

2016 FHWA Work Zone Safety Training: Post-Construction Evaluation Process

Process Document
March 2021



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16. Abstract This document was developed to help agencies manage and evaluate work zone activities and document the lessons learned. Its objective is to outline a structured post-construction evaluation process that uses a feedback loop to help evaluate and improve performance during the construction phase and generate lessons learned for future use. The scope for this work was as follows: <ul style="list-style-type: none">• Define a structured review process that includes evaluation• Define a feedback loop to document and mitigate project issues and generate lessons learned• Develop a structure for lessons learned documentation• Demonstrate the implementation of lessons learned in example projects The four appendices (A through D) at the end were designed to be easily accessed at a later date. Appendix C provides a sample Lessons Learned form that readers can adapt and use on their projects.			
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ACKNOWLEDGMENTS

This material is based upon work supported by the Federal Highway Administration (FHWA) under Cooperative Agreement DTFH61-1-RA-00018, 2016 FHWA Work Zone Safety Training.

The FHWA Work Zone Safety Grant Program was established in 2005 through Section 1409 of the Safe Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). This initial four-year, \$20 million program provided funds to nonprofit and not-for-profit organizations to develop guidelines and provide training to prevent and reduce work zone injuries and fatalities.

In years since, and most recently under the 2016 Fixing America's Surface Transportation (FAST) Act, additional funds were allocated to continue the grant program, totaling more than \$40 million as of 2017. The three grant emphasis areas include the following:

- Area 1: Training for construction workers
- Area 2: Development of processes to help improve work zone safety
- Area 3: Training for state and local governments, transportation agencies, and other groups implementing the results

Grant recipients are competitively selected and conduct activities under one or more of the three emphasis areas. To help identify specific needs, information from various sources were used, including the following:

- Grant team industry knowledge brainstorming sessions
- Practitioner panel-facilitated sessions that included the FHWA, state departments of transportation (DOTs), consultants, and academia
- Feedback from a series of practitioner workshops
- Practitioner surveys to prioritize identified topics

Each grant recipient identified topics and subject areas for development; the FHWA also provided input on final topic areas to better coordinate between grantees. In some instances, topics addressed within products are similar, but tailored for a specific audience or developed in alternative formats.

To date, the Work Zone Safety Grant Program has generated a wealth of products, publications, and training resources for roadway construction industry practitioners. As of 2017, more than 101,000 practitioners and craft workers had received training through more than 3,800 courses. More than 55 process publications, 95 training modules, and an entire learning program had been developed.

The development of new products is scheduled to continue through 2022, with some product topics still being planned. These processes, training, and other resources are expected to provide benefits and positive impacts for years to come.

INTRODUCTION AND BACKGROUND

Work zones impact the workers involved on the projects, roadway users, and communities in the vicinity of the project. The changes in roadway configuration, capacity, and other work zone-related factors often contribute to crashes, injuries, and fatalities (Pigman and Agent 1990). In 2018, the number of work zone fatal crashes was 672, which resulted in 755 individual fatalities (National Work Zone Safety Information Clearinghouse 2018).

Work zones also account for an estimated 10 percent of overall congestion (Cambridge Systematics and TTI 2004) and 24 percent of unexpected freeway delays (Chin et al. 2004), which lead to increased road user costs.

The Plan-Do-Check-Act (PDCA) cycle is an iterative four-step management method used for the control and continuous improvement of processes and products. Construction projects can benefit from using the PDCA cycle, and the “check” phase of the process can be accomplished through evaluation of the project during any phase of the project life cycle, as seen in Figure 1.

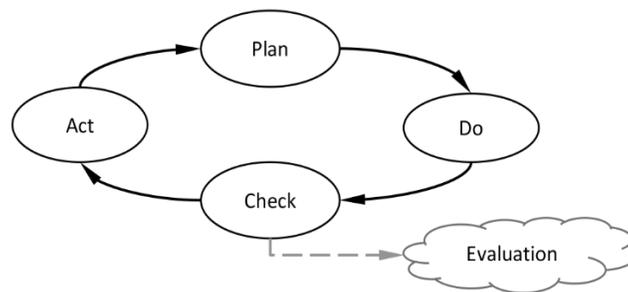


Figure 1. PDCA iterative cycle and evaluation

The objectives and the process to be used are established during the “plan” phase. The “do” phase involves implementing the planned process, which is then “checked” to monitor the process and determine whether or not it is meeting the requirements. Lastly, the “act” phase involves taking action based on the lessons learned during the “check” phase. If the change doesn’t work, the cycle starts again using a different plan. One benefit of evaluating the construction phase of a project is the opportunity to document the lessons learned about how the project team handled and solved issues that arose during the life of the project. Documenting lessons learned can benefit other project teams by helping reduce the amount of time they spend addressing the same or similar issues.

An evaluation can be conducted at any point during a project life cycle. For example, a post-execution evaluation can be conducted at the completion of any phase. However, evaluating the entire project life cycle, from planning through the post-construction phase, can help identify and address issues early, thereby helping to avoid or mitigate negative impacts on a project as it progresses.

implemented on the current project or on future projects to help improve work zone activity performance.

This document also provides information regarding when and how this process can be implemented.

SCOPE OF WORK

The scope for this work was as follows:

- Define a structured review process that includes evaluation
- Define a feedback loop to document and mitigate project issues and generate lessons learned
- Develop a structure for lessons learned documentation
- Demonstrate the implementation of lessons learned in example projects

EVALUATION, FEEDBACK, AND LESSONS LEARNED

In this document, a phase is defined as a specific period of time during which a series of tasks occur. The construction project life cycle is generally considered to have five main phases: planning, project development, design, construction, and operation/maintenance/monitoring. It is important to note that some agencies and companies may use different terminology for each of these five phases or may employ different phasing for its projects. Appendix A contains a description of each phase discussed in this document, and it is helpful to understand what each entails so that agencies and companies can relate them to their own project phases.

The five phases can also be organized into three groupings:

- Pre-construction: planning, project development, and design phases
- Construction: construction phase
- Post-construction: operation, maintenance, and monitoring phases

Evaluation/At What Point During a Project's Life Cycle Can Evaluation Take Place?

The evaluation process does not need to wait until the construction phase has been completed. It can occur during or after the completion of any phase.

One advantage of conducting an evaluation during an active phase is it presents an opportunity to gather feedback from the project personnel while they are still performing the work. It also makes it easier to capture information on what is happening in real time and reduces the possibility of details being forgotten or inadvertently omitted.

Likewise, performing an evaluation after the completion of a phase can help future projects avoid similar issues and identify areas for improvement and noteworthy practices that can be replicated.

Figure 3 shows a flowchart developed to illustrate how evaluation and lessons learned are incorporated into each phase.

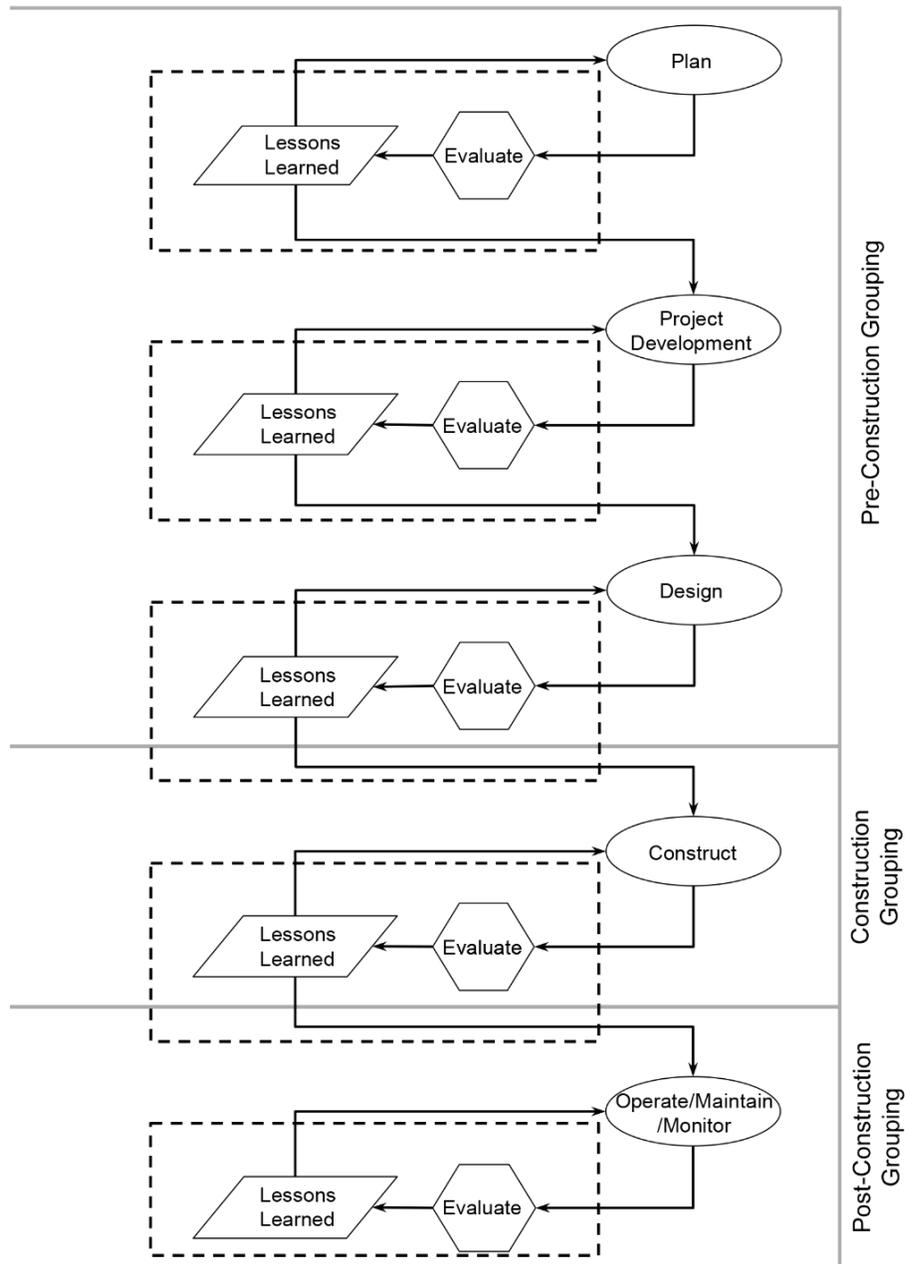


Figure 3. Evaluation and lessons learned flowchart

Note that all phases have identical processes that include evaluation and lessons learned.

Feedback Process

Communication is key to a thorough evaluation, and especially the feedback and interaction amongst the members of each team involved with planning, designing, and building the project, and between the various teams as well. The feedback involves comparing an input, like the work zone issue being evaluated, to a reference and generating an output (Klein 1989). The output can be used to help make the necessary decisions or to make a change. Any change generated by an output becomes a new input, thus creating a feedback loop as shown in Figure 4.

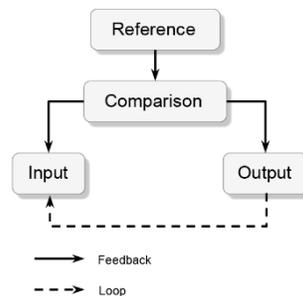


Figure 4. Feedback loop

The feedback process is designed to increase communication and interaction between personnel involved in all phases of a project and generate information to help evaluate and improve work zone activity performance. This process can occur formally or informally, and the formal process is preferred because it generates lessons learned documentation that is shared across the agency and can be implemented on the current project or on future projects to help improve performance.

The feedback findings in the lessons learned documentation may impact different phases and various project personnel, so it is important for everyone involved with any phase of the project to receive the information. Appendix B contains examples of how feedback occurs and its impact on a project.

Lessons Learned

To capture and preserve the lessons learned from a project, whether evaluation and feedback or a different method is used, it is key to document the information. Documenting lessons learned creates a long-term asset for the agency that allows personnel to learn from projects that they weren't personally involved with and use that information to make adjustments and improvements on other projects. Appendix B contains examples of how using lessons learned can impact a project.

When an evaluation is performed while a construction phase is active, it is important for the construction team to continuously analyze and document issues as they occur in the form of lessons learned. As Figure 5 shows, the lessons learned are documented and updated whether or not an alternative is used or a solution is found.

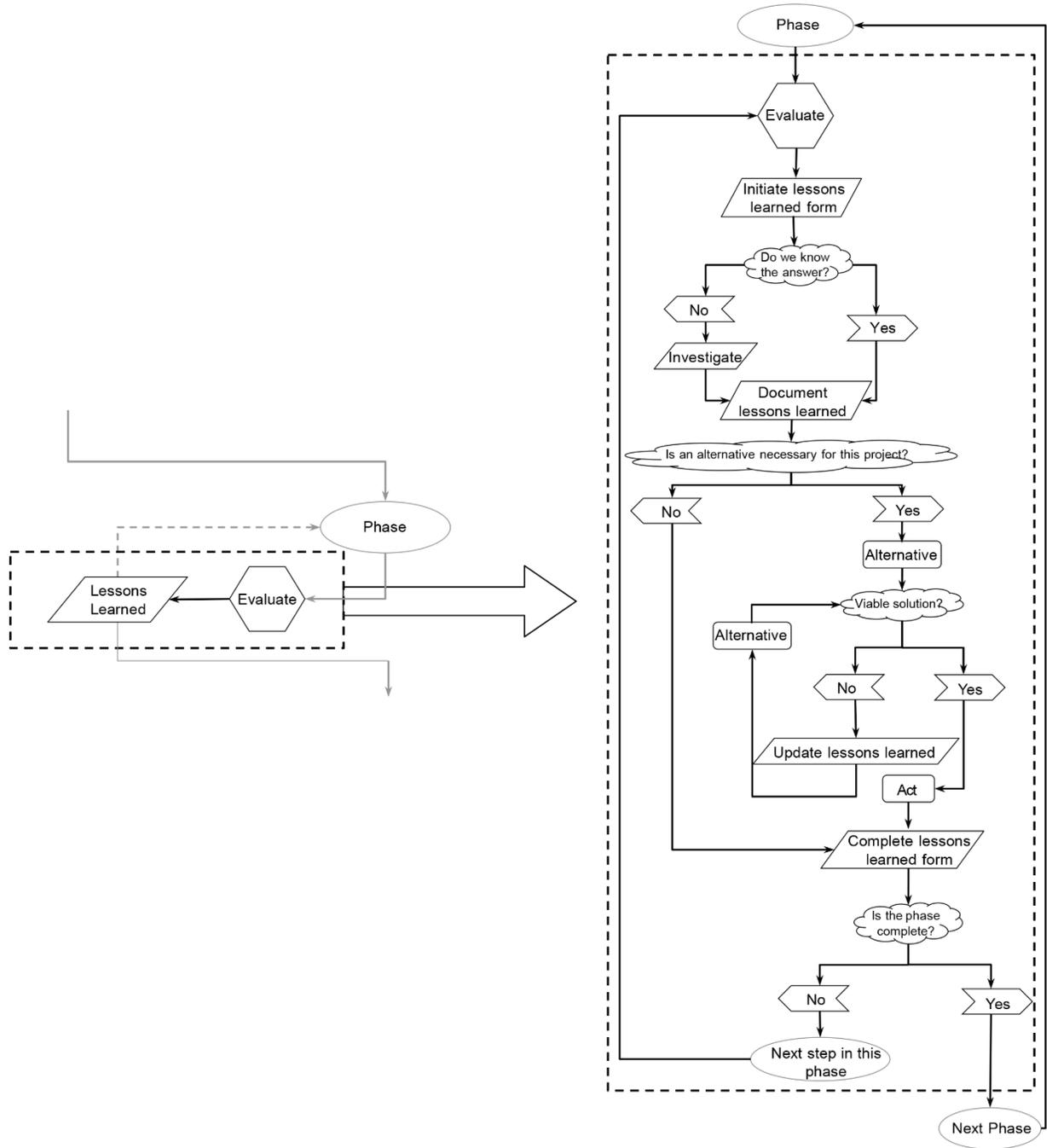


Figure 5. Evaluation process flow

The lessons learned may not always lead to a solution but are still important because they define the issue, the projects that have encountered it, and any actions taken toward a solution. Lessons learned documentation also helps preserve this information for future use across an agency or company.

It is preferable to use a form to capture the formal feedback information and document the lessons learned. Appendix C contains an example form. It is designed to document the issues faced in the work zone and generate ideas for alternative solutions. Any alternative solutions considered can be documented on the form as well and be evaluated for current and future use. It is important to note that even though a Lessons Learned Form was initiated during a particular project, it may not be finalized during that project if no feasible solution was found to address an issue encountered during the project.

Agencies may empower anyone on the construction team who is trying to solve an issue or discovers something worth documenting to begin completing the form. It is important that everyone involved in all phases of the project be made aware of any Lessons Learned Form related to the project and have the ability to update it as needed. The completed forms could be housed in the agency's document management system for easier access and discovery.

The evaluation process flow diagram in Figure 5 shows how information is generated for the Lessons Learned Form. Once the evaluation process flow has been completed, the project either continues on with the current phase or moves to the next phase (see previous Figure 3). Appendix D further describes developing lessons learned using the evaluation process flow and the Lessons Learned Form.

THE POST-EVALUATION PROCESS

The post-evaluation process consists of three steps: evaluation, feedback, and documenting the lessons learned. Evaluation is the first step of the structured review process and involves performing an analysis of issues, obstacles, alternatives, etc. experienced on the project. The results of the analysis may include ways to mitigate or eliminate an issue or obstacle, or the pros and cons of an alternative, either of which allows project personnel to make an informed decision.

Feedback is the second step of the process and is designed to increase communication and interaction between personnel involved in all phases of a project and generate information to help evaluate and improve work zone activity performance.

Documenting lessons learned is the last step of the process and it creates a long-term asset for the agency that allows personnel to learn from projects that they weren't personally involved with and to use the information to make adjustments and improvements on other projects.

CONCLUSION

This document defines the evaluation process and contains examples of how to structure a formal feedback process and document the lessons learned. Each agency can use its own document management system to catalog the lessons learned and allow agency-wide access to benefit current and future projects.

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APPENDIX A: CONSTRUCTION PROJECT LIFE CYCLE PHASES

Pre-Construction Grouping

Planning

The planning phase consists of activities during the earliest stage of project development when the current and future needs of the project are identified and actions and alternatives are studied. This phase may also include determination of the project type and broad traffic and planning studies, including a preliminary understanding of any environmental, community, economic needs, and goals for the project.

Project Development

During the project development phase, the project's concept is refined, and the needs, strategies, and purpose are established. This phase receives input from the planning phase, which helps clarify a number of items, including the project's needs, working plan, schedule, and feasibility study needs.

Design

After the project purpose and needs are established, the design phase can begin to develop the construction plans. During this phase, the preliminary and the final design occur, unless the preliminary design has already been completed during the planning phase. The preliminary design process can also include an additional analysis of alternatives. In this document, the preliminary and the final design are combined into one process, which involves making the key design decisions before moving to the construction phase and developing construction plans that consider exceptions and possibly safety and mobility data, and include design standards, specifications, and a cost estimate.

Construction Grouping

Construction

The construction phase follows the design phase or can happen concurrently with design for design-build projects. This phase can include bidding and contractor selection and is when the construction activities are performed in compliance with the applicable permits, standards, regulations, and laws.

During this phase, a significant amount of interaction may occur between multiple companies, a variety of teams, and possibly the public through a public information process that addresses questions and concerns. At the conclusion of this phase, the project is closed and accepted, and the as-built plans and closure documents are finalized.

Post-Construction Grouping

Operation, Maintenance, and Monitoring

This is the final phase of a project when operation and monitoring begin and the maintenance needs are considered. It is a good time for the agency to provide feedback to the teams involved in the first four project phases regarding the final lessons learned that can be considered for future projects.

APPENDIX B: FEEDBACK EXAMPLES FOR LESSONS LEARNED

Feedback Across Teams Example

During the construction phase, if the construction team identifies an issue in the project's design that could be improved or needs to be addressed, this would directly impact the design team. In this case, the construction team would provide feedback to the design team, preferably through documented lessons learned, and the two teams would work together toward a solution that best addresses the issue. Even for relatively minor issues, the design team can take responsibility for completing the lessons learned documentation because it may directly affect how they design future projects.

Feedback and Lessons Learned Within the Same Team – Designing a Curve Example

A designer unfamiliar with the current requirements, regulations, and specifications completes the design for a curve (input). The manager of the area reviews the design and, through comparison between the input and the current requirements, regulations, and specifications, determines the design is incorrect. The manager gives the designer feedback regarding the necessary changes (output) and, based on this output, the decision at hand is whether or not to modify the curve design.

In this case, the decision was to modify the design (creating a new input), and a comparison between the new input and the reference can be made, thereby creating a feedback loop. Without this feedback and communication, the designer would still be unaware that a reference exists and that the design could change.

Because of the feedback received on this project, the designer will be able to complete similar project designs in the future without committing the same mistake. Taken a step further, if the lessons learned are documented, they will be available to help educate other designers about the current requirements, regulations, and specifications that apply to this type of design.

Feedback and Lessons Learned Within the Same Team – Zipper Merge Example

The construction team of a project implemented a zipper merge as suggested by the design and planning team. During the construction, a member of the construction team observed the performance of the zipper merge was less effective than expected, causing longer work zone queues and delays. The construction team member concluded that changing the way the work zone was signed could improve the performance of the zipper merge. However, they were the only member of the construction team who reached that conclusion and did not discuss it with anyone else on the team.

Later that year, the same agency implemented the use of the zipper merge on another project. The construction team was the same as on the previous project, except for the team member who

had previously observed that changing the work zone signing could improve the zipper merge's performance. The new project experienced the same issue with longer work zone queues and delays than expected. In addition, the issue negatively impacted the construction schedule, delaying the entire project.

If the construction team member on the original project had documented their observations about improving performance by changing the work zone signing and communicated the information to the rest of the construction team, the new project would not have experienced similar delays. Documenting the situation as lessons learned could have made the information available to the entire agency, thus helping prevent other construction project teams from experiencing the same issue.

Feedback and Lessons Learned Across Teams – Zipper Merge Example

During the planning phase of a project, implementation of the zipper merge was considered. The planning team's decision to include the zipper merge in the construction plans would impact both the design and construction teams, which would benefit from understanding how to incorporate this type of merge in the plans and how to best implement it during the construction phase. Failure by the planning team to communicate early on with the design and construction teams could result in a less than optimum design and the zipper merge performing poorly during construction.

Continuing on with this example, the construction team implemented the zipper merge, as designed, on the project. After implementation, the construction team realized the zipper merge was not performing as well as expected, thus delaying the construction project schedule and escalating the cost. If the construction team does not communicate this issue to the planning and design teams, future projects implementing the zipper merge could experience the same schedule delays and increased costs. Therefore, documenting the lessons learned during the original project would likely lead to changes to the standard plans for zipper merge implementation, thus helping construction teams on future projects avoid this issue.

APPENDIX C: SAMPLE LESSONS LEARNED FORM

Project:

Team filling out the form:

Topic:

Keywords:

Describe the issue:

What led up to this issue?

What could improve?

Which team does this impact?

What are some possible solutions?

Which team does this impact?

What are our team lessons learned?

Team Impacted

Project:

Alternative 1:

Lessons learned from alternative 1:

Alternative 2:

Lessons learned from alternative 2:

Alternative 3:

Lessons learned from alternative 3:

LL form — reference:

APPENDIX D: DEVELOPING LESSONS LEARNED USING THE EVALUATION PROCESS FLOW AND THE LESSONS LEARNED FORM

As the previous Figure 5 shows, the evaluation process can begin once the issue a project's construction team is facing is identified. The first step in the evaluation process is to begin completing the Lessons Learned Form with the information that the responsible team already knows (e.g., project, team filling out the form, topic, keywords, and a description of the issue). The project team can also use the form to document ideas about how to resolve the issue and list the other teams impacted and any other useful information.

It is recommended the responsible team complete as many fields on the form as possible. For the fields that will need further investigation to complete, the process can begin with searching for Lessons Learned Forms of other projects with the same topic or keywords and by communicating across the agency about the issue.

The Lessons Learned Form is designed to document issues, capture information about the efforts taken to mitigate or resolve the issue(s), document any alternatives that were tested and whether or not they were successful, and list other possible untested alternatives.

After documenting the possible alternatives, either the responsible team that created the form or the impacted team can analyze its viability as a solution. If it is determined an alternative is not a viable solution, the responsible team can then update the form, document the lessons learned, including the reason why it is not viable, and recommend finding other alternatives to analyze for viability.

To find other alternatives, it may be necessary to conduct further investigation and solicit feedback from other teams across the agency. If an alternative is determined to be a viable solution, the responsible team can update the Lessons Learned Form to show the alternative selected and what they learned from implementing it.

If a different form is used to document alternatives, it is important to reference it on the Lessons Learned Form so future project teams will know where to find the information. Once the responsible team has completed the Lessons Learned Form, the project either continues on with the current phase or moves to the next phase (see previous Figure 3).

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