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ANALYSIS OF UTILITY COORDINATION IMPACT ON PROJECTS DELIVERED USING ALTERNATIVE CONTRACTING METHODS

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Abstract: Third party issues are known to create both cost and schedule risk on urban transportation projects where public rights of way are shared by utilities and other stakeholders. The potential negative impact of those risks on project performance increases as public agencies attempt to accelerate delivery schedules using alternative contracting methods (ACM) like Design-build (DB), Construction Management/General Contractor (CMGC), and Alternative Technical Concepts (ATC). This paper reports the result of a survey of 30 US state departments of transportation aimed at benchmarking the state-of-the-practice of utility coordination on ACM projects, and a content analysis of 77 ACM project solicitation documents worth more than $17 billion from 27 states. The paper uses Importance Index Theory to objectively determine the relationship between utility coordination tasks and their effectiveness in the previously mentioned ACMs. It finds that there is a strong relationship between specific utility coordination tasks and specific ACMs. The paper's contribution is twofold. First, an objective ranking of ACM project utility coordination tasks is determined that can be used as a checklist for planning the utility coordination aspects of ACM projects, and secondly, recommendations for selecting the appropriate ACM based on specific project utility requirements are proposed.

1 Background

Alternative contracting methods (ACM), such as Design-build (DB), Construction Management/General Contractor (CMGC), and Alternative Technical Concepts (ATC) have been proven to accelerate the construction, reconstruction, and rehabilitation of aging, structurally deficient infrastructure because they entail early contractor involvement during the procurement process (Gransberg 2013), and in some cases, ACMs also allow construction to begin before the design is fully completed (FHWA 2006). ACMs also allow the public agency to shift some of the responsibility for completing the subsurface investigations necessary to support the design after the award of the DB or CMGC contract. This creates a different risk profile than that of a traditional design-bid-build (DBB) project. A Strategic Highway Research Program 2 (SHRP2) R01 project brief succinctly describes the issue as follows:

> *"Current technologies and tools can only find 80–90% of existing utilities. Finding the other 10–20% and successfully managing utility conflicts require new tools. When a highway construction project is surprised by a utility, the results can include redesign costs, delay costs, change orders, claims, and damages." (SHRP2 2012).*

The impact of unforeseen utility conflicts is further exacerbated when the construction is being accelerated to meet an aggressive scheduled completion date. In these cases, the use of ACMs permit the DOT to get the contractor personally involved in locating, cataloging, and coordinating utilities found within the project limits during the design phase. For example, the California DOT (Caltrans) chose CMGC to deliver the Fresno 99 project so that the agency could award an early construction package for the CMGC contractor to dig test holes (a practice commonly called “pot holing”) and physically locate the utilities during early design. This permitted the Caltrans design team to literally design around the existing utilities with a much higher level of confidence and minimized the risk of utility conflicts during construction in this urban project site (Caltrans 2014). It also transfers the responsibility for utility coordination from the agency to the contractor, reducing the potential for differing site condition claims after construction commences.

1.1 Differing Site Conditions

The major contractual risk involving utility systems is the accurate characterization of existing subsurface conditions (Hatem 2011). In DBB projects, the owner must include all known existing utilities on the project plans, and it must also indicate those requiring relocation, replacement, demolition, or abandonment. If the actual conditions materially differ from those shown in the construction documents, then the project’s scope of work has changed and the contractor is due additional compensation. Federal Highway Administration (FHWA) mandates the use of a Differing Site Conditions (DSC) clause for DBB projects on federal aid highway projects, unless the use of such a clause is contrary to state law (23 CFR 635.109). The typical DSC clause provides broad relief to a contractor for physical conditions that materially differ from what is anticipated by the contract. FHWA does not, however, have the same mandate for DB projects. Instead, FHWA encourages state DOTs to use these clauses when appropriate for the risk and responsibilities that are shared with the design-builder. On DBB projects, the DSC risk is almost always the responsibility of the owner (Tufenkjian 2007). While this is largely due to the presence of a DSC clause, it is also caused by the fact that prevailing case law and sound contract management principles require the owner to disclose to bidders virtually all subsurface information in its possession.

On ACM projects, the DSC risk is less clear (Clark and Borst 2002). DB contracts are often awarded before a full subsurface site investigation is made by either the owner or the design-builder (Smith 2001). This leads to a question of how to identify an appropriate baseline for the DSC clause (if one is included in the contract) (Hatem 2011). There is also a policy question for the agency as to how much information it should furnish about the subsurface site conditions (Blanchard 2007; Dwyre et al. 2010). The more information that is provided, the more likely it is that the design-builder can submit a competitive price since the design-builder will be able to reduce the contingencies contained in the price proposal (Christiansen and Meeker 2002). However, because the DB delivery process has proven to be an effective means of compressing project delivery periods to their shortest states (FHWA 2006), there is frequently an incentive for the agency to start the procurement process before a thorough site investigation and analysis have been performed (Higbee 2004; Kim et al. 2009). In all, potential risks are created for both parties on a DB project that are not present in a DBB delivery process (WSDOT 2004).

On the other hand, CMGC is a two-part contract where the contractor is first awarded a preconstruction services contract to provide input and assistance during the design process and once a price for the final project is established, the second contract to commence and complete the construction is awarded. This ACM permits the agency to literally use the CMGC contractor during the preconstruction phase to coordinate the identification and location of utilities impacted by the construction before the design is complete (Scheepbouwer and Humphries 2011). Transit Cooperative Research Program Project G-08: *Alternative Project Delivery for Transit Projects* (Touran et al. 2009) found that rail transit agencies preferred the use of CMGC for projects in urban areas, and one of the best practices documented in the G-08 report was assigning the CMGC contractor the responsibility for coordinating all the utility work during preconstruction. That research also found that transit agencies using DB-Finance-Operate-Maintain (also called a public-private partnership or P3 project) delivery assigned the utility coordination, permitting, and DSC risk to the design-builder, and the approach was very successful in expediting the site investigations and permitting process on those jobs (Touran et al. 2009).

1.2 Alternative Contracting Methods

The following is a list of the definitions used for each project delivery method covered in the research. To further clarify, a description of the entity that is the "prime contractor" in each ACM is included.

- DBB: The traditional project delivery method that uses a low bid award mechanism. The prime contractor is the entity that performs the construction work under contract to the agency.
- CMGC: A two stage delivery method where a construction contractor is retained during design under a preconstruction services contract to perform specific tasks such as cost estimates, schedules, constructability reviews, etc. At some point a price for the construction is negotiated and the second stage, construction, commences. The prime contractor is entity that performs the preconstruction services contract and once design is complete and a price is agreed, the entity that performs the construction work. Commonly called the "CMGC", "CM-at-Risk", or the "CMGC contractor."
- DB: A method where the agency awards a contract for both design and construction. The prime contractor entity that performs the design and construction work under a DB contract to the agency. Commonly called the "design-builder."
- ATC: ATCs are not a project delivery method, but rather an optional feature that can be applied to all four of the above project delivery methods. An ATC is proposed during procurement and constitutes a change to the project's scope of work by a competing bidder. While ATCs are normally expected to consist of changes to the project's design, they can also be changes to the contract's terms and conditions.

2 Research Problem Statement

The term "utility coordination risk" evokes different meanings to different stakeholders in the transportation engineering and construction industry. Many approaches to managing this issue have been tried and many have failed (Loulakis et al. 2015). A common unsuccessful method is to insert a clause in the invitation to bidders to the effect that each contractor must thoroughly familiarize itself with the conditions at the project site and bid the work accordingly. This contractual approach is usually ineffective in protecting the owner from compensating the contractor when it unexpectedly hits a previously unknown utility line. On one hand, the US court system generally ascribes superior knowledge of site conditions to the owner and rarely permits the transfer of risk if it requires extraordinary abilities to have foreseen the differing site condition (Loulakis et al. 2015). On the other, ACM project delivery involves early contractor involvement in the design process, creating an opportunity to negotiate the allocation of utility coordination risk between the parties to the contract (West et al. 2012). As a result, the issue becomes one of which party can best management the utility coordination risk rather than the classic dispute over whether or not an unforeseen utility conflict constitutes a DSC. Developing guidance for the equitable distribution of utility coordination risk in ACM projects is the motivation for this research as well as its primary objective. The study seeks to identify and evaluate opportunities that measurably reduce the levels of utility coordination uncertainty for both the owner and the competing industry partners where possible before project advertisement and award, as well as equitably distributing the remaining risk between the parties during contract execution.

3 Research Methodology

The results reported in this paper come from three independent lines of information: a comprehensive literature review, a survey of DOTs, and a content analysis of ACM solicitation documents. The literature provided a benchmark of the current state-of-the-practice. The literature review's results were utilized in the development of a web-based survey questionnaire founded on Oppenheim's (1992) questionnaire design principles. The questionnaire sought to identify DOT utility coordination procedures to delivering ACM projects ACMs. The survey had three sections with the first section containing respondent demographic information and ACM experience. The second section focused on agency ACM procurement policies and procedures. The last section collected ACM project utility coordination information.

The survey targeted state DOTs and the sample consisted of DOT employees involved in the utility coordination process. The initial survey was sent to the members of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Right of Way, Utilities, and Outdoor Advertising Control. The respondent population includes a total of 29 state DOTs and the District of Columbia with a final response rate of 58%.

A content analysis of the utility coordination requirements contained in ACM solicitation documents was performed. A total of 73 requests for qualifications (RFQ) and/or requests for proposals (RFP) for CMGC and DB projects worth a total of $15.2 billion in 27 different states were collected for the content analysis. The documents were analyzed using Neuendorf's (2002) content analysis protocol. The protocol starts with the creation of a set of information categories. The words that appear in solicitation document are then recorded in the various categories with the frequency of a each word's appearance being used to infer the content of the document (Weber 1985). The procedure yields "valid inferences from a message, written or visual, using a set of procedures" (Neuendorf 2002).

4 Research Results and Analysis

The ACM research literature (Alleman et al. 2017; Scheepbouwer and Humphries 2011) led the researchers to infer that state DOTs can be divided into two categories:

- Agencies with a mature ACM program.
- Agencies with developing ACM programs.

The survey responses indicated that those DOTs whose ACM program is not yet mature treat utility coordination on an ACM project in the same fashion as they would on a traditional DBB project. In DBB, the project development process is linear with its various components taking place in a relatively sequential manner (Tran et al. 2016). Utility coordination issues are often lumped into those activities that deal with right of way (ROW) acquisition requirements (AASHTO 2004). Often these efforts are delayed until a final project footprint is determined, reducing the potential for designing the project in a manner that minimizes utility coordination issues. This in turn reduces the project delivery team's ability to address the issues in a manner that does not involve relocating those utilities in conflict with the project design. In the words of one researcher: "Historically, the most convenient strategy for the transportation designer was to ignore the utilities during design and make them relocate if they end up conflicting with the highway construction footprint" (Anspach 2010). Lastly, DBB does not provide an opportunity for early contractor involvement which has been clearly demonstrated by past research to enhance the project's overall constructability (Alleman et al. 2017; Gransberg 2013; Scheepbouwer and Humphries 2011).

4.1 ACM Utility Strategies

The primary data of interest was the level of ACM experience inherent to the sample population of 30 DOTs. Once that was determined, it permitted the research team to ascribe more credence to ACM utility coordination procedures used by agencies with mature ACM programs than those used by DOTs with developing ACM programs. Past research found statistically significant differences for DOTs that have institutionalized their ACM business and contracting practices and DOTs that are experimenting with pilot ACM projects (Gransberg and Loulakis 2011; West et al. 2012; Alleman et al. 2017). NCHRP Synthesis 429: *Geotechnical Information Practices in Design-Build Projects* (2011) used 5 completed DB projects as the break point between what it termed "experienced and inexperienced" DOTs and found that the perceived impact of subsurface risk changed significantly once an agency had gained experience with multiple projects. The survey instrument for the synthesis included underground utility risks in addition to geotechnical risks. The study's primary conclusion was as follows:

> *"DOTs with DB experience evaluate the risk and impact of unforeseen geotechnical conditions before selecting DB project delivery and the emphasis on formal risk analysis differentiates the DOTs with multi-project DB experience and those new to the delivery method*." (Gransberg and Loulakis 2011).

Hence, this paper's utility experience survey analysis used the same breakpoint between mature and developing DOT ACM programs. Because DB is the ACM with which the US highway sector has the greatest experience having been in use for nearly 30 years and that CMGC and ATC projects are newcomers only achieving national recognition with the FHWA EDC program in 2010, the decision was made to use DB project experience as the discriminator of ACM maturity. This is consistent with the literature that reports on the occurrence of a "paradigm change" (FHWA 2006) or "procurement culture shift" (Koch et al. 2010) when a public agency implements and institutionalizes DB project delivery. In a nutshell, the decision to use a best value procurement process rather than a low bid process is the catalyst that causes the overall change to public procurement culture rather than the use of a specific ACM (Tran et al. 2016).

Table 1 summarizes the ACM experience of the 30 sample population agencies with each of the studied ACMs. One can see that the greatest amount of ACM experience is found in DB projects with 27 of 30 DOTs having completed at least one DB project. The use of ATCs is less and CMGC is essentially in the pilot stage for all but a few DOTs.

Table 1: Survey respondents' ACM experience

Number of Projects	DB	CMGC	ATCs
Never = 0	3	17	11
1 - 2 projects	6	7	8
3 - 5 projects	3	3	3
6 - 10 projects	2	0	2
>10 projects	16	3	6
Mature DOTs > 6 DB Projects	18	3	8
% Mature DOTs using each ACM	60%	10%	27%

The DOTs' preferred utility strategies were the second item of interest. SHRP2 Report S2-R15B-RW-1 (Quiroga et al 2009) provided a list of possible strategies for addressing utility conflicts, and the respondents were asked to indicate the frequency with which each SHRP2 strategy was applied on ACM projects of all types. Table 2 illustrates the output from that analysis.

Table 2: DOT ACM Utility Strategy Preferences

DOT Type	Frequency of occurrence	Protect in place	Aban-don in place	Relocate before construction	Relocate during construction	Accept an exception to policy	Change project geometry
Mature	Rarely	0%	17%	6%	0%	56%	33%
	Some	61%	50%	22%	39%	44%	67%
	Frequently	39%	33%	72%	61%	0%	0%
	Some + Frequently	100%	83%	94%	100%	44%	67%
Develop-ing	Rarely	0%	8%	0%	0%	75%	42%
	Some	75%	67%	25%	50%	25%	58%
	Frequently	25%	25%	75%	50%	0%	0%
	Some + Frequently	100%	92%	100%	100%	25%	58%

Comparing the two types of DOTs in Table 2, one can conclude the following with respect to the utility strategies implemented by the two types of DOTs:

- Mature DOTs are more likely to protect the utility in place
- Developing DOTs are more likely to abandon utilities in place.
- There is no difference in regards to when utilities requiring relocation are relocated.

- Mature DOT's are more likely to consider both exceptions to policy and design changes to address utility conflicts in ACM projects.

The overarching inference that can be made from the Table 2 conclusions is that implementing ACMs appears to promote the implementation of a strategy of utility relocation avoidance where practical. This culture shift in utility coordination approach is facilitated by the early contractor design involvement available through ACMs that is absent in traditional low bid DBB project delivery.

4.2 ACM Impact on Utility Coordination Performance

Research has shown that risk is largely a function of perception in spite of engineers' best effort to quantify it (Roberds et al. 2015). A developing DOT will typically perceive the risks inherent with ACMs as much higher than mature DOTs due to their lack of familiarity and preconceived conclusions based on anecdotal data (Gransberg and Loulakis 2011). As a result the survey asked respondents to assess the perceived effect of implementing ACMs on the utility coordination and utility conflict resolution aspects of ACM projects as compared to DBB projects. The questionnaire was divided into two sections. The first involved general perceptions of the change in the project utility risk profile when it was delivered using ACMs and secondly, respondents were asked to provide an assessment of the magnitude and frequency of those utility risks.

A Likert scale was used to measure the perceptions and each project factor was assessed on both how frequently the issue occurred in a typical project and when it occurred, how much impact it had on project outcomes. A rigorous objective methodology based on utility theory was used to rank the importance of each factor. The rubric is termed the "Importance Index" (I) (Assaf and Al-Hejji, 2006). In essence, the importance index is a combination of the frequency at which a specific factor was observed in the survey responses and its ultimate impact on project utility outcomes as measured by a function of the Likert index. As such, the importance index holds that factors that occur frequently and have a high impact are more important that low frequency, impact practices. This permits an objective ranking of ACM project utility factors, which can then be used to infer the relative importance of designating a specific ACM utility practice as effective and worthy of inclusion in the guidelines. The value of the process is that provides a level of objectivity that reduces potential bias by the analyst. It is also important to note that the process is neither considered absolute nor completely authoritative. Index number theory merely seeks to assist the analyst in becoming more fluent with the various interdependencies within and between the variables, not act as a proxy decision tool (Assaf and Al-Hejji, 2006).

The importance index is derived by first computing a frequency index (f) and an impact index (i) based on Equations 1 and 2 to furnish input in the calculation of I as shown in Equation 3:

[1] Frequency Index (f) (%) $= \sum(n/ N) * 100/T_n$

Where: n = Number of observations of a practice in a specific category

N = Total observations of all practices in a specific category

T_n = Total observations of all practices in all categories

[2] Impact Index (i) (%) $= \sum(d/ D) * 100/T_d$

Where: d = Number of DOTs using a practice in a specific category

D = Total DOTs using all practices in a specific category

T_d = Total DOTs using all practices in all categories

[3] Importance Index (I) (%) = (f * i)

Table 3 contains a list of ten utility-related issues that were found in the literature (Quiroga, et al. 2014). The survey respondents were asked to rate the frequency and impact of each issue in the ACM context using the Likert scale described above. An importance index was calculated for both mature and developing DOTs. The full suite of indices for only the mature DOTs is displayed in the table to enhance the clarity of presentation. Both sets of indices were then ranked and the difference in the two populations is compared in the "∆ Rank" column. The fact that the difference in the two populations' importance ranking is more than four ranks validates the underlying assumption used throughout this report that organizational ACM maturity is an important discriminator and that more credence should be ascribed to the output coming from the more experienced DOTs with regard to what will eventually classified as effective ACM utility coordination practice and published in the guidelines during the Phase II research.

Table 3: Utility-related issues on ACM projects.

Utility- Related Issue	Mature DOTs			Rank		Δ Rank
	Impact Index	Frequency Index	Importance Index	Mature	Devel-oping	
Increased Utility Design Cost	66.25	81.25	53.83	1	5	4
Delayed Utility Design Process	58.46	90	52.62	2	7	5
Delayed Utility Design Schedule	62.50	80	50.00	3	6	3
Unsatisfactory Communication between DOT and Utility	62.50	80	50.00	4	9	5
Unsatisfactory Communication between Constructor and Utility	66.25	75	49.69	5	3	2
Increased Utility Design changes due to approved ATCs	65.00	76.25	49.56	6	1	5
Reduced Utility Design Quality	51.25	88.75	45.48	7	10	3
Unsatisfactory Overall Relationship between Constructor and Utility	58.75	73.75	43.33	8	2	6
Unsatisfactory Relationship between DOT, Utility and Contractor	56.25	76.25	42.89	9	4	5
Delayed Utility Construction	50.00	81.25	40.63	10	8	2

Table 3 shows that the top three issues are all related to cost and schedule certainty in the front end of the project delivery process. The fact that “Delayed Utility Protection/ Relocation/Installation Construction” is rank last by mature DOTs is pragmatically explained as merely the result of imperfect information in the early stages and demonstrates that even the most well-planned and designed projects will still suffer unforeseen events during construction that are utility-related.

4.3 ACM Effectiveness in Addressing Utility Issues

Table 4 reveals the responses when mature DOTs were asked to identify those ACMs they would believe to be effective given a list of common utility issues drawn from the literature. To furnish a method to differentiate between various utility issues, the median of the sum of responses for all the utility issues in each ACM is calculated and will be used the objective metric to differentiate those utility issues that the mature DOT respondents felt to be effectively addressed using ACMs. The median was selected over the mean because it is not impacted by outliers, which is also consistent with past ACM research (FHWA 2006; Love et al. 2011). The table demonstrates the value of ACM experience in that more mature DOTs reported that ACMs were effective approaches to deal with typical utility issues than developing DOTs. One can infer from this trend that the mature DOTs have found ways to surmount the barriers to project delivery inherent to low bid DBB by leveraging early contractor involvement in the utility coordination process. Across the board, the mature respondents perceptions were roughly equal for all three ACMs. The one exception is the last row of the table. Apparently DB is not an effective delivery method is the owner wants to transfer the utility coordination risk to the contractor. However, 3 out of 3 of the DOTs that were classified as having mature CMGC programs indicated that it was effective in achieving that purpose. The same was true for ATCs.

A last portion of the survey asked the respondents to rate ACM project performance against DBB performance on utility coordination issues above. ACMs were rated more successful than DBB in the following areas of project performance:

1. Utility conflict mitigation or elimination
2. Efficiency of overall project design process
3. Mitigate overall project cost overruns
4. Utility protection measures usage
5. Mitigate overall project schedule delays
6. Improve efficiency of overall construction process.

Table 4: Mature DOT evaluation of ACMs' effectiveness in addressing project utility issues.

Utility Issues	DB		CMGC		ATC	
	Mature	Develop	Mature	Develop	Mature	Developing
Complexity of utility relocations	16	3	3	10	10	2
Aggressive project delivery schedule	16	6	3	8	10	4
Scale of projected utility relocations	15	3	3	9	10	2
Local permit processing time	15	6	3	6	7	1
Time available to coordinate utility work	10	4	3	8	10	3
Complexity of projected utility protection measures	9	4	3	9	10	1
Availability of agency utility coordination staff	9	4	3	5	9	4
Need to minimize number of relocations	7	4	3	9	9	1
Ability to pay for utility work by ACM contractor	7	3	3	8	9	3
Number of different utility companies involved	6	3	3	10	10	2
Desire to assign utility coordination responsibility to the ACM contractor	1	2	3	8	10	3

4.4 Mapping the Survey to the Content Analysis

The page limitations for the paper make impossible to furnish details of the content analysis. Therefore, only those findings that intersected with survey findings are reported. Nearly a third of DB documents contained no utility information; whereas, 80% of CMGC documents included specific utility information. Utility factors were found more frequently and more heavily weighted in CMGC pre-award evaluation plans than in DB RFP evaluation plans. Additionally, asking the competing contractors to disclose the details of their utility coordination approach via an evaluated utility narrative and quantify its cost via inclusion as a line item in the proposal was also found to occur more often in CMGC. This lends credence to the notion that agencies often turn to CMGC project delivery to those projects with thorny utility issues. Given that a third of the DB solicitations had no utility data and two-thirds assign no weight to utilities in the evaluation plan may be a continuation of the traditional approach descried by Anspach (2010) where utility issues are not addressed until a project's final footprint is established. Utility-specific ATCs were invited in 95% of the DB RFPs versus 8% for CMGC. The disparity is explained by the fact that CMGC selection plans do not involve a design component. The DB result leads to a conclusion that asking for utility-related ATCs is perceived as adding value to the procurement process.

The other key outcome of the content analysis regarded the roles assigned to ACM contractors after award. To summarize, the solicitation documents indicated a major shift of utility coordination responsibilities from the owner with the most frequently transferred responsibilities being Identifying utility conflicts, developing the utility schedule of work, conducting design phase utility coordination meetings and working directly with impacted utility companies to resolve utility issues.

5 Conclusions

The analysis of the survey output with respect to the effectiveness of ACMs to adequately address common utility coordination issues resulted in three conclusions:

- ACMs are effective tools for projects requiring complex utility strategies to be executed according to an aggressive schedule, as well as a potential utility coordination risk mitigation measure.
- DOTs should consider delivering projects with above normal utility coordination issues using ACMs. As previously discussed, ACMs provide a spectrum of early contractor involvement.

Therefore, the inference extends to differentiating between ACMs and selecting the one that provides the greatest potential on a project-specific basis.
- ACMs appear to promote the implementation of a strategy of *utility relocation avoidance* where practical.

When the survey output is combined with the content analysis the following general conclusions are reached with respect to the three ACMs.
- ATCs: Requesting utility related ATCs permits the DOT to evaluate specific utility strategies during procurement, which provides an opportunity for innovation and results in the alternatives being competitively priced.
- CMGC: This ACM allows the DOT to assign the CMGC contractor responsibility for the utility coordination effort in its preconstruction services contract during the design phase to include the excavation of test holes to physically locate them and support the SUE survey, if applicable.
- DB: Using DB project delivery creates an opportunity for the DOT to assess multiple solutions to the same utility-related design problem. When the DOT includes evaluation criteria on competing proposals' ability to optimize the utility strategy with the proposed design, the DOT is able to compare various approaches for satisfying the utility coordination performance criterion.

The above analysis resulted in the following list of recommendations to improve the utility coordination process for ACM projects:
- Include necessary utility data in ACM solicitation documents to sensitize the competitors to the potential impact of utility coordination requirement to project success.
- Include utility considerations in ACM evaluation plans and assign appropriate weight to them.
- Encourage utility-related information interaction during procurement process via ATCs.
- Encourage utility-related ATCs during the procurement process.
- Consider those aspects of the utility coordination process that might be better handled by the design-builder than the preliminary engineering consultant and include them in DB solicitation documents as appropriate.
- Leverage the DB team's control over design process to reduce utility relocations

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