Task 2 Details and Summary

The focus of Task 2 was to analyze a number of ABC projects, completed under the Highway for Life (HfL) program. To help perform this analysis, a data collection template was developed using Microsoft Excel and Visio. The first version of the data collection template was built as an Excel spreadsheet, in which data entities were represented in columns and projects were represented in rows. Figure 1 provides an illustration of this template.

Category	Variable	1	2
General Bridge Information	Age	53	80
	Bridge ADT	25000	680
	Bridge Location	State: VA, Gainesville ,Prince William County	Addison, Washington County, Maine
	Environmental Characterstics	Adjacent to historic properties: Buckland Historic District	School, cumercial trucks, emergency vehicles, sensitive water courses that restrict the construction footprints and
	Existing Structure Details	3 spans reinforced concrete T-beam 130 ft, Two Lane	Single span precast/prestressed concrete with integral abutments, 200 ft roadway, Width: 28 ft
	Contract type	A+(B*C)	
	Detour Length	11mi	16mi
	Detour Delay	9461 v-h	
	New Structure Details	Width: 38.5 ft	Width: 28 ft, 46 ft single span
	Conventional Construction Cost (Estimated)	$3,346,300	
	Conventional Construction Time (Estimated)	100 Days	270 Days

Figure 1. Data Collection Template - Spreadsheet Format

The second version of the data collection template was developed using a flowchart representation. The flowchart version provides a clearer representation of the data elements and relationship between data elements than can be provided in the Excel, spreadsheet representation. This template was developed using Visio and an illustration of this template is provided in Figure 2.

Data from eight different HfL projects have been collected and compiled using both of these templates. The data collection templates were presented in the April TAC meeting. The templates were reviewed and approved by the TAC team. Depending on the results of Task 3, additional review of archival records and/or interviews may be conducted to collect additional information on these HfL projects.

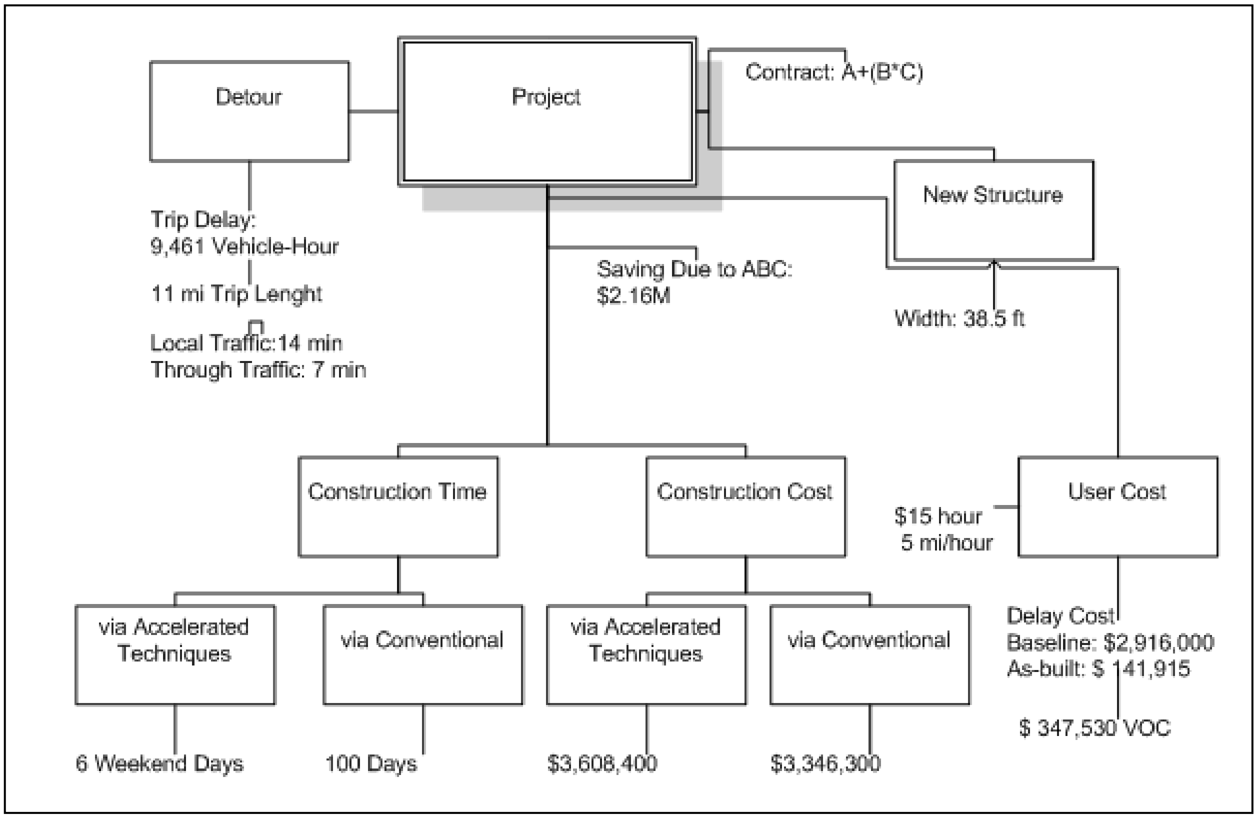

Figure 2. Data Collection Template - Flowchart Version

Task 3 Details and Summary

At the April face-to-face meeting with the TAC team, held in Portland, a summary of Task 1 and Task 2 results was presented, and new TAC members from Montana and Texas were introduced. The research team also used the meeting to get input from the TAC team needed to initiate Task 3. In a series of brainstorming sessions, TAC members discussed the criteria currently considered by their states in the decision-making process for determining if conventional or ABC techniques would be used. The focus of the brainstorming was to identify a complete list of any/all factors affecting decisions on the type of construction techniques used for a bridge replacement/rehabilitation project. The outcome of this effort was the creation of a comprehensive list of factors that enter into the decision-making process. Preliminary categories for each decision criteria were also identified. This list along with definitions is provided in the Appendix 1.

From the brainstorming work of the TAC team as well as this review of the literature, it was determined that bridge construction decisions are based on both quantitative and qualitative data. In addition, it was determined that some of the factors that enter into the decision-making process are difficult to fully quantify at the point in which decisions must be made. Having these diverse types of decision criteria make finding a suitable technique difficult, since many decision-making techniques are not able to integrate both qualitative and quantitative criteria simultaneously. After a comprehensive literature review, the research team recommended that a tool called Analytical Hierarchy Process (AHP) be considered for this project. AHP is technique that aids decision makers in prioritizing multiple criteria, and the outcome from an AHP analysis is a ranking of various design alternatives. Overall, AHP is well-suited for multi-criteria decision-making. AHP was introduced by Saaty (1977 and 1993), and its application in other domains is well-documented in the literature.

Despite the introduction of the AHP in the civil/structural engineering literature, the process has not been widely used in practice and may be unfamiliar to transportation personnel. The underlying hierarchy model uses pairwise comparisons of different criteria and a process by which these are combined to create a final recommendation. If the model or pairwise comparisons do not accurately reflect the criteria, this will be directly reflected in the results and inconsistencies in the comparisons will make the results unreliable. There will be more discussions on the AHP process when the project data are applied into the model and the results are shown.

AHP is a decision support tool that can be applied to complex decisions. AHP uses a multi-level hierarchical structure of objectives, criteria, subcriteria, and alternatives. The pertinent data to conduct an AHP analysis are created using a set of pairwise comparisons. These pairwise comparisons are used to calculate the importance weight for each decision criteria, and to evaluate the relative performance of each alternative in terms of each decision criterion. The pairwise comparisons are stored in a series of comparison matrices. These comparison matrices are briefly explained in next. The criteria list developed by the TAC members was converted into a hierarchy. The hierarchy developed for this research has three different levels (see Figure 3). The three levels produce a “four-level” (including the alternatives) AHP problem. The decision hierarchy is also described in more detail.

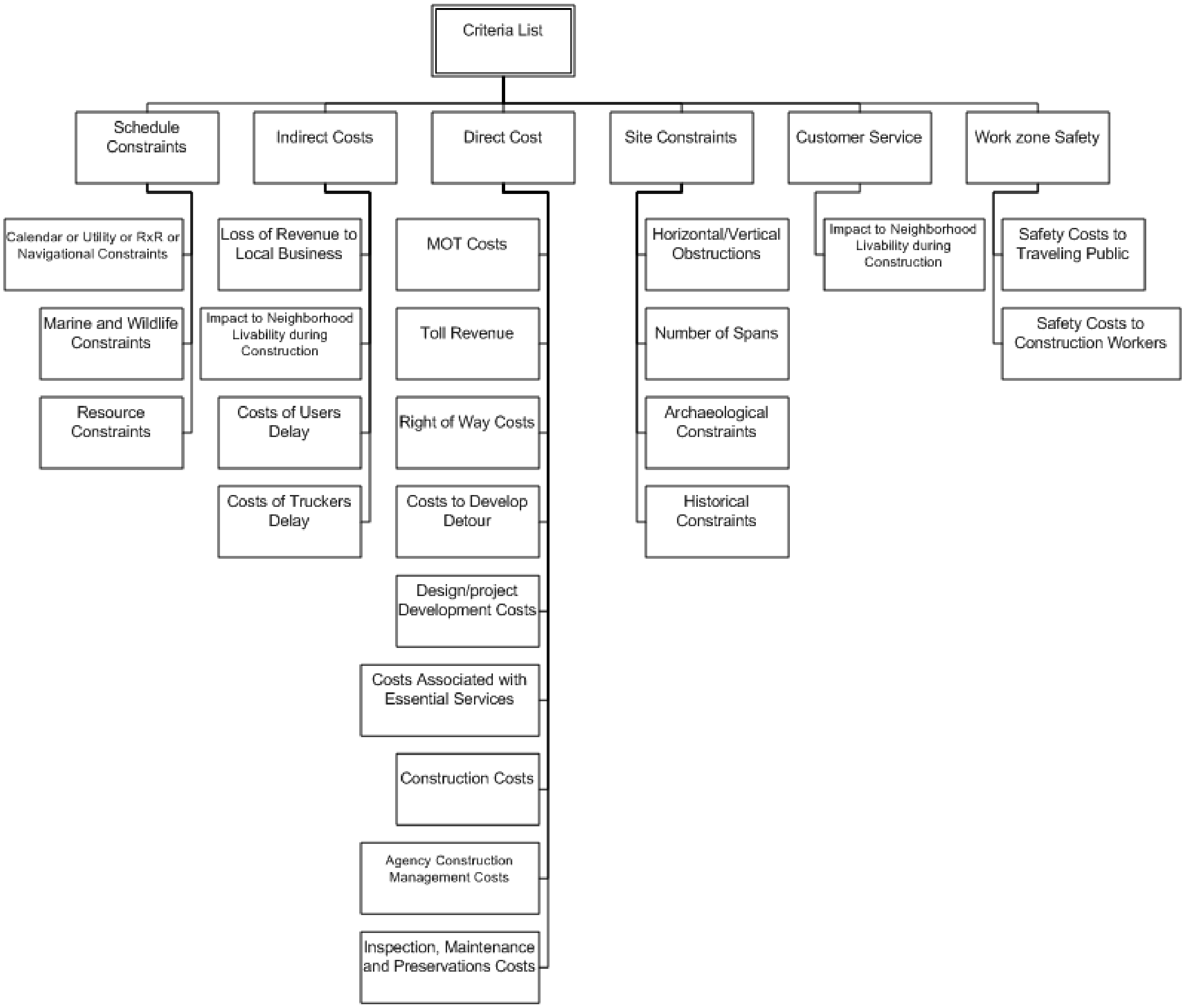

Figure 3. Decision Criteria Hierarchy

It is important to note that the hierarchy and the list of criteria are not finalized at this point, and it is expected that additional modifications to both the hierarchy and criteria will occur as Task 3 work continues. In particular, the research team is working with TAC team members and other domain experts to ensure that the criteria list contains all the necessary elements that should be considered in a bridge design selection problem and that the hierarchy has properly categorized each criterion.

The hierarchy was used, along with the criteria to develop a survey, which could be used to collect pairwise comparisons and used to complete an analysis for a bridge project. The survey contains all required pairwise comparisons associated with the current version of the decision hierarchy. The current survey format was designed to enable bridge designers and project personnel to be able to complete the required comparisons, without a deep knowledge of AHP or the mathematical procedures associated with AHP. The current version of the survey is included in Appendix 2.

To check the robustness of the criteria and to provide an illustrative test of how the AHP tool could be used for a bridge construction project, a test case was completed. Reports have been collected for a number of completed bridge construction or rehabilitation projects, under the Highway for Life (HfL) program. Figure 4 illustrates an example of the output of an AHP analysis completed for one of these bridge construction projects, which occurred in Gainesville, Prince William County, VA. The data provided in the HfL report was used to perform the required pairwise comparisons. Although the comparisons were performed by a member of the research team, who is not an expert in bridge construction, the results were satisfying. In this example, the results of the AHP analysis suggested that the ABC construction alternative was preferable over Conventional construction methods. Based on the results, 'Safety' and 'Site Constraints' were the decision criteria that had the greatest contribution to this recommendation.

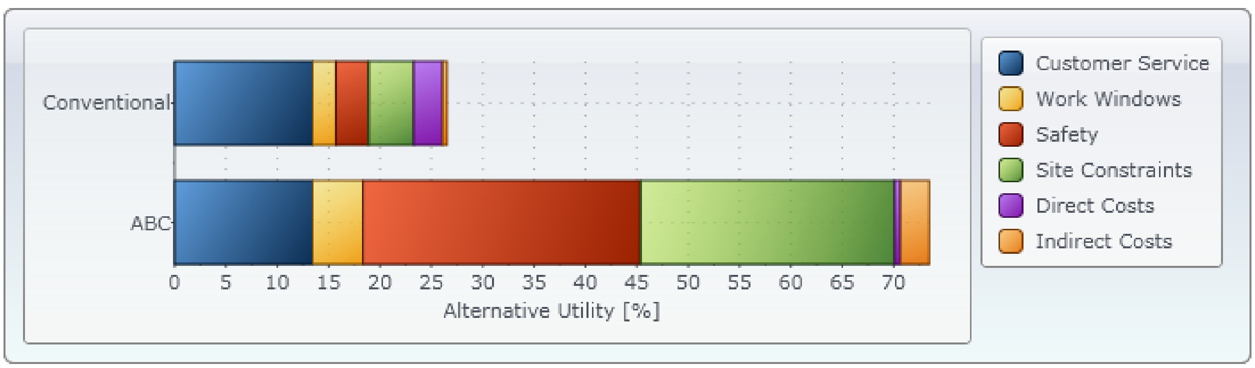

Figure 4. Example AHP analysis Results for the Gainesville Project

The research team intends to perform a series of similar tests on previously completed and potentially on in-process bridge construction projects. Since not all of the necessary data for the required pairwise comparisons is available in the written HfL reports, the research team may need to contact personnel at the appropriate DOT, familiar with the projects. Data required to perform pairwise comparisons for these additional projects will be collected through interviews. Plans are all ready underway to conduct interviews with a number of ODOT personnel located in Salem and Portland, OR. During the next quarters, additional interviews are also planned with personnel from other TAC member DOTs.

Analytical Hierarchy Process Details

Analytical Hierarchy Process (AHP) is a decision-making technique that is designed to cope with both rational and intuitive criteria to identify the best alternative from a set of alternatives evaluated with respect to several criteria (Saaty & Vargas, 2001). In this technique, the decision maker performs pairwise comparisons, which are then used to develop overall priorities for ranking the alternatives.

The simplest form that AHP can be used in is a decision making problem that consists of three levels: the overall goal of the decision, the criteria by which the alternatives will be evaluated, and the available alternatives (see Figure 5). The AHP hierarchy schema helps the decision maker decompose the decision-making problem. The factors affecting a decision (i.e. criteria and sub-criteria) are decomposed in gradual steps from general criteria, in the upper levels of the hierarchy, to specific criteria, in the lower levels of the hierarchy. This structure makes it possible to judge the importance of the elements in a specific level with respect to some or all the elements in the adjacent level.

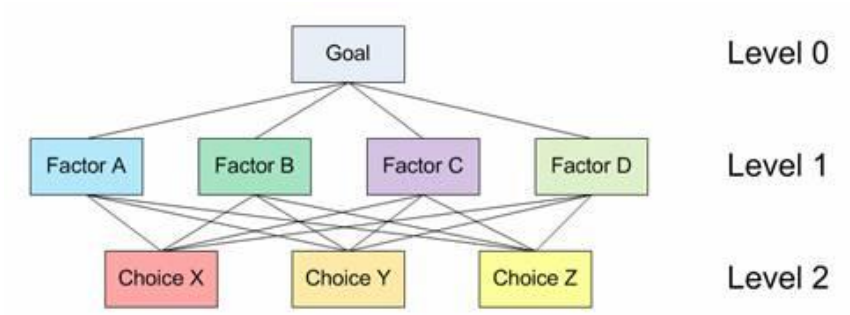

Figure 5. A schematic Three-Level Decision Making Hierarchy

When hierarchies are constructed, enough relevant detail must be included to present the problem as thoroughly as possible, but not so detailed as to lose the ability to distinguish between elements. When constructing a hierarchy, a number of important issues such as the environment surrounding the problem, attributes contributing to the solution, and the role of various stakeholders must be considered. The elements included in the hierarchy must be homogeneous. However, the hierarchy does not need to be complete; that is, an element in a given level does not need to function as a criterion for all the elements in the level below. Further, a decision maker can insert or eliminate levels and elements as necessary to clarify the pairwise comparison or to sharpen the focus of the analysis on one or more parts of the system. Sometimes, elements deemed to be less important to a particular decision can be dropped from further consideration, if the judgments and prioritization show that certain elements have a relatively small impact on the overall objective.

AHP Analysis Procedures

The AHP technique can be used to extract ratio scales from both discrete and continuous pairwise comparisons in multilevel hierarchy structures. These comparisons can be performed from actual measurements or from evaluations made using a scale that represents the relative strength of preferences and feelings about criteria. The AHP analysis takes several factors into consideration simultaneously, allowing for dependence, and making numerical tradeoffs to arrive at a synthesis or conclusion.

The first step in using AHP to model a problem is to develop a hierarchy or a network representation of the problem. In the next step, a series of pairwise comparisons must be carried out to establish relationships between elements within the hierarchy. These comparisons lead to the generation of a set of reciprocal matrices (see Figure 6). More information about the characteristics of these matrices can be found in [Saaty, 1977; Saaty, 1993]. Pairwise comparisons in AHP are performed over pairs of homogenous elements. The scale of values to represent the intensity of a judgment is shown in Table 1. This linear scale is a one-to-one mapping between the set of discrete linguistic choices available to the decision maker and a discrete set of numbers which represent the importance or weight of the choices (Triantaphyllou, 2000). This scale has been validated for effectiveness, not only in many applications by a number of people, but also through theoretical justification (Saaty, 2001).

	Loss of Revenue to Local Business	Impact to Neighborhood Livability during Construction	Costs of Users Delay	Costs of Truckers Delay
Loss of Revenue to Local Business	1.00	0.14	0.20	0.25
Impact to Neighborhood Livability during Construction	7.00	1.00	3.00	3.00
Costs of Users Delay	5.00	0.33	1.00	3.00
Costs of Truckers Delay	4.00	0.33	0.33	1.00

Figure 6. Comparison Matrix

Table 1. The AHP Pairwise Comparison Scale

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

In 1846 Weber (as reported in [Saaty, 1980]) stated his law regarding a stimulus of measurable magnitude. According to this psychological theory a change in sensation is noticed if the stimulus is increased by a constant percentage of the stimulus itself. That is, people are not able to make choices from an infinite set. For example, people cannot distinguish between two very close values of importance, say 3.00 and 3.02 (Miller, 1956). This reasoning was used by Saaty to establish 9 as the upper limit of his scale and 1 as the lower limit, with a unit difference between successive scale values (Saaty, 2001).

Synthesis is obtained by a process of weighting and adding down the hierarchy, leading to a multilinear form. In the disruptive mode of the AHP, the principal eigenvector is normalized to yield a unique estimate of a ratio scale underlying the judgments. This vector shows relative weights among the elements that are compared. Aside from the relative weights, one should also check the consistency of pairwise comparisons. A comparison matrix 'A' is said to be consistent if

$$a_{ij}.a_{jk} = a_{ik}$$

for all i, j, and k. However, consistency should not be forced. Since the decision criteria included in a model incorporate criteria that require human judgment, i.e. there is not quantitative method for evaluating some criteria, too much consistency is undesirable. Saaty proved that for consistent reciprocal matrix, the largest eigenvalue is equal to the size of comparison matrix, or

$$\lambda_{max} = n$$

Subsequently a measure of consistency, called Consistency Index was defined as the deviation or degree of consistency using the following formula:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

The Consistency Index is compared to a Random Index (RI) and is used to calculate the Consistency Ratio (CR) using the following formula:

$$CR = \frac{CI}{RI}$$

The RI are obtained by randomly generating reciprocal matrices using the scale and generating a random Consistency Index to see if it is about 10% or less. The average random Consistency Index of sample of 500 matrices is shown in the Table 2. If the value of Consistency Ratio is smaller or equal to 10%, the inconsistency is acceptable. If the Consistency Ratio is greater than 10%, the subjective judgments should be reviewed

Table 2. Average Random CIs of a Sample of 500 Matrices

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

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Appendix 1 - Decision Criteria List

Category	Variable	Units	Notes	Reported by:	Type
Direct Cost	Toll Revenue	dollar	This is the loss or revenue due to a closure of a toll facility should the ABC project elect to close the faculty		Quantitative
Direct Cost	Delta Right of Way Costs	dollar	This is the difference in cost to procure ROW between ABC and Conventional Construction. Either permanent or temporary procurements/easements.	ROW Staff	Quantitative
Direct Cost	Delta Maintenance of Traffic (MOT) Costs	dollar	This is the difference in the maintenance of traffic costs ABC and Conventional Construction at the project site. Includes costs associated with the maintenance of detours during construction and the preparation of detours prior to construction. Examples include: signage, signals, barriers, temporary overlays, crossovers, , Capturing this cost may require a traffic control plan be developed for each alternative including temporary structures. Or possibly use estimates used based on DOT experience. This may need to broken down into multiple variables so that persons reporting data can provide proper input.	roadway/traffic staff	Quantitative
Direct Cost	Delta Costs to Construct Detour Bridges	dollar	This is the difference in the requirements to construct detour bridges to accommodate traffic through the project site ABC and Conventional Construction at the project site. Cost to construct detour bridges	Bridge Staff	Quantitative
?	Number of Spans	?	The ABC construction might require using simple spans versus using continuous spans under a convention issue. This is a design decision that may have effect on cost or an owner's preference over the type of bridges put into their inventory, i.e. bridges with joints.	?	Quantitative
Site Constraints	Horizontal/Vertical Obstructions	Yes/No	Physical constraints dictate construction alternatives. Such as bridges next to tunnels, ROW limitations, bridges on sharp curve or steep grade, urban areas with bridges on both sides which lock the bridge into a single site.	Bridge or Roadway Designers	Qualitative

Direct Cost	Delta Design/Project Development Costs	dollar	These are the difference in costs associated with the design of a bridge. This may be influenced by the designer experience with ABC and/or specific ABC elements and could be a +/- costs. For example; a state that has institutionalized ABC it may cost more in design to go back to conventional design. Additionally, there may be delta costs related to project development based on the construction method, for example if the construction method avoids impacts to the environment then the cost to obtain permits could be reduced. There is also the ability to mitigate impacts by using a certain construction method (this may not be measurable).	Bridge or Roadway Designers	Quantitative
?	Resource Constraints	Yes/No	A DOT may be resource constrained in terms of staff available to come up to speed on ABC. Whereas the conventional designs may be expedited through the use of standard designs or similar designs. A state may be forced to go to a consultant which may require additional time to get the consultant on board and deliver the project.	Bridge or Roadway Designers	Qualitative
Indirect Costs	Delta Loss of Revenue to Local Business	time or dollars	This is the difference in lost local business revenues due to limited access to local business due to construction activity or people don't want to go thru construction zone to visit local businesses.		Quantitative
Direct Cost	Delta costs associated with Essential Services	dollar	This is the difference in costs associated with the need to provide essential services that may be impacted by the type of construction selected. For example; If the bridge is shut down, is there an acceptable alternate route to provide defense, evacuation, emergency access to hospitals, schools, fire station, and law enforcement, etc.		Quantitative
Indirect Costs	Impact to Neighborhood Livability during construction	time	This is the impact to the neighborhoods due to construction activities i.e. noise, delays, limited access. There may be a desire to accelerate construction in order to minimize a neighborhoods exposure to construction activities.		Quantitative
Customer Service	Impact to Neighborhood Livability during construction	time	This is the impact to the neighborhoods due to construction activities i.e. noise, delays, limited access. There may be a desire to accelerate construction in order to minimize a neighborhoods exposure to construction activities.		Quantitative

Indirect Costs	Delta Costs of Users delay	dollar	Includes POV costs of delay at project site due to reduced speeds and costs associated with delays due to the use of off-site detour routes. Includes cost of queues times. Calculate by ADT, delay time, operating costs (driver and vehicle).		Quantitative
Indirect Costs	Delta Costs of Truckers delay	dollar	Includes Truckers costs of delay at project site due to reduced speeds and costs associated with delays due to the use of off-site detour routes. Includes cost of queues times. Calculate by ADTT, delay time, operating costs (driver and vehicle).		Quantitative
Work windows	Calendar or Utility or RxR or Navigational Constraints	time	These are the constraints placed on the project that might affect the timing of the project including weather windows, significant or special events, RxR needs, navigational channels. One type of construction may have advantages over other with regards to accommodating these "events".		Quantitative
Work windows	Marine and Wildlife Constraints	time	These are the constraints placed on the project by resource agencies to protect marine or wildlife species. Including in water work windows, migratory bird windows, nesting requirements, etc.		Quantitative
Safety	Delta Safety Costs to traveling pulbic	dollar	These are the delta costs associated with the user exposure to construction zone, including crashes accidents. The generally idea is that the longer construction duration results in higher risk to safety. This could be based on accident rates which may be based on ADT levels.		Quantitative
Safety	Delta Safety Costs to construction workers	dollar	These are the delta costs associated with the workers exposure to construction zone. The general idea is that the longer construction duration results in higher risk to safety.		Quantitative
Direct Cost	Delta Construction Costs	dollar	These are the delta estimated costs associated with the construction of the project. This item should include premiums associated with new technologies or construction methods. The premium is intended to address contractor availability, materials availability, and contractor risk.		Quantitative
Direct Cost	Delta Agency Construction Management Costs	time	This is the delta costs associated with the agency project oversight costs.		Quantitative
Direct Cost	Delta in maintenance and preservations costs	dollar	This is the costs associated with the life cycle maintenance and preservations costs associated with the individual bridge elements or overall bridge design.		Quantitative

Appendix 2 – AHP Survey

"What is the worth of a specific bridge construction technique in terms of a customer service criterion?"

Although information about questions like the previous one are vital in making the correct decision, it is very difficult, if not impossible, to quantify them correctly. Therefore, many decision-making methods attempt to determine the relative importance, or weight, of the alternatives for each criterion involved in a given decision-making problem.

Pairwise comparisons are used to determine the relative importance of each alternative for each criterion. In this approach the decision-maker has to express his opinion about the value of one single pairwise comparison at a time.

Each choice is a linguistic phrase. Some examples of such linguistic phrases are: "A is more important than B", or "A is of the same importance as B", or "A is a little more important than B", and so on.

For instance, when system A is compared to system B then the decision-maker has determined that system A is between to be classified as "essentially more important" and "demonstrated more important" than system B (see also Table1). Thus, the corresponding comparison assumes the value of 6.

Please indicate the level of preference by choosing the most descriptive score (both value and direction) in the rubrics below.

Level 1

	Extremely more Important								Equally Important								Extremely more Important	
Work Windows	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indirect Costs
Work Windows	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Direct Cost
Work Windows	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Site Constraints
Work Windows	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Customer Service
Work Windows	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Safety
Indirect Costs	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Direct Cost
Indirect Costs	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Site Constraints
Indirect Costs	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Customer Service
Indirect Costs	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Safety
Direct Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Site Constraints

Direct Cost	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Customer Service
Direct Cost	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Safety
Site Constraints	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Customer Service
Site Constraints	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Safety
Customer Service	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Safety

Level 2

Work Windows:

Resource Constraints	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Marine and Wildlife Constraints
Marine and Wildlife Constraints	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Calendar or Utility or RxR or Navigational Constraints
Resource Constraints	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Calendar or Utility or RxR or Navigational Constraints

Indirect Costs:

Loss of Revenue to Local Business	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Impact to Neighborhood Livability during Construction
Loss of Revenue to Local Business	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs of Users Delay
Loss of Revenue to Local Business	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs of Truckers Delay
Impact to Neighborhood Livability during Construction	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs of Users Delay
Impact to Neighborhood Livability during Construction	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs of Truckers Delay
Costs of Users Delay	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs of Truckers Delay

Safety:

Safety Costs to Traveling Public	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Safety Costs to Construction Workers

Direct Cost:

MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Toll Revenue
MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Right of Way Costs

MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs to Construct Detour Bridge
MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Design/ project Development Costs
MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs Associated with Essential Services
MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Construction Costs
MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Agency Construction Management Costs
MOT Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Maintenance and Preservations Costs
Toll Revenue	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Right of Way Costs
Toll Revenue	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs to Construct Detour Bridge
Toll Revenue	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Design/ project Development Costs
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Toll Revenue	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Construction Costs

Toll Revenue	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Agency Construction Management Costs
Toll Revenue	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Maintenance and Preservations Costs
Right of Way Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs to Construct Detour Bridge
Right of Way Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Design/ project Development Costs
Right of Way Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs Associated with Essential Services
Right of Way Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Construction Costs
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Costs to Construct Detour Bridge	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Design/project Development Costs
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Design / project Development Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Costs Associated with Essential Services
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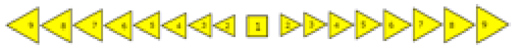
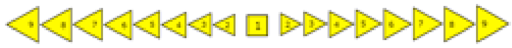
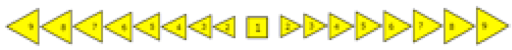
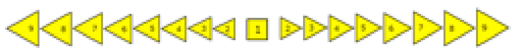
Design / project Development Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Agency Construction Management Costs
Design / project Development Costs	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Maintenance and Preservations Costs
Costs Associated with Essential Services	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Construction Costs
Costs Associated with Essential Services	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Agency Construction Management Costs
Costs Associated with Essential Services	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Maintenance and Preservations Costs

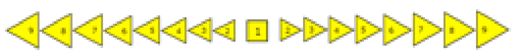
Construction Costs		Agency Construction Management Costs
Construction Costs		Maintenance and Preservations Costs
Agency Construction Management Costs		Maintenance and Preservations Costs

Site Constraints:

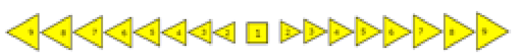
Horizontal/Vertical Obstructions		Span Design

Level 3

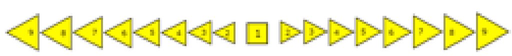
Calendar or Utility or RxR or Navigational Constraints:

ABC		Conventional

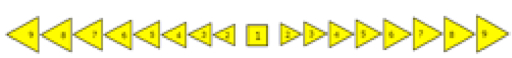
Marine and Wildlife Constraints:

ABC		Conventional

Resource Constraints:

ABC		Conventional

Safety Costs to Traveling Public:

ABC		Conventional

Safety Costs to Construction Workers:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Loss of Revenue to Local Business:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Impact to Neighborhood Livability during Construction:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Costs of Users Delay:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Costs of Truckers Delay:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Horizontal/Vertical Obstructions:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Span Design:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

MOT Costs:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Toll Revenue:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Right of Way Costs:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Costs to Construct Detour Bridge:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Design/ project Development Costs:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Costs Associated with Essential Services:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Construction Costs:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Agency Construction Management Costs:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional

Maintenance and Preservations Costs:

ABC 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Conventional