Research Report
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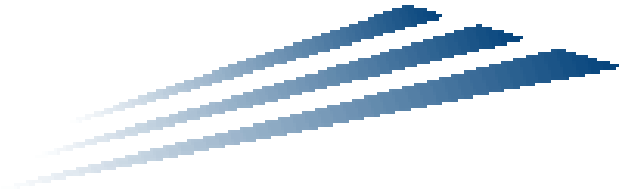
CONSTRUCTIBILITY ISSUES ON KYTC PROJECTS



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Constructibility Issues on KyTC Projects

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Constructibility Issues on KyTC Projects

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16. Abstract

Constructibility is defined by the American Association of State Highway and Transportation Officials Subcommittee on Construction as "a process that utilizes construction personnel with extensive construction knowledge early in the design stages of projects to ensure that the projects are buildable, while also being cost-effective, biddable, and maintainable" A successful constructibility review process for a transportation agency must follow an established methodology similar to value engineering. The process must be flexible and address the critical issues impacting transportation construction projects, such as ease of construction, environmental factors, construction phasing and scheduling, project safety, and accommodation of future maintenance and operations. To obtain maximum benefit from a constructibility review, it must be initiated early in the planning phase of the project and continue through design and construction.

Several key topics related to CRP are presented in this report, with emphasis on the KyTC Project Development Process, and constructibility input to this process. Several recommendations have been proposed to enhance the program.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter I Introduction

In order for a transportation agency to receive the best results for any project, the plans and specifications for the project must be both "biddible" and "buildable". In recent years, there has been increasing concern among transportation officials, contractors and design professionals that project plans and specifications do not always allow the project to be constructed as detailed. When this occurs, projects are delayed, project costs increase, and frequently costly construction claims develop. To help overcome this problem, establishing a careful interaction of planning, design and engineering with construction has shown significant savings in both cost and time required for completing projects. Studies done by the Construction Industry Institute (CII), the National Cooperative Highway Research Program (NCHRP) and the American Association of State Highway and Transportation Officials (AASHTO) have demonstrated that the constructibility review process leads to better project performance. The studies encourage transportation agencies to begin a constructibility review process (CRP) that would include designers, contractors, suppliers and other groups in an effort to provide better plans for projects.

1.1. Problem Statement

Transportation agencies recognize the need for project plans and contract documents that will ensure rational bids and minimize problems during the construction of facilities. A significant aspect of developing high quality contract documents is to incorporate a review process in the planning and design phases to assess a project's constructibility. This process must include input from all professionals involved in planning, design, construction, operation, and maintenance of transportation facilities. Constructibility reviews have the potential to minimize the number and magnitude of changes, disputes, cost overruns, and delays during construction.

Constructibility has been defined in a number of ways. "Constructibility is the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives" (Constructability: A Primer, 1986). Constructibility is also defined as "a measure of the ease or expediency with which a facility can be constructed" (Hugo et al). The AASHTO Subcommittee on Construction defines Constructibility Review as "a process that utilizes construction personnel with extensive

construction knowledge early in the design stages of projects to ensure that the projects are buildable, while also being cost-effective, biddible, and maintainable" (Constructibility Review Best Practices Guide, 2000).

Constructibility reviews involve a formal process of allowing construction experts to provide input on the design of a project. The process involves the construction expert determining the level of difficulty of construction by reviewing the design, and then suggesting design revisions in order to improve the construction process while creating potential cost and timesavings, and less disputes. Such a review process not only enhances better communication between the designer and the contractor but also results in a better-quality final product.

It is generally agreed that the maximum benefits of constructibility occur if the process is formalized and started at the inception of a project. Conceptually, the maximum benefits are measured by the ability to influence cost with the highest influence occurring during the planning phase of a project. It is during the early project phases that key decisions are made and changes are implemented with minimum difficulty. These decisions, if made in a timely manner, can result in significant savings as shown in Figure 1 (Paulson, 1976).

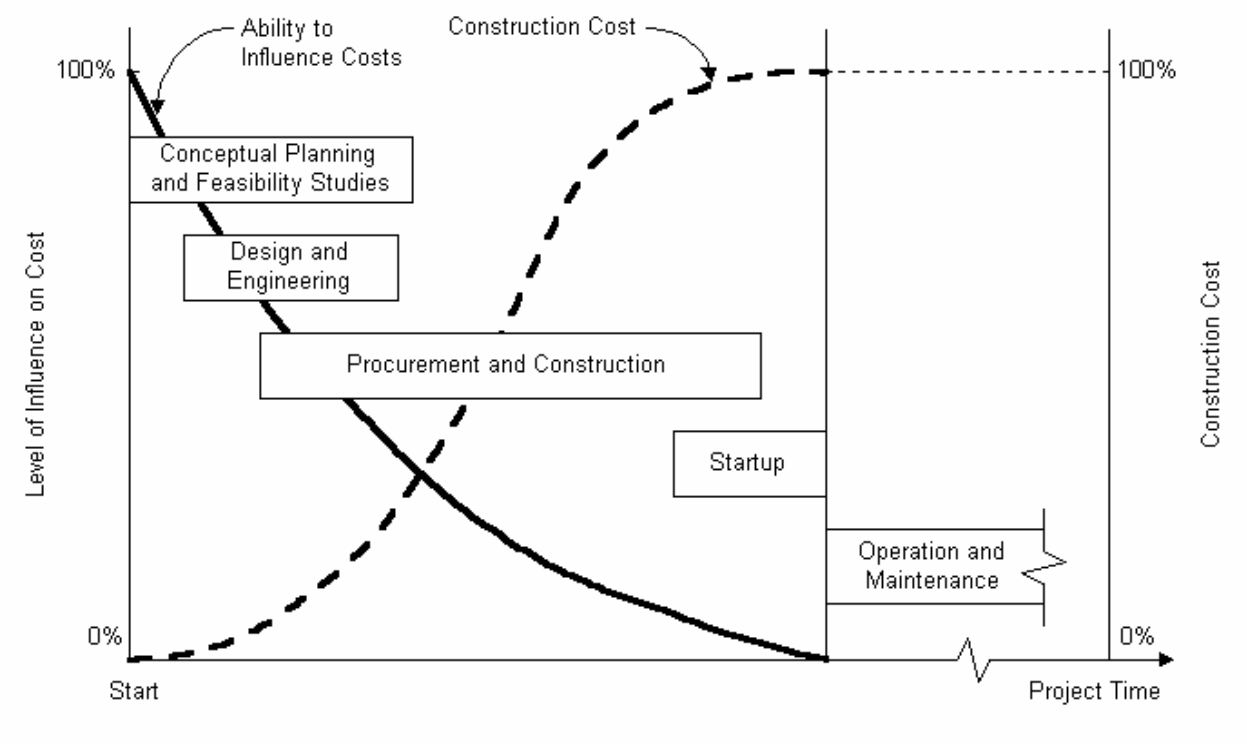

Figure 1: Level of Influence of Changes on Project Costs

1.2. Background and Significance of Work

A significant constructibility review process for a transportation agency must follow an established methodology similar to value engineering. The process must be flexible enough to apply to all types of projects handled by the agency. Furthermore, the process must address the critical issues impacting transportation construction projects, such as ease of construction, environmental factors, construction phasing and scheduling, project safety, and accommodation of future maintenance and operations. To obtain maximum benefit from a constructibility review, it must be initiated early in the planning phase of the project and continue through design and construction. There are several tools that can be used to implement this process, such as the capture and utilization of "lessons learned" on previous construction projects.

Several Kentucky Transportation Cabinet (KyTC) construction projects are now reconstruction and rehabilitation projects. There are many constructibility issues encountered on these projects, which are repetitive in nature, and often cause disruptions and disputes. A major concern is with utilities relocation, which often results in delays, claims, overruns and difficult dealings with utility companies. These repetitive problems of constructibility need to be identified and alleviated.

The Cabinet sponsored workshops on constructibility in the summers of 1995 and 1996. These workshops were well attended by contractors, designers and KyTC personnel. The cooperation and creative solutions developed by the participants at these one-day workshops on sample problems exhibited the will and capability of the participants in the KyTC construction process to resolve constructibility issues. However, since the workshops were conducted, little to no formal activity has taken place to implement constructibility on KyTC projects.

1.3. Goals and Objectives of the Study

The goal of this study is to provide the Kentucky Transportation Cabinet with an evaluation of the feasibility and implementation needs to more fully utilize constructibility processes on its highway construction projects. The following objectives have been identified for this study:

1. Identify the constructibility practices currently used by other DOTs.
2. Identify the primary constructibility issues on KyTC construction projects.
3. Identify practices to alleviate or minimize the impact of major constructibility issues.

4. Evaluate the development of a “lessons learned system” which can be effectively implemented for use in constructibility reviews on KyTC construction projects.
5. Recommend guidelines for implementation of the constructibility review process for KyTC construction projects.

Chapter II Research Data Collection

The research team used various methods to gather information concerning the use of the constructibility review process (CRP) on highway construction projects. A series of activities were conducted to accomplish this research.

- A literature review was performed to determine what research had already been done in this area and to identify CRP specifications in other states.
- A research advisory committee was formed to review the work of the research team and give input throughout the course of the project.
- A nationwide survey was conducted to get information on this topic from Departments of Transportation (DOTs).
- A second survey specifically for Kentucky resident engineers and highway contractors was performed to gather information on constructibility issues on KyTC projects.

2.1. Literature Review

A detailed literature review was conducted specific to the highway sector. Although constructibility has been studied in the transportation industry, its coverage has not been as extensive as in the industrial and building construction industries. Nonetheless, pertinent articles related to constructibility were identified and reviewed in detail.

The Construction Industry Institute (CII) at the University of Texas at Austin is comprised of owners, academics designers, contractors, and other construction experts. The mission of CII is to improve construction industry effectiveness and circulate state-of-the-art knowledge to the construction industry. One of the early research projects funded by CII is the Constructibility Task Force, which sought to enhance the interface between designers and construction professionals. This research conducted by CII has been the driving force behind the formalization of constructibility. The CII constructibility research emphasizes the importance of construction input to all project phases. Figure 2 shows the potential for achieving project savings or enhanced performance during various phases of a project. Obviously, the earlier the input, the better the chance for improvement. The CII also developed a Constructibility Concepts File developed from private industry data, primarily the industrial sector. The concepts

were organized into three major project delivery phases: (1) conceptual planning, (2) design and procurement, and (3) field operations (CII, 1993).

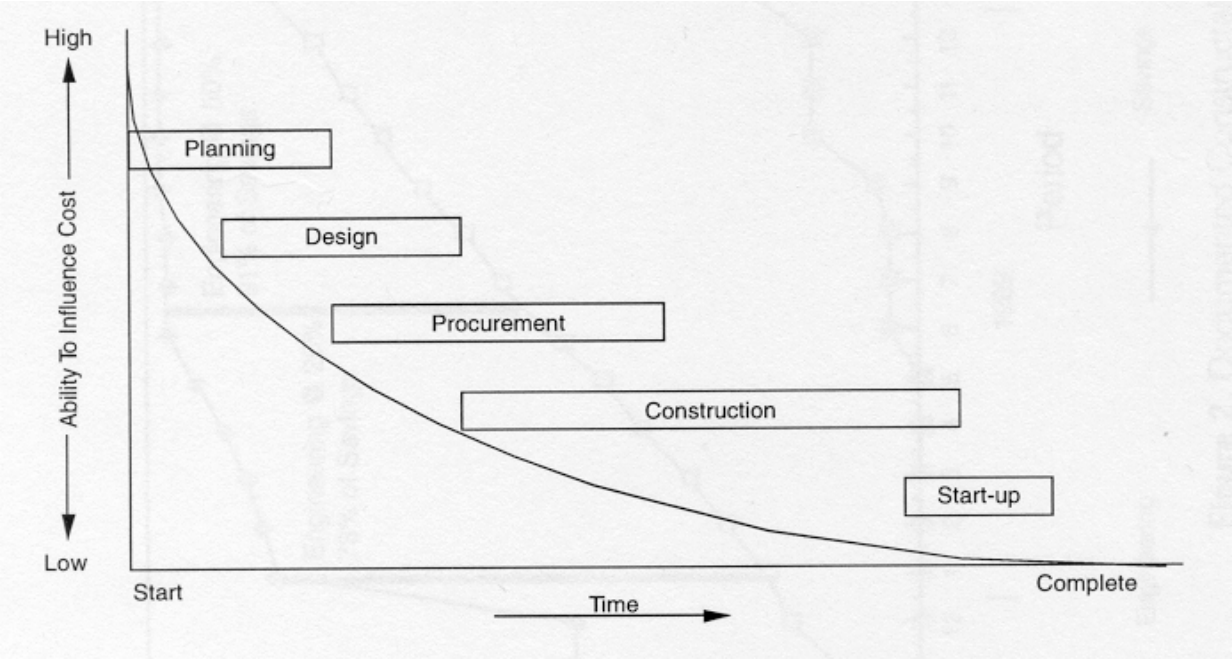

Figure 2: Ability to Influence Final Cost over Project Life (Preview, 1993)

2.1.1. NCHRP Report 390 and 391

The research findings, published in National Cooperative Highway Research Program (NCHRP) Report 390, "Constructibility Review Process for Transportation Facilities," present the logic, reasoning, and development required for the formalization of a constructibility review process for transportation projects. The basic objective of this study was to develop a systematic approach and methodology for a constructibility review process. This methodology must incorporate constructibility concepts, existing analytical tools to support constructibility reviews, and functions needed to apply both concepts and tools. Also, the methodology must be designed to fit different project characteristics and requirements. Finally, it must be adaptable to different State Transportation Agency (STA) approaches to project development.

The publication surveyed 40 Departments of Transportation (DOTs) agencies to identify the critical issues of common barriers to constructibility reviews on DOT projects. Of the 40 state DOTs surveyed, 23 percent have formal constructibility programs. Of the agencies that had a formal constructibility program, five provided documentation of their programs. Respondents were asked to list three issues pertinent to implementing constructibility. The number of times a

general issue was cited was then recorded in terms of frequency. Table 1 summarizes the results obtained:

Number	Constructibility Issue (DOTs)	Frequency
1	Lack of Feedback to Designers	17
2	Plans and Specifications Improvement	14
3	Inadequate Time to Review	12
4	Lack of Construction Experience	11
5	Traffic Control	10
6	Cost	8
7	Geotechnical Issues	7
8	Manpower	7
9	Environmental Factors	6
10	Better Input from Personnel	6
11	Including Contractor's in Process	5
12	Maintenance and Operations	5
13	Communication	4
14	Accessible Database	3
15	Safety	3
16	Balancing with Socioeconomic Factors	1

Table 1: Summary of Critical Issues (NCHRP Report 390)

The report also surveyed owners, designers and contractors. A finding from the survey regarding the five most common critical issues involved in impeding constructibility is shown below. A short discussion on each issue is provided in the report.

1. Unclear designs, plans and specifications.
2. Poor scheduling and phasing of construction.
3. Lack of communication and feedback.
4. Early review of design concepts not stringent.
5. Lack of experience and knowledge.

Based on the common barriers to constructibility, three major project development phases were defined. They were (1) planning, (2) design, and (3) construction. Based on these criteria, a modeling technique was required that permitted the design and layout of the process. IDEFO (Integrated computer aided manufacturing DEFinition) function modeling was selected to develop and portray the CRP. This technique formalizes a process by identifying the primary

functions of the process and representing them in a structured procedural form. IDEF0 uses cell modeling graphic representation as shown in Figure 3.

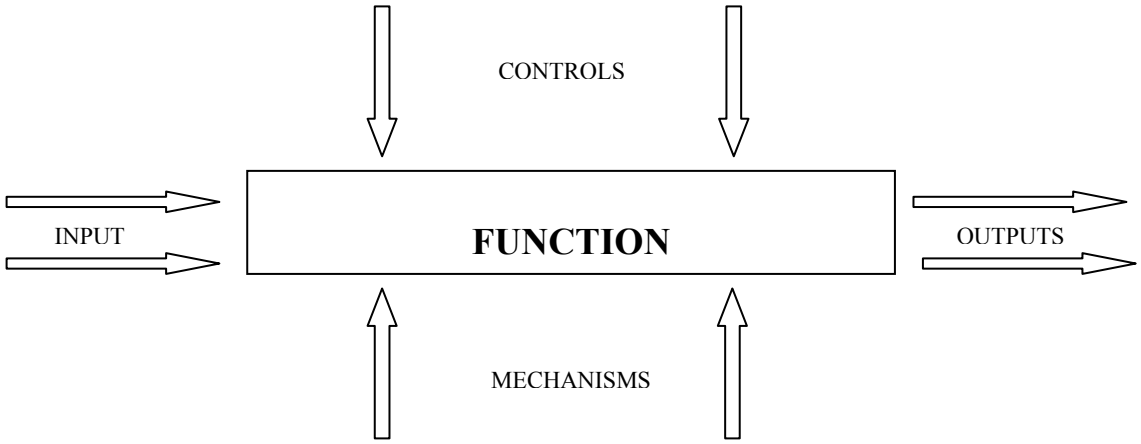

Figure 3: Cell Modeling Technique (NCHRP Report 390)

The key to the IDEFO function modeling approach is mechanisms, which are arrows entering the bottom of a function box. Mechanisms are tools, which might be a person, a computer, a machine, or some other device that aids in carrying out the function. The mechanism shows how that function is accomplished and is to be performed. The function itself, with its inputs, controls, and outputs indicates what the system does. The input indicates the information needed to perform the function. The output indicates the information produced by the function. Controls are information that governs the accomplishment of the function.

IDEFO function was used to develop and portray the CRP. Determination of critical issues regarding constructibility indicated the need for a formalized constructibility review process. To fulfill this need, a preliminary CRP framework was developed based on the literature review and survey results. The CRP was revised further as different State DOTs reviewed it. Then extensive inputs from and reviews by the research advisory team helped to develop the details of the complete framework. Concurrently, a generic Project Development Process (PDP) framework was derived to adequately illustrate integration with the CRP. To evaluate CRP viability, the framework was tested using actual projects. The framework was found to be adequately adaptable to a variety of projects. A workbook was developed to convey the philosophy of the CRP and make its details easily understandable to users.

The final CRP framework is identified in Figure 4. It is comprised of 21 functions, 7 in planning, 7 in design, and 7 in construction, and supported by 27 review tools. These cells or functions are hierarchical in nature and in this form build a complete CRP as illustrated in Figure 4. A0 is the context or summary diagram. A0 is decomposed into three functions: A1, A2, and A3. The decomposition continues until the desired level of detail is reached. For instance, A2 is decomposed into A21, A22, and A23. The final decomposition involves the breakdown of A21 in three constructibility functions: A211, A212, and A213.

An example of a mechanism for the function "evaluate draft plans and specifications for constructibility" (A221 in Figure 4) might be suggestion forms. Using a constructibility suggestion form allows the constructibility team to capture a potential constructibility idea, comment, or suggestion as an improvement to the design that requires further documentation and analysis before acceptance. Once recorded on the suggestion form, benefit/cost analysis might be conducted next on an improvement that has significant potential impact, for instance on cost or schedule. This analysis is performed through the constructibility function "validate constructibility improvements" (A222 in Figure 4). A second descriptive tool form, benefit/cost analysis might be used to confirm the true economic viability of an improvement. Finally, if validated, the improvement can be formally documented on lessons learned log. This improvement can be captured for lessons learned database. This approach as described for identifying and linking analytical tools to appropriate constructibility functions was developed for all functions represented in the CRP framework.

To formalize the final CRP, the framework was reviewed by four state DOTs and the research advisory team. Two applications of the CRP were developed for actual projects of different size and complexity. Further review and project applications provided evidence that the model was flexible and could be applied to different project types.

To implement the CRP at the agency level, the publication recommends early efforts to be focused on training senior management to secure their active support and involvement. Then, an assessment of in-house constructibility capabilities and practices should be conducted. This should determine current practice, identify barriers to constructibility, and confirm need for improvement. To achieve successful implementation, barriers must be removed. Commitment to implementation of constructibility would not be complete without the development of an

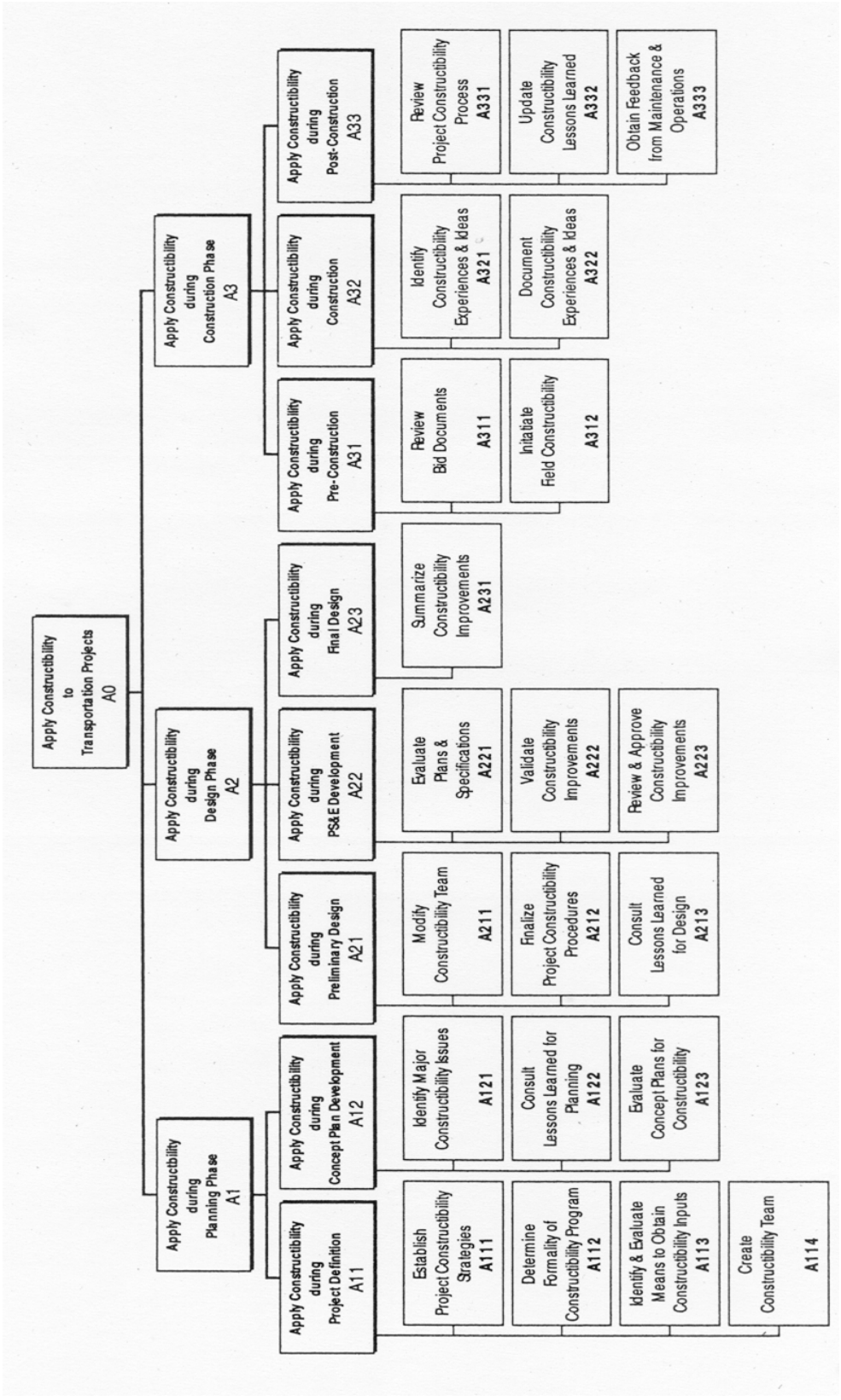

Figure 4: Final CRP Framework (NCHRP Report 390)

implementation policy. Such policy helps emphasize the agency's constructibility program, ensures a high level of commitment, and defines the level and extent of program efforts.

The publication also recommends that in order to establish an agency's constructibility program, a constructibility sponsor or champion is required with a high level of authority and influence. The leader should be dedicated to the cause of constructibility and possess the necessary technical and managerial experience, as well as time. The leader should also ensure that the procedure for constructibility programs is minimal. Procedures should include the structure of the agency's constructibility organization, definition of roles and responsibilities of this organization, a project CRP, a feedback process for constructibility ideas and experiences, and maintenance of the agency's lessons-learned database. Besides the constructibility champion or sponsor as shown in Figure 5, two other positions were recommended for an agency-level organization:

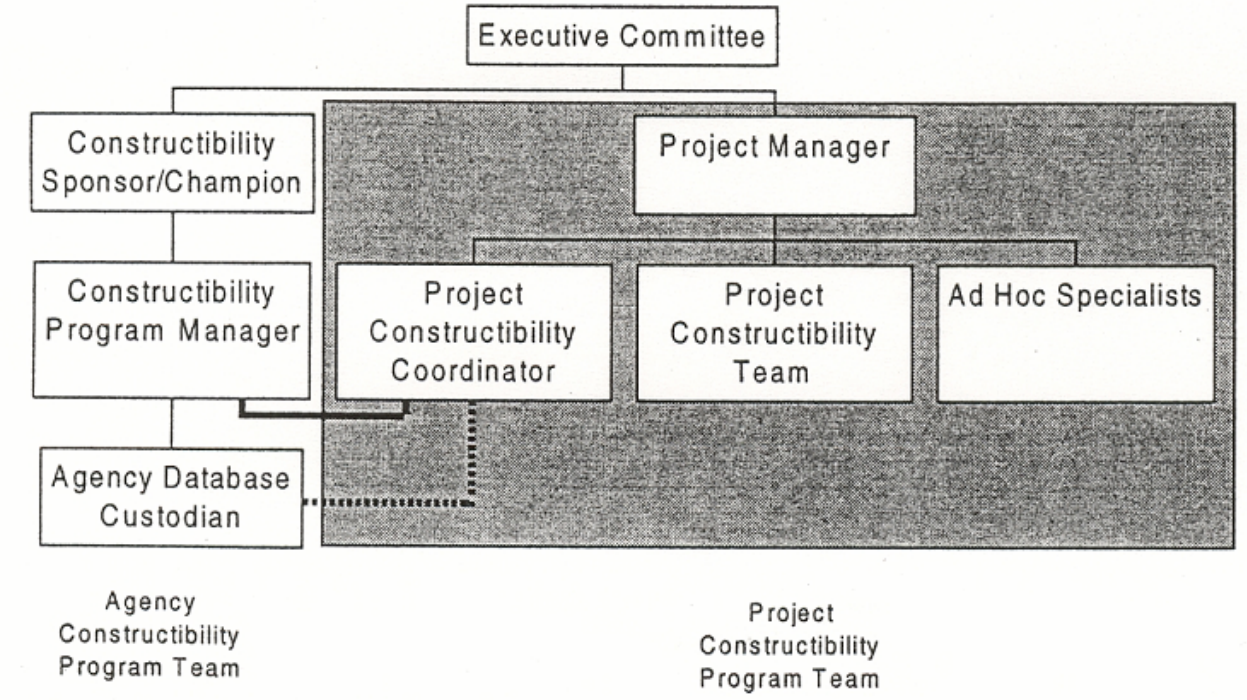

Figure 5: Constructibility Organization Structure (NCHRP Report 390)

(1) Constructibility program manager: Responsibilities include coordinating day-to-day constructibility activities, supervising project constructibility coordinators, and tracking agency constructibility program goals.

(2) Database Custodian: Responsibilities include documentation, tracking, and distribution of constructibility ideas and experiences.

Certain critical issues impede implementation of a CRP. The following lists the issues that make implementing CRP difficult as indicated in the publication:

Issues:

- Lack of detailed and clear design plans, specifications and project planning (scheduling, accessing, traffic phasing, sequencing, environmental, and others).
- Process level: Time for review, feedback, coordination, communication, interaction among various personnel.
- Shortage of resources (money, people, experience).
- Time, commitment and formalization of CRP.
- Post construction feedback to designers, and obtaining feedback from maintenance and operations.
- Formation of a "constructibility team" – (team approach, leader-champion).
- Recognition of favorable benefit/cost ratio.

To address these critical issues, possible paradigm shifts have been identified both at the project and agency levels. The paradigm shifts are summarized below as indicated in the publication:

Project-Level Paradigms:

- Formalize project constructibility process to include planning, design, and construction.
- Implement use of constructibility review tools.
- Use team approach.
- Enhance plans, specifications, and contract documents for constructibility.
- Provide feedback to designers on construction performance of design.
- Collect feedback from maintenance and operations personnel.

Agency-Level Paradigms:

- Establish an agency constructibility policy.
- Recognize favorable benefit/cost ratio.
- Allow for alternate contracting strategies.

- Use a constructibility consultant/engineer coordinator.
- Develop and implement a constructibility lessons-learned database.

To begin to formalize a CRP, pilot projects are the most important process for an agency. Some criteria that are needed for pilot projects to be chosen with care as explained in the publication are:

- Selection of projects.
- Execution of projects.
- Feedback mechanism on projects.
- Training and education.

The agency should move to full-scale implementation, once pilot project demonstrate the success of CRP. The publication points out that full-scale implementation can be accomplished through the following:

- Training: It should cover agencies program objectives, policies, and barriers to implementation among others. Project level training would focus on the CRP and the mechanisms involved in using the process.
- Process reengineering: This requires reengineering of the PDP (Project Development Process) to better adapt the CRP for timely application within the context of the PDP.
- Process improvement: The CRP improvement could include automated lessons learned or use of future tools.
- Future tools: Future tools include checklists, financial analysis, and GPS technology among others.
- Agency culture: Implementing a new and formalized constructibility program will necessitate change within the organization.

A companion publication, generated during this research, NCHRP Report 391, "Constructibility Review Process for Transportation Facilities--Workbook," supports the process for constructibility reviews that can be applied by State Transportation Agency's. The process consists of elements subdivided into increasing levels of detail. The workbook further details the functions, steps, actions, and tools essential to conduct a formal, comprehensive project-level Constructibility Review Process (CRP) to assist STAs in implementing constructibility. The CRP is in a generic format that can be tailored to meet the characteristics of different project

types and agency-level approaches. The NCHRP report 391 shows when constructibility is used the owners in the industrial construction sector experience an average reduction in total project cost and schedule of 4.3 to 7.5 percent.

2.1.2. NCHRP Special Report, 2002: "Cost/Benefits of Constructibility Reviews"

The research report "Cost/Benefits of Constructibility Reviews" stresses the importance of CRP during the planning and design stages of the project. This is because the concept behind constructibility review is the understanding that the early infusion of construction knowledge into project development process (PDP) results in the greatest impact and the least disruption in terms of cost. The report suggests a typical project development milestone plan as shown in Figure 6.

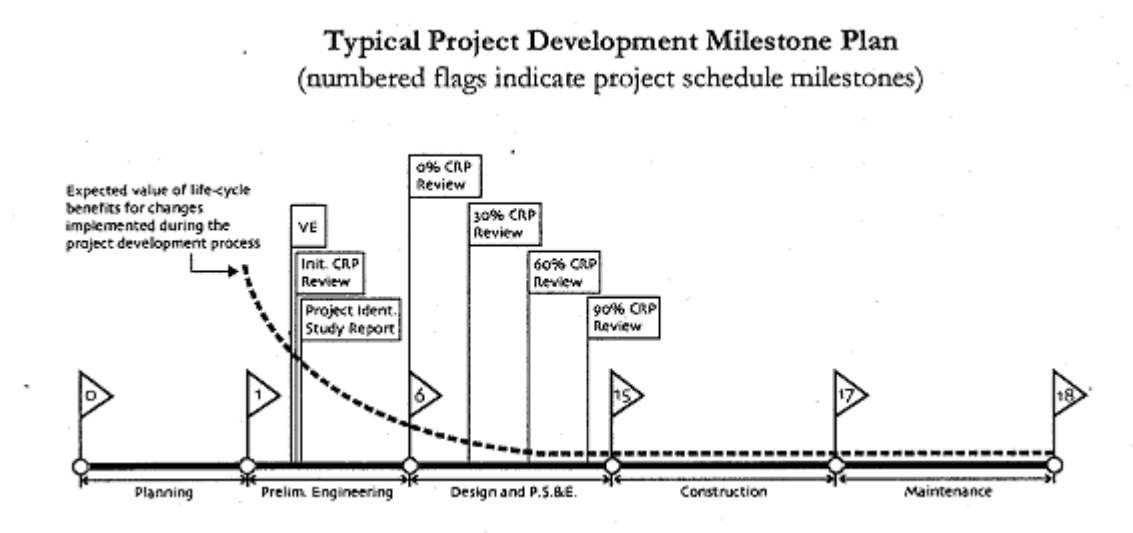

Figure 6: Typical Project Development Milestone Plan (Dunston, 2002)

The figure shows projects that are typically reviewed for constructibility at milestones in the PDP that roughly coincide with project design initiation and at 30%, 60%, and 90% design stages. Further, Figure 6 provides project engineers with a mechanism for pacing the development of plans and specifications and for exploiting the interaction between numerous agency units through a coordinated team-building activity. The report also emphasizes the need of a CRP team, headed preferably by the Project Design Manager (Champion). It describes in detail about four mechanisms desirable for implementing CRP:

(1) Need for a constructibility champion that is responsible for oversight, training, and documentation of lessons learned;

(2) Recognition of the benefit of a quality driven process rather than schedule-driven process;

(3) Flexible guidelines for application of constructibility concepts at various levels of expertise, degrees of effort, and times in the PDP, and levels of resources; and

(4) Efficient and effective incorporation of construction expertise.

The report states that successful implementation of CRP would result in savings derived from design modifications to facilitate constructibility as being much greater than the cost of the constructibility effort. Reduced contract changes and more effective use of design time are some of the measurable benefits of CRP. The study used the benefit-cost model below on two case analyses to evaluate the CRP:

$$\text{Design Related Benefits (DRB)} = (DCE_{med} - DCE_i) + [(DDurE_{med} - DdurE_i) * (Lday_{med})]$$

where, $DCE_{med,\ i}$ = design cost escalation (dollars)

$DdurE_{med,\ i}$ = design duration escalation (days)

$Lday_{med}$ = liquidated damages (dollars per day)

$$\text{Construction Related Benefits (CRB)} = CCCSi + (CCCE_{med} - CCCE_i) + [(CCDurE_{med} - CCDurE_i) * (Lday_{med})] + (CECE_{med} - CECE_i)$$

where, $CCCS_i$ = construction contract cost savings (dollars)

$CCCE_{med,\ i}$ = construction Contract cost escalation (dollars)

$CCDurE_{med,\ i}$ = construction contract duration escalation (days)

$CECE_{med,\ i}$ = construction engineering cost escalation (dollars)

$$\text{Design Related Costs (DRC)} = DHE_{exp} + \text{Travel} + \text{Tools} + \text{Misc.}\%$$

where, DHE_{exp} = design-hour expenditures; person-hour CRP costs during design (dollars)

Travel = costs attributed to field or remote office visits for constructibility reviews (dollars)

Tools = major costs associated with tools dedicated to constructibility reviews such as computer modeling or mock-ups (dollars)

Misc.% = combined cost of minor expenses such as simple computing, record-keeping, copies, transmittals, etc. (dollars)

Construction Related Costs (CRC) = CHE_{exp} + Travel + Tools + Misc.%

where, CHE_{exp} = construction-hour expenditures - person-hour CRP costs during construction, including pre-construction and post-construction review (dollars)

Benefit/Cost (B/C) = [(DRB + CRB) / (DRC + CRC)]

Successful implementation of constructibility reviews on projects is evident as long as the benefit to cost ratio is higher than 1.0. The use of the benefit-cost model on the first case analyses (Pulver road channelization/SR20 project) shows a benefit to cost ratio of 2.29 while the second case analyses (SR513/Bridge deck repair and seismic retrofitting project) shows a benefit to cost ratio of 2.10. This is another instance that indicates the benefits of implementing constructibility review process on projects. Furthermore, the benefits of CRP to design, construction and maintenance as indicated in the article are:

- Early opportunity for designer to explain intent.
- Increase in the designer's knowledge of current construction industry practices.
- Ability to gather input about the construction site without an official visit.
- Updates on licensing and permitting issues.
- Reduction in design time.
- Early resolution of significant problems that may have arisen during project execution.
- Opportunity to effect changes that minimize problems during construction and reduce the number of change orders.
- Pre-bid input regarding estimated working days, reasonable project staging, and scheduling time lines.
- Input into the development of a traffic control plan.
- Opportunity to discuss issues of maintainability during design.
- Early collaboration with the designer resulting in plan clarity.

2.2. Research Surveys

In order to better understand the CRP, this research conducted two separate surveys. The first survey, started in fall, 2001 and completed by spring, 2002, was conducted among state DOTs. The second survey, started in spring, 2002 and completed by summer, 2003, was conducted among resident engineers and highway contractors. Copies of survey 1 and survey 2 are shown in Appendix I and II respectively. A total of 19 state DOTs responded to the first survey whereas, 13 highway contractors and 8 resident engineers responded to the second survey. The first survey was used to identify both critical issues facing state DOTs, and common practices among state DOTs concerning CRP and post construction review process. The second survey was used to identify common recurring constructibility issues on KyTC projects among highway contractors and resident engineers as well as their suggested permanent resolutions. All issues identified from the survey were analyzed and documented. Results from both surveys are shown below.

2.2.1. UK Survey 1

The first survey was compiled using the AASHTO Constructibility Review Best Practices Guide. The survey was mailed out to the 27 state DOTs listed in the AASHTO Constructibility Review Best Practices Guide. Below is a list of 27 states that have responded to the AASHTO questionnaire that utilize a constructibility review program. The states in bold have indicated that they have a written procedure. The states marked with an asterisk have indicated that they utilize contractors in their constructibility review program.

- Arkansas, **California***, Connecticut*, Delaware*, **Florida**, Indiana*, Iowa*, **Kansas**, **Kentucky***, **Louisiana**, **Maine***, **Maryland**, Michigan, **Missouri**, Nevada*, **New Jersey**, **North Carolina***, Ohio*, Oregon*, **Pennsylvania**, **South Carolina**, South Dakota*, Texas, Virginia*, **Washington**, Wisconsin, Rhode Island.

The purpose of the first survey was to evaluate the feasibility and implementation needs required to utilize constructibility and post-construction reviews on transportation construction projects, and to obtain more information on their current constructibility and post construction review practices. Of the 27 states, 19 states responded to the survey. The states that replied were: Arkansas, California, Connecticut, Florida, Indiana, Kansas, Kentucky, Maryland,

Michigan, Missouri, Nevada, New Jersey, North Carolina, Ohio, Oregon, South Carolina, South Dakota, Texas, and Virginia.

Out of the 19 state DOTs that responded to the survey, 95 percent of the state DOTs currently have a constructibility review program. 58 percent of the respondents currently have a formal constructibility review program. Lack of adequate time for review, lack of practical construction experience by design personnel, manpower restrictions, and contractors limited input to remain competitive are some of the common barriers to constructibility as identified by the state DOTs is indicated in Figure 7.

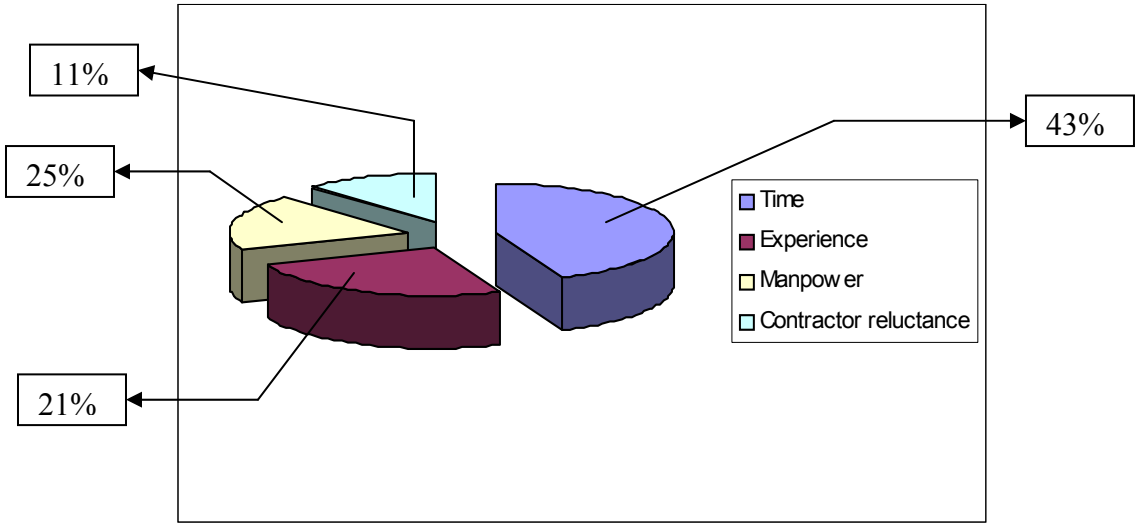

Figure 7: Common Barriers to CRP

Further, reduced cost, increased quality output, better maintenance of traffic, and reduction in total duration are a number of success factors experienced on state DOT projects by implementing constructibility as shown in Figure 8.

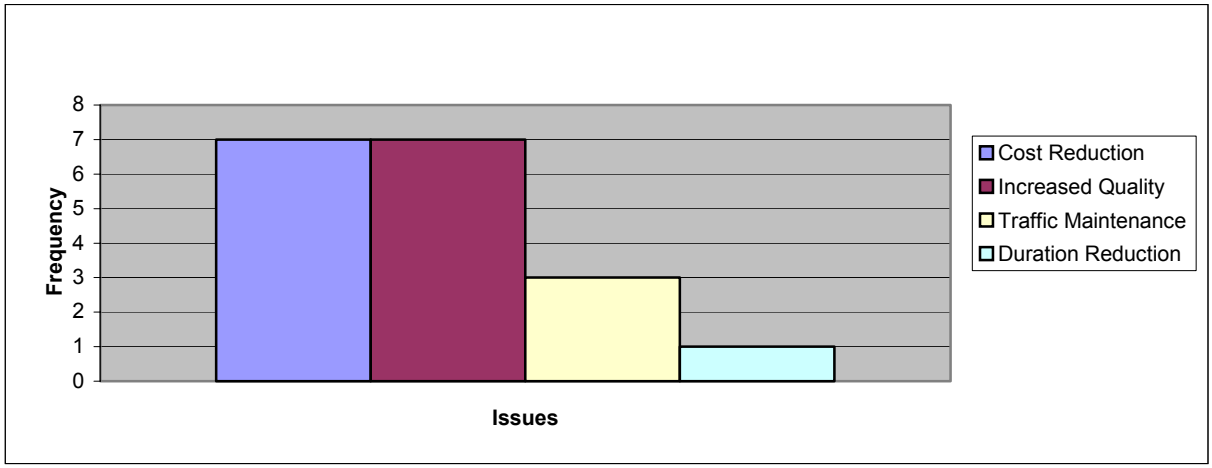

Figure 8: Success Factors to CRP

From the state DOT's surveyed, Figure 9 shows the distribution of construction input during the design phase while Figure 10 shows the different personnel that the state DOT's use to conduct the CRP.

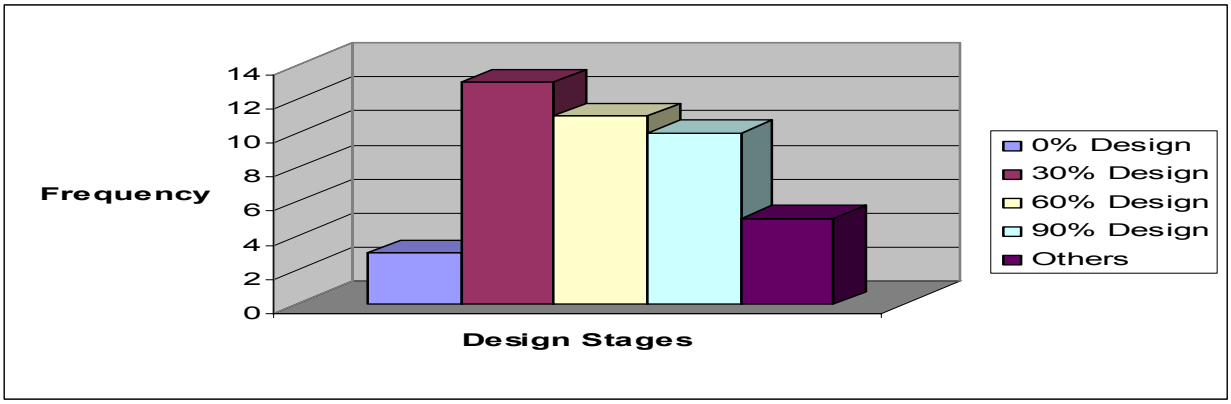

Figure 9: Stages of Construction Input to Design

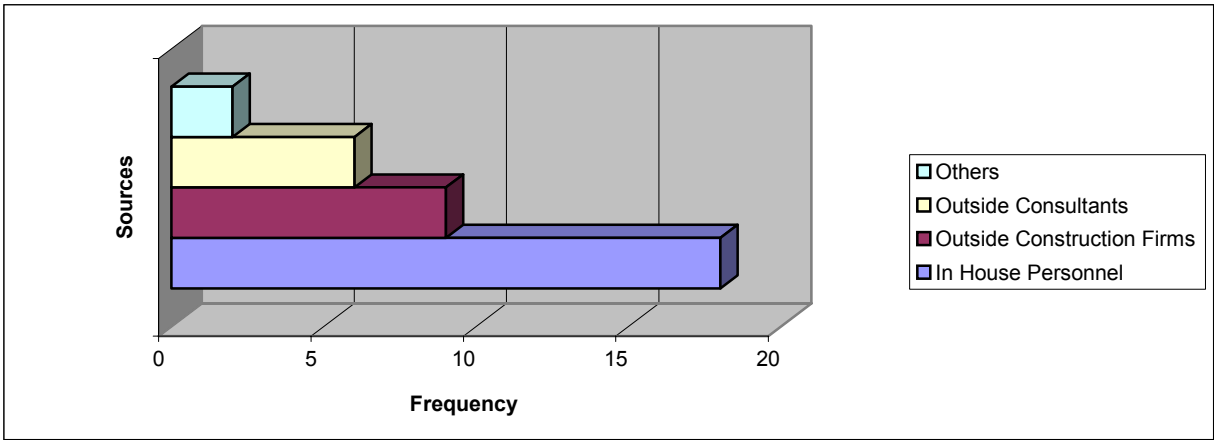

Figure 10: Different Sources used by DOTs to conduct CRP

The second part of the first survey was focused on the current practices of the post construction review process (PCRP). Of all the state DOTs that responded, 53 percent currently have a formal PCRP. Of the 53 percent that currently have a formal PCRP, 63 percent have documented PCRP in writing. Finally, 33 percent of state respondents with formal PCRP invite the same participants to both reviews (CRP & PCRP).

Respondents to the survey identified staffing versus workload, and contractor reluctance to complete the PCRP forms as some of the common barriers that prevented state DOTs from implementing PCRP. The PCRP forms were not completed since the contractor did not want to create a possible conflict with the designer and also it was difficult for construction personnel to remember the reasons for change orders at the end of a project. Performing PCRP before the completion of the project where all construction personnel involved in the project are still onsite, and providing information to construction personnel on the benefits of PCRP can solve these issues.

2.2.2. UK Survey 2

The second survey was sent to several resident engineers and highway contractors within the state of Kentucky. The purpose of the survey was to identify recurring constructibility issues on KyTC construction projects, resolutions developed for such issues, impact of these issues on cost, schedule and quality, and suggestions to KYTC practices to avoid the same issues on future projects. Constructibility issues identified through this survey was used to create a lessons learned database to help avoid these issues from recurring. Table 2 (arranged in order of frequency) summarizes the combined (resident engineers & contractors) common constructibility issues on KyTC projects. Traffic control and existing utilities was the most frequent issues identified whereas, existing utilities had the highest average impact on cost, schedule and quality.

Issues	Frequency	Cost Impact (1-5)	Schedule Impact (1-5)	Quality Impact (1-5)	Average Impact (1-5)
Traffic Control	11	4	4	3	3.7
Existing Utilities	11	4	5	3	4.0
Geotechnical	10	4	3	3	3.3
Right Of Way	9	4	4	2	3.3
Structure	7	4	3	2	3.0
New Utilities	7	4	4	2	3.3

Table 2: Combined Common Constructibility Issues in KyTC Projects

Table 3 (arranged in order of frequency) shows the common constructibility issues identified by the resident engineers. Existing utilities was the most common issue identified by the resident engineers followed by traffic control, inadequate plans, water drainage and Right of Way (ROW).

Issues	Frequency	Cost Impact (1-5)	Schedule Impact (1-5)	Quality Impact (1-5)	Average Impact (1-5)
Existing Utilities	4	4	4	4	4.0
Traffic Control	4	4	3	2	3.0
Inadequate Plans	4	3	4	2	3.0
Water Drainage	3	4	3	3	3.3
ROW	2	4	4	2	3.3

Table 3: Common Constructibility Issues Facing Resident Engineers in Kentucky

The contractors surveyed identified seven common recurring constructibility issues facing the construction industry in Kentucky. Geotechnical was the most common issue identified by the contractors followed by traffic control, ROW, existing utilities, structure, new utilities, and pavement. Table 4 (arranged in order of frequency) shows the contractor's rating of the common constructibility issues addressed by the contractors.

Issues	Frequency	Cost Impact (1-5)	Schedule Impact (1-5)	Quality Impact (1-5)	Average Impact (1-5)
Geotechnical	9	4	4	3	3.7
Traffic Control	7	4	4	4	4.0
ROW	7	4	4	2	3.3
Existing Utilities	7	4	5	3	4.0
Structure	7	4	3	2	3.0
New Utilities	6	4	5	2	3.7
Pavement	5	5	3	3	3.7

Table 4: Common Constructibility Issues Facing Contractors in Kentucky

Resolutions and suggested permanent resolutions of issues indicated in Table 3 and Table 4 are shown in Appendix III and IV respectively. The results obtained from survey 1 and 2 helped provide the research team valuable information on the current CRP and PCRP issues and practices, and current recurring constructibility issues on KyTC projects. This information was used as basis to develop CRP, suggested checklists and suggestion form for KyTC projects as

shown in detail in Chapter 5. The information obtained from the second survey was used to develop a lessons learned database as discussed in Chapter 6.

2.3. AASHTO Subcommittee on Construction

In the research report, Constructibility Review Best Practices Guide, the AASHTO (American Association of State Highway and Transportation Officials) Subcommittee on Construction assumed the responsibility for developing a best practices guide for constructibility and post-construction reviews. The subcommittee action plans were: (1) Conduct survey to determine current practice, (2) Develop best practices guidelines, (3) Develop plan for industry involvement, and (4) Initiate related research. In the report, AASHTO stressed that the constructibility review should assure that:

1. The project can be constructed using standard methods, materials and techniques;
2. The plans and specifications provide the contractor with clear concise information to prepare a competitive and cost effective bid;
3. The project will be maintainable in a cost effective manner.

The AASHTO Subcommittee on Construction performed surveys, collected data and held several discussions on constructibility reviews. In 2000, they produced the Constructibility Review Best Practices Guide. Highlights of the recommendations for implementing a constructibility review process in DOTs are noted below:

1. Champion: A constructibility program needs a champion who is recommended to be from senior management and part of their job is to emphasize the team concept ensuring that cooperative and communication flows freely, vertically and horizontally. The Champion should also have the authority to authorize plans and specifications revisions when constructibility review uncovers a significant problem.
2. Team Composition: It is important to keep the team as small as possible and at the same time provide the required expertise for the project to be reviewed. The team may be composed of:
    - Construction professionals;
    - Internal DOT construction staff;

- Consultants, states may retain consultants on rather a project by project basis or use an on call consultant for multiple assignment while keeping in mind that it is recommended for the consultants not to review their own designs;
- Regulatory representatives;
- Utilities representatives;
- Railroad representatives;
- Material suppliers (on projects where non-standard materials are to be used).

3. Frequency of reviews: It is determined by considering the agencies resources and benefits to be achieved, realizing that reviews conducted during the early stages of a project design have the best potential for providing meaningful benefits with minimum delay and cost. For instance, the California agency has developed a three-level process, which is applied to all projects:
    1. *Level 1 constructibility review*, which includes reviews at the project initiation document (PID) stage and 30%, 60%, 95% design stages.
    2. *Level 2 constructibility review*, which includes a PID stage and 30% and 95% design stages.
    3. *Level 3 constructibility review*, which includes a PID stage and 95% design.
4. Resources: In developing a constructibility review process, agencies should avoid creating a process that is complex and resource intensive. The ideal process should be simple to implement and should focus on the major issues involved in the project. Agencies need to adjust the constructibility process to fit their goals realizing that the following variables will affect the program:
    i. *Manpower*: More resources may be required in the early phases than the later ones;
    ii. *Funding*: Savings from reduced change orders and claims will typically offset possible additional funding earlier in the project schedule;
    iii. *Time*: the process may impact some project schedules but any time lost in the design phase will typically be made up for in the construction phase due to a more constructible and maintainable project.

5. The review process:
    a. Type and length of review meeting: The agenda of the reviewers must be organized to complete the constructibility review in one meeting and should include specific items of concern to the design as well as the construction office, while allowing time for discussion and resolving issues. The review should also allow reflection on previous decisions and determine whether the project is on tract with respect to scope, schedule and cost.
    b. Checklist: Many agencies have found that it is imperative that certain guidelines/checklist be developed for the review to follow. Some agencies have found that general checklists are appropriate while other agencies have developed detailed checklists of items that have historically caused constructibility problems.
    c. Responsibility for review follow through: It is also recommended by the AASHTO review that the constructibility review plan include a mechanism that follows through on the comments produced during the review. Most agencies have the project manager review comments and reply back to the reviewers with what was or was not included in the design. It is also well recommended that the plan have a resolution procedure that assigns responsibility for deciding whether review comments will be incorporated into the project design.
    d. Dissemination of review comments: The AASHTO subcommittee also pointed out the importance for state agencies to disseminate and store the lessons learned from their constructibility review process. Washington and Maine agencies store their lessons learned for future reference by designers/agency staff. Maine also posts their results on their Internet home page.
6. Measuring constructibility review results and benefits:

    It is difficult for agencies to effectively measure the cost and benefits of constructibility reviews other than through anecdotal results. AASHTO has concerns that there appears to be no viable methods developed to date to provide a measure of the success of constructibility review programs.

7. Post construction reviews:

   Post construction reviews allows agencies to eliminate repeated mistakes that increase costs and effect project scheduling, as well as provide design with feedback on issues that can be addressed in the future. It is important for post-construction reviews to:

   a. Have a champion to lead the process;
   b. Provide benefit to the owner agency; and
   c. Include external representatives who are familiar with the project and the issues that occurred during construction.

   These reviews should also be conducted near the end of a project while the project personnel are still readily available to attend. Agencies conducting post-construction reviews should also have a mechanism for distributing and sharing the review with all parties involved in the project.

A follow-up questionnaire was developed by AASHTO and sent to 50 states. As of April 2002, out of the 21 state DOTs that responded, 81 percent of state DOTs reviewed the August 2000 Constructibility Review Best Practices Guide. Of the 81 percent of state DOTs that reviewed the report, 38 percent of state DOTs currently have a formal CRP. The survey also indicates that 56 percent of state DOTs currently have a formal post-construction review process.

2.4. KyTC Study Advisory Committee Meetings

A study advisory committee was formed in order to help the research team achieve the goals and objectives of the project. The advisory committee was composed of designers, contractors and highway department employees. Table 5 lists the name and organization of the advisory committee members. The UK research team members are indicated in Table 6. A total of eight advisory committee meetings and two workshops (see Chapter 3) were held at the University of Kentucky. Valuable input was received from these meetings, which is incorporated into various parts of this report. Each of the advisory committee meetings consisted of three major activities:

- To update the advisory committee on the progress of the project.
- Discussions on topics that the research team deemed necessary in order to gather viewpoints of the advisory committee.

- Discussion of the next meeting date and the next target for the research team to accomplish.

Number	Name	Organization
1	Bart Bryant	KyTC District 7 Construction
2	Bob Farley	FHWA
3	Bob Nunley	KyTC District 7 Design
4	Bryan Ledford	Hinkle Contracting Corporation
5	David Kratt	KyTC Central Office Program Management
6	Don Hartman	Kentucky Transportation Center
7	Don Schneider	American Consulting Engineers
8	Gary Raymer	KyTC District 4 Construction
9	Glen M. Kelly	QK4
10	Greg Groves	KyTC District 5 Pre-Construction
11	James Ballinger, Chairman	KyTC District 7 Design
12	Jim Gallt	Palmer Engineering
13	Joe Bironas	Central Bridge Company
14	Joette Fields	KYTC Central Office Design
15	Robert Semones	KYTC Central Office Design
16	Ron Gray	Ky. Assoc. Highway Contractors
17	Tom Proffitt	Central Rock Company
18	Vibert Forsythe	KyTC Central Office Construction

Table 5: Advisory Committee Members

Number	Name	Position
1	Dr. Donn E. Hancher	Principal Investigator
2	Dr. Paul M. Goodrum	Co-Principal Investigator
3	Don C. Hartman	Co-Principal Investigator
4	Mohammed Yasin	Graduate Research Assistant
5	Joseph Thozhal	Graduate Research Assistant

Table 6: UK Research Team

The input and dedication of the external advisory committee members, especially the committee chair, James Ballinger, was very helpful to the research team.

Chapter III Mini Constructibility Review Workshops

3.1. Background

The University of Kentucky Construction Engineering and Management research team sponsored two constructibility workshops, which were held on the 7th and 9th of January, 2003. The research team with the help of Mr. James Ballinger, Mr. Randy Turner, and Mr. Bob Walling was able to select two projects that were deemed suitable for the constructibility workshops. The two projects selected were the Nicholasville Road Bypass Project (US 27) and the Leestown Road Project (US 421), both in intermediate stages of development. The objectives of the constructibility workshops were:

- Provide the advisory committee with project review experience.
- Provide the research team an opportunity to observe and document a real project review process in a 1-day format.
- Provide input to District 7 on project feasibility.

The output of the workshops was to come up with four or more specific recommendations to improve the constructibility of each project.

Prior to the workshops, on December 10, 2002, Mr. Dan Eaton (KyTC Engineer Tech Sr.) and the student research assistants made short on-site videos of the two projects. The videos were later transferred to a Compact Disc (CD). The purpose of the videos was to provide the advisory committee members a better picture or representation of the existing conditions of the projects. This was felt to be more efficient than taking the team on a van ride of the sites.

The advisory committee members at these one-day workshops were mailed a set of current project plans three weeks in advance that also included the objectives of the project, plus the agenda of the workshop. This allowed the advisory committee members to analyze and investigate potential constructibility issues, prepare questions, and develop potential constructibility solutions prior to the workshop. Furthermore, the advisory committee members were informed of the availability of certain resources during the workshop, such as a laptop computer with wireless Internet connection, a computer projector, phone, scanner, and fax machine.

The agenda for the constructibility workshops is shown below:

Time	*Programs*
8:00a – 8:30a	Constructibility Review Workshop Kickoff [overview & presentation of project plans to date]
8:30a – 9:00a	Q & A session [team asking presenters]
9:00a – 9:15a	Review instructions & orientation on resources
9:15a – 9:30a	**Break**
9:30a – 11:00a	Team Discussion [brainstorm possible improvements]
11:00a – 11:30a	Prioritize possible improvements [select top 4-5 topics & make sub team assignments]
11:30a – 12:00p	**Lunch Break**
12:00p – 2:00p	Sub team studies/analyses
2:00p – 2:15p	**Break**
2:15p – 3:15p	Sub team presentations & discussion
3:15p – 4:00p	Prepare final power point presentations for Cabinet
4:00p – 4:30p	Presentation to KyTC personnel
4:30p – 5:00p	Workshop analysis

Table 7: Agenda for the Constructibility Workshops

The subsequent sections of this report detail each project's overview, advisory committee members input, discussion points, pictures taken during the constructibility workshops (see Appendix V), and presentation of recommendations that each sub-team discussed, analyzed, and assembled. The report also covers the pros and cons of the constructibility workshop from the advisory committee's viewpoint.

3.2. Workshop 1 – Nicholasville Road Bypass Project

3.2.1. Overview

The Nicholasville Road project was initiated in December of 1998 when funding was authorized to begin the design phase. The scope of the project is to improve traffic flow and safety at the North Main Street/US 27 Intersection, relieve downtown traffic and local street traffic, and meet the 2022 design level of service (LOS). This project is expected to go to construction in August 2008. The estimated construction cost is $42 million.

3.2.2. Current Project Goals and Objectives

The following is a brief summary of the project goals and objectives:

Goal #1:	Recognize the US27 Management Plan.
Objectives:	-Preserve and enhance the capacity of the US27 corridor.
Goal #2:	Improve traffic flow and safety.
Objectives:	- Improve the flow of traffic at the North Main Street/US27 Intersection.
	- Meet design criteria.
	- Relieve downtown traffic and local street traffic.
Goal #3:	Minimize impacts to existing facilities.
Objectives:	- Minimize disruptions to schools.
	- Minimize adverse impacts to farmland.
	- Minimize adverse impacts to commercial and private property.
	- Minimize impacts to infrastructure.
Goal #4:	Preserve the corridor for the East Bypass.
Objectives:	- Adopt official maps for corridor preservation.
	- Discourage development in the corridor until a final alignment has been established.
Goal #5:	Minimize Environmental Impacts.
Objectives:	- Encourage public involvement.
Goal #6:	Provide for an economical transportation system.
Goal #7:	Promote job opportunities.

Objectives: - Enhance access to the Industrial Park.

- Minimize impacts and promote access to employment center.

3.2.3. Workshop 1 Activity

The constructibility review process meeting for the Nicholasville road project was scheduled on January 7th, 2003. The meeting was held in Room 112 of the Oliver Raymond Building at the University of Kentucky. Dr. Donn E. Hancher was the person in charge of conducting the constructibility workshop for this project. The following table entails the advisory committee team members that attended the constructibility workshop:

NICHOLASVILLE ROAD PROJECT			
DATE:	1/7/2003		
LEADER:	Dr. Donn E. Hancher		
CONTRACTOR	KyTC/FHWA	CONSULTANT	UK
Ron Gray	Bob Farley	Don Schneider	Dr. Paul Goodrum
Tom Proffitt	Bob Nunley	Glen Kelly	Joseph Thozhal
	Greg Groves		Mohammed Yasin
	Vibert Forsythe		

Table 8: Advisory Committee Team Members (Workshop 1)

Dr. Hancher called the meeting to order at 8:00am. After the introduction of the attendees, Dr. Paul Goodrum gave a presentation on the overview of the constructibility workshop (Photo: 1). Ben Edelen (Quest Engineers, Inc.) then gave a brief presentation on the project overview, history, statistics, and different alternatives Quest Engineers had considered. This was followed by a series of questions from the advisory committee members, which were answered by either Ben Edelen or Bob Walling (Photo: 2-7). At 9:00am, a review on the resources available and instructions on how the workshop was to proceed was given by Dr. Hancher. This was followed by a short break.

At 9:30am, Dr. Hancher initiated the Team Discussion session (brainstorm possible improvements) with the advisory committee members (Photo: 8-10). The following issues were made:

- Make US 27 route not just a by-pass but also the main highway road.
- How about changing the proposed interchange and coming up with a new interchange plan?

- How about the drainage issues in the Carey Trust Properties, LLC where two pipes drain onto a property, and also the road across from property owner.
- What about the vertical alignment at the Grogan's Ferry connection?
- Why not buy permanent utility easement along US 27 that will help ease implementing the proposed intersection?
- The option of using an elevated bridge structure on the proposed interchange will help reduce earthwork on both sides of the interchange.
- Did the designers consider how the current traffic volume would be maintained during the construction of the proposed interchange?
- Does the proposed interchange facilitate pedestrian or bicycle access?
- Has the signalization of interchange movements been factored in the design process, especially the access control on ramps?
- Does the proposed interchange provide access to current restaurants?
- What about the signage in the free flowing ramps in the urban interchange? The plans seem to show that the free flowing ramps are "too open."
- Hare the drainage issues pertaining to the railroad property been considered? If not, it is a critical issue that needs to be addressed since oftentimes railroad problems can cause major constraints and delays to a project.
- Is there an adequate "staging area" for the contractor(s) to use?
- Has the process involving the reviewing of the environmental document(s) and purchasing of right of way been done yet. If not, the process needs to speed up.
- How about using the old roadway as the current west bypass and reduce to 2 lanes?
- It is better if phase 2 of the project was done prior to phase 1. This is because phase 1 involves a lot of fill, whereas phase 2 involves a lot of cut. By doing phase 2 first, the contractor can utilize excess cut material for fill purposes. Vertical alignment of phases 1 and 2 needs to be looked at.
- It is important that the east bypass be completed along with the proposed interchange or forget about constructing the whole interchange.
- Was the possibility of not having an interchange considered?

Dr. Hancher then asked the advisory committee team members to prioritize the suggestions made above by selecting the top four issues. The following four issues were selected:

1. No new interchange, rather an "at-grade intersection" with 6 lanes.
2. Revise interchange.
3. Right of Way (Environmental Document) "speed up process."
4. Reducing earthwork for current design location.

After the advisory committee team members selected the top four issues, these issues were then discussed in terms of both the positives and negatives (Photo: 11-12). The following comments were made to each issue:

#1 issue: No new interchange, rather an "at-grade intersection" with 6 lanes (Figure 11, 12)

The benefit of having the proposed at grade intersection with six lanes rather than a new interchange is that it helps avoid potential railroad and drainage issues, helps in minimizing the impact on traffic, it is consistent with the existing roadway system, helps minimize impact on local business, reduces the overall project construction time, more user-friendly for bikes and pedestrians, and helps maintain the integrity of US 27, i.e., US 27 is not just a bypass but a major highway.

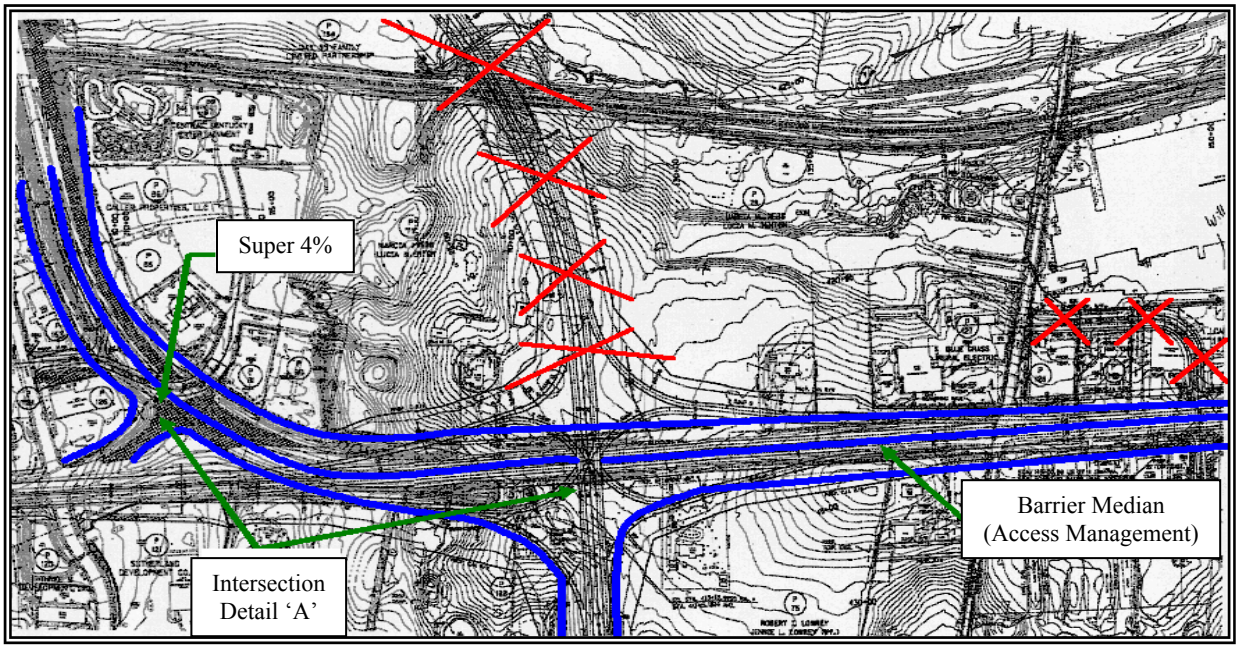

Figure 11: At-Grade Intersection

The drawback of having the proposed at-grade intersection with six lanes is that the cost of constructing it is huge. Also, the proposed at grade intersection won't satisfy the 2022 design level of service therefore slowing down the thru traffic. The proposed at-grade intersection may also impede development and may be contrary to public buy-in.

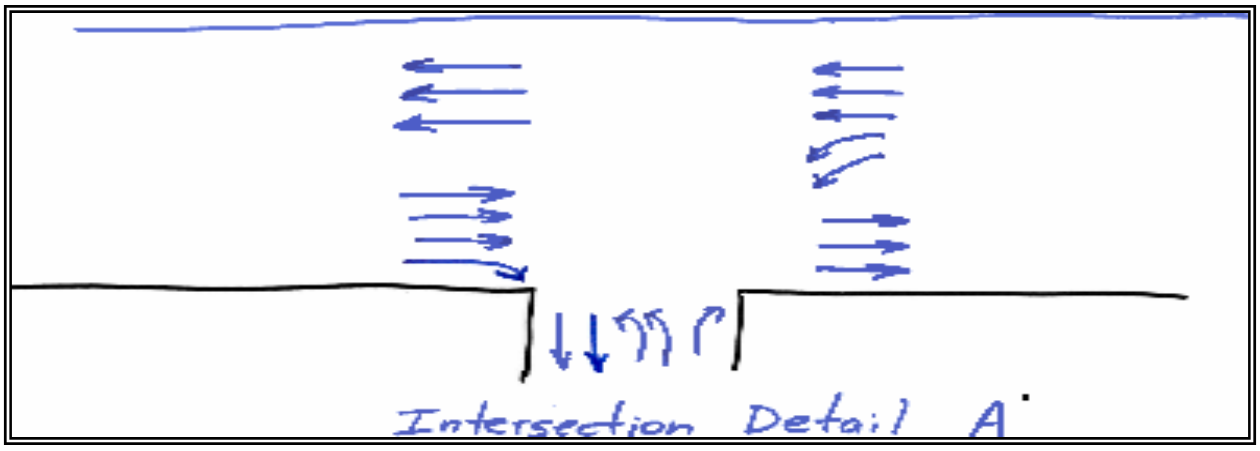

Figure 12: Intersection Detail 'A'

#2 issue: Revise interchange (Figure 13, 14, 15)

The advisory committee members suggested an access road that connected between Baker Lane access road to North Plaza Drive instead of having access roads and ramps through property 79 that would eventually join US 27 bypass road.

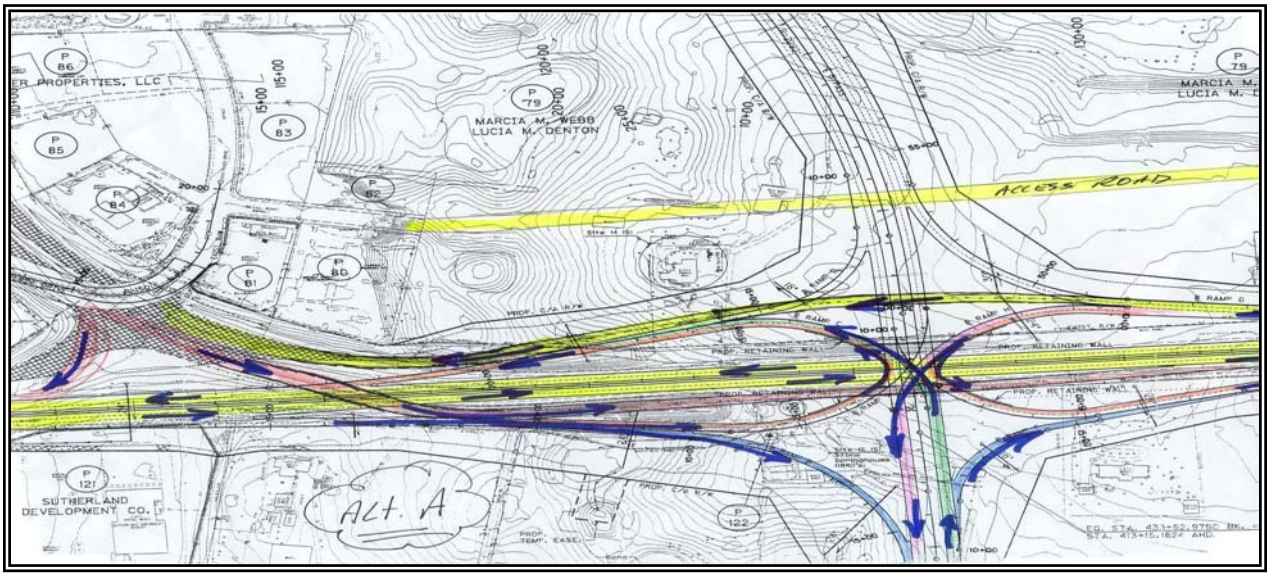

Figure 13: Alternative Interchange 'A'

The positives of implementing the revised interchange are that it lessens the impact of cost and time to construct, it avoids the problem of dealing with the railroad and no bridge is required, it enhances the traffic control during construction, and lessens the impact on local business. Additionally, it promotes future site development and reduces public hostility.

The downside of implementing the revised interchange are the questions about feasibility of grades to make it work, a drainage issue that needs to be addressed, weaving traffic might be a problem as it may be confusing not only to the motorist but also causes confusion as to the US 27 path.

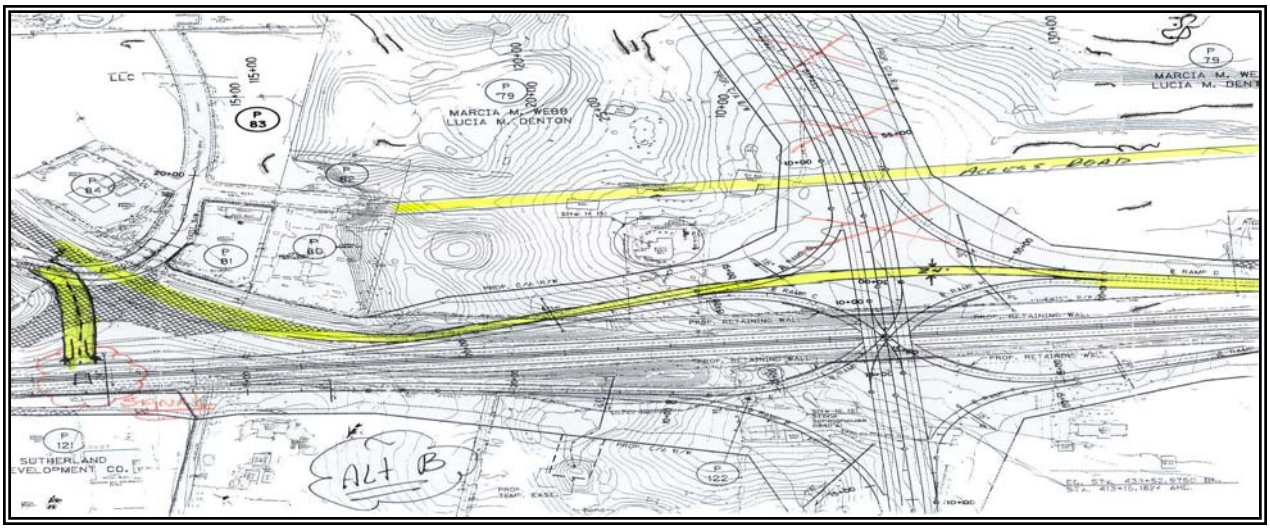

Figure 14: Alternative Interchange 'B'

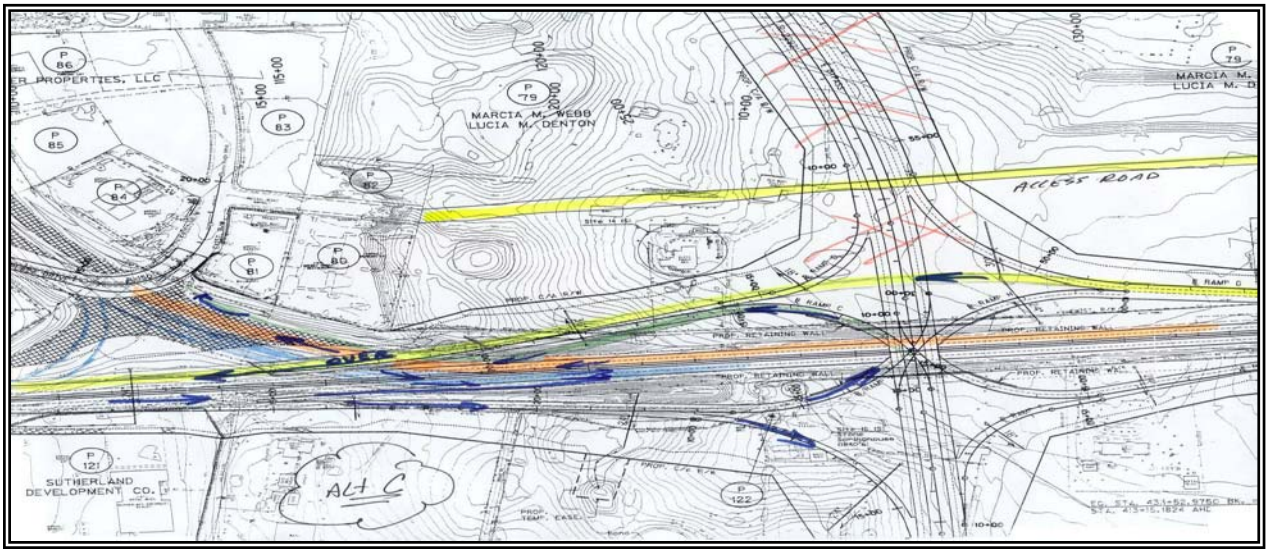

Figure 15: Alternative Interchange 'C'

#3 issue: Right of Way (Environmental Document) "speed up process"

The advisory committee suggested speeding up the process of obtaining ROW, which would ease and prevent delay during the construction process.

The advantages of speeding up the ROW process are that it helps reduce cost, speeds up development of the areas that are associated with the proposed interchange, and reduces uncertainty and/or fear about whether the project can be constructed and completed. Furthermore, speeding up the process of ROW will enhance utility locations, geological investigation process, maintain property owner continuity, and the impact of inflation or property valuation increases.

The disadvantages are that it will delay another project in the state plan (uncertain impact??), reduce flexibility if major changes take place, and there is a possibility that an environmental issue may be missed.

#4 issue: Reducing earthwork for current design location

The advisory committee members suggested reducing the earthwork, especially on the east side of the project since this would cause a lot of havoc on the traveling public heading towards US 27 bypass road. Further, the committee members suggested borrowing material from another site, which would help in, improve development opportunities.

The benefits of reducing earthwork for the current design location are that it will lessen the impact on the traveling public, reduce ROW requests and achieve a possible cost reduction, enhance development opportunities, and reduce environmental impacts.

The drawbacks are it may have property owner problems, more maintenance problems, and the east side may require a steeper grade.

After the half hour break, at 12:00 pm, Team A (assigned issues #2 and #4) and Team B (assigned issues #1 and #3) were asked to further analyze, discuss and put together a power point presentation of their recommendations (Photo: 13-14). The following table shows the team members for Team A and Team B.

Team A was assigned Rm. 112, while Team B was assigned Rm. 120. Each team had a research assistant that helped the team members in various tasks such as scanning documents, and putting the power-point presentation together. Dr. Hancher helped lead Team A, whereas Dr. Goodrum helped lead Team B in their respective sub-team analyses/studies session.

NICHOLASVILLE ROAD PROJECT					
DATE:	1/7/2003				
LEADER:	Dr. Donn E. Hancher (Team A), Dr. Paul M. Goodrum (Team B)				
TEAM A			TEAM B		
CONTRACTOR	KyTC/FHWA	CONSULTANT	CONTRACTOR	KyTC/FHWA	CONSULTANT
Tom Profitt	Bob Farley	Glen Kelly	Ron Gray	Greg Groves	Don Schneider
	Bob Nunley			Vibert Forsythe	

Table 9: Sub-Team Members (Workshop 1)

At 2:00pm, Team A and Team B made presentations to one another. This enabled each team to further improve their presentation because the other team was allowed to assess and critique the other team's work. Presentations were then made at 4:00pm by Team A and Team B to the KyTC design team (Photo: 15-17). The following recommendations were made:

1. The advisory committee team members strongly emphasized that it is vital that the new bypass on the east side of town be completed along with the proposed interchange, or forget about the whole interchange project.
2. The main objectives of the revised interchange (Figure 13, 14, 15) are potential cost and timesavings, and to be able to modify the design of the proposed interchange in order to reduce traffic conflicts and to utilize the existing infrastructure more fully.

   The committee members suggested the advantages are potential cost savings, reduced construction time, enhanced traffic control during construction, less disruption to local businesses, enhances future development (large development area on west side), minimizes drainage problem by diverting the discharge to north side of bypass, and avoids a new bridge over the existing railroad.

   The disadvantages as pointed out by the committee members are questions about the feasibility of profile/grading requirements to make it work, certain geometric issues might still need resolving, weaving traffic movement might be more confusing to motorists (possible solution by increased signage) and even more confusing when it deals with the US 27 route.
3. The objectives of the elevated east-west roadway (Figure 16) are to reduce earthwork requirements and enhance movement throughout the parcel on the west side of US 27. The advantages suggested by the committee members are: possible cost reduction, less impact on the traveling public, reduces right of way requirements, reduces

environmental impact (eliminates need for box culvert), and enhances development opportunities on the west side of US 27.

The disadvantages are: there might be some difficulty convincing the property owner on the west side of US 27, there may be more maintenance problems with a bridge structure versus a roadway, and the east side of the roadway requires a steeper grade.

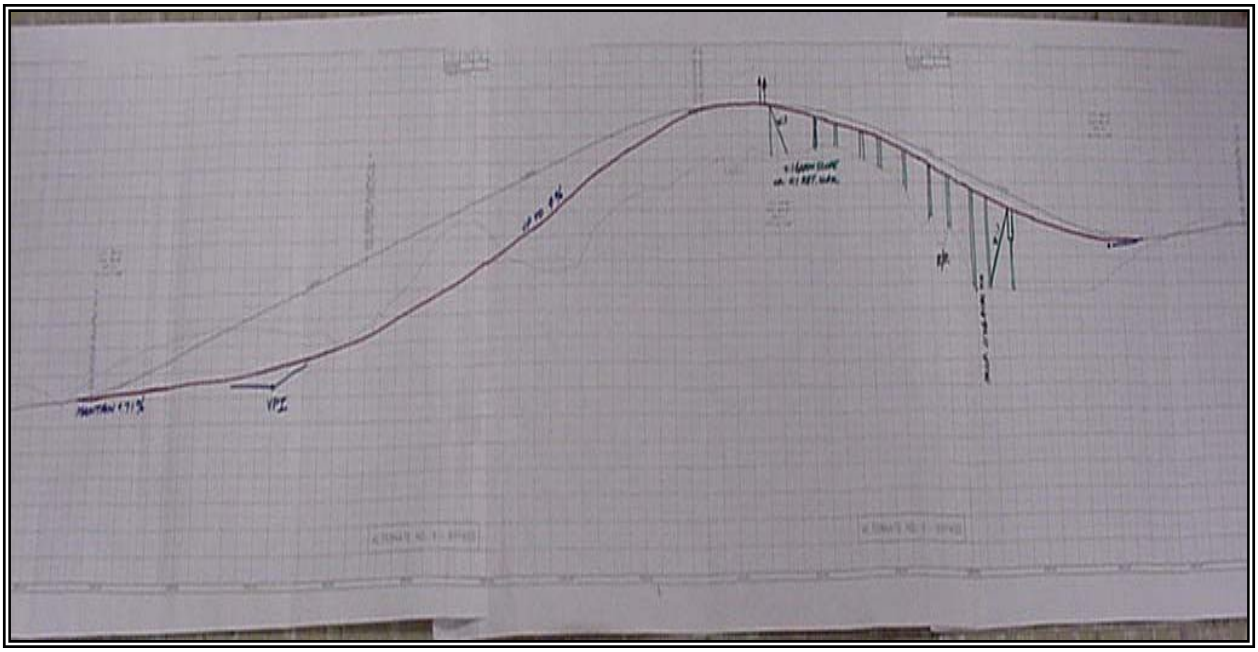

Figure 16: Elevated East-West Roadway

4. The committee members pointed out that the advantages of an at-grade intersection (Figure 11, 12) are that it: is consistent with the existing roadway, is consistent with the level of service feeding into the system, is a significant reduction in money and construction time, it improves the possibility of funding in the six year plan, has more conventional pedestrian and bicycle access, eliminates a new railroad crossing, lessens the impact on existing utilities, reduces impact on traffic during construction, lessens impact on local business, reduces environmental impacts, and reduces borrow/excavation requirements.

   The disadvantages are: it will not satisfy design 2022 level of service, may be contrary to public buy-in, and would increase business relocation.
5. Corridor preservation was used to define acquiring of land prior to development. This can be accomplished by finalizing alternative alignment(s) as soon as possible,

complete environmental assessment, hold public hearing, complete FONSI (Finding of no significant impact), prepare ROW plans, and fund ROW acquisition prior to development.

The committee members suggested that the advantages are: cost reduction, reduction in uncertainty and fear, enhanced utility location, and it maintains public and owner continuity.

The disadvantages are that it may impact other projects in the six-year plan, which may reduce flexibility if changes occur.

The presentations were then followed by the workshop analysis session conducted by Dr. Hancher, and Dr. Goodrum. This provided the advisory committee members an opportunity to evaluate the pros and cons of the constructibility workshop (Photo: 18). The following comments were made:

Positives of constructibility workshop:

1. Good exchange of ideas.
2. Much quicker than value engineering.
3. Mailer prior to workshop helped.
4. Contractor involvement was helpful.
5. Background/overview by designer was helpful.
6. Facilitator and support staff was needed to move the process along and helped the team concentrate on the issues.

Negatives of constructibility workshop:

1. The workshop would have been even more beneficial had it been done earlier in the design process.
2. More chronology on the project to date would have been helpful.
3. There could be a conflict if the contractor involved in the review, was later bidding on the project.
4. The project still requires detailed engineering review/ cost analysis to evaluate suggestions.

3.3. Workshop 2 – Leestown Road Project

3.3.1. Overview

The Leestown Road project was authorized in October of 1995 to begin the design phase. The scope of the project is to replace the structurally and geometrically deficient bridge over the existing Norfolk - Southern railroad. The bridge should meet the current vertical and horizontal clearance requirements for the railroad, while meeting other current design standards. This project is expected to go to construction in August 2004. The estimated construction cost is $7,240,000.

3.3.2. Current Project Goals and Objectives

The following is a brief summary of the project goals and objectives:

- Replace the functionally obsolete and structurally deteriorated bridge.
- Absolutely avoid any right-of-way taking of Lexington Cemetery (a National Register of Historic Places site) along U.S. 421 and Price Road.
- Minimize encroachment onto Calvary Cemetery.
- Avoid taking any Palumbo Lumber Company buildings.
- Design U.S. 421 for a 60 kph (35 mph) design speed.
- Provide sufficient width on the proposed bridge deck to permit one lane to remain open to traffic during a future re-decking operation.
- Replace pedestrian facilities in kind or improve those facilities.
- Meet Norfolk Southern Railroad horizontal and vertical clearance envelope criteria for current and future tracks.
- Minimize construction time to reduce impact to railroad operation and to the motoring public.
- Minimize utility relocations (example: overhead electric lines above truss and along the existing right-of-way).
- Provide enhancements to US 421 if they can be done without major additional cost or right-of-way impact (example: left turn lane at Clyde Street and two-way left turn lane to Forbes Road).

- Design any Price Road improvements to work with a Price Road Loop to be constructed in the future by others.
- Maintain or improve the vertical clearance for Price Road and the Vaughan Tobacco Company entrance below the bridge.
- Minimize construction cost by designing the US 421 profile grade as asphalt overlay of the existing pavement.
- Maintain existing drainage patterns.
- Provide roadway lighting (currently under design by Lexington - Fayette Urban County Government).
- Provide a staging area for bridge demolition and erection (purchase of Parcel 7 buildings and lots).
- Provide adequate sight distance for motorists traveling on Price Road under the bridge and motorists exiting the Vaughan Tobacco Company lower entrance by careful pier placement and design.
- Provide adequate sight distance for motorists stopped at the US 421/Price Road intersection and at the Price Road/Price Road Drop Ramp intersection.
- Use AASHTO 2001 design criteria for any re-design and AASHTO 1994 design criteria for previously completed design that was retained in the final plans.

3.3.3. Workshop 2 Activity

The constructibility review process meeting for the Leestown road project was scheduled on January 9th, 2003. The meeting was held in Room 112 of the Oliver Raymond Building at the University of Kentucky. Dr. Paul Goodrum was the person in charge of conducting the constructibility workshop for this project. The following table entails the advisory committee team members that attended the constructibility workshop:

LEESTOWN ROAD PROJECT			
DATE:	1/9/2003		
LEADER:	Dr. Paul M. Goodrum		
CONTRACTOR	KyTC	CONSULTANT	UK
Bryan Ledford	David Pratt	Brad Robson	Dr. Donn Hancher
Joe Bironas	Gary Raymer		Joseph Thozhal
	James Ballinger		Mohammed Yasin
	Steve Goodpasture		

Table 10: Advisory Committee Team Members (Workshop 2)

Dr. Hancher called the meeting to order at 8:00am. After the introduction of the attendees, Dr. Goodrum gave a presentation on the overview of the constructibility workshop (Photo: 19). Raymond G. Robison, Jr. (Skees Engineering, Inc.) then gave a brief presentation on the project overview, history, schedule, and the proposed bridge structure and retaining walls. This was followed by a series of questions from the advisory committee members, which were answered by either Raymond G. Robison, Jr. or Randy Turner (Photo: 20-21). At 9:00am, a review on the resources available and instructions on how the workshop will proceed was given by Dr. Hancher (Photo: 22). This was followed by a short break.

At 9:30am, Dr. Goodrum initiated the Team Discussion session (brainstorm possible improvements) with the advisory committee members (Photo: 23-25). The following questions and suggestions were made:

- Have the state buy the steel directly. This would help in reducing the overall project time. Also, who will be responsible for the payment of steel when delivered?
- Before the construction phase starts, someone needs to coordinate with railroad (RR) officials in arranging the shutdown and flagging process.
- This project needs to consider improving Price Road.
- Has the state considered the closure period on roads during the construction phase?
- Has the use of pre-cast for the bridge been considered by the design team?
- Leaving the truss in place could help in reducing the construction time and cost. Hence, modify as needed.

- Transmission lines appear to be too close to the truss of the bridge. Has the designer verified the clearance limitation of the transmission lines? Has the shut down coordination and safety been considered?
- It is important to coordinate with the city officials regarding traffic control and information about property owners since the contractor has to work with the local property owners.
- Have adequate plans for detouring traffic during construction been considered?
- The railroad crossing on Forbes Road needs to be improved.
- Has the use of mechanically stabilized embankment (MSE) walls as part of bridge been considered in order to eliminate space?
- Why not purchase additional property for staging for construction like the Palumbo's, Lexington Cemetery, and houses along Price Road? Has elimination of parking under the bridge been addressed?
- How about bringing Price Road to grade with the bridge?
- Have issues related to utilities like gas, water, and telephone been addressed?
- Has the safety of pedestrian or bicycle users on Leestown road been considered? What about pedestrian and bicycle accommodations with the bridge?
- How about relocating Price Road?
- Have closures for Old Main Street been allowed? Has the issue of timing and problems with cranes using Old Main Street been considered? How about maintaining traffic during construction?
- Why not move new piers away from old piers?
- Why not utilize old piers so that fewer new piers are required? This would help reduce construction time and cost.
- Is it possible to close Vaughn Tobacco Company and the road that leads to the company? Also, how about closing the entrance under the bridge?
- How about pre-casting the bridge deck?
- Is there a need for a public communication program so that people around the area will know the issues and benefits with regards to the proposed project?
- How about relocating the benchmark on existing retaining wall?

- Where does the drainage pipe on Price Road go?
- Do we really need to replace the bridge now??

In order to focus more on the significant issues pertaining to the project, the review team members were able to narrow down the topics to five main issues. The following issues selected from above were discussed further and considered to be critical if the project was to be completed on time, within budget, and efficiently.

1. The first issue was the coordination between the railroad and the Kentucky Utilities (KU) Company. Coordination between the two companies would ensure adequate timing with the schedule of construction activities. It would help in getting to the bottom of certain issues, like: who is responsible for flagging and paying; utility crossings; safety; agreements prior to bidding; providing adequate clearance (horizontal/vertical); and upgrading the railroad crossing at Forbes road.
2. The second issue deals with Price Road. This addresses issues such as: relocation or closing Price Road access to Leestown during the construction phase; bringing Price Road to grade with Leestown Road (Tobacco Co. property); a traffic signal for Price Road and Leestown road intersection; buying lumber company property for added room for a curve; location of drainage pipe to railroad area, enhancing Price Road at Leestown "ramps"; accessing the Southwest Tobacco Company (Apts.); and buying Lexington Cemetery property to improve ramps.
3. The third issue discussed was specific to the bridge on Leestown road. This concentrated on issues such as: upgrading the existing bridge structure and existing piers (enhance); restricted parking under the bridge; changing piers or new structure to avoid existing piers; the possible use of a pre-cast deck system, or the use of pre-cast beams to raise beams; or the use of MSE walls to shorten the bridge height.
4. The fourth issue addressed traffic control and detour routes. This included topics such as: an agreement with city officials on construction plans; possible detour plans and the adequacy of proposed detour route(s); upgrading roads like Price Road; conflict with Old main street concerning construction equipment use and the maintenance of an access "work room" area; and the need for a "Public Communication Program."
5. The fifth issue discussed was the schedule related to the project. The issue of schedule addresses: construction schedule limitations (RR limits, KU, # of work days); closure

schedule of roads related to construction activities; total closure vs. contract time; schedule of when the State (if agreed upon) needs to buy the bridge steel to save time; incentive/disincentives for scheduled closure time; and utility coordination that relates to gas, electric, and others.

Dr. Hancher then asked the advisory committee team members to prioritize the five issues outlined above. The issues were then discussed in terms of both the positives and negatives (Photo: 26-28). The following comments were made:

#1 issue: KU/RR coordination

The KU/RR coordination issue helps deal with problems like when should the state pay for RR flagging requests, establish easements for utilities on RR prior to letting contract, identify clearance requirements/shut downs for construction operations "specify in proposal, discuss impacts of detour plan, and recognize required temporary crossings for contractor.

#2 issue: Price Road

The Price Road issue gives attention to issues like bringing Price Road up to meet Leestown at grade by avoiding or minimizing impact on Lexington Cemetery (access to apts.), enhancing the existing ramps for Price Road to improve traffic movements/safety, to take a closer look at the acquisition of property from Palumbo Drive for enhancing loop for Price/Leestown road intersection, and considering closing Price Road during the construction phase.

#3 issue: Bridge

The bridge issue focuses on upgrading existing structure instead of replacement (request to still get Federal aid), utilizing existing piers (enhancements required) and evaluating feasibility, reducing length of the bridge by using MSE walls (close Price Road, eliminates Vaughn Tobacco entrance), relocating new piers away from existing piers (piers #2, 3, 4, 5) to allow construction of new piers, and whether utilizing pre-cast bridge deck system and pre-cast beams will help speed up construction.

#4 issue: Traffic control/Detour

The traffic control/detour issue contemplates the need of having a detailed detour plan "approved by the city" (is current plan adequate) prior to bid letting (look at impact on local property owners/business), concerns with the proposed detour plan, considers improvements on detour route (resurfacing, enhanced RR, crossing, etc.), the importance of a good Public

Relations officer for the project (need public information session prior to letting), and whether the Old Main Street road needs to be closed to thru traffic and parking during construction since the contractor needs to work with local property owners during construction.

#5 issue: Schedule

The issue of schedule helps look at topics such as when is the appropriate time to close the bridge, work with the city early to set road closure (relate to detour plan), establish work relations by railroad and Kentucky Utility (KU) company prior to bidding and putting in the bid proposal, addressing the water, sewer, and gas work in contract, and when can KU de-energize transmission lines? Also, addressing the issue of schedule helps to concentrate on a contract time allowance. This is important because it ties letting schedule to construction requests, sets closure time allowance for the bridge separate from total contract time, and limits bridge closure to one construction season.

After a short break, at 12:00 pm, Team A (assigned issues #2 and #4) and Team B (assigned issues #1 and #3) were asked to further analyze, discuss and put together a power point presentation of suggested improvements. The following table shows the team members for Team A and Team B:

LEESTOWN ROAD PROJECT					
DATE:	1/9/2003				
LEADER:	Dr. Paul M. Goodrum (Team B), Dr. Donn E. Hancher (Team A)				
TEAM A			TEAM B		
CONTRACTOR	KyTC	CONSULTANT	CONTRACTOR	KyTC	CONSULTANT
Joe Bironas	Gary Raymer			David Pratt	Brad Robson
Bryan Ledford				Steve Goodpasture	

Table 11: Sub-Team Members (Workshop 2)

Team A was assigned Rm. 112, while Team B was assigned Rm. 120. Each team had a research assistant that helped the team members with various tasks such as scanning documents and putting the power-point presentation together. Dr. Hancher helped lead Team A, whereas Dr. Goodrum helped lead Team B in their respective sub-team analysis/studies session.

At 2:00pm, Team A and Team B made presentations to one another; each team was allowed to assess and critique the other team's presentation. This enabled each team to further improve their presentation and recommendations. Presentations were then made by Team A and Team B to the KyTC design team (Photo: 29-33). The following recommendations were made:

1. The objective of the schedule is to establish specifically how much time and when the RR and KU will allow their facilities to be shut down during construction. This should be included in the contract bid document.

   The advisory committee members suggested that the advantages associated with schedule are:

   - It will create a more level playing field for all contractors.
   - It will reduce risk and provide more information to the contractors and lower costs for the owner.
   - It may identify insurmountable conflicts between KU and RR that may require relocation of KU lines or other re-design considerations.
   - It may help establish the construction letting date so as to complete the project in one season.
   - Allow for timely steel procurement (could be 6 to 9 months) and utility relocation.
   - Help to distinguish completion date from allowable road closure days.
   - It may be beneficial to include the schedule of other utility work (water, sewer, gas) in contract.

2. The traffic control/detour issue addresses the need for a good public relation effort for the project conducted by the District Project Information Coordinator prior to letting and during construction, and the need for a public information meeting prior to the letting. The advisory committee members pointed out that

   - The traffic control/detour issue helps in determining the best detour routes during construction.
   - If the detour routes include city streets, consider improvements to maintain relationships (i.e., resurfacing, enhance R/R crossings, etc.).
   - The Old Main Street must be closed to thru traffic and parking during construction. This is because the contractor must coordinate their work activities with local property owners.

3. The KU/Railroad Coordination issue deals with when the State should directly pay for RR flagging requirements. The committee members suggested that the advantages are:
    - The contractor is not assuming the risk and the department is not being overcharged.
    - Assure that utility easements with RR are secured prior to letting contract.
    - Identify physical clearance requirements around power lines and include in bid proposal.
    - Helps recognize temporary RR crossing requirements at bridge site for contractor.
4. The objective of the bridge issue is to speed up construction and achieve cost reduction of the project. The committee recommended:
    - Upgrading existing structure instead of replacement (funding issues), and to include pedestrian and bike access on the south.
    - Locating new piers away from existing piers to enhance construction of new piers.
    - Consider pre-cast bridge deck system and pre-cast beams to speed up construction.
    - Utilizing existing piers with some enhancement (evaluate feasibility).
    - Reducing length of bridge by using MSE walls. The impact is more feasible only if Price Road and the entrance to Vaughan Tobacco are closed.
5. The objective of Price Road issue is to reduce the complexity of the project, a potential reduction of the cost, and speeding up of construction. It also enhances the safety of the facility. The committee recommended:
    - Building at-grade intersection for Price Road at Leestown Road. It helps eliminates the ramps and enhances safety with potential cost savings. It also enhances the existing ramps for Price Road by making ramps one-way only since it potentially lowers cost and enhances safety. Hence, there is no need to buy property from Palumbo's.
    - The proposed future acquisition for enhancement of turning movements on to Price Road at Palumbo's is only feasible if the price of land is right.

- The committee believed in closing Price Road on North side of bridge and existing ramps will help the contractor finish the project on time.

The presentations were then followed by a workshop evaluation session by Dr. Hancher and Dr. Goodrum. This provided the advisory committee team members an opportunity to evaluate the pros and cons of the constructibility workshop (Photo: 34-36). The following comments made:

Positives of constructibility workshop:

1. Plans ahead of time were helpful.
2. Video was helpful (some had already visited the site).
3. It was good to have design team present and then leave during brainstorming.
4. It was good to have computer/technology assistance (power point).
5. Timeliness of constructibility recommendations was good.
6. Length of time or review was good.
7. It was good to share ideas and inputs with different agencies and parties (contractor, owners and designers).
8. Having contractors present at the workshop was very helpful.

Negatives of constructibility workshop:

1. It would have been better to do review earlier at least for bridge and Price Road. However, it was appropriate for reviewing KU/RR coordination, schedule and traffic control/detour.
2. Are there ways to increase contacts between contractor and consultants for the constructibility review process (maybe consultant hire contractor as sub.)?
3. A better aerial photograph would have been helpful.
4. A ROW strip map of the project would have been helpful.
5. Plans were crowded with too many information.

3.4. Summary on Workshops: 1 and 2

The two workshops helped provide the advisory committee members the opportunity to understand the purpose or objective of the design, and seek clarification regarding the design of the project. In turn, the design team was given valuable information regarding the

constructibility issues in the design of the project. The design team was also provided information on suggested solutions to overcome constructibility issues identified by the advisory committee members. This workshop also provided valuable input to the UK research team on the advantages and disadvantages of a constructibility review process (CRP), and helped in developing the project development process for KyTC. It was generally agreed by the participants in the workshop that the benefits of CRP were:

- It enhances the quality of construction.
- Helps provide better design.
- Helps in the early identification of problems.
- Helps in the reduction of errors and rework.
- Reduces change order potential.
- Reduces exposure to claims and disputes.
- Improves maintainability, operability, and reliability of the project.

Overall, the workshop help enhance better communication between the design team and the advisory committee members that comprised of construction personnel. It also helped provide the participants in the workshop valuable feedback on the importance of CRP.

Chapter IV KyTC Project Development Process

4.1. KyTC Project Decision Making Process

Over the last few years the project development process in the KyTC has enhanced to accommodate environmental concerns. The Empower Kentucky effort created a process that added Environmental Coordinators in each district and promoted a team decision-making process. To insure that promises made in one phase is communicated to the next, the KyTC currently institutes the CAP (Communicate All Promises) document for each project. Traditionally, Phase 1 designs of a project evolve around the roadway design process where the design alternatives are provided to the environmental experts to "clear" them. The key points below should be followed in the decision making process in order to better accommodate the project development process. The purpose of these key decisions is to ensure that the environmental and design processes are integrated, and that the different entities are providing the necessary input to the project team at the appropriate time to make the best possible transportation decisions.

1. Purpose and Need: This is a key element of the decision making process. Each project will have a purpose and need that will be utilized to establish the scope of the required work. The scope describes the boundaries of the project and defines what the project will deliver and what it will not. The project team will also use this purpose and need to develop alternatives and to guide their decisions. For projects where the Division of Planning has completed studies, review and adoption or modification of the resulting purpose and need must be considered.
2. Range of Alternatives: The next step is to determine an area of study within a range of alternatives that meet the purpose and need. The design team (consultant or in-house) would present a range of alternatives that meet the purpose and need. Alternatives previously evaluated by the Division of Planning during the development studies should be the beginning point. Alternatives eliminated during development studies need not be reconsidered unless absolutely necessary. While the project team may eliminate alternatives from further consideration with adequate and supporting documentation, there would be no project team alternative recommendation.

The Subject Matter Experts (SME) would then proceed with an evaluation of those alternatives left for consideration. SME's are those professionals that have specific expertise and are responsible for completing the environmental baseline. They evaluate existing conditions and determine the possible environmental impacts. The SME will need to consider a corridor approach as opposed to a given alignment so that adjustments can be made to avoid or minimize impacts. They also need to remain involved in the decision making process to insure environmental impacts are considered and offer suggestions on how to minimize or mitigate when necessary.

The range of alternatives should have preliminary information about the total project cost, and should also consider the ROW, utility and stream impacts.

3. Scope of Impacts: The SME would present to the project team (ROW, geotechnical, utility and any other professional staff) the corresponding impacts of each alternative on environmental and ROW resources. They would offer suggestions on the risk associated with moving forward with each alternative and the time frame involved in resolving the issue. The project team may also brainstorm potential opportunities to avoid, minimize or mitigate these impacts considering environmental impacts, economics and engineering.
4. Avoidance, Minimization, Mitigation, and Enhancement (AMM&E): The design team would use the currently developed information and further investigate the alternatives. They would present their evaluation to the project team detailing the impacts/issues involved with each alternative. The project team would discuss and possibly determine a recommended alternative, with all decisions that are made documented. The environmental assessment would be finalized, reviewed, and approved. If public and resource agency involvement is determined to have been sufficient to do so, the project team may identify a preferred alternative in the environmental document.
5. Selected Alternative: The next step following the approval of the environmental assessment and the public hearing, the project team would meet and select a preferred alternative based on environmental, economic, and engineering issues and public input. The final environmental document would then be prepared, reviewed, and approved. The project team has the flexibility to combine these key decision points on a project-by-

project basis. The design team must work with the SME's in determining the time required for completing their responsibility and setting the schedule appropriately.

4.2. KyTC Project Team Concepts

A primary component of the Cabinet's current project development process is the establishment of project teams as shown in Figure 17. The project teams are made up of central office personnel (C.O.), district office personnel, and engineering consultants working together to discuss and facilitate project development. Typically, a team consists of the project managers in the district or central office and representatives from other Cabinet offices possessing the capability to provide expertise on project specific issues.

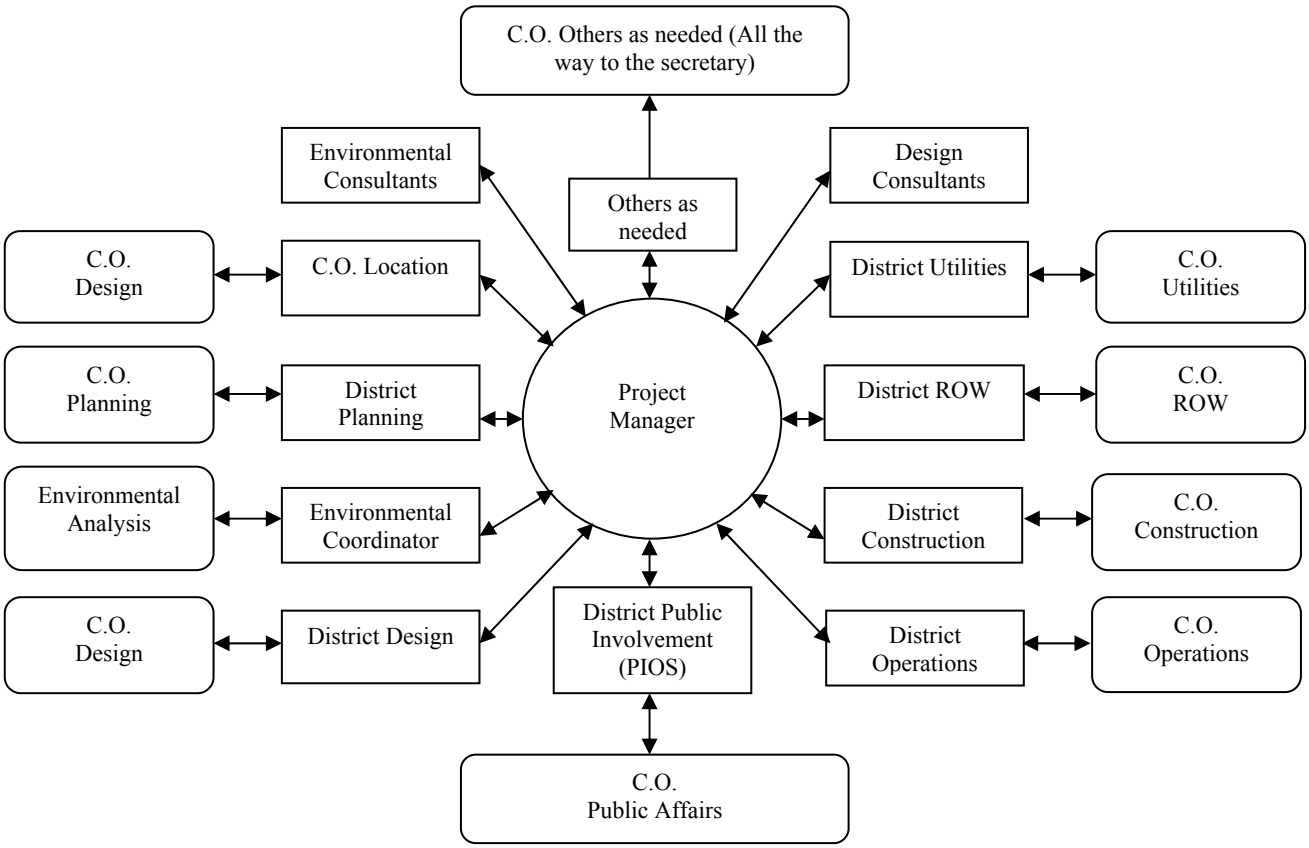

Figure 17: KyTC Project Team Approach

A major part of the Cabinet's project development process is the project delivery core processes as shown in Figure 18. The project delivery process is divided into two stages: (1) conceptual, and (2) production. The conceptual stage involves planning that identifies the

project purpose and needs. This is followed by the selection of a project manager, which leads to the formation of a project team. The opportunity to provide input into the development of the project can be offered at the intermediate planning meetings. In the intermediate planning meetings, the project team along with the KyTC employees discusses conceptual design (line & grade), corridor location (alternative evaluation), conceptual permits, and environmental documentation (as discussed above) of the project. The project is then followed through to the production stage where meetings are scheduled in order to discuss or resolve the issues in question. The meetings engage discussion of key issues such as right of way, utility relocation, environmental issues, final design (Roadway, Bridges, and Final plan Development), and necessary permits. The production stage also involves National Environmental Policy Act (NEPA)/permit feedback, safety audits, and post construction and lessons learned reviews. The project is then followed through to the project operation phase that includes maintenance of NEPA commitments.

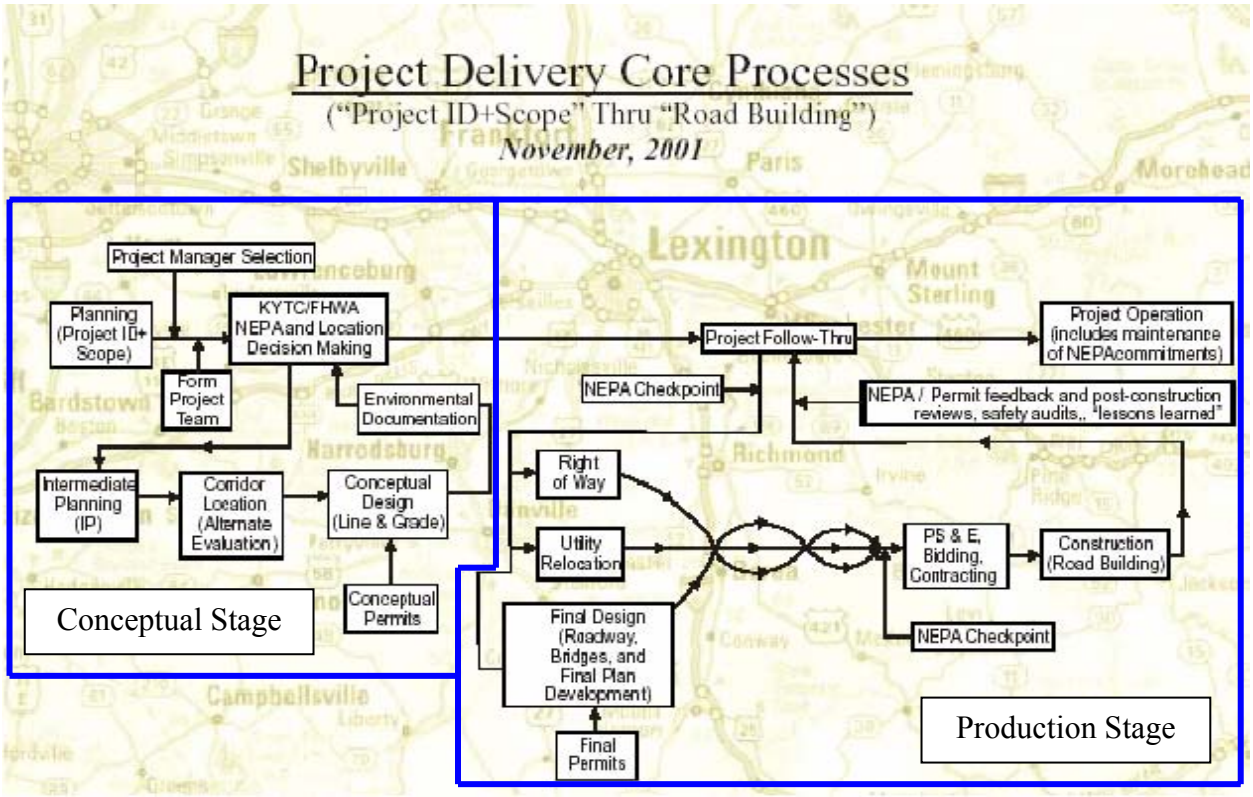

Figure 18: KyTC Project Delivery Core Processes

Figure 19 shows the role of the Central Office Program Managers. The responsibilities of the Program Managers are (1) to supervise the project delivery core processes for projects, (2) communicate with the FHWA, and (3) ensure that the projects are consistent in project function, cost and context. Currently, David Kratt serves as the Program Manager for Districts 1 to 6, while Ray Polly serves as the Program Manager for Districts 7 to 12.

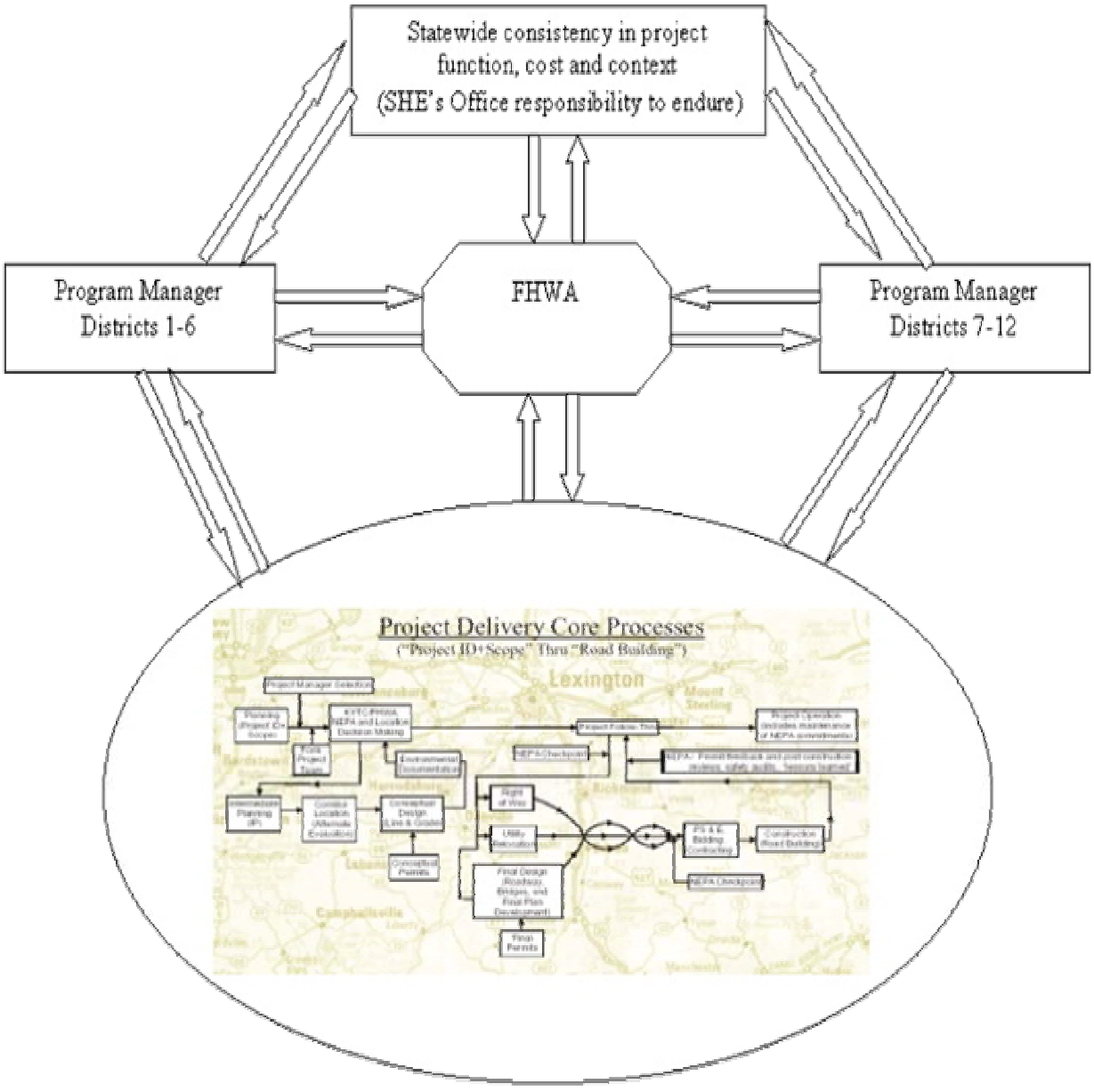

Figure 19: Role of the Central Office Program Managers

The project team approach, and the KyTC project delivery core processes employed by the KyTC allows for developing a consensus on the best alternative to complete a final design. The purpose of the project team approach is to provide input where all aspects of a project can be discussed and evaluated with respect to the impact on project development, and reduce opportunities for miscommunications among district or central office personnel and representatives from other Cabinet offices. The importance of a project team approach is that others' ideas are respected, listened to, and discussed. Also, one can gain knowledge and learn different perspective of what is feasible or not through this project team process. Adding participants that have expertise in various fields of transportation projects will only enhance the project team approach. For instance, adding construction participants to the project team is essential since most designers do not have field construction experience. In order to make the project team approach process more effective, construction personnel need to be involved early in the design process through Advisory Team Meetings and Public Information Meetings. This would ensure that the construction personnel would see the issues first hand and help the designer improve the design in terms of constructibility. Also, having resident engineers attend and participate fully in meetings would further help the project team process. Hence, the significance of the project team process is that it improves the quality, schedule, and safety of the project, and avoids costly change orders.

Chapter V Constructibility Input to KyTC Project Development Process

5.1. Constructibility Input to Project Development Process

The success of a constructibility review process depends on the systematic review of all the important aspects of the project with regards to constructibility and maintainability of the project. Implementing a formal constructibility review process (CRP) is a means to ensure that specific constructibility activities are conducted when most appropriate on the project, and also validates an agency's commitment to constructibility. The proposed formal process consists of suggested sample checklists and a suggestion form (see Appendix VI) that are designed to provide a guide for the phase reviews. The suggested checklist is provided as a tool, and indicates the minimum documentation required for a complete project submission. Comments should not be limited to items on the checklist. Opportunities for constructibility input during the project development process for KyTC projects (see Figure 20) are discussed in this chapter.

5.1.1. Planning Phase

The planning phase (see Table 12) is the first component of the Phase I design milestone. In this phase, the district and central office personnel would determine the project purpose and needs. An initial assessment of environmental overview, project timing requirements, and special problems and limitations such as ROW and utilities are discussed. During the planning phase the KyTC conducts public meeting(s) in order to understand community issues and concerns, and engage the public in the early stages of project problem solving.

The research team suggests getting construction experts involved in public meeting(s) to attend in 'observation mode' so that they can see first hand issues raised by the public. The research team also suggests that depending on the size and need of the project, certain projects must perform detailed studies of the issues by including input from the 'Construction Branch.'

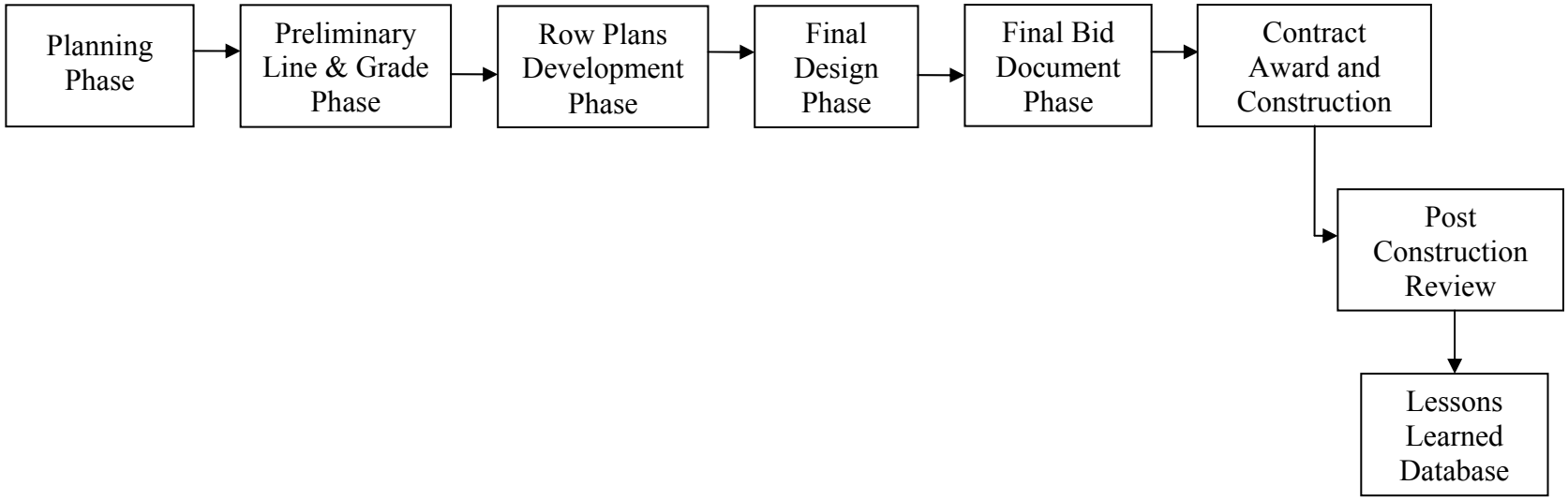

Figure 20: Kentucky Transportation Cabinet Project Development Process

"Phases of Current Project Development Process"	**Opportunities for Constructibility Input**
• **Planning Phase [Phase I Design]**	
• Determine project purpose and needs. • Conduct Environmental overview. • Establish project timing requirements • Identify project special problems and limitations. • Conduct public meeting.	• Get construction experts involved in public meeting to attend in 'observation mode.' • Some projects must perform a detailed study of the issues by including input from "Construction Branch."

Table 12: Planning Phase Agenda and Opportunities for Constructibility Input

5.1.2. Preliminary Line and Grade (PL&G) Phase

The Preliminary Line and Grade phase (see Table 13) is the second component of the Phase I design milestone. In this phase, the Environmental Document is developed (see Chapter 4), and critical issues such as ROW, utilities, railroads, etc. are identified and discussed in detail. During this phase, alignment and grade are selected, public meetings are conducted, and the project team verifies if project goals and objectives are being met. Also, compatibility studies on future projects are performed where feasible.

The research team suggests using in-house constructibility consultants that have expertise in fields such as ROW, utilities, railroad, environmental, among others based on specific project requirements. The research team also suggests a geotech review of PL&G either through a consultant or retired geotech expert. Depending on the size and need of the project, soliciting input from an outside contractor is another option to consider. The outside contractors can be obtained from the Kentucky Highway Contractor Association (KHCA). Table 13 shows some of the suggested checklists to use during the PL&G phase.

"Phases of Current Project Development Process"	Opportunities for Constructibility Input
• **Preliminary Line and Grade (PL&G) Phase [Phase I Design]**	

• Determine if project objectives (purpose & needs) being met.
• Environmental Document developed
• Identify critical ROW issues.
• Identify special problems with utilities, railroads, etc.
• Public involvement required.
• Select corridor (line and grade).
• Compatibility study for future projects where feasible.
	• Bring on In-house constructibility consultant.
	• Solicit input from outside contractor (retired construction contractors) that is dependent on project size and need.
	• Use KHCA as a source to obtain construction personnel.
	• Geotech review of PL&G (either consultant or retired geotech).
	• Suggested checklist to use:
	  • Preliminary Design checklist
	  • Clearing/Grubbing/Excavation checklist
	  • Removal/Demolition checklist
	  • Environmental checklist

Table 13: PL&G Phase Agenda and Opportunities for Constructibility Input

5.1.3. Row Plans Development Phase

The ROW Plans Development phase (see Table 14) is the first component of the Phase II design milestone. In this phase, a critical review of project Purpose and Needs, preliminary quantities, bridge requirements, and construction erosion control plans are performed. Furthermore, signalization, maintenance of traffic, phasing, ROW and utilities plans, plus railroad (RR) needs are identified and developed. It is during this phase that ROW, drainage, structure, and geotech plans are finalized.

The research team suggests early In-house input during the critical review and identification process of various issues as noted above. Soliciting input from the utility coordinator is critical when ROW and utilities plans plus RR plans are developed. During this phase, constructibility input is requested from construction, traffic & maintenance, geotech,

bridge design, utilities, and ROW experts in order to better facilitate the constructibility review process. It is also suggested that any required or desired Value Engineering reviews (usually by external consultant) be done during this phase. Table 14 shows some of the suggested checklists to use during the ROW Plans Development phase.

"Phases of Current Project Development Process"	**Opportunities for Constructibility Input**
• **ROW Plans Development Phase [Phase II Design]**	

• Critical review of project objectives (purpose & needs).
• Review preliminary quantities of project objectives.
• Identify Signalization, Maintenance of Traffic, phasing needs.
• Construction Erosion Control plans.
• Develop ROW and Utilities Plan plus RR.
• Final ROW.
• Finalize drainage, structure, geotech design.
• Critical review of bridge requirements (understand the context of project design).
	• Early In-house input; if needed bring in external consultant for VE study.
	• Solicit utility coordination input (KU).
	• Constructibility input requested from construction, traffic & maintenance, geotech branch, bridge design, utilities, and ROW experts.
	• Suggested checklist to use:
	  • Structures checklist
	  • Utilities checklist
	  • Drainage checklist
	  • Maintenance of Traffic checklist
	  • Schedule/Phasing/Access checklist
	  • Site survey/plan/profile checklist

Table 14: ROW Plans Development Phase Agenda and Opportunities for Constructibility Input

5.1.4. Final Design Phase

The Final Design phase (see Table 15) is the second component of the Phase II design milestone. In this phase, maintenance of traffic, signalization, signs and striping plans are finalized; special notes, traffic and community impact studies, project objectives and criteria, and bridge design requirements are reviewed.

The research team suggests getting input from both the resident and construction engineers. During this phase, constructibility input is requested from construction, traffic and maintenance, utilities, and ROW experts. Table 15 shows some of the suggested checklists to use during the Final Design phase.

"Phases of Current Project Development Process"	**Opportunities for Constructibility Input**
• **Final Design Phase [Phase II Design]**	

• Review project objectives (purpose and needs) and criteria.
• Review Bridge Design(s) and requirements.
• Finalize final Maintenance of Traffic plans, signalization, signs and striping plans.
• Review Special Notes requirements (blasting, environmental, historical, etc.).
• Finalize construction restrictions (timing, work restrictions, etc.).
• Review traffic and community impact studies.
	• Get resident and construction engineer input.
	• Constructibility input requested from construction, traffic & maintenance, utilities, and ROW experts.
	• Suggested checklist to use:
	  • Drawing/Title page checklist
	  • Claims prevention checklist

Table 15: Final Design Phase Agenda and Opportunities for Constructibility Input

5.1.5. Final Bid Document Phase

The Final Bid Document phase (see Table 16) involves obtaining right of entry on all ROW parcels, reviewing all bid items to see if they are current, checking and updating utility impact notes, having necessary permits obtained (environmental, water, historical), and reviewing of the documents for biddibility.

The research team suggests using In-house personnel to conduct the final bid document phase in order to ensure the biddibility of the documents before the contractors bid on the project. Table 16 shows the suggested checklist to use during the Final Bid Document phase.

"Phases of Current Project Development Process"	**Opportunities for Constructibility Input**
• **Final Bid Document Phase**	
• Review of documents for biddibility (timing restrictions, specifications, materials, etc.). • Obtain right of entry on all ROW parcels. • Review all bid items to see if they are current. • Review and update necessary permits obtained (environmental, water, historical, etc.). • Check to be sure utilities are relocated or utility impact notes are reviewed and updated.	• In-house personnel conducts final bid document phase. • Suggested checklist to use: • Pre-bid checklist

Table 16: Final Bid Document Phase Agenda and Opportunities for Constructibility Input

5.1.6. Post Construction Review Phase

The Post Construction Review phase (see Table 17) should be performed before or at 90% of project completion. The purpose of this review is to capture significant problems and their solutions, plus constructibility knowledge on projects, while the issues are fresh on the minds of all involved. Representatives from the highway department, the contractor and the designer organizations should attend this meeting. The review should be conducted by the District, usually the Project Manager with meeting minutes sent to the Central Office in Frankfort, attempts should be made to recommend new items for the Lessons Learned Database discussed in Chapter 6.

It may also be advantageous to hold other construction reviews during a project when significant events or milestones occur. For instance, it may be beneficial to hold a field review after the earthwork and drainage structures have been completed or nearly completed when it is believed that major "lessons learned" have occurred. Such lessons can be captured while the issues are still "hot" on the minds of the contractor, the resident and other parties involved. Such meetings do not have to be long in duration or formality, but the essence of the lessons learned need to be captured and submitted to the Lessons Learned Database in Frankfort.

"Phases of Current Project Development Process"	**Opportunities for Constructibility Input**
• **Post Construction Review Phase**	
• Performed before or at 90% of project completion. • Conducted by the Districts on all projects. • Results sent to Frankfort and Lessons Learned Database.	• Bring In-house personnel to conduct post construction review that should include project manager, consultants, resident engineers, general and sub-contractors. • Have multiple post construction reviews if feasible.

Table 17: Post Construction Review Phase Agenda and Opportunities for Constructibility Input

The purpose of a post construction review process as part of the constructibility review process is that it provides feedback to representatives from the highway department, the contractor and the designer organizations regarding the recently finished project. Furthermore, the advantages of post construction review processes are:

- Helps eliminate repeated mistakes in future projects;
- Helps in the modification of specifications in order to eliminate repeated mistakes in future projects;
- Increases communication between different parties; and
- Addresses maintenance concerns on the recently finished project.

Chapter VI Lessons Learned Database

6.1. Lessons Learned System

From the construction site craftsman to the project manager, construction is an experience-based industry. Therefore, knowledge of past problems with a particular issue can assist in identifying potential problems at an early stage on future projects, thereby reducing the impact of the problem. Unfortunately without a formal mechanism to retain this knowledge, much of this experience is not passed from project to project or from person to person. If this wealth of construction knowledge could be retained and used in the planning and the execution of future projects, there are tremendous potential benefits in terms of improved cost, schedule, safety and quality.

Traditionally, lessons learned during the construction phase of a project are not effectively incorporated into the design and construction phases of future projects. Constructibility knowledge is usually transferred informally. A formal mechanism to archive and disseminate lessons learned as part of a constructibility process could reduce or eliminate time spent in resolving problems during construction. Methods of collecting and disseminating lessons learned have only enjoyed limited success due to:

1. Unreliable communication channels between construction experts and less experienced individuals;
2. An unmanageable format that limits access, retrieval, and updating of the potentially enormous volume of lessons;
3. Difficulty in integrating new systems into existing operations and procedures; and
4. A primary focus on failures or incidents, rather than a balance of positive and negative experiences with constructed facilities.

Prior research has outlined a lessons learned process, which has been used in other state transportation agencies. The function of a lessons learned system (Figure 21) is to create a central and categorized source of construction information available through the simple use of electronic media for contractors, designers, and other construction professionals. Lessons learned systems have traditionally been driven by databases that organize the stored data for accelerated storage and retrieval of information. Databases are designed to facilitate storage, retrieval, editing, and deletion of data in addition to other data processing operations. Databases

are typically composed of a file or sets of files. Information in the files are stored in tables, with each table broken down by fields, which are the basic building block of databases since they describe only a single attribute of the entity described by the database.

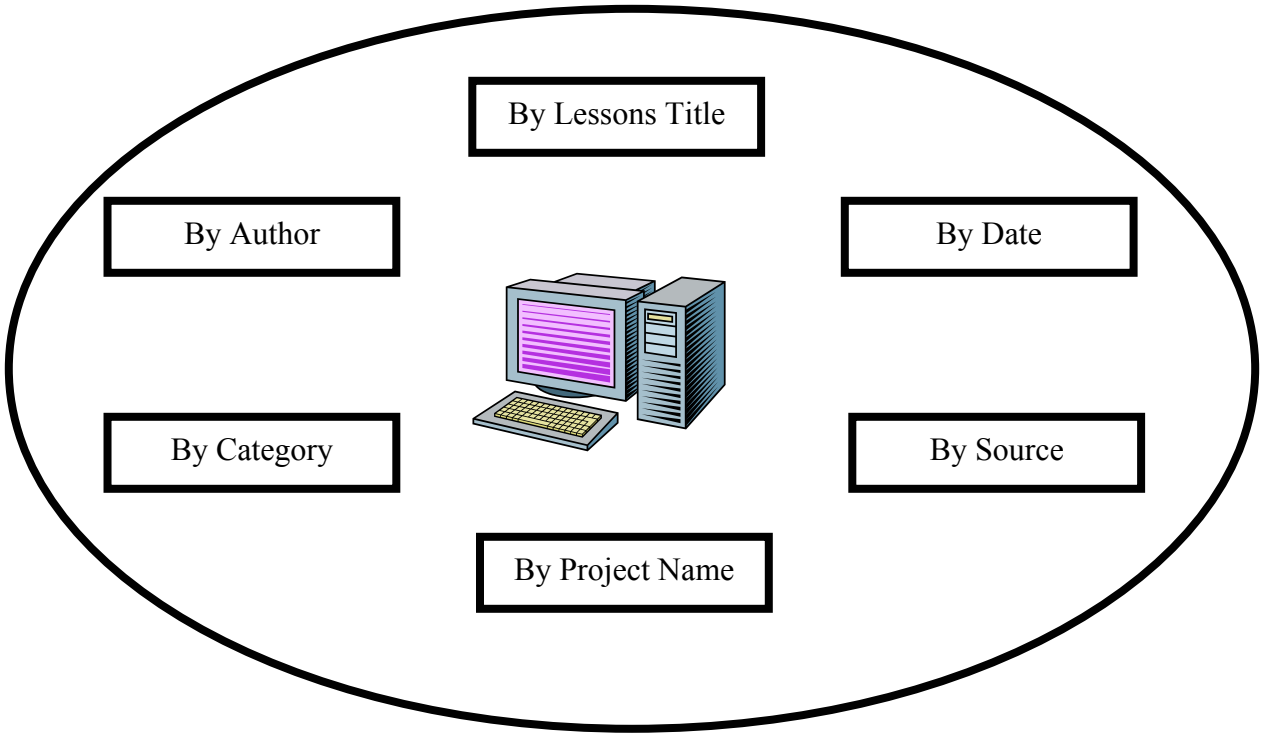

Figure 21: Lessons Learned Database (Kartam, 1996)

The general outline of collecting lessons learned follows a process as shown in Fugure 21.

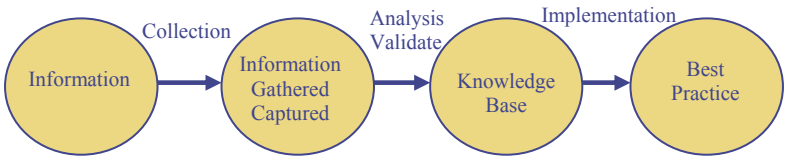

Figure 22: Lessons Learned Process

The first step is to collect information. A system should be designed to collect information from all project participants including project managers, designers, crafts people, subcontractors, and owners. Information on lessons learned should be collected continuously not just at the end of a project. Second, information is captured and analyzed. This includes acknowledging the receipt

of the information in order to make the contributor understand that his/her input is valuable. This step also includes categorizing the information usually in accordance with standard specifications of the owner organization. The information should also be prioritized in terms of the value it adds to the organization. Third, the information undergoes implementation in a knowledge base. Owners of the process need to determine the type of improvements required by their agency in order to implement the lesson learned. Will it require systemic changes within their organization, training, and/or changes in policy? Finally, the lesson learned becomes one of the organization's best practice's. This involves communicating the lesson to interested parties and maintaining a database of lessons learned knowledge. The lessons learned system and process developed for the Cabinet is further explained in the report titled Lessons Learned System for Kentucky Transportation Projects (KYSPR-03-262) written by Dr. Paul M. Goodrum, Mohammed Yasin, and Dr. Donn E. Hancher.

Chapter VII Summary and Recommendations

7.1. Summary

This research found that 58 percent of state DOTs currently have a formal constructibility review process. A constructibility review process, with procedures similar to those presented in Chapter 5, provides two general benefits to a transportation agency. First, enhanced teamwork and communication early in project development leads to more cost effective design and construction, and second, more effective sharing of lessons learned occurs between projects.

This research found that time, available manpower, experience, and contractor reluctance were four categories of barriers to most constructibility programs among transportation agencies; whereas, traffic control, existing utilities, geotechnical, ROW, bridge structures, and new utilities are some of the common constructibility issues encountered on KyTC projects.

Two one day mini-workshops for constructability reviews of current design projects were conducted as part of the study. Members of the study advisory committee served on the teams and identified several suggested improvements for each project. Their overall evaluation of the one day workshops was very positive, and some major benefits were identified:

- Good exchange of ideas with the multidisciplinary teams;
- Contractor involvement was very helpful;
- Helps in the early identification of problems and errors;
- The review process would have been more helpful to the Cabinet had it been done earlier in the design process for the projects

The researchers feel that the KyTC should take steps to implement constructibility reviews on its projects. The agency needs a sponsor or champion, in the main office and in each district, that is fully committed to the constructibility review process. The sponsor or champion is the driving force behind constructability reviews on projects by: (1) setting project objectives, (2) selecting the contract strategy, (3) selecting which outside consultants or contractors will participate if needed, and (4) funding constructibility resources during planning and design.

The constructibility review process should be started at the same time that the initial project planning starts in order to maximize the potential benefits. This is achieved when persons with construction knowledge and experience become involved at the early stages of the project development. The amount of involvement depends on the type and complexity of the

project. A post construction review, or reviews, is also a valuable part of the constructibility review process.

In conclusion, a constructibility review process, whether carried out in-house or by an independent third party, will help minimize conflicts, ambiguities, omissions and change orders, improve competitiveness in bidding, and reduce the possibility of legal problems. CRP can significantly enhance the achievement of project safety, quality, productivity, schedule, and cost. In short, CRP would assure that contract documents are biddable, and that the project is buildable at a reasonable cost, within a reasonable amount of time.

7.2. Recommendations

The following recommendations on constructibility review and post construction review process (not in the order of priority) are offered by the researchers:

1. It is recommended that the Kentucky Transportation Cabinet formally implement constructibility review and post construction review on all highway projects. The key is to seek timely input during the project development process and to capture valuable lessons learned on projects.
2. It is as important as ever that the KyTC measure the performance of constructibility review process in order for it to continue to improve. The use of a benefit to cost model as discussed in Chapter 2 would be a means for benchmarking and for justification for continuing the constructibility review process.
3. An employee in each Kentucky Transportation Cabinet district office needs to be delegated the responsibility of being the champion in the constructibility review process for the district.
4. The KyTC districts should assess their current constructibility approach to determine the best means for constructibility improvement. Assessment should include evaluating: in-house constructibility resources, external sources of constructibility input, timing of constructibility input, implications of contract strategies used, contractor feedback, and project performance (i.e., scope changes, design errors, field engineering, labor productivity, among others). As a result of self-assessment, the districts should be able to identify with the process discussed in Chapter 5.

5. All KyTC districts should employ “uniform practices” for the constructibility review and post construction review processes.
6. A constructibility review process training program should be developed for appropriate Kentucky Transportation Cabinet personnel.
7. The KyTC needs to better communicate with highway contractors, consultants, and resident engineers the objectives of the constructibility review and post construction review processes, and the potential benefits that can be achieved.
8. The KyTC district offices need to conduct post construction review on their highway projects before or at 90% of project completion. Field reviews may also be beneficial at significant milestones during the project, especially when major “lessons learned” occur. Minutes of all meetings should be sent to the Value Engineering office in Frankfort.
9. Significant results obtained from constructibility reviews and/or post construction reviews for projects should be submitted to the Value Engineering section in Frankfort through the Lessons Learned Database system. All inputs need to be submitted in an accurate, comprehensive, and timely manner.
10. More consideration should be given to using retired KyTC employees, and local contractors and design consultants for project reviews instead of consultants from out of state who are often not familiar with Kentucky practices.

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APPENDIX - I

COPY OF STATE DOT SURVEY

Kentucky Transportation Center Constructibility Survey
(KYSPR-02-236)

Section A - General Information

Date of Survey: _____

Name: _____ **Title/Position**: _____

Agency: _____ **Telephone number** _____

Address: _____ **Fax number** _____

_____

_____ **Email address**: _____

Section B

This section is designed to survey the presence of your agency's use of construction input to design

1. Does your agency provide an opportunity for construction input to design? (If answered yes, please proceed to question 2. Otherwise, proceed to question 11.)

2. Is there a formal or informal process by which construction provides input to design?

3. Do you call the process constructibility? (If answered yes, please proceed to question 5. Otherwise proceed to question 4.)

4. If by some other name, what do you call it?

Section C

This section is designed to survey when and how you provide construction input

5. Is construction input provided to design on all projects? (If answered "Yes", please proceed to question 6, otherwise proceed to question 5.a.)

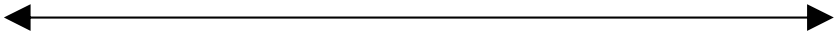
    a. If not, how is it decided when to include construction input?

6. At what project development stage is construction input provided? Please check "Yes" or "No" for the appropriate stage. If construction is provided at multiple stages, please indicate this in your response.

	Yes	No
Planning	☐	☐
Design	☐	☐
Pre-Bid	☐	☐
Post-Bid/Preconstruction	☐	☐

7. At what design stage is construction input provided? Please place an "X" at the appropriate design stage. If construction is provided at multiple stages, please indicate this in your response.

0% Complete 100% Complete



8. If your agency does provide construction input during design, who provides the input?

   In-house construction individuals? ☐

   Outside construction contracting firms? ☐

   Outside consultants? ☐

   Other _____ ☐

9. What have been the biggest barriers your agency has experienced in using constructibility?

10. What have been the biggest success factors your agency has experienced in using constructibility?

Section D

This section surveys your "Post Construction Review" process.

11. Does your agency have a formal post construction review? (If answered yes, please proceed to question 11.a. Otherwise, proceed to question 16.)

    a. If so, do you conduct post construction reviews on all of your projects?

    i. If you don't, how do you choose which projects to include in a post construction review?

.

12. Is there a written report of the post construction review? (If yes, please proceed to question 12.a. Otherwise, proceed to question 13.)

    a. If so, are the reports disseminated afterwards and to whom?

13. Are designers involved in the post construction review? (If yes, please proceed to question 13a. Otherwise, proceed to question 14.)

    a. If so, do you involve the original project designers?

14. What have been the biggest barriers your agency has experienced in using post construction reviews?

15. What have been the biggest success factors your agency has experienced in using post construction reviews?

Section E

This section will survey your process for capturing lessons learned, i.e. lessons learned from past experiences (eg. mistakes and solutions to the mistakes)

16. Does your agency have a formal process for capturing lessons learned from your constructibility and post construction review processes? (If answered yes, please proceed to the next question, 16a, otherwise proceed to question 17.)

    a. If so, does your agency have a formal lessons learned database? (If answered yes, please proceed to the next question, 16a.i, otherwise please proceed to question 17.)

        i. If so, when are ideas included in the database?

        ii. How is the database accessed?

        iii. Who maintains the database?

        iv. How are new ideas disseminated when they are added?

Section F

This section will survey contact information in your agency that we may use for follow-up.

17. Who in your agency may we contact regarding:

a. Constructibility?

1. Name

2. Phone Number

b. Post Construction Reviews?

1. Name

2. Phone Number

c. Lessons Learned Process?

1. Name

2. Phone Number

APPENDIX - II

COPY OF CONTRACTOR, RESIDENT ENGINEER SURVEY

Section A - General Information

Date of Survey: _____

Name: _____ **Title/Position**: _____

Agency:_____ **Telephone number**:_____

Address:_____ **Fax number**:_____

_____

_____ **Email address**:_____

Section B

This section is designed to survey recurring constructibility issues on state high way projects and the practices developed to over come them.

18. Our research has found most constructibility issues fall within 10 areas (see "a" through "j" below).

    a. Traffic control during construction.

    b. Water drainage during construction.

    c. ROW

    d. New utilities

    e. Working around existing utilities

    f. Geotechnical issues.

    g. Environmental factors.

    h. Motorist Safety

    i. Worker Safety

    j. Site access

    k. Other areas not listed

19. (a) Based on these and other issues please use the following forms to answer the questions;

- What are the most recurring issues during construction for state DOT projects?
- What are the ways or means used by your firm to resolve such issues?
- Are there permanent resolutions to KYTC practices you suggest to eliminate such issues?

(b) Rate the issues you identify on the attached forms according to their impact on:

i) Project Cost.

ii) Project Schedule.

iii) Project Quality.

* The survey includes five forms for your use in completing this survey. If you need additional forms, please feel free to copy as many forms as you need to discuss recurring Constructibility issues in KYTC projects. As well, included in the survey is a completed example form for your convenience.

Section C

20. Who in your agency may we contact regarding further surveys:

1. Name

2. Phone Number

3. Name

4. Phone Number

Issue	Geotechnical Issues- Mostly unanticipated soil conditions, this issue frequently is the leader of a project's change orders.
Resolution	1- More emphasis between the designer and geotechnical engineer is crucial to alleviate this problem. 2- Require project manager to be involved with the soil meetings
Suggested permanent resolution	1- More thorough soil investigation. 2- More involvement from project manager or project engineer in soil meetings and reports

Impact of issue	Low		Med		High
Cost	1	2	3	4	5
Schedule	1	2	3	4	5
Quality	1	2	3	4	5

Issue					
Resolution (If known)					
Suggested permanent resolution (If Known)					
Impact of issue	Low		Med		High
Cost	1	2	3	4	5
Schedule	1	2	3	4	5
Quality	1	2	3	4	5

APPENDIX - III

COPY OF RESIDENT ENGINEER ISSUES, RESOLUTIONS, AND SUGGESTED PERMANENT RESOLUTIONS

RESIDENT ENGINEERS

NUMBER	ISSUE	RESOLUTIONS	SUGGESTED PERMANENT RESOLUTIONS	IMPACT ON COST	IMPACT ON SCHEDULE	IMPACT ON QUALITY
1	(1) Bid items not included in items to handle geotech notes. (2) Geotech notes/drawings not interpreted correctly by contractor. (3) Improper use of shrink/swell factors by designer. (4) Overrun of pile quantities when driving piles (friction).	(1) Change order to add items. (2) N/A. (3) Contractor must make his own interpretation during the project bidding phase, so it shouldn't be a problem, but often ends up in a dispute. (4) Wait period and re-strike to allow pile setup.	(1) Better communication between geotechnical engineer and roadway design engineer during the projects design phase. (2) Educate contractors about geotech information in plans - more thorough review of available data by contractors. (3) Educate designers on proper application of shrink/swell factors. Eliminate shrink/swell information from plans. (4) Adhere to wait period/re-strike during construction.	3	2	3
2	ROW: (1) Many parcels mot clear prior to letting. (2) Failure to communicate agreements with property owners made during ROW negotiations.	(1) Avoid work in these areas until parcel is clear. (2) Negotiate with property owner on project to develop agreement that is fair to both parties.	(1) Clear all ROW parcels prior to letting the project. (2) include a summary that documents all the promises made to property owners during property acquisition.	4	5	3
3	Utilities - Utility relocation not complete prior to construction which prevents contractor from working in affected areas of the project.	Partnering/maintain an open and cooperation line of communication with utility companies.	Include utility relocation in the highway department's scope of work.	3	5	4
4	Environmental factors - Permits over looked during design.	Have all permits in hand prior to letting the project.	Same.	1	5	2

5	Traffic control plan.	Extensive discussions at planning stages and with local officials.	Include some local non-cabinet officials in project team.	2	4	4
6	Scheduling.	Contractors must present a schedule which must be reviewed and signed off by Resident Engineers / TEBM before start work notice is issued.	Same.	3	5	2
7	Utility.	Move before construction or include in contract.	Standardize water and sewer line construction. Same note and drawings.	5	5	4
8	Environmental - Erosion control ever changing "rules."	Training KyTC and contractors for installation and use of "Best Management" plan.	Get system to stop making constant changes.	4	4	3
9	Bridge wings if near existing bridge.	Make sure plot of wings made and coordinated with roadway plans.	Buy some ROW and move new bridge farther away from old building.	4	5	3
10	ROW - Property owners giving their interpretation of agreements.	Most problems were resolved after ROW agreements were obtained by Resident Engineer and discussed with the property owner.	Include copies of ROW agreements with property owners with construction plans provided to Resident.	3	3	3
11	Geometric Design - Radii on streets - Have encountered some inadequate designs.	After brought to Department's attention and unable to change - tear it out and reconstruct after problem was obvious to public.	Proposal review consultant designs and/or require acknowledgement that "Computer Turn Radius Program" has shown radii can be negotiated by vehicles.	5	3	4
12	Construction of 1/2 width bridges vs. transferring traffic to other lanes.	Transfer traffic off of bridges under construction - when possible. Worker Safety - Better. Public Safety - More expensive. Quality of construction - Much better!, anticipate less construction cost.	Same.	4	1	5

13	Traffic control during construction - At times the plans call for a distance between traffic and a depth of drop-off and do not provide enough room, inside ROW or on existing pavement, to shift traffic and maintain clearance.	Plot on cross sections what traffic is going to have to do to get a better idea what is required.	Same.	4	4	1
14	Construction phasing that does not balance the yardage between phases.	Better planning.	Same.	4	4	1
15	Utility plans not being accurate, it seems like every job we build the utilities are not spotted accurately. Many jobs have as part of them to relocate the utility and when the contractor digs down to relocate the line it is not where it is supposed to be.	Better planning and spotting of utility lines.	Same.	5	4	3
16	New Utilities - Schedule for relocation and route of relocation are most often less than correct.	Construct facilities around erroneous relocation of utilities.	(1) Require that relocations be made under direct daily control of a licensed professional surveyor or engineer. (2) Make professional sign off on relocation and furnish accurate coordinates and elevations.	4	5	5
17	Working around existing utilities.	Make utilities location of utilities at any possible point of conflict with new work. Prior to start of work in that area.	Accurate survey information on location both horizontally and vertically. Removal of old, abandoned lines.	5	5	4
18	Traffic control during construction.	Allowance and payment for more public hostile control devices such as fences, barriers, gates, etc.	Civil penalties for other infractions that speeding such as trespassing when the sign reads "Road Closed."	3	2	2
19	Traffic Control - When doing split phase construction, pavement edge drop off has to be protected.	Provide quantity for DGA pavement wedge when it is necessary or expected.	Include the pavement wedge under the maintain and control traffic portion of the specs.	2	3	1

20	Water drainage during construction - Erosion control plans are not designed for phased construction.	Provide additional checks, so to accommodate phases in construction. Provide the ability to relocate erosion control structures.	Design erosion control plans after the project phasing is completed.	1	1	3
21	Plans not thoroughly reviewed and contains too many errors.	Make the designer responsible for their errors and omissions since the design is a purchased product.	Have designers with actual construction experience instead of desk time.	4	4	5
22	Proper drainage in wet areas. Dealing with unsuitable material. A section of road under construction is located in a very flat area with little to no drainage. A one foot undercut is set up for the job with one foot of 23's for backfill. This was not adequate for providing a stable road bed. Additionally, the drainage set up for the job neglected to drain the sub-grade.	An additional six to eighteen inches undercut was allowed on the job using 23's for fill. Class II channel lining was used where the existing material was the worst (layer of Class II. Remainder with 23's). Holes were knocked out of the bottom of the drainage boxes with perforated pipe extending into the sub-grade.	Better geotech information would have been helpful on this project. More specifically, better communication between geotech, roadway design and drainage design. If proper stabilization would have been designed, perhaps the water problems would have been taken care of also.	4	3	3
23	Water drainage between phase construction. In superelevated vertical sag sections water ponds due to higher new pavement. Pounded water sometimes reaching across traveled way.	Drilled core holes down to drainage blanket to drain water.	Include pavement wedge to reverse crown and/or divert water onto new pavement.	2	2	2
24	Working around existing utilities - Utilities are not located where shown on plans. Utilities are not shown on plans at all. Utilities are not moved or repaired in a timely fashion.	We have had to move or repair utility lines that were in the way of construction. Construction was delayed because of utilities.	Improve utility location procedures. Communicate more with local utility companies to better locate/determine dead lines vs. live lines and their proper location.	2	3	2

25	Plan quantity miscalculations. Plan errors in general. On one particular project a large quantity of asphalt base was overlooked in the calculation of the plan quantity sum. Incorrectly dimensioned bridge plans resulted in a beam seat being placed in the wrong location. Various errors in re-bar length resulted in reordering extra re-bar.	Change orders had to be written for all problems.	More thorough inspection of plans before a job is let.	2	3	2
26	Sometimes there are changes in the property adjacent to the road between the time the project was designed and when it is let, sometimes a 10 year time frame. Examples: New building constructed, site graded, new utility locations, etc.	Have consultant review site before letting.	Have consultant contact the District design to have updates yearly.	4	5	1
27	Utilities installed with only the final road location considered, not any temporary pavement locations or detours.	Have utility companies be made aware of detours or any temporary construction.	Have utility companies get copies of the detours, diversions, and any temporary work that is needed to complete. The project especially where the new construction ties into the existing roadway.	5	5	1

Legend:
1- Low
2- Medium Low
3- Medium
4- Medium High
5- High

APPENDIX - IV

COPY OF CONTRACTOR ISSUES, RESOLUTIONS,
AND SUGGESTED PERMANENT RESOLUTIONS

CONTRACTORS

NUMBER	ISSUE	RESOLUTIONS	SUGGESTED PERMANENT RESOLUTIONS	IMPACT ON COST	IMPACT ON SCHEDULE	IMPACT ON QUALITY
1	Water drainage during construction	Depending on situation: (1) Utilize existing drains and safe load in later stages. (2) Add drainage structures/pipes (temporary and/or permanent). (3) Adjust proposed permanent drainage alignment and/or elevations to accommodate phases. (4) Regrade/modify cross-section to redirect water.	(1) More attention paid to by designers an KyDOT reviews (quality of plans to increase). (2) Issue needs to be resolve in pre-construction meetings, etc.	3	4	5
2	Traffic Control (also involves worker safety). Particularly temporary alignments not giving enough room to construct (safety) a particular phase.	More attention to drawing traffic phasing on cross sections so one can see clearances, etc. Plan views don't always show vertical alignments.	KyDOT to require designers to show horizontal and vertical alignments that are temporary in traffic plans.	5	4	5
3	(1) ROW (no access to work in some areas). (2) New utilities (long delays in getting installed). (3) Existing utilities (not accurately located, not considered in phasing, etc.).	(1) ROW (and site access) - No input by contractor - at mercy of KyDOT lawyers, etc. (2) New Utilities - No control by contractor other than cooperate and try to provide best access possible to work site. (3) Existing Utilities - Try to adjust phasing construction and alignment to allow for existing and/or relocated items.	More consideration and attention to detail in design process. Jobs need to be let when full access to project acquired.	5	5	4
4	Geotechnical issues	Geotech factors sometimes tied to ROW and/or access problems. Need to get information even on temporary alignment.	More detailed geotech investigations (closer spacing, etc. on test sites).	3	3	3

5	Environmental issues	KyDOT to allow more items for dust control, runoff, etc.	Make sure enough bid items included to control all factors.	3	3	3
6	Safety (Traffic and worker)	More involvement of local authorities to control traffic. More attention paid to traffic/worker separation in phasing construction.	Same.	3	3	3
7	ROW and new utilities - Schedule of relocation of utilities and ROW clearance are inconsistent.	Obtain ROW and relocate utilities, where possible, prior to construction.	Also, more cooperation and scheduling periods are needed for concurrent utility and construction work.	3	3	1
8	Traffic control during construction - Making relocated "tie-ins" to existing roadways under traffic.	Construct detours to re-route traffic while performing "tie-ins."	Take sufficient R/W on temporary easement to allow this additional phone to be completed.	2	2	5
9	Working around existing utilities. Plan information is inaccurate.	Attempt to work closely with affected utilities to obtain accurate "as builts."	Random check in field before developing plans.	2	4	3
10	Traffic control during construction - Use existing surfacing areas when applicable rather than removing and replacing for detour construction and deconstructing for final product.	Review during design to evaluate if existing pavement can withstand short term loading during the life of the detour.	Milling and re-shaping existing surface area to fit desired typical section of detour and add additional material as necessary.	2	4	4
11	Site access.	Provide a sufficient length of project that construction work maybe progressed in a logical manner. Provides easement or other ROW if project is inaccessible.	Obtain ROW prior to construction.	2	3	1
12	Geotech issues - Provide better information for drainage and stabilizing existing ponds.	Provide more complete soundings and depth of unstable material to assist field personnel on removal, stabilization techniques, etc.	Additional field work needs to be performed by geotechnical consultant. Quantities need to be included also.	3	4	4

13	The Department has too many asphalt mix designs. I have heard that there's over 100 different possibilities. Each requires a new lab mix design - cost ± $5,000.00/each.	Consolidate - Its silly with something as basic as asphalt paving to have all those mix designs. It runs price up!	Same.	5	2	2
14	Traffic control - With ever increasing traffic, the times when resurfacing can be performed are extremely limited. Night paving is not always the answer because people complain that the noise keeps them awake. Vibratory roller can be heard for great distance.	Since there is no absolute resolution, I think that an appeal to the public for the good of all to tolerate the inconvenience with a little bit more of patience and good will. After all, a street normally traveled or where you live only gets resurfaced about every seven to ten years. Its been out experience that many people become what is akin to road rage if they have to sit for even a few minutes.	The Department should put some thought into each project. For example, instead of requiring a 9 to 3 windows (we can't do much in set hours with set up of traffic, etc.). Restrict traffic into town in the morning and outbound in the afternoon. In the morning (inbound traffic) you can't start till 9:00am but you can work as late as you want. The reverse would be true in the afternoon (outbound).	3	5	3
15	Penalty/Bonus - Both too high - The penalty on the I-64 project in Louisville last year could have amounted to $880,000.00/day. The bonus the contractor received was over $5,000,000.00	Both are completely out of line: (1) The big penalty restricts competition. The Louisville Project has in effect only one bidder. (2) The bonus should be copped.	Same.	5	3	2
16	Structure issues - Building new bridges in same location as existing bridges.	(1) More emphasis put on substructure location. (2) More consideration on future settlement. (3) Direct contract between construction and design. (4) Better access to original drawings.	(1) Locate new substructure to eliminate involvement of existing substructure. (2) Disturb original ground as little as possible especially at end structures. (3) Lengthen or shorten spans existing structures and disturbing original ground.	5	4	1

17	New utilities - relocation sometimes causes more problems than it solves.	(1) More emphasis put on relocating utilities as far away from new construction as possible. (2) Utility location should be more apparent.	(1) Never relocate new utilities under bridges or other permanent structures until construction is completed. Utilities could be temporarily relocated until new construction is complete. (2) Owners should have utilities identified and located before construction begins. Most of the time, it is a big guess.	5	5	1
18	ROW - Generally not enough space given for working area.	(1) More attention given to the amount of storage space available to the contractor. (2) More room for machinery to work. Example: ditches to be built within 10' of ROW.	(1) Temporary easements outside area of new construction. (2) More thought given to the size of machinery compared to the space given to work.	1	5	1
19	Project Phasing (Traffic control/phasing) - Often projects are designed with construction phasing that appears to not consider "Constructibility", i.e. paving widths and maintaining traffic on ramps and low volume roads. These can greatly increase time of completion as well as costs.	(1) Get contractor input at design stage. (2) Allow (or be more open to) suggestions and value engineering proposals by contractors. (3) Consider the overall project time and cost when evaluating whether to close a ramp or road or build in phases.	(1) Contractor input. (2) More thorough design consideration to phasing.	5	5	5
20	Selecting pavement type - Often pavement type is selected without full consideration given.	(1) Utilize life cycle cost analysis. (2) Bid alternate equivalent pavement types. The commonwealth can save huge revenues and construct/reconstruct more roads.	Same.	5	5	5

21	Environmental - Archeological concerns over artifacts that can be found most anywhere in the state, i.e., arrow heads, old camp remains, etc. have held up and drastically increased the cost of many projects.	Modify parameters and requirements for these concerns.	Relax requirements.	5	5	1
22	Geotechnical - A project cut/fill balance differs due to erroneous shrink/swell assumptions made prior to bid. An embankment job can swing to a waste situation if additional rock is encountered, and there is no compensation for waste site, etc.	(1) More/better subsurface investigation. (2) Uniform and fair treatment of changed conditions. (3) Additional pay items for work now considered "incidental."	Same.	4	3	3
23	Pavement Thickness - Our overlays are thinner than surrounding states, and we end up repaving sooner than necessary when they don't hold up.	(1) Increase asphalt surface thickness. (2) Add more leveling and welding quantity to restore template.	Same.	4	1	5
24	Division of construction is not involved in setting up jobs to bid. This leads to unnecessary items, items left out, unrealistic quantities, change orders.	(1) Have division of construction representatives involved in setting up jobs. (2) Streamline change order process.	Same.	5	4	4
25	Pavement Rideability is often applied inappropriately. Thin overlays over unstable bases (such as PCC pavement) are examples. Also, curb and gutter sections should not have rideability. As the paver must match the gutter elevation, and is not free to use electronics.	Remove rideability requirement from inappropriate situations, or come up with revised criteria for special circumstances.	Same.	4	2	3

26	ROW/geotechnical - Projects are bid without having all geotechnical investigations complete due to ROW problems. We have bid jobs that we had no idea where rock was located because ROW issues were not resolved.	Do not advertise projects until all geotechnical investigations have been completed.	Same.	4	5	1
27	Utilities - Existing or New - Projects are bid without having all utilities clear.	Do not advertise projects until all utilities are clear.	Same.	4	5	1
28	Bridge construction - Normal pool elevation of stream is not always on the plans.	Place this information on the plans. This may determine whether to use sheeting.	Same.	4	5	1
29	Traffic control during construction - Small bridge replacement projects with detours instead of closing road.	Any bridge replacement with 50 working days or less should be closed during construction if at all possible.	Same.	5	5	3
30	Water drainage during construction.	In-depth review of plans, including traffic phasing to identify problem areas.	Same.	2	2	2
31	New Utilities/Existing.	Try to work with utility companies to identify where utilities are.	Need to have better cooperation from some of the utility companies, when possible don't start project until utilities have been relocated.	3	5	3
32	Traffic Control.	Review by project team to recognize all traffic problems and develop workable plan with least impacts to traffic.	Project team with help of contractor group review plans thoroughly and make sure traffic control plan does not conflict with other construction activities, such as earthwork balance.	4	4	4
33	ROW.	Try to work in areas where ROW is acquired.	Don't start project until all ROW is acquired.	4	5	1
34	Geotech Issues.	Generally causes more concern for contractor for bidding purposes.	Better geotech exploration prior to letting.	1	1	2

35	Environmental factors.	Erosion control plan and identify all required permits and any special items particular to the project.	Requirements need to be realistic, maybe have environmental people more involved in design process and have all items identified in plan documents.	2	3	1
36	Motorist/Worker safety.	Make contractor aware of traffic control plans, MUTCD and standard drawings relating to traffic items during preconstruction conference. Be proactive with media to alert motorist of construction activities and try to schedule projects when possible for less impact on traffic.	In-depth review of traffic control plan prior to letting project. Identify problem areas and look for options for building.	4	5	4
37	ROW - Dealing with adjoining property even though they have even dealt with during ROW negotiations.	(1) A through public involvement program that allows 1 on 1 communication between the designer and the property owner. (2) When designing the project, someone looks at the design from the property owners perspective.	Same.	2	2	5
38	Utilities - Working around existing utilities.	This is the same problem throughout the years. It is very complicated because of budgets and fiscal years with utility companies and the trust for construction the utility companies have with the Cabinet. Utility relocations are always the last part of the pre-construction process and appear to hold up the lettings. The designer has little control a the end of the project but can identify the major utility that has a potential for avoidance and design to avoid. Consideration should be given to the expensive and time consuming utilities when selecting alignments and drainage concepts.	Location of major utilities that have the potential for avoidance should be located accurately. A redesign after the utility has been determined impacted only costs, time and money. Don't let The project until there is assurance the utility will be relocated as advertised.	5	5	5

39	Geotechnical issues - Mostly unanticipated soil conditions.	This issue frequently is the leader of a project's change orders. Additional design costs may not reduce the change orders or the construction cost. More emphasis between the designer and geotech could help.	Require project manager or project engineer to be involved in soils meeting.	---	---	---
40	Environmental factors - Contractor knowing what has been agreed to in permits and approved environmental document.	A section in the P. S. & E. document that highlights environmental commitments.	Same.	---	---	---
41	ROW - During the purchase of ROW, the buyer often makes commitments that cannot be placed on the plans because of time constraints.	District ROW should review every memorandum of agreement and give the contractor all the ROW commitments at the preconstruction conference. District 4 has initiated this and has improved the ROW communication with the contractor.	Same.	2	2	3
42	The longitudinal construction joint in the deck of a bridge under phased construction needs to be placed over a beam if at all possible. Placement of the joint in midspan between beams requires that portion of the deck be constructed on overhang jacks. These are subject to settlement making the tie-in of the second phase more difficult.	This makes it necessary for the contractor to request a change each time. In some cases the request is denied and in most cases the change could have been made during design. Processing the requests consumes the time of several people repeatedly unnecessarily.	Issue a requirement to all consultants that the joint be located over a beam.	4	3	4

43	A bid item for a cofferdam infers that sheeting is required to get paid. In most instances on normal jobs it is possible to shore an excavation with something other than sheeting. And when we feel a cofferdam is not required or is unlikely we must unbalance our bid.	Try to reach agreement with the engineer after the bid.	Change the wording to include the use of other shoring methods.	5	4	1
44	Flowable fill is being increasingly as a substitution for structural Granular Backfill. This is not yet a standard practice but is usually handled through the engineer.	There are several unanswered questions relating to its use because there is no standard practice. This means that in every instance the same questions are always rehashed.	Develop a standard that can be utilized every time.	3	2	1
45	On some bridge replacement projects the new End Bents are placed too close to or even over the old End Bent. This practice contributes to problems in the field having to deal with conflicts between the two.	Time is lost and in some cases the work is shut down due to having to resolve the problem.	Take a closer look at each case in the design stage. In most cases the new End Bent can be placed sufficiently behind the old to eliminate or atleast minimize any interference.	5	4	4
46	Longitudinal construction joints in bridge decks during phased construction are sometimes too close to existing decks both horizontally and vertically.	Sometimes lengthy and detailed discussions are required to make the situation workable. These problems are not evident to the contractor at bidding because of the lack of clearance details provided.	Every case dealt with could have been prevented during design. More time is required during design to investigate possible conflicts. It would be helpful if more information were provided of the clearances to existing structures.	5	3	3
47	In some cases Temporary Barrier Wall is not shown on the roadway drawings as protection for bridge construction.	The bridge contractor is faced with having to convince the engineer and the prime contractor of the need and then to get it installed.	Roadway designers must be aware of the need for TBW for workers as well as for the monitoring public.	3	1	1

48	What is an acceptable bridge deck finish?	The issue existed when Class AA decks were used and was magnified with the use of AAA. Now with us looking at a possible use of a modified AA we will have new ideas of how this new material can be finished.	We spend a lot of time over tried and proved procedures with new faces that have never handled concrete before. Communication will remain a challenge for us all.	4	4	2
49	Conflict with utilities during bridge construction. Utilities though shown in most cases on roadway drawings are not shown on bridge drawings.	Everytime a utility is suspected the BUD process is used but this does not allow the contractor to make adequate provisions during bidding. Conflict then is not limited to the utilities but now involves the parties concerned. Time is consumed often resulting in delays.	Show overhead and underground utilities locations on bridge drawings including heights and depths.	5	4	2
50	Geotechnical Issues - Boring information is simply incorrect.	Complain.	Have quality engineering performed in design. Do not guess at conditions.	5	5	3
51	New utilities - Relocated in and incorrect manner.	Complain.	Let the contractor control the utilities.	3	5	3
52	Other issues - Jobs that show small amounts of Rock excavation that grow to enormous amounts after we are low bidder. If its our responsibility to draw own conclusions, we should be able to access ROW bid.	Put a rock clause in state contracts. Reimburse for contractor drilling and shooting expense atleast.	Have core drill personnel held to a criteria in their testing same as we are on building of highway. Give more accurate numbers on rock excavation before bid is let. Issue change orders for contracting to least recoup drilling and blasting expense. If overrun is greater than 20%.	5	5	3
53	Existing utilities - Delays on projects due to utilities being located in wrong places and unknown places.	Make sure everything is located and moved before project starts or as part of project bid.	Working closely with utility companies and coming up with a quicker way to relocate lines to speed up projects.	4	5	5

54	Blacktop controls everything - When a project is let big blacktop business can raise prices and take it out of earthwork to cost smaller company's the job. Thus small business is pushed out and big business prospers.	Let blacktop and grade items separate on separate contracts, thus small business can prosper.	Have separate lettings on asphalt and grade and drain.	5	5	4
55	Poor Plans.	Double check plans and make sure everything is OK before letting. Changing everything after the project is let is costly to the state and contractor also.	Layout a set of plans that a road can be built by without numerous changes and delays.	4	5	5
56	The swell and shrinkage factor on earthwork quantities are not accurate with actual construction practices.	Use factors from previous projects and experiences.	Additional conditions, time, etc. should be used to determine swell and shrinkage factors.	5	1	2
57	Electronic data should be made available to the contractor.	Recalculate and redraw.	Make electronic data, drawing file, grade calculations, etc. available.	5	3	2
58	Disposing of wate material on a highway construction project.	Finding private land that is not affected by Corps of Engineers permit.	Department of Transportation should acquire all waste areas.	---	4	---
59	Unrealistic commitments made by design and righ of way personnel to property owners and the public general.	Inform the public of the scope of construction and explain the realistic construction procedure.	All commitments, regardless of how minute, should be made in writing and made a part of the plans.	4	3	1

60	Not enough right of way for construction equipment and material. At culverts and bridge construction there is usually not enough room for equipment and material storage within the right of way limit.	Talk to property owners and obtain consent to place material on their property.	Take additional property as temporary or drainage easement.	4	1	2
61	The condition that utility companies and/or utility contractors leave the site in before the project is let to contruction.	Usually the grade contractor must remove bush, debris, etc. and then dress the area for seeding.	All utility work bing done on transportation projects should require companies doing said work to dress, seed and provide erosion control as would any grade contractor.	5	2	2

Legend:
1- Low
2- Medium Low
3- Medium
4- Medium High
5- High

APPENDIX - VI

SAMPLE CHECKLISTS AND SUGGESTION FORM

Constructibility Review Checklist

PRELIMINARY DESIGN CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 PDC	Has coordination and agreements with appropriate utility companies been acquired?			
2 PDC	Have appropriate "lessons learned" from previous project been reviewed?			
3 PDC	Have agreements with appropriate ROW landowners been acquired?			
4 PDC	Have permits been identified and secured?			
5 PDC	Has geometrics and roadway alignment (e.g., curve data, sight distance, vertical datum) been addressed?			
6 PDC	Was early construction input used for assessing labor capabilities for innovative construction methodology?			
7 PDC	Is cross referencing between various contract documents consistent?			
8 PDC	Did designer obtain constructor input on the design?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
	_____
_____	_____
_____	_____
Designer's Comment	_____
	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

PRE-BID CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 PBC	Has earthwork design (e.g., temporary borrow, additional access) been considered?.			
2 PBC	Has lighting & signs (e.g., conduit size, design of structures, compatibility) been considered?			
3 PBC	Has accessibility to jobsite been analyzed?			
4 PBC	Has ROW acquisition (e.g., construction easements, adequate work space, desirable clear zone, utility relocation) been considered?			
5 PBC	Were utilities (e.g., accuracy of location, proposed relocation, conflicts with other structure) considered?			
6 PBC	Were pavement (e.g., design criteria, flexibility to change) considered?			
7 PBC	Was budget and schedule feasibility performed?			
8 PBC	Were any suspected, unrealistic or incompatible tolerances investigated?			
9 PBC	Were adverse effects of weather considered in selecting materials or construction method?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
_____	_____
_____	_____
Designer's Comment	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

CLEARING/GRUBBING/EXCAVATION CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 CGEC	Were grubbing, clearing and lanscaping limits delineated?			
2 CGEC	Are underground utilities marked clearly on plans?			
3 CGEC	Is the quantity of borrow shown on plans?			
4 CGEC	Is the percentage of soil shrinkage used satisfactorily?			
5 CGEC	Have provisions (such as phasing of work) to minimize borrow and use of excavated material for fill been considered?			
6 CGEC	Are soil laydown areas on the same side of road as fill area?			
7 CGEC	Are sites for temporary fill and top soil storage indicated?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
	_____
_____	_____
_____	_____
Designer's Comment	_____
	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

REMOVAL/DEMOLITION CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 RDC	If a structure is to be removed or renovated, has an asbestos survey been performed?			
2 RDC	Are there clear limits of horizontal removal?			
3 RDC	Are there clear limits of vertical removal?			
4 RDC	Is there adequate construction access for demolition?			
5 RDC	Is there a clear method of disposal?			
6 RDC	Are there adequate provisions if signs or road markers are to be removed?			
7 RDC	Is there appropraiate milling details for existing pavement(e.g., limits are identified)?			
8 RDC	Is there utility relocation in or near these sites?			
9 RDC	Are contamination sites clearly delineated on plans?			
10 RDC	Are drawings of manholes, hydrants and provisions (i.e., access or space to operate) for relocation shown on plans?			
11 RDC	Is adequate specified protection requirements (e.g., for existing utilities, existing structure) shown on plans?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
_____	_____
_____	_____
Designer's Comment	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

STRUCTURES CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 SC	Is the Traffic Control Plan coordinated with construction roadwork phasing?			
2 SC	Is the depth of water sufficient to float barges if needed?			
3 SC	Will barges block boat traffic?			
4 SC	Were other structure characteristics(e.g., mix design, strength, concrete & steel requirements) considered?			
5 SC	If access not practical by barges, have temporary work bridges or fill been considered? Are these methods consistent with permits?			
6 SC	Is proposed construction consistent with permits?			
7 SC	Has power service points for lighting been confirmed?			
8 SC	Has Traffic Control Plan addressed channeling traffic from under overhead work?			
9 SC	Are there any problems with ROW or easement?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
	_____
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_____	_____
Designer's Comment	_____
	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

UTILITIES CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 UC	Is a list of all utility owners and contact numbers shown on plans?			
2 UC	Are existing utility locations marked on plan?			
3 UC	Are utility conflicts and their relocation indicated in design?			
4 UC	Are disruptions of other utilities and provisions to restoration considered?			
5 UC	Are new utilities connecting points with existing utilities verified?			
6 UC	Is there adequate description of connection and reconnection points shown?			
7 UC	Is availability of indicated existing utility ducts and their proximity to highway facility and traffic considered?			
8 UC	Have utilities required for construction operation and field offices been considered?			
9 UC	Are sewer lines below water mains?			
10 UC	Are gas lines above other utilities?			
11 UC	Does space between ROW line and drainage structure allow for construction?			
12 UC	Do utilities conflict with drainage?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
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_____	_____
_____	_____
Designer's Comment	_____
	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

DRAINAGE CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 DC	Are existing drainage patterns, their continuity and high water indicated in design?			
2 DC	Are drainage easements, if required, shown on plans?			
3 DC	Are proposed methods of connecting new and old drainage facilities shown?			
4 DC	Are outfall locations of temporary and permanent drainage facility, if any, shown?			
5 DC	Is identification and adequacy of all drainage items and quantities shown?			
6 DC	Are needed elevations shown in the plans?			
7 DC	Have drainage structures (e.g., new and standardized structures, size of pipe) been addressed?			
8 DC	Is the location of required design elevations compatible with existing conditions?			
9 DC	Are temporary drainages for construction areas during work shown in the plans?			
10 DC	Are temporary drainage facilities provided for the lanes on which traffic is to be maintained during work?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
_____	_____
_____	_____
Designer's Comment	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

MAINTENANCE OF TRAFFIC CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 MOTC	Is Traffic Control Plan complete (e.g., work area, transition area) and approved?			
2 MOTC	Are location of traffic control signs, warning devices and barricades encroaching on lanes?			
3 MOTC	Is detour facility, if any, considered?			
4 MOTC	Is maintenance of traffic, if any, considered?			
5 MOTC	Are traffic operation requirements (i.e. signing, signal) properly addressed ?			
6 MOTC	Is relocation item for barrier wall or fence considered?			
7 MOTC	Is location of flashing arrow boards, if needed, at apprpriate places?			
8 MOTC	Is there sufficient clearance within the work zone for the operation (e.g., crane swing room)?			
9 MOTC	Are adequate accommodations for intersecting and crossing traffic addressed?			
10 MOTC	Are pedestrian and bicycle accommodations addressed?			
11 MOTC	Are exits and entrances to the work zone adequate and safe?			
12 MOTC	Are restrictions (e.g., lane closure, general construction or peak hour restrictions in urban areas) indicated in plan?			
13 MOTC	Are lanes on which traffic is to be maintained compatible to local conditions?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
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Designer's Comment	_____
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Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

SCHEDULING/PHASING/ACCESS CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 SPAC	Are activity needs considered during scheduling and phasing of the project?			
2 SPAC	Is maintenance access to all occupied spaces considered by reviewing the schedule of the project?			
3 SPAC	Is maintenance access to all occupied spaces considered by sequence of work restrictions?			
4 SPAC	Is maintenance access to all occupied spaces considered by delineated work areas?			
5 SPAC	Is type and limits of fence to be used for limited access highways considered?			
6 SPAC	Are sufficient space for trailers, material storage and construction operations addressed?			
7 SPAC	Are requirements for local/state special permits available before construction begins?			
8 SPAC	Were critical pieces of construction equipment identified?			
9 SPAC	Is haul route different from most direct route and indicated in Traffic Control Plan?			
10 SPAC	Is special access required to adjacent property?			
11 SPAC	Is safe pedestrian access and access to business and residences provided through the project's duration?			
12 SPAC	Is easement to adjacent property for storage & construction available throughout the project's duration?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
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Designer's Comment	_____
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Designer's Comment	_____
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Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

ENVIRONMENTAL CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 EC	Are erosion and pollution control items/measures shown?			
2 EC	Is depiction of all existing trees and shrubs to remain and those to be removed shown on plans?			
3 EC	Have all permit requirements been addressed?			
4 EC	Are local agency requirements clearly identified in either plans or specifications?			
5 EC	Are provisions to prevent groundwater contamination and other environmental pollution addressed in either plans or specifications?			
6 EC	Are provisions for noise abatement (e.g., permanent noise wall, alternative construction schedule) considered?			
7 EC	Are landscaping and planing requirements and their conflicts with utilities (e.g., irrigation lines) verified?			
8 EC	Is there sufficient space for power mowers around proposed tree plantings?			
9 EC	Is compliance with all applicable or relevant and appropriate environmental and public health requirements identified?			
10 EC	Are all substantive permit requirements clearly identified in the design with a description of the means of demonstrating compliance?			
11 EC	Have all required off-site permits been applied for by the designer?			
12 EC	Are all performance standards clearly identified?			
13 EC	Has perimeter air monitoring been specified?			
14 EC	Are dust and noise control measures specified?			
15 EC	Were provisions in plans and/or bid documents for silt fences, turbidity barriers, etc considered?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's Comment	_____
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Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

SITE SURVEY/PLAN/PROFILE CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 SPPC	Are right-of-way and property line dimensions shown on plans?			
2 SPPC	Do site conditions conform to those shown on plans?			
3 SPPC	Is existing topography accurate and up to date?			
4 SPPC	Does the existing profile fit the terrain?			
5 SPPC	Are work elements clearly identified and all corresponding pay items included with adequate quantities to construct project?			
6 SPPC	Are plans clear and legible?			
7 SPPC	Are there any apparent conflict between plans and specifications?			
8 SPPC	Are benchmark data, elevations, and curve data shown on plans?			
9 SPPC	Are water table elevations and requirement of dewatering addressed?			
10 SPPC	Are appropriate general notes and special provisions required for construction?			
11 SPPC	Is pavement design shown graphically matches with the verbal description on specifications?			
12 SPPC	Are existing drainage patterns shown?			
13 SPPC	Are plans for existing and proposed right-of-way shown?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
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Designer's Comment	_____
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Designer's Comment	_____
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Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

CLAIMS PREVENTION CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 CPC	Have the contract documents been reviewed to ensure that conflicts do not exist among various plan sheets and specifications?			
2 CPC	Do the contract documents adequately support the terms of payment selected (i.e. fixed price or cost reimbursement)?			
3 CPC	Does the contract adequately explain the contract and consequences it contains for the contracting party and constructor?			
4 CPC	Are the performance standards complete, adequate, and unambiguous?			
5 CPC	Is there a remedy and procedure for changes?			
6 CPC	Are the estimated quantities reasonable and certified?			
7 CPC	Is the site investigation (e.g., geotech report) and disclosure of technical information adequate?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
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Designer's Comment	_____
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Designer's Comment	_____
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Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

DRAWING/TITLE PAGE CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Yes	No	N/A
1 DTPC	Are all of the views needed to construct provided, such as plans, elevations, sections, schedules, riser diagrams, and details?			
2 DTPC	Are all the necessary supplementary documents provided to define the relevant existing conditions, for example, land surveys, geotechnical, environmental?			
3 DTPC	Do all large scale plan views match the smaller scaled views?			
4 DTPC	Is the layout and content of each sheet clear, and concise?			
5 DTPC	Have matchlines been used only when absolutely necessary?			
6 DTPC	Is the drawing-layering, sequencing and numbering in conformance with the Uniform Drawing System [UDS]?			
7 DTPC	Have all of the drawn by and checked by blocks been initialed? Have the drawings that are initialed been carefully checked?			
8 DTPC	Is there adequate cross-referencing indicated on the plans?			
9 DTPC	Are all symbols and abbreviations provided in the appropriate legends?			
10 DTPC	Are all scales correctly shown?			
11 DTPC	Are the title blocks complete and current?			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
_____	_____
_____	_____
Designer's	_____
Comment	_____
_____	_____
_____	_____
Designer's	_____
Comment	_____

Completed By:_____ **Sign:** _____ **Date:** _____

Constructibility Review Checklist

SIGNALIZATION CHECKLIST

PROJECT TITLE: _____

PROJECT ID NO.: _____ DESIGN PHASE: ☐ 30 ☐ 60 ☐ 90

NAME OF REVIEWER: _____ DATE: ___/___/____

Item No.	Item to be Checked	Ok	Not Ok	N/A
1	Are pole locations and their conflict with utilities and drainage structures addressed?			
2	Are controller, signal head, pull box, pedestrian pole locations addressed?			
3	Are clear zone requirements met?			
4	Verification of conduit street crossing to become overhead.			
5	Fiberglass insulators needed for span wire due to power overhead lines and adequaet provisions.			
6	Number of detectors is right.			
7	Any signs attached to the overhead span wire for the traffic signal.			
8	Disposition of existing signal poles and other equipmen, if they are removed.			
9	Signal arms far enough to provide sidewalk access.			
10	Existing controller compatible to added items.			
11	Pole imbedment conforms to proper depth criteria.			

Suggested Changes: (to be completed for items checked "NOT OK")

Item No.	Explanation of Change/Addition
Designer's Comment	
Designer's Comment	
Designer's Comment	

Completed By:_____ **Sign:** _____ **Date:** _____

CONSTRUCTIBILITY REVIEW SUGGESTION FORM

Item No.	Explanation of Change/Addition
NAME:	SIGN:
APPROVED BY:	DATE:
Designer's Comment	
NAME:	SIGN:

Item No.	Explanation of Change/Addition
NAME:	SIGN:
APPROVED BY:	DATE:
Designer's Comment	
NAME:	SIGN: