arrow points to its label. Below it is a "Location" field with a text input box and an example: "(Example: Intersection of HWY109 and US14 or 1 South Wilmington Raleigh NC or Near Exit on I-85)". At the bottom is a "Division" field with a dropdown menu labeled "Select".

**Step 4 d: Identify location of observation.** Enter the location where you observed the issue. If it was observed in multiple locations, enter the most recent occurrence location.



A screenshot of the same web form as above. In this view, a blue arrow points to the "Location" label, which is highlighted with a blue box. The "Occurrences Encountered" field is also visible above it.

**Step 4 e: Division and County.** Using the drop-down options, select the Division and County that are related to the issue that needs a solution. Region will automatically populate based on the Division selected. County will also populate based on the Division selected, and thus, the Division must always be selected prior to selecting County and/or Region.



Describe the issue, problem, or obstacle you encountered

Date Observed

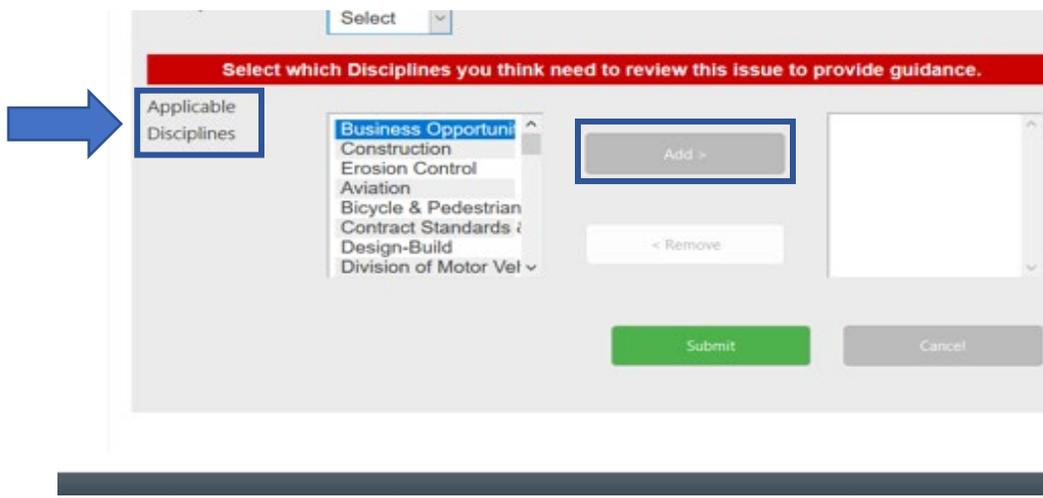
If occurred multiple times, choose one date of occurrence and indicate number or frequency below

Occurrences Encountered   
(Approximate number of occurrences or frequency this problem was encountered earlier)

Location   
(Example: Intersection of HWY109 and US14 or 1 South Wilmington Raleigh NC or Near Exit on I-85)

Division  Select

**Step 5: Identify applicable disciplines.** Select the Applicable Disciplines for this lesson; 38 disciplines are possible within the scope of this project. Although the number of applicable disciplines is not limited, please select only the most pertinent or applicable discipline(s). You can scroll down and view all 38 applicable disciplines. For multiple selections, press and hold the Ctrl button on the keyboard to select all the applicable disciplines using a mouse-click. Once you have made all possible selections, click on 'Add' to finalize the selections. If you added an option by mistake or want to remove selection(s), you can select the discipline to be removed from the list and press the 'Remove' button.



Select which Disciplines you think need to review this issue to provide guidance.

Applicable Disciplines

- Business Opportuni
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestrian
- Contract Standards
- Design-Build
- Division of Motor Vel

Add >

< Remove

Submit Cancel

**Step 6: Check fields and submit.** Upon completing the form, kindly go through all the fields to check for any missing fields. Once you are satisfied that the form is complete, click on ‘Submit’. The submission will be sent to the gatekeeper in the Value Management Office for review. Once the ‘Submit’ button is clicked, no further changes can be made to the form. Clicking on ‘Cancel’ will erase all the information that has been entered and should be used only if the submitter does not intend to submit the Solution Needed information.

Select

**Select which Disciplines you think need to review this issue to provide guidance.**

Applicable Disciplines

- Business Opportuni
- Construction
- Erosion Control
- Aviation
- Bicycle & Pedestrian
- Contract Standards i
- Design-Build
- Division of Motor Vel

Add >

< Remove

Submit

Cancel

**Thank you for your contribution.**

## Appendix K. Standard Operating Procedures for End-Users to Search for Lessons Learned

### Instructions for Searching Lessons Learned and Creating a Personal View

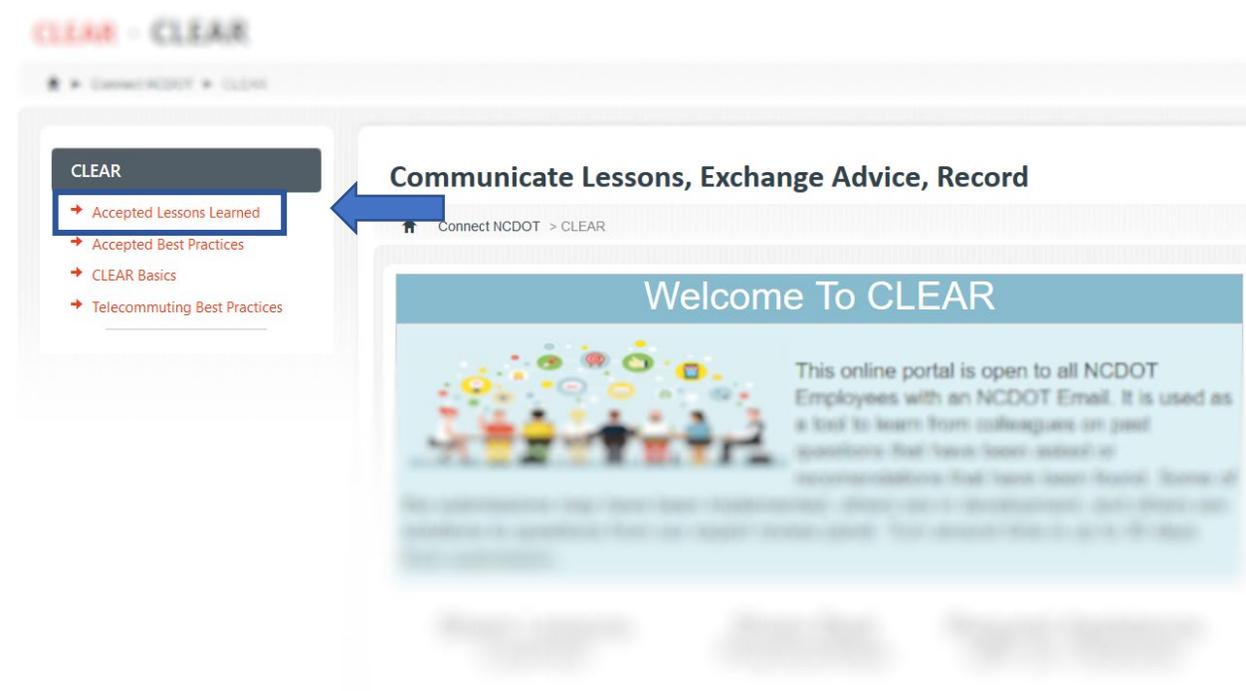
The following guidelines provide direction for users to search for lessons learned in the North Carolina Department of Transportation (NCDOT) CLEAR (Communicate Lessons, Exchange Advice, Record) database. Searching for lessons learned reduces the need to sift through numerous approved lessons learned and promptly displays the most relevant results based on the search criteria provided. Searching for lessons learned will help users to explore the existing knowledge base and apply appropriate knowledge to their projects as needed. This SOP also provides steps to create a personal view. By creating a personal view, users can customize the level of detail that they want the lessons learned to be displayed. Thank you for your support of this important program.

The following steps will help guide you through the search process.

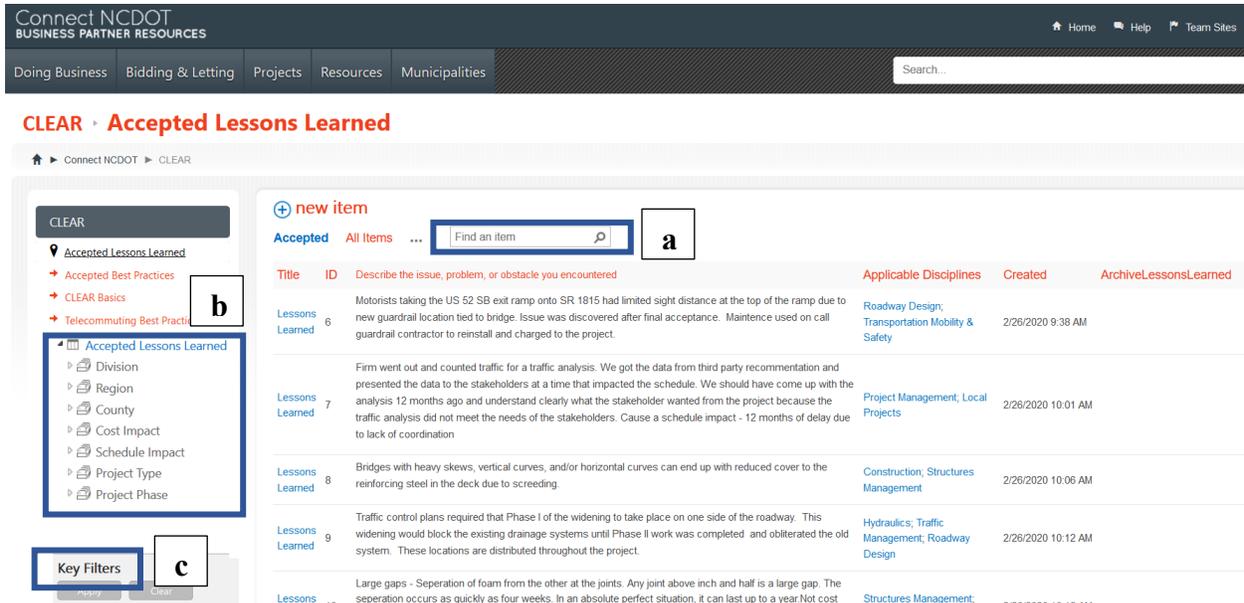
**Step 1: Log in.** Click on the following link which will bring you to the log-in screen.

<https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>

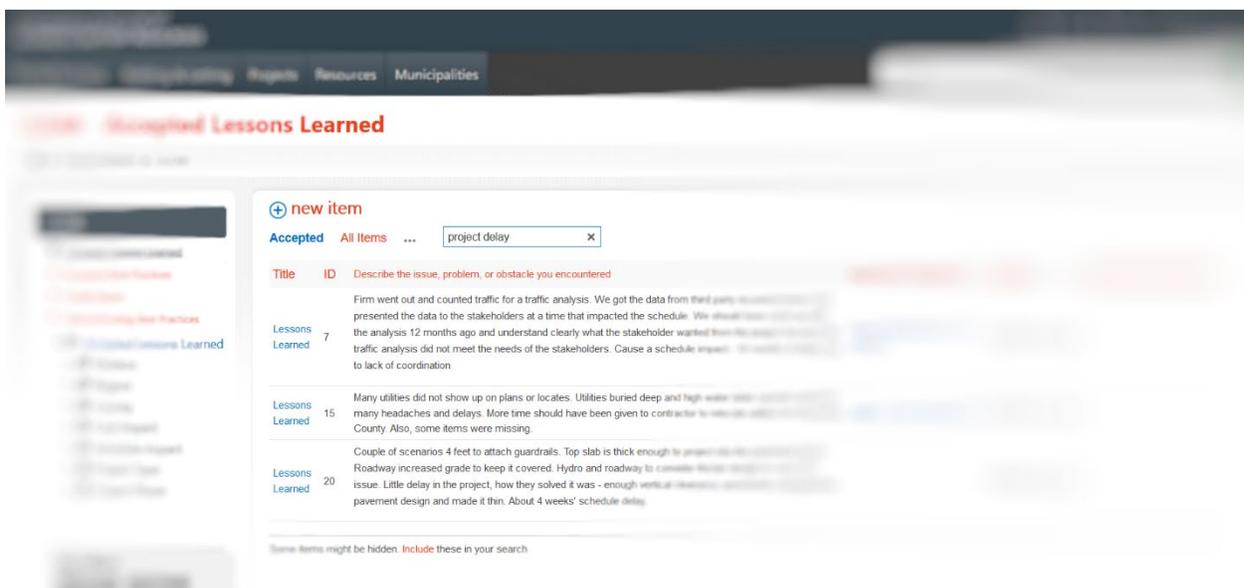
Log in with required credentials (you may bypass this part of the log-in process if you are already logged into the NCDOT network) and click on 'Accepted Lessons Learned' to start entering information.



**Step 2: Search for relevant lessons learned.** On this webpage, you have three options (keywords, a single criterion, or multiple filters) to use the search functionality, as shown below. Note that only one search option can be used at a time.



**Step 2 a: Search using keywords.** The first option is to use relevant keywords to search for lessons learned. Multiple keywords can be entered to narrow the search. For example, if you want to search for lessons learned that contain the keyword ‘project delay’, the search results will display only the lessons learned that contain that keyword, as shown in the screenshot below.

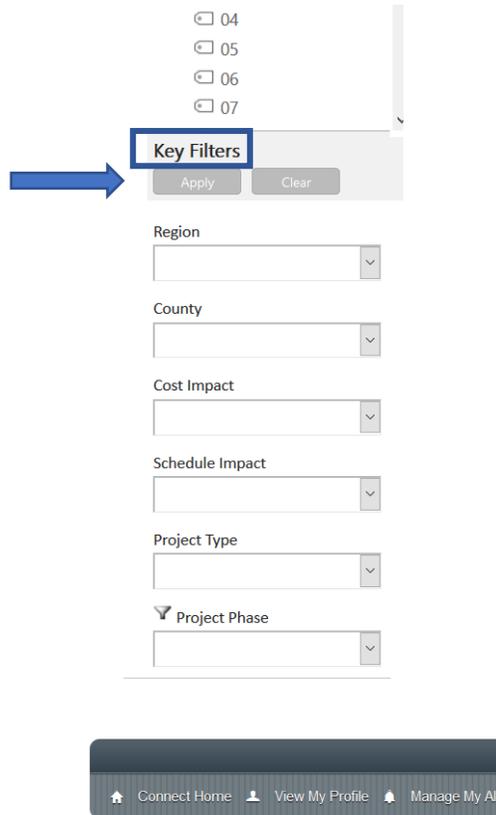


**Step 2 b: Search using a single criterion.** The second option is to search for lessons learned based on a single criterion in terms of the following fields: Division, Region, County, Cost Impact, Schedule Impact, Project Type, or Project Phase. This option is suitable if you want to look at all the lessons learned that pertain to any of these fields. For instance, the screenshot below shows all the accepted lessons learned in Division 3.

The screenshot displays a web application interface for managing lessons learned. On the left, a sidebar contains a 'CLEAR' button and a list of navigation items: 'Accepted Lessons Learned', 'Accepted Best Practices', 'CLEAR Basics', 'Telecommuting Best Practices', and 'Division'. The 'Division' item is selected, and a sub-menu is visible with options 'Select', '01', '02', '03', '04', '05', '06', '07', and '08'. Two blue arrows point to the 'Accepted Lessons Learned' and 'Division' items in the sidebar. The main content area shows a 'new item' header and a search bar. Below the search bar is a table of lessons learned, with the 'Accepted' filter selected. The table has the following columns: Title, ID, Describe the issue, problem, or obstacle you encountered, Applicable Disciplines, Created, and ArchiveLessonsLearned. The table contains four rows of data, each representing a lesson learned. The first row (ID 13) is highlighted in light blue. The second row (ID 15) is also highlighted in light blue. The third row (ID 16) is highlighted in light blue. The fourth row (ID 17) is highlighted in light blue.

Title	ID	Describe the issue, problem, or obstacle you encountered	Applicable Disciplines	Created	ArchiveLessonsLearned
Lessons Learned	13	No Traffic Control planning to address drainage design. Lack of construction easement as well prevented contractor from having adequate space to work. Had to utilize steel plate covers and message boards to work in lanes. Also, water valve adjustments shown on plans, but not in contract.	Project Management	2/26/2020 10:48 AM	
Lessons Learned	15	Many utilities did not show up on plans or locates. Utilities buried deep and high water table caused contractor many headaches and delays. More time should have been given to contractor to relocate utilities for Brunswick County. Also, some items were missing.	Utilities; Project Management	2/26/2020 11:07 AM	
Lessons Learned	16	Town of Ocean Isle Beach preferred stain, but contractor argued not enough cost in contract and had concerns about look and application of stain. Also, held up contractor from pouring apron while town deciding on color, process. Painting/Stain preference for roundabout truck apron was not detailed enough in contract specification.	Local Projects; Project Management	2/26/2020 11:33 AM	
Lessons Learned	17	No borrow excavation in contract broken out from Grading. Plans conflicting with spec on the matter	Construction; Project Management; Roadway Design	2/26/2020 11:40 AM	

**Step 2 c: Search based on key filters.** The third option is to search for lessons learned using several drop-down options for multiple criteria to narrow the search results. Once the search drop-downs are finalized, click on the ‘Apply’ button to search. To reset the drop-down options and restart the drop-down selection options, click on the ‘Reset’ button.

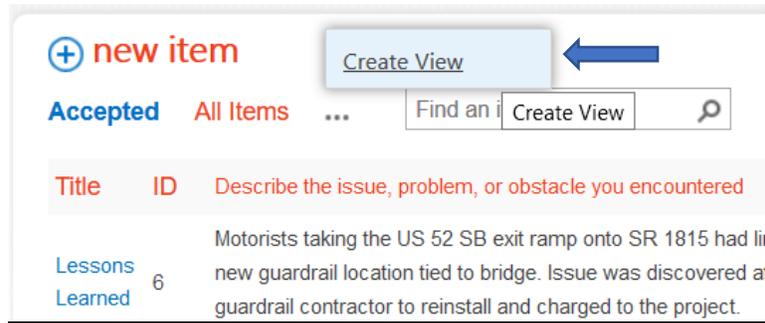


**Step 3: Create a personal view.**

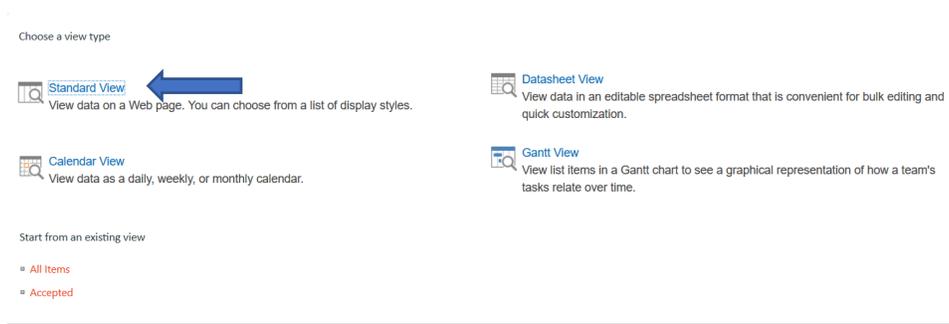
**Step 3 a: Click on the ellipses located at the top of the list.**



### Step 3 b: Select ‘Create View’.



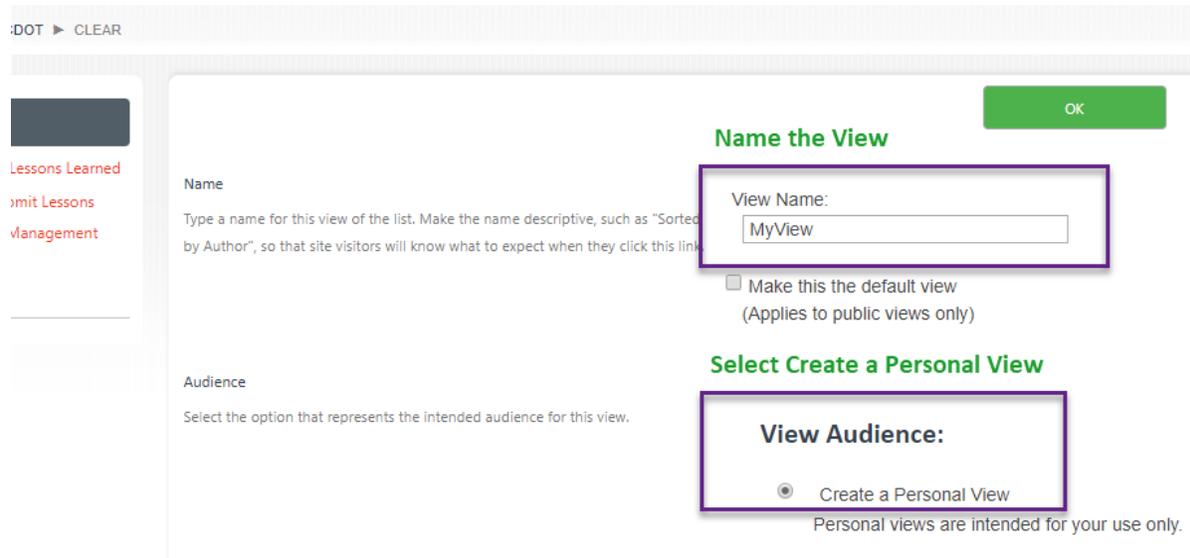
### Step 3 c: In the Settings ‘View Type’ page, select ‘Standard View’.



### Step 3 d: In the ‘Create View’ page, name your view in the ‘View Name’ text box and under ‘View Audience’, select ‘Create a Personal View’.

#### Settings > Create View

Use this page to create a view of this list.



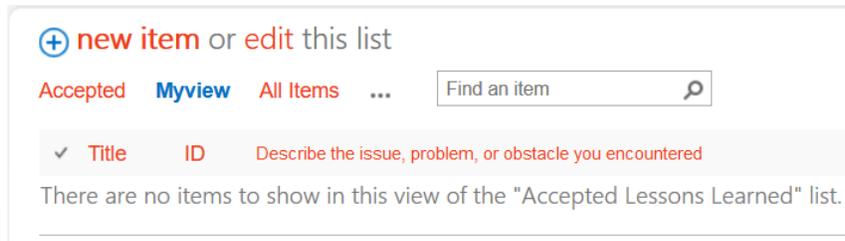
**Step 3 e: Customize the personal view.** You can make specific selections to customize the appearance of your personal view. For instance, if you want to create a personal view to browse lessons learned that have Construction as the Applicable Discipline, then select 'Filter' that is near the bottom of the page. Select 'Show items only when the following is true' and then select 'Applicable Disciplines' in the drop-down menu. In the next drop-down menu, select 'is equal to'. In the next text box, enter 'Construction' in the list, as shown in the image below. Note that the fields are not case-sensitive. You can add multiple filter criteria using the 'And'/'Or' option to narrow or expand the search results, respectively.

The screenshot shows the 'Filter' configuration interface. On the left, a 'Filter' button is highlighted. Below it, a text box explains filtering options, including a link to 'Learn about filtering items'. The main configuration area has two radio buttons: 'Show all items in this view' (unselected) and 'Show items only when the following is true:' (selected). A red arrow points to the second option with the text 'Select Show Items only when the following is true'. Below this, the text 'Show the items when column' is followed by a dropdown menu set to 'Applicable Disciplines', with a red arrow pointing to it and the text 'Select Applicable Disciplines'. The next dropdown menu is set to 'is equal to', with a red arrow pointing to it and the text 'is equal to'. Below that, a text input field contains 'Construction', with a red arrow pointing to it and the text 'Select Discipline'. There are radio buttons for 'And' and 'Or', with 'Or' selected. At the bottom, there is a 'When column' dropdown set to 'None' and another 'is equal to' dropdown, both with empty text input fields below them.

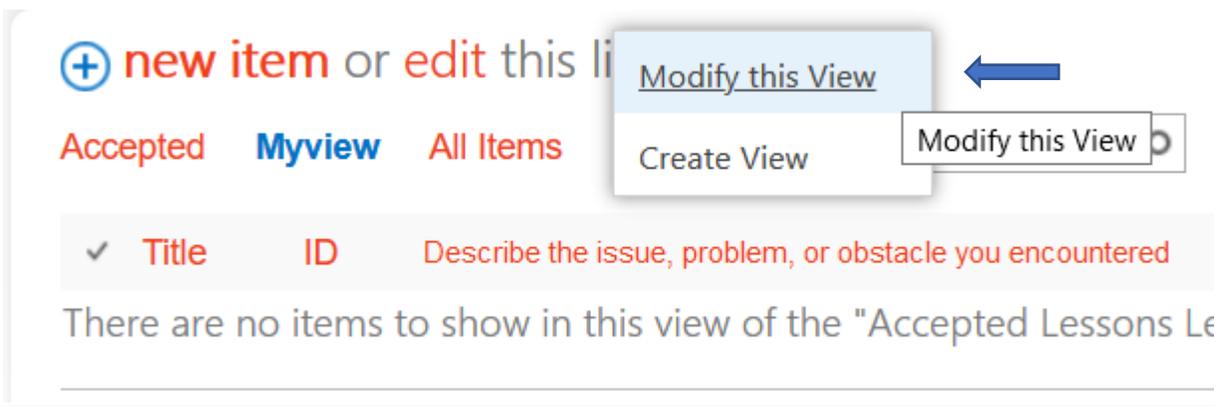
**Step 3 f: Once all the necessary selections have been made, click 'OK' to complete.**



**Step 3 g: Find personal view.** To find your personal view, open the list. Your personal view will be located at the top of the page or in the drop-down menu.



**Step 3 h: Modify personal view.** Click on the ellipses to modify your personal view.



**Thank you for using the CLEAR database.**

## **Appendix L. Frequently Asked Questions (FAQs) Related to CLEAR**

### **Why should I enter information into the CLEAR database?**

The CLEAR database is intended to serve as a data repository for knowledge about projects that has been gained by North Carolina Department of Transportation (NCDOT) personnel. To serve its purpose effectively, you are encouraged to submit any relevant lesson learned/best practice using the appropriate form in CLEAR to help NCDOT personnel work on future projects more effectively.

### **What qualifies as a lesson learned?**

Lessons learned are experiences that should be taken into consideration for future projects, process improvement, and/or guideline improvement. After a challenge (e.g., a risk or problem) or opportunity has been observed, the lesson learned is the knowledge or insight gained from that experience that then can be shared to promote/reinforce positive outcomes and reduce/eliminate the potential for future mishaps and failures.

### **What qualifies as a best practice/idea?**

A best practice/idea is an innovative solution that has been practiced or is proposed.

### **What qualifies as a solution needed?**

If you are looking for ways to improve certain workflow processes or solve a particular problem or issue, you can submit a 'Solution Needed' form to obtain helpful responses and potential solutions from other units or divisions.

### **What happens to my submission once I've submitted it?**

Once submitted, your submission goes to the gatekeeper for initial review. The gatekeeper will ensure the completeness of the information you have shared and, if necessary, will ask you to provide additional information or clarification before sending the file to the Expert Review Panel (ERP). The ERP will review the submission, provide comments or responses, and decide on its contribution to the CLEAR database.

### **Can my consultant use the CLEAR database to submit and search lessons learned/best practices/solutions?**

The CLEAR database can be accessed by anyone with valid official NCDOT credentials. Currently, external consultants do not have access to files internal to the NCDOT and hence cannot access and use the CLEAR database directly. However, if you are an NCDOT employee and have access to the database, you can submit lessons learned that are associated with your work in consultation with the external consultant.

### **How can I share information in the CLEAR database with my consultant?**

Due to the nature of the database, external consultants do not have direct access to CLEAR. However, you can enter lessons learned on their behalf by entering printed reports and uploading email correspondence, etc.

**Can I edit my submission once it is submitted?**

No, once you click 'Submit', the submission cannot be retrieved and modified.

**What if I get an email that is 'Request for Information'?**

This email would indicate that the gatekeeper requires additional information from you in order to vet the submission.

**What information do I need for a submission?**

The information you enter will vary depending on the form(s) that you choose to use (i.e., Lessons Learned, Best Practice or Idea, or Solution Needed).

**Why would my submission be rejected?**

A submission may be rejected for several reasons, including: (1) the submitted form is incomplete and/or (2) the ERP does not consider the submission acceptable for CLEAR.

**How many submissions can I have?**

You are encouraged to input as many useful lessons learned/best practices as possible. The number of submissions is unlimited.

**What if I want to continue to be a part of the review process?**

At the end of the submission form, you will be asked if you would like to be a part of the development and implementation of your idea and you will be able to indicate if you would like to be involved in this process.

**Who is an Innovation Coordinator?**

Innovation Coordinators are personnel who are highly motivated in championing the cause of CLEAR, thereby promoting the culture of innovation within their units or offices.

**Can I save my submission and finish editing at a later time?**

No. The submission cannot be saved to work on later. Once the 'Submit' button is clicked, the form is submitted.

**What does 'accepted' mean?**

An accepted lesson learned/best practice is a submission that has been fully vetted and reviewed by the ERP and has been made available for sharing. You can find approved submissions in the accepted lessons learned list or accepted best practices list.

**Who reviews my submission?**

Each submitted lesson learned goes through two rounds of screening. The gatekeeper will perform the initial screening to ensure completeness of the entered data. The ERP will make the final decision regarding acceptance/rejection of the submission.

**How long does it take for my submission to be reviewed?**

The ERP will have a 30-day window to report its decision to the gatekeeper.

### **Who do I contact if I want an update?**

Please contact Clare Fullerton at the NCDOT Value Management Office: [clear@ncdot.gov](mailto:clear@ncdot.gov) or (919) 707-6683.

### **How do I log in to the CLEAR SharePoint site?**

You can log in with your official credentials using the following link: <https://connect.ncdot.gov/site/lessons-learned/Pages/default.aspx>. If you already are logged in to the Connect NCDOT portal, you may bypass the requirement of entering your credentials.

### **How do I search for accepted submissions?**

The approved submissions can be searched based on various conditions, such as Division, keywords, etc. The link to search for submissions is provided on the CLEAR webpage in the Connect NCDOT portal.

### **Is my name and contact information published?**

No. This information is used only by the gatekeeper in case additional information or clarification is needed from you. Your information is made available only to the gatekeeper and ERP. Your contact information also will not be shared once the submission is approved.

### **How do I know what next steps to suggest?**

If you think that the information you entered can be developed further into an innovative idea, such as the organization-wide application of a novel material or application of Lean Six Sigma to improve project processes, then such information constitutes a strong basis for suggesting 'Next Steps'.

### **If I select 'Suggest a Next Step', will someone contact me regarding Lean Six Sigma, a research project idea, etc.?**

Based on the usefulness of the Next Steps suggested and its applicable benefits to the NCDOT, you might be contacted by the Value Management Office or a member of the ERP to discuss your suggestion further.

### **How do I decide which Applicable Disciplines to select?**

Based on the information entered, select the discipline that is the most relevant or applicable to your lesson learned or best practice. Even if a discipline is not directly applicable for the submission, select one that may be even indirectly applicable.

### **Which form do I select to enter information?**

Currently, you can choose among three forms to enter information into the CLEAR database: (1) the Lessons Learned form to enter useful information about successes and failures in a project (2) the Best Practices form to share an innovative idea or best practice that can yield significant organizational benefits to the NCDOT, and (3) the Solution Needed form to solicit solutions to a problem faced in a project.

### **How can I learn more about entering information in one of the forms?**

Standard operating procedures (SOPs) have been developed for each of the three forms. On the website landing page, look for 'CLEAR SOPs'. Under the title for each form, step-by-step guidance about entering information is provided. Also, video training material is available under 'CLEAR Videos' to show users how to enter information.

**How long will a submission stay in the database?**

If the submission becomes superseded by, e.g., a specification or policy, it will be archived so that such records can be maintained.

## **Appendix M. What Happens to a Lesson Learned? Specific Case of Utilities**

This appendix presents an example of a lessons learned experience to show how the North Carolina Department of Transportation (NCDOT) CLEAR (Communicate Lessons, Exchange Advice, Record) database can be used to improve the NCDOT knowledge base and address a specific problem that pertains to utilities claims.

### **How did we identify this issue?**

During the lessons learned data gathering phase for the CLEAR database, the NCSU Research team realized significant project concerns that relate to, for example, utilities not being moved within the agreed-upon timeframe. Unknown utilities often were discovered during construction and other unexpected utilities conflicts led to claims and supplementary agreements that ultimately increased project costs and schedules.

### **What are some next steps to investigate an issue?**

The NCDOT Value Management Office determined that next steps were needed to investigate this ongoing issue and requested further research to understand the actual cost and schedule impacts and to identify the root cause(s). The North Carolina State University (NCSU) research team performed careful analysis of utilities claims data for 1996 through 2018. The NCSU team also carried out a literature review to understand how other state DOTs mitigate potential utilities issues on their projects. The team also solicited feedback from current NCDOT personnel about ways that utilities-related issues are handled on a day-day basis. The data analysis revealed the following observations:

- Approximately 90% of projects with utilities claims had one or two utilities-related claims.
- Each division had at least 30 utility-related claims during the study period.
- Smaller projects (up to \$5 million) were most affected by utilities claims; roughly three out of four projects were affected by utilities claims.
- Claims that pertain to utilities conflicts accounted for about 57% of all utilities-related schedule delays.
- For the projects affected by utilities claims, project costs increased by about 2.4%, with schedule delays increased by 70 days on average.

Based on the literature review and discussions with NCDOT personnel, the NCSU research team identified the following key mitigation strategies:

- Communicate early and frequently with utilities providers in order to have a shared sense of responsibility (with the NCDOT) in relocating utilities.
- Hold constructability reviews with utilities owners to minimize plan changes.
- Explore the possibility of imposing liquidated damages on utilities companies to ensure that they do not default on agreed-upon dates for utilities relocation.

- Perform comprehensive subsurface investigations on all projects to avoid encountering buried utilities.

**What can be done to implement this experience into a lessons learned or to make positive change in the NCDOT?**

The NCSU research team provided this information to the NCDOT utilities group for further action. This sharing of knowledge may lead to revising contract language that pertains to utilities providers and specifications to detect underlying utilities by ensuring that proper subsurface investigations are performed on all projects, thus turning the lessons learned into lessons remembered. These changes will allow the NCDOT to be more efficient and effective in their workflow processes and mitigate utilities-related claims in future projects. In this instance, the recommendation was for the NCDOT to consider a Strategic Implementation Team to review the data and best practices from other states and pilot some new initiatives to work on this ongoing issue.

## Appendix N. CLEAR Training Feedback Form

### Feedback from Division Personnel

#### Consent Agreement

Your participation in providing feedback is voluntary and you can choose not to participate or to stop participating at any time. You consent that you are willing to participate in this survey by providing feedback. Your input will provide valuable perspectives about the CLEAR program and will allow the research team to improve it accordingly.

Division:

County:

Number of years working at the NCDOT:

Currently, users can use three forms to share/solicit relevant information. Rank the forms based on your preference and the one(s) that you think you would use the most.

CLEAR Input/Sharing Options	Rank (1 = highest, 3 = lowest)
Share lesson(s) learned	
Share best practice/idea that has been implemented	
Solicit information to resolve a challenge/issue/problem faced on a project	

Please select your response to each of the following statements.

Response	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The presentation of the CLEAR program and its objectives are clear to me.					
I feel the CLEAR program will help the NCDOT become more efficient in its project delivery.					
I found the forms easy to complete.					
I will share information about the CLEAR program with my colleagues and encourage them to learn more by accessing CLEAR.					
I know who to contact if I have any questions about using the CLEAR program.					

If you have anything else you would like the CLEAR team to know about your perspectives and ideas regarding this program, please add it here.

## Appendix O. Lessons Learned Information Gathered from NCDOT Personnel Regarding Utilities

This table lists a few issues and suggested solutions provided by the respondents in the form of ‘Lessons learned’ within the CLEAR database that were related to utilities. Any respondent identifier information has been removed as required by the North Carolina State University’s (NCSU) Institutional Review Board for privacy reasons.

<b>Division</b>	<b>County</b>	<b>Issue Description</b>	<b>Issue Details</b>	<b>Solution to the Issue</b>
3	Brunswick	On this project utilities were deep and stacked; they were “located but not picked up”.	Utility items left out of contract.	Add supplemental field surveying when there are several utilities.
3	Brunswick	Several utilities conflicts identified on project.	Utilities not located on plans, causing delays to the contractor.	Contractor worked around utility issues by utilizing different drainage designs, traffic control phasing, and processes.
14	Buncombe	Existing 15" drainage pipe was not in the location as noted on the plans.	Contractor waited for a redesign, which overran on pipe quantities.	Hold field meeting ahead of the project bid and let process.
3	Onslow	Sporadic interactions between contractor and DOT; DOT and municipalities.	Utility owners are late in relocating utilities, causing schedule delays.	Need to obtain early buy-in from all stakeholders; get contractor involved.
14	Jackson	Several utilities are generally involved on a widening project whose relocation can inadvertently affect nearby businesses.	Cost and schedule impacts: Added a few months to project schedule. Cost impacts are almost double.	Meet with utility owners and municipalities early on and try to minimize impacts due to utilities.

5	Durham	NCDOT Prime Contractor had crews scheduled to begin on date of availability, but utilities were not relocated.	Impacts increased project cost and delayed the schedule.	Issue was solved with SUE investigation and additional utilities coordination during construction. Should be resolved during Preconstruction.
5	Durham	Coordination issues with utility companies; getting the utility owners to move utilities is a challenge.	Less than 1% impact on cost and schedule.	Possible solutions include compensating the utilities to get relocation work done on time and conducting division level meetings with utilities which improves communication and minimizes surprises.