GEORGIA DOT RESEARCH PROJECT 21-06

Final Report

EFFECTIVE MANAGEMENT AND EMERGING BEST PRACTICES OF GEOTECHNICAL AND UTILITIES RISKS IN ALTERNATE DELIVERY

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16. Abstract
In recent decades, state transportation authorities (STAs) such as the Georgia Department of Transportation (GDOT) have increasingly relied upon alternative contracting methods (ACMs) to deliver complex surface transportation infrastructure projects. ACM delivery allocates greater levels of responsibility to the private sector for the completion of engineering design, and by extension, greater levels of risk. This study examines two categories of risk agreed by public and private industry to be of significant import: geotechnical risks and utilities risks. The study utilizes a mixed-methods approach featuring (1) content analysis of contractual and programmatic STA documentation and (2) semi-structured interviews with subject matter experts across a broad cross section of the national project delivery network. Synthesizing these results, the study presents commonly identified challenges related to the identification, allocation, mitigation and management of utilities and geotechnical risks in ACM contexts. It furthermore identifies the best practices and strategies utilized across STAs and ACM project networks to address those challenges. The study thereby contributes a highly contextualized integration of contractual analysis supplemented with practitioner perspective. The results offer guidance to GDOT as it seeks to effectively manage utilities and geotechnical risks while fostering a competitive procurement environment.

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Final Report

EFFECTIVE MANAGEMENT AND EMERGING BEST PRACTICES OF GEOTECHNICAL AND UTILITIES RISKS IN ALTERNATE DELIVERY

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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EXECUTIVE SUMMARY

Recent expansions to transportation infrastructure construction activity, particularly as a result of high-profile legislation like the Investing in Infrastructure and Jobs Act of 2021 (IIJA), have coincided with increases in the usage of alternative contracting methods (ACMs) such as design–build (DB) and public–private partnership (P3). ACM project delivery transfers responsibility for project design and other major components to a private design–build team (DBT). While such arrangements enable expedited delivery, they also confer significant risks, including those related to geotechnical and utility elements. A holistic investigation is required to assess the wide range of strategies developed by state transportation authorities (STAs) to address geotechnical and utility risks in ACM settings and to share them equitably and efficiently with industry partners. The overarching goal of this research is to synthesize those common challenges and strategies to provide guidance to STAs for effective risk management. Researchers approached this task utilizing a two-pronged approach of archival content analysis of STA documentation supplemented with subject matter expert (SME) interviews.

The research initiative began with a comprehensive review of the academic and professional literatures addressing the subjects of geotechnical and utilities risks. This effort integrated scholarship from such sources as the Transportation Research Board (TRB), the National Cooperative Highway Research Program (NCHRP), the National Transportation Library's (NTL) Repository and Open Science Portal (ROSA P), and the American Society of Civil Engineers (ASCE) library. Professional associations, including the Design-Build Institute of America (DBIA) and the American Road and Transportation Builders Association (ARTBA), were also consulted for relevant reports and presentations. The themes and particulars of risk management that emerged from this literature review (e.g., the contextual requirements and limitations governing change order requests) informed the focus of the subsequent content analysis.

The archival content analysis examined relevant documentation from STAs and other governmental authorities to assess the diversity of approaches from state to state and project to project. The documentation included project-specific content, such as requests for qualifications (RFQs), requests for proposals (RFPs), design–build agreements (DBAs) and other contractual forms, plus technical addenda and provisions. It furthermore included programmatic documents like manuals, guidelines, whitepapers, and policy statements related to ACM delivery and utilities and geotechnical risks. Altogether, researchers examined documents from 54 individual projects across 12 states, plus 25 programmatic documents across 14 states. The population of examined STAs was aligned with those states demonstrating large and active ACM portfolios. Significant variation in the treatment of utilities and geotechnical risks was observed during archival analysis; the major themes are captured below:

- Scope, quality, and typology of utilities and geotechnical investigations
- Contractual availability and reliability of utilities and geotechnical data
- Differing site conditions (DSC) clause boundaries and implementation
- Deductibles and other contractual risk-sharing mechanisms
- Third-party communication and coordination

This analysis made clear several areas of alignment and divergence for the management of both risks. For example, while many STAs engaged in similar activities to locate utility conflicts through a process known as subsurface utility engineering (SUE) investigation, the quality level of investigations pursued and the subsequent spatial reliance provided to DBTs displayed considerable variance. Similarly, DSC clauses providing relief or compensation to DBT upon encountering unexpected geotechnical elements were present in 10 out of the 12 examined states, but demonstrated variation in the exact subsurface conditions covered. The implementation of this strategic diversity became the focus of subsequent SME interview analysis.

Researchers utilized a snowball sampling approach to engage with 64 SMEs in semi-structured interviews about geotechnical and utilities issues. SMEs commanded extensive public and private expertise in at least 17 states and territories, with only 4 having worked fewer than 15 years in the field. Interview subjects were asked to reflect on their experiences managing geotechnical and utilities risks and to provide context to the policies and procedures identified during content analysis. For example, utilities experts and project managers were asked to weigh the relative advantages and disadvantages of strategies, such as providing spatial tolerances for STA-provided utility information. Geotechnical experts were asked to assess the appropriate content (e.g., borehole and geophysical data) and contractual vehicle (e.g., geotechnical baseline report) for investigative data provided to DBTs during procurement phases. The broad background of SME expertise enabled a comparison of perspectives from around the project delivery network, and the mixed methods approach facilitated a holistic evaluation of STA practice with site-level contextualization; SMEs differentiated which project factors might incline an STA to pursue an advance relocation of a utility facility, for example.

Altogether, SMEs emphasized the importance of the level of contractual reliability affixed to STA documentation provided during project procurement phases. Perhaps unsurprisingly, private-sector SMEs demonstrated broad agreement that STAs should "stand behind their data" to guarantee the accuracy of geotechnical and utilities information, including omissions of unexpected utility facilities and differing site conditions. Public-sector SMEs acknowledged the difficulty of risks facing private partners, but varied in their specific prescriptions for a balanced risk allocation. In general, increases to the scope and quality of geotechnical and utilities investigations may afford STAs the confidence to affix the resulting data with higher levels of informational guarantee. More frequent STA execution of advance utility relocations can serve to right-size the "economy of risk" of a project by removing a complex scope with extended lead times. In concert with risk-sharing contractual mechanisms like deductibles and scope validation periods, these approaches may serve to contain excessive contingencies during proposal while mitigating and managing unexpected complications in post-award phases. This research contributes by providing a synthesis of best practices for the identification, allocation, mitigation, and management of geotechnical and utilities risks.

CHAPTER 1. INTRODUCTION

BACKGROUND

Alternative contracting methods (ACMs) combine multiple phases of infrastructure projects into a single contract. In this arrangement, a state transportation authority (STA) develops a preliminary project design and solicits bid submissions from private partners for the opportunity to complete design, construction, and occasionally other financing, operations, and maintenance activities. The added flexibility of an ACM is supposed to offer a means for the private sector to introduce greater innovation and more effective practices for managing known risk factors.

A large and growing portion of transportation infrastructure activity utilizes ACM, with the Design-Build Institute of America (DBIA) projecting national public expenditure on such projects to increase from $53 billion to $81 billion from 2021 to 2025 (FMI and DBIA, 2021). Existing trends toward ACM usage have been accelerated in wake of landmark expansions to sector spending, such as the United States' $863 billion Investing in Infrastructure and Jobs Act of 2021 (IIJA). Although vesting a single private entity with the responsibilities for both design and construction creates opportunity for efficiency gains relative to traditional project delivery systems, it also introduces significant risks to successful on-time and on-budget delivery. Two of the largest such factors are geotechnical risks and utilities risks.

Geotechnical risks commonly materialize through the discovery of unexpected or "differing" subsurface conditions. Utilities risks commonly materialize through the discovery of unexpected or undocumented facilities as well as third-party coordination challenges between STAs, design–build teams (DBTs), and utility owners. Even slight adjustments to a project's scope of work can generate a ripple effect of delays and consequential damages as a result of the highly expedited post-award schedule environment. Unanticipated changes to geotechnical or utilities conditions may precipitate changes to DBT construction means and methods, and potentially require the acquisition of specialized equipment with long lead times. This can further trigger the modification of permit requirements by coordinating state and federal agencies, adding significant risk to the project duration. Altogether, these developments can significantly affect a project's critical path and engender conflict between a project's public and private partners.

Therefore, ACM project performance depends on the successful identification, allocation, mitigation, and management of utilities and geotechnical risk factors. A variety of contractual and programmatic strategies have been developed for this purpose by STAs and ACM project delivery networks across the country. These strategies reflect the learned experience of industry, in addition to evolving norms of the appropriate mechanisms of risk transfer and allocation between public and private partners. This is captured by the New York State DOT *Design-Build Manual* (NYSDOT 2011), which states that "[a] risk sharing approach is a compromise between warranting all site conditions as with design–bid–build and the other extreme of holding the Design–Builder responsible for all site conditions. The latter results in uncertainty, price contingency in the Proposal price and time after award to conduct investigations." Given the critical nature of geotechnical and utility risks, the demonstrated diversity of strategic managerial approaches emerges as a topic worthy of investigation.

OBJECTIVES

As part of its mission, the Georgia Department of Transportation (GDOT) administers a large and growing portfolio of alternative delivery construction contracts to ensure a safe, efficient, and reliable transportation network for its citizens. In particular, the advent of comprehensive initiatives like the Major Mobility and Investment Project (MMIP) will leverage billions of dollars to re-engineer and expand network capacity for the future. This task, from planning to execution, requires the orchestration of a vast public and private network of practitioners in a high-risk, high-dollar setting. The effective stewardship of public funding in service of these aims will require thoughtful and strategic action to identify best practices for ACM delivery.

To this end, this study explores both historical precedent and current practitioner perceptions regarding the challenges and best practices for utility and geotechnical risk identification, allocation, mitigation, and management. The researchers achieve this through extensive archival analysis of contractual documentation from 12 STAs with active ACM portfolios, in addition to semi-structured interviews with 64 public- and private-sector subject matter experts (SMEs) with extensive experience across a broad cross section of the project delivery network. Supplementing the ACM documentary record with contextualized practitioner perspective provides comparative analysis to identify where public- and private-sector managers agree and disagree regarding the nature and level of risk that their respective organizations should absorb under ACM projects. We also catalog the range of risk mitigation practices that have emerged from 20+ years of experience managing ACM contracts. In identifying common challenges and synthesizing best practices, we aim to provide GDOT with comprehensive guidance as it seeks to engage private industry in productive partnership.

LITERATURE

Utility Risk Management

Previous studies have identified utilities as one of the most significant sources of risk related to ACMs (Shabana and Gad 2023, Omer et al. 2022). With long, uninterrupted spans connecting and transecting major population centers, interstate highway corridors make for convenient byways to align utility facilities of all types. The modern highway system features a high density of such facilities, and the utilities typically lease the requisite right-of-way from the governmental body that owns the corridor (GDOT 2016). As expansions, modifications, and repairs to the surface infrastructure network proceed, therefore, the need for utility accommodation and relocation rises. Both physical construction and stakeholder coordination activities require significant resources and pose high levels of schedule and cost risk to project performance (National Cooperative Highway Research Program [NCHRP] Report #939; Molenaar et al. 2020). Incompleteness to both project design and investigative scope at the time of procurement increases the potential for utility conflicts to emerge in later phases (NCHRP 20-07 Task 373; Gransberg et al. 2017). The discovery of previously unidentified subsurface utility facilities can severely delay and complicate construction, as occurred, for example, in high-profile failed projects like the I-405 Sepulveda Improvement Project in Los Angeles (Nelson 2016).

Utility information for construction projects is commonly collected through a systematic approach known as subsurface utility engineering (SUE). Standards of SUE practice are formalized through the American Society of Civil Engineers (ASCE) publication *Standard Guideline for Investigating and Documenting Existing Utilities*, most recently updated in 2022 (ASCE 38-22; ASCE 2022a). This guideline delineates four "quality levels" of SUE investigations, from the lowest (QL-D) through the highest (QL-A). The collected information for each utility includes but is not limited to its type (i.e., water, gas, electric, etc.), size (i.e., diameter, carrying capacity), ownership, and position (i.e., horizontal and vertical). A QL-A investigation, known as utility “locating,” consists of a test hole excavation to expose the utility facility and document its precise location and characteristics. A QL-B investigation, known as utility “designating,” consists of explorations using geophysical tools (e.g., ground penetrating radar) to ascertain the approximate location of a facility. STAs commonly perform or procure QL-B investigations because the approach achieves informational sufficiency at a lower cost relative to QL-A data (Victorio et al. 2023).

With this said, a recent NCHRP report (20-07 Task 407; Taylor and Omer 2021) documented high degrees of variance within STA administrative approaches to utility risk management for ACM projects and found that 50 percent of surveyed STA administrators reported decreased efficiency in utility coordination in design–build (DB) versus design–bid–build (DBB) projects. The incompleteness of design for ACM projects may impede the pursuit of a comprehensive pre-award SUE investigation. Compared with STAs, DB firms may have less established relationships with utility owners, and without intervention they may struggle to manage the multitude of third-party coordination activities required from design completion through to substantial completion. Particularly as utility risks are transferred from public to private sectors in ACM projects, utility-related change orders, relief, and compensation events can threaten the successfulness of public–private cooperation.

Geotechnical Risk Management

Geotechnical engineering presents a highly technical and risk-laden scope of work required for the completion of transportation construction projects. The critical incidence and magnitude of geotechnical risks are well-documented, and they result from a variety of factors, including poor geotechnical investigative programs; poor contractual risk management; and poor judgment in the assessment of geotechnical engineering properties, models, design, and data (*Analysis of Change Orders in Geotechnical Engineering Work at INDOT*; Mohan et al. 2011). These risks present significant threats to successful project delivery on multiple fronts; Gransberg et al. (2018) assert, "Geotechnical risk occupies a unique position in the project risk register because of its early occurrence and deserves to be treated with the necessary respect and attention because of its potential impact on project cost and schedule performance."

Problems of geotechnical risk identification, mitigation, allocation, and management are exacerbated in ACM settings, and particularly in lump-sum ACM settings wherein a private partner is required to make critical design and bidding decisions typically in absence of comprehensive geotechnical data. The selection of project engineering and constructability components depends upon a holistic assessment of subsurface geotechnical conditions. Absent this, design–builders may encounter a variety of problems, including an excess of differing site conditions (DSC) that render pre-award engineering calculations inappropriate or unusable. An array of geotechnical risk items with heightened exposure in ACM contexts has been documented in the professional literature, including NCHRP Report 884, which noted:

> "The major factors for which a risk mitigation strategy is needed to resolve common geotechnical issues present in most DB projects are as follows:
>
> - Delays due to untimely actions by third party stakeholders.
> - Inefficiencies in the project delivery process due to failure to include salient geotechnical risk issues in the procurement process.
> - Lost opportunities to avoid difficult geotechnical conditions.

- Claims due to DSC.
- Delays due to utility coordination, existence, and location failures.
- Poor quality post-award geotechnical investigations."

Legally, DSC refer to subsurface conditions which: (1) differ significantly from those indicated on project documentation during procurement and/or (2) those "of an unusual nature, differing materially from those ordinarily encountered," which would not have been anticipated by a reasonable and experienced practitioner, given site characterization and history. Either of these two conditions may trigger contractor relief through eligibility of so-called "DSC Clauses," the standardized process for which is provided under 23 CFR 635.109 (a-1-ii),[1] which states:

> "Upon receipt [of notification of having encountered differing site conditions], the engineer will evaluate the contractor's request. If the engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly."

While contractual inclusion of the federal DSC clause (or state-level analog) is typically required for any project receiving federal aid funding, this is not true of ACM projects. Paragraph (c) of the CFR definition holds that STAs "may consider" the use of DSC clauses for DB projects, but ultimately provide STAs discretion over the boundaries and mechanisms of geotechnical relief. As DSC clauses are considered foundational for geotechnical risk

[1] Title 23 Code of Federal Regulations (23 CFR) §635.109. Retrieved from https://www.ecfr.gov/current/title-23/part-635/section-635.109.

management in traditional delivery settings, there exists the potential for substantial variation between and within STA ACM projects with respect to the comprehensiveness of DSC and other risk-sharing mechanisms in practice. Due to the contours and allocation of geotechnical risk exposures across ACM projects, in addition to the perceptions and responses of industry partners to those dynamics, this topic emerges as one meriting extensive investigation.

Indeed, the presence of such significant risks catalyzes a need for risk mitigation strategies, and a diverse set of strategies has been developed and implemented on ACM projects across the United States and internationally. These strategies may be broadly organized into two categories—investigational and contractual—each tailored to target the nature of different risk exposure items. For example, modifications to geotechnical investigative strategies may address risks resulting from the informational deficiencies already alluded to, while contractual risk-sharing strategies (including, but not limited to DSC clause variations) may serve to allocate and manage the remaining risks between public and private partners.

There is a natural synergy between these approaches demonstrated in the literature and in the implementation of ACM projects. The extent of risk transfer from public to private partner is mediated through contractual and other measures, while the magnitude of risk is contained through owner-led site investigation and characterization in pre-award phases. According to Federal Highway Administration (FHWA) guidance (*Geotechnical Site Characterization Geotechnical Engineering Circular No. 5*; Loehr et al. 2016),

> "For design–build projects, the project owner should generally provide site characterization information that is sufficient to allow prospective bidders to confidently develop designs and estimate costs during the bid period, and to reduce risks for changed site condition claims after contract award. The site

characterization data furnished by the owner should be sufficient to generally characterize stratigraphy, soil and rock properties, and groundwater conditions."

Therefore, while it is understood that pre-award investigations may fall short of 100 percent completeness and may be followed by a supplementary investigative plan by the DBT in post-award phases, STAs are nevertheless expected to furnish sufficient geotechnical information to facilitate confident DBT bid submission.

Despite this, the simple fact remains that bidding based on incomplete data significantly heightens the risk of post-award scope issues and changes to construction means and methodology. According to McLain et al., "awarding design–build (DB) contracts before a complete subsurface investigation is completed makes mitigating the risk of differing site conditions difficult, if not impossible" (*Managing Geotechnical Risk on US Design–Build Transport Projects*; McLain et al. 2014). Indeed, it has been established that no matter the extent of the geotechnical investigations in the pre-bidding phase of the project, some probability of DSC will remain. Gransberg et al. (2018) found that "risk is a function of perception, and both owners and their industry partners agree that geotechnical risk is perceived to be high as well. Without a differing site conditions clause that allocates this risk, the study found that members of the design–build industry perceive that the risk is much higher than does the department of transportation's geotechnical staffs." These concerns are especially heightened in light of industry tensions regarding the "contractual reliability" of STA-furnished data, and by extension, the applicability of DSC and other risk-sharing mechanisms. Variation in the STA implementation of such practices holds the potential to significantly impact project outcomes, as well as perceptions about ACM viability in the industry at large.

As the construction industry dramatically accelerates the adoption of ACM practices and principles in the coming decade (FMI and DBIA 2021), the handling of geotechnical risks emerges as an essential area of examination. Utilizing a mixed-method exploration of ACM project documentary analysis and extensive SME interviews, this research endeavors to achieve two primary objectives, namely: (1) to identify and analyze the most prevalent and challenging issues associated with geotechnical risks in ACM projects and (2) to explore and analyze those best practices for the identification, mitigation, allocation, and management of these geotechnical risks. A critical analysis of STAs' stated policies and procedures, supplemented with the on-the-ground perspective of practitioners in those states, enables a more holistic analysis that accounts for areas of agreement and disagreement between industry sectors. In exploring these key dimensions, this study offers valuable insights for the effective management of geotechnical risks and the realization of successful infrastructure projects.

CHAPTER 2. RESEARCH METHODOLOGY

ROADMAP

As STAs increasingly adopt ACM strategies for their largest and most complex projects, variance in the incidence and character of utility and geotechnical risk-management approaches emerges as a critical subject of inquiry. The research utilized a two-phased research methodology of (1) archival content analysis and (2) semi-structured interviews. Particularly in the absence of widely available performance data related to ACM projects, these methods enable a holistic investigation of stated STA practices supplemented with the experiences of the personnel responsible for their implementation. Prior research examining questions of risk and performance in ACM settings has utilized similar mixed methodologies to overcome the shortcomings of each approach in isolation (Mostaan and Ashuri 2017). The development and logical flow of the research methodology is depicted in figure 1 and discussed in greater detail below.

Public Sector Content Analysis

To aggregate diverse perspectives and practices, researchers scraped STA websites for alternative delivery project documentation such as requests for qualifications (RFQs); requests for proposals (RFPs); and signed contracts, technical provisions, and reference information documents (RIDs). These documents, particularly the signed contracts, establish the foundational structure of a given alternative project. They formally specify the organizational and capacity requirements of the partnering entities, the standards of project design and performance to be met, and importantly, the boundaries and rules of engagement for conflict resolution. The contract allocates the responsibilities of each party during each phase of project delivery and specifies the cost and schedule mechanisms activated in the event of a conflict. Contractual documents were gathered for 54 alternative delivery projects spread across 12 states.

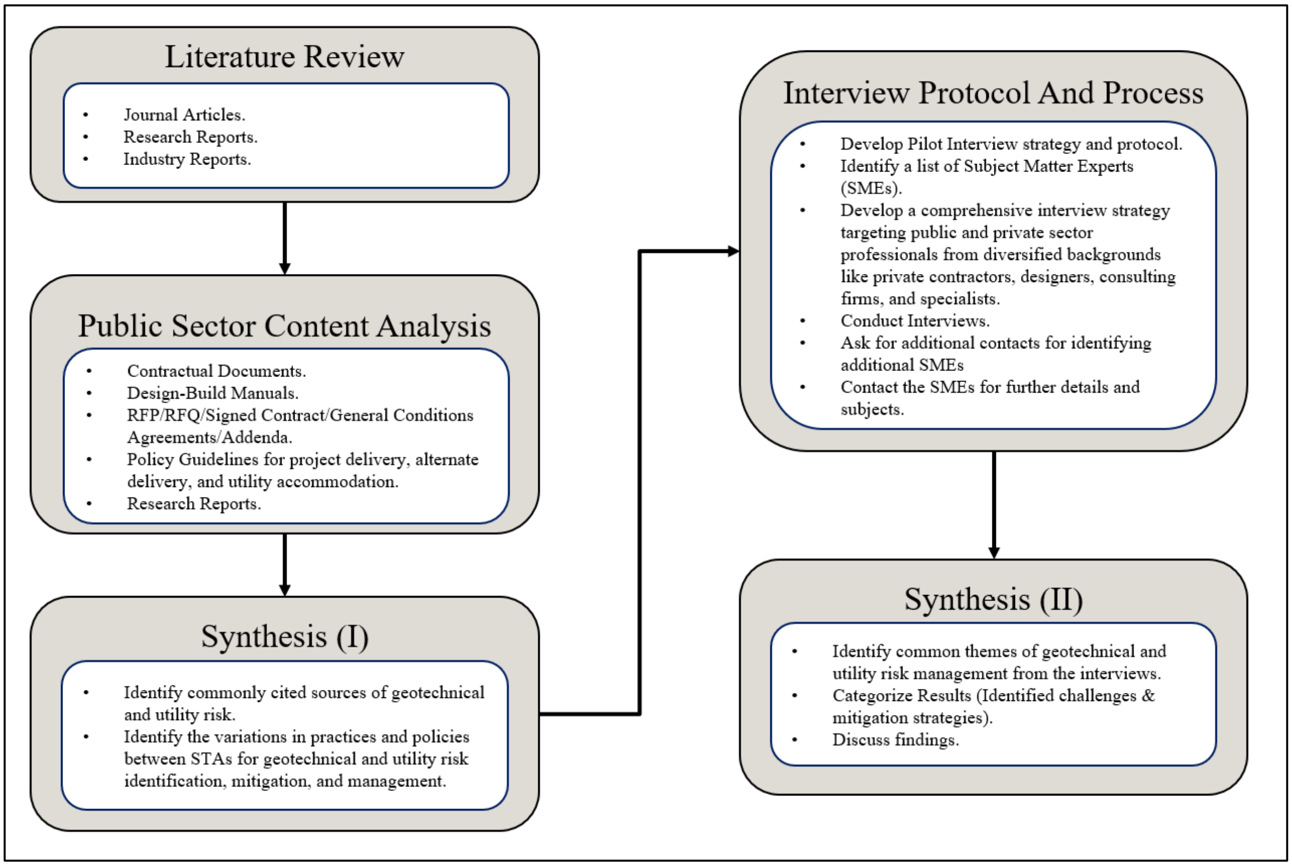

Figure 1. Flowchart. Research methodology.

The researchers further scraped STA websites for programmatic documents, including manuals, policies, and templates related to ACM portfolios and utility management and geotechnical investigation (table 1). In addition, 25 guidance documents and manuals related to alternative delivery and utilities management and geotechnical investigation management were aggregated from 14 STAs (table 2). ACM project contracts commonly require private contractors to abide by the standards, methods, and procedures outlined in these programmatic documents. Although typically these will be subordinated to project-specific requirements specified in a contract

, STA manuals nevertheless provide a foundation to understand typical practice in a state. Researchers targeted STAs known to have mature and active alternative delivery programs and spread across diverse state sizes and geomorphologies. Source information for each document is provided by corresponding number in the bibliography.

Table 1. Documents examined for content analysis.

Examined Documents			
Project Contractual Documents			
Project Name		**State**	**Year**
1	Loop 202 South Mountain Project	Arizona	2016
2	I-405 Sepulveda Pass Widening Project	California	2009
3	I-405 Caltrans	California	2009
4	1-15/I-215 Interchange – Devore Project	California	2012
5	Central I-70 Project	Colorado	2017
6	SR 66 from SR 35 (US 17) to Charlie Creek, Hardee County	Florida	2023
7	SR 70 from Lorraine Road to Bourneside Boulevard, Manatee County	Florida	2023
8	201215-3-52-01 I-4 at SR 557 Interchange	Florida	2020
9	I-75 (SR 93) at SR 951	Florida	2022
10	I-95 Express Lanes Project – Phase 3C	Florida	2017
11	I-16/I-95 Interchange Project	Georgia	2018
12	East Interchange Project	Georgia	2022
13	Savannah River Bridge Project	Georgia	2018
14	Eastside Bridge Replacement Project	Georgia	2021
15	SR 25 at Savannah & Middle River Bridges	Georgia	2021
16	SR 400 Phase 1 Design–Build Project	Georgia	2022
17	I-85 Widening, Phase 1	Georgia	2020
18	SR 135 at Altamaha River Bridge Replacement Project	Georgia	2019
19	MD 32 – Linden Church Road to I-70	Maryland	2018
20	Purple Line Project	Maryland	2016
21	IS 270 – Innovative Congestion Management Contract	Maryland	2016
22	US 219 from I-68 to Old Salisbury Road	Maryland	2017
23	US 113 (Phase 4) from North of MD 365 to North of Five Mile Branch Road Design–Build Worcester County	Maryland	2016
24	NM 31/NM 128 Design Build Project Management Engineering Service	New Mexico	2020
25	Tappan Zee Hudson River Crossing Project	New York	2012
26	Kosciuszko Bridge Project – Phase 1	New York	2013
27	I-81 Central Viaduct Project	New York	2022
28	Lower Westchester Bridge Bundle	New York	2019

Examined Documents			
Project Contractual Documents			
Project Name		**State**	**Year**
29	Kew Gardens Interchange	New York	2018
30	I-2513B & D	North Carolina	2023
31	R-5777C- US 70 from the Havelock Bypass to east of SR 1116 (Thurman Road)	North Carolina	2022
32	I-635 LBJ East Project	Texas	2018
33	Oak Hill Parkway Project	Texas	2019
34	SH 99 Grand Parkway Segments H, I-1, and I-2	Texas	2017
35	Southeast Connector Project	Texas	2022
36	I-35 NEX Central Project	Texas	2021
37	I-2/I-69C Interchange Project	Texas	2018
38	Hampton Roads Bridge Project	Virginia	2018
39	I-77 over Route 606 Bridge Replacement	Virginia	2022
40	I-81 (Mile Marker 48) Northbound Acceleration Lane Extension, Smyth County	Virginia	2021
41	US Route 15/29 Improvements at Vint Hill	Virginia	2019
42	SR 167/I-5 to SR 509 – New Expressway Project	Washington	2021
43	SR 509, 24th Avenue South to South 188th Street – New Expressway	Washington	2023
44	SR 520, I-5 to Montlake – I/C and Bridge Replacement	Washington	2022
45	I-405, SR 167 Interchange Direct Connector Project – A Design Build Project	Washington	2016
46	SR 99, Alaskan Way Viaduct – SR 99 Bored Tunnel Design–Build Project	Washington	2010
47	I-5, SR 16 Interchange – Construct HOV Connections – A Design Build Project	Washington	2016
48	SR 20, Olson Creek and Unnamed Tributary to Skagit River – Fish Passage	Washington	2022
49	I-405/Brickyard to SR 527 Improvement Project	Washington	2022
50	I-405 Renton to Bellevue Project	Washington	2019
51	I-5 Corridor Improvements Project	Washington	2017
52	US12 Nine Mile Hill to Frenchman	Washington	2019
53	I-405 Widening and Express Lanes	Washington	2011

Table 2. Documents examined for content analysis.

Examined Documents			
Manuals			
Document Name		**State**	**Year**
1	*Guideline for Accommodating Utilities on Highway Rights-of-Way*	Arizona	2015
2	*Geotechnical Investigations Manual*	California	2020
3	*Design–Build Manual*	Colorado	2017
4	*Design–Build Standard Specifications FY 23–24*	Florida	2023
5	*Soil and Foundations Handbook*	Florida	2022
6	*Design–Build Guidelines*	Georgia	2019
7	*Utility Accommodation Manual*	Georgia	2016
8	*Design–Build Manual*	Maryland	2013
9	*Standard Specifications for Subsurface Exploration*	Maryland	2019
10	*Design–Build Manual*	Minnesota	2017
11	*Design Build Manual*	New York	2011
12	*Geotechnical Guidelines for Design Build Projects*	North Carolina	2009
13	*Standard Specifications for Roads and Structures*	North Carolina	2023
14	*Innovative Delivery Toolkit*	Pennsylvania	2013
15	*General Design–Build Specifications*	Texas	2018
16	*Design Build Template*	Utah	2020
17	*UDOT Geotechnical Manual of Instruction*	Utah	2022
18	*Utility Coordination Manual of Instruction*	Utah	2017
19	*Partnering Field Guide*	Utah	2019
20	*Utility Manual of Instruction*	Virginia	2016
21	*Design Build Standard Template*	Virginia	2016
22	*Requirements for Advertising Design Build RFP*	Virginia	2023
23	*Utility Accommodation Policy*	Washington	2014
24	*Utilities Manual*	Washington	2019
25	*Geotechnical Project Development, Reports, and Support for Design–Build Projects*	Washington	2020

Researchers then parsed the aggregated documents for passages and policies relevant to utilities risk and geotechnical risk identification, allocation, mitigation, and management. These passages were synthesized for their areas of content similarity and difference. Researchers drew comparisons between projects from within the same state and from projects in different states, noting the evolution of contractual language and the relative emphasis on different components of utility and geotechnical risk management. As thematic elements of language and policy began to emerge between documents, the following issue topics were isolated for further exploration:

<u>Utilities</u>

- Scope and quality of owner-initiated utility investigations.
- Contractual reliability of owner-provided utility spatial information.
- Scope and boundaries of eligible change orders, relief events, and compensation events related to utilities relocation and accommodation.
- Contractual risk-sharing mechanisms like banded cost-sharing deductibles or scope validation periods.
- The practice of advance utility relocations.
- Personnel requirements and prescribed mechanisms of communication and coordination between owners, design–builders, and third-party utility entities.

<u>Geotechnical</u>

- Scope, typology, and quality of geotechnical investigation performed by STAs during pre-procurement project phases.
- Scope and mechanisms of geotechnical information-sharing implemented by STAs during procurement phases.
- Scope and mechanisms of contractual reliability applied to STA-supplied geotechnical information.
- Scope of private geotechnical investigations and characterizations permitted or obligated during procurement and post-procurement phases, respectively.
- Contractual, geotechnical risk-sharing mechanisms employed during post-procurement phases.

The encountered variance of contractual strategies between states and projects motivated and framed the subsequent exploration of utility and geotechnical risk through interviews with SMEs.

Subject Matter Expert Interviews

A semi-structured interview research methodology was employed to engage a diverse set of stakeholders. Altogether, researchers conducted 52 interviews with 64 SMEs related to utility risk allocation, geotechnical risk management, and alternate project delivery management. A snowball sampling methodology was employed to assemble a pool of SMEs with professional expertise spanning both public and private sectors and occupying a broad cross section of different project delivery roles (figure 2). Interviews began with SMEs based in Georgia and expanded to include professionals with project experience in more than 17 states and territories (figure 3). Interview participants commanded extensive professional experience with alternative project delivery, geotechnical, and utilities management, with only four having worked fewer than 15 years in the field (figure 4).

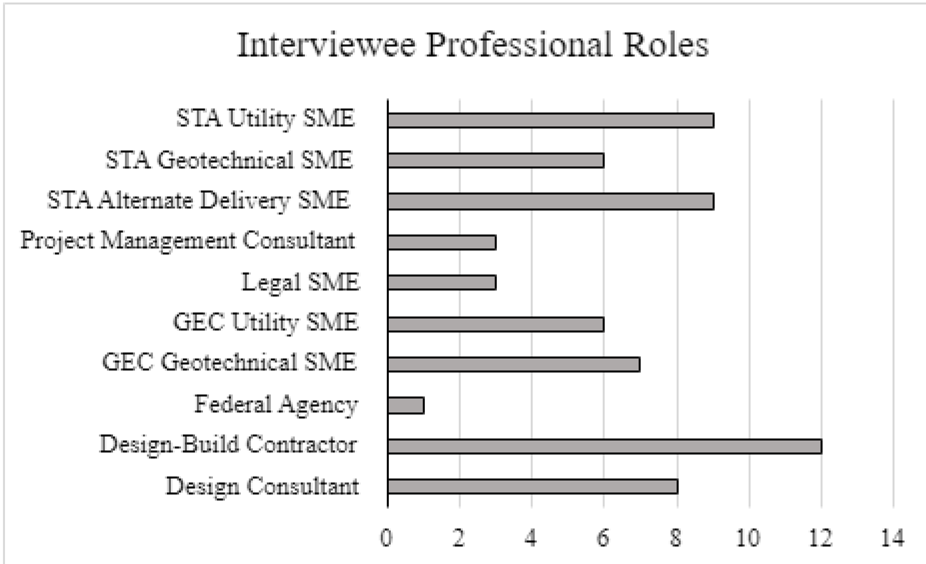

Figure 2. Chart. SME interviewee professional roles (n = 64).

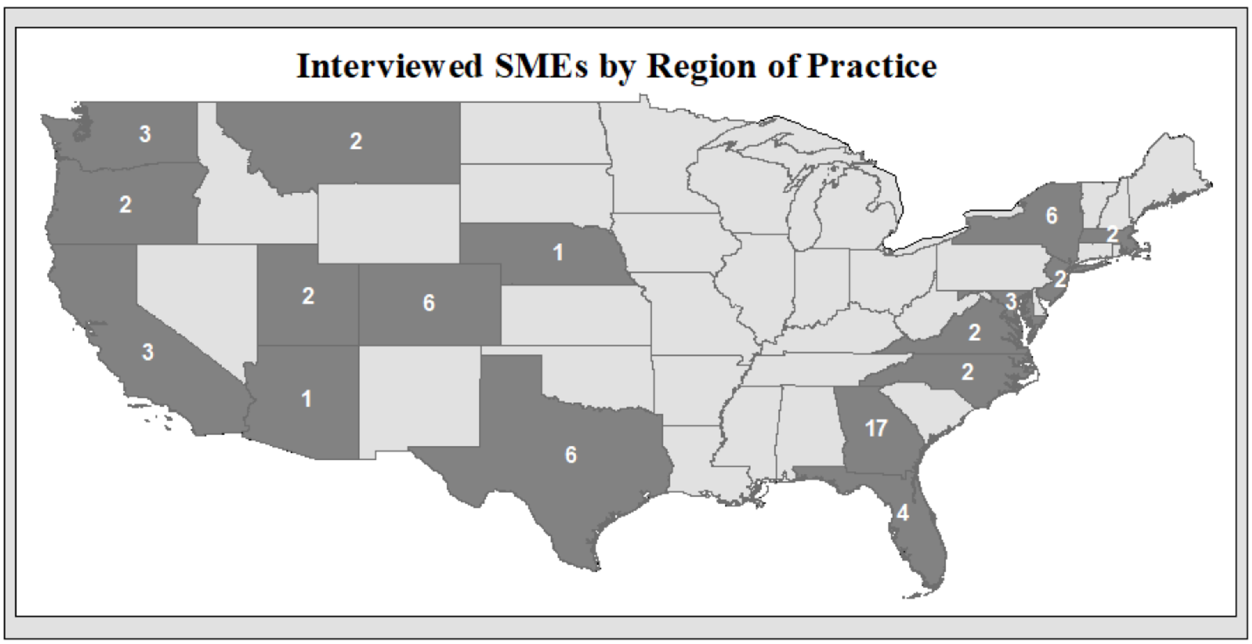

Figure 3. Map. Geographical and numerical distribution of interviewed SMEs. No SMEs from Hawaii or Alaska were interviewed. Several SMEs had project experience in more than one state or region; a primary state was selected for depiction for each SME.

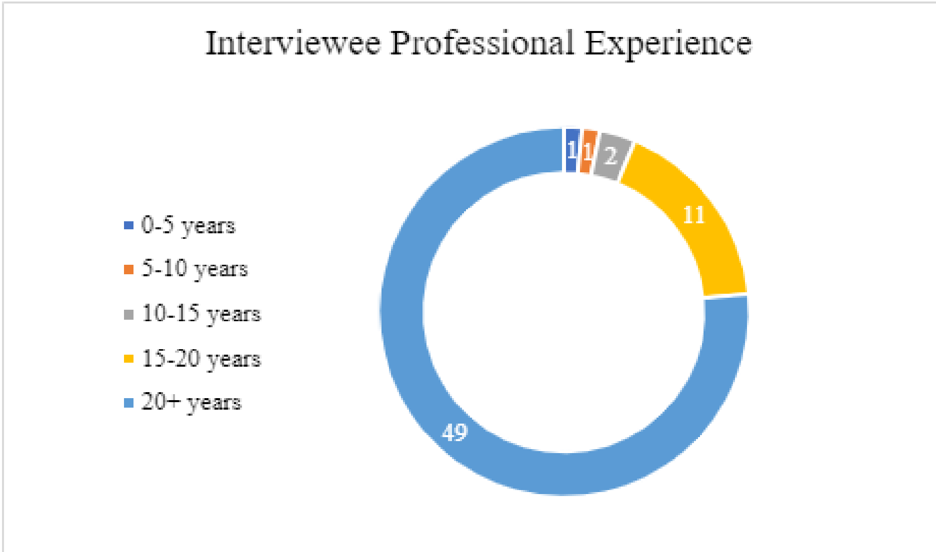

Figure 4. Chart. SME interviewee professional experience (n = 64).

Researchers first approached STA administrators and subject-specific SMEs to conduct exploratory interviews about utilities and geotechnical challenges in ACM settings. Participants were asked to clarify agency policies and implementation practices encountered in contractual and guidance documents and share their "on the ground" experience implementing those policies in ACM contexts. Private-sector practitioners (i.e., design consultants, engineering consultants, utility owners and subcontractors, financing developers, and legal experts) were asked to share their experiences interacting and responding to those public policies and practices. All participants were asked to contrast the utility and geotechnical risk profiles of traditional and alternative delivery projects; share their professional experiences and opinions related to the nature and source of risks; and offer strategies for effective and equitable utility and geotechnical risk allocation, mitigation, and management.

Researchers utilized a semi-structured interview format, asking participants a series of generalized, open-ended questions about utilities and geotechnical risks in ACM contexts, followed by clarifying questions depending on the participant's response and in keeping with a natural flow of conversation. When relevant, researchers asked prepared, personnel-specific questions related to policies and ACM projects of interest. As common themes began to materialize through multiple interviews, such as the importance of SUE investigations for utilities risk management and contractual reliability attached to pre-award documentation for geotechnical risk management, researchers incorporated associated questions into future interviews. An interview protocol template is presented in the appendix.

Interviews were conducted using Microsoft Teams video conferencing software. Each interview lasted approximately one hour. Following completion, interview notes were transcribed into NVivo software to facilitate the mapping, comparison, and analysis of participant responses. SME interviews provided clarification and contextualization to archival research results and enabled the distillation of both challenges and best practices for utility and geotechnical risk management in ACM contexts.

CHAPTER 3. IDENTIFIED CHALLENGES

The results of both archival and interview research consistently recognized utilities and geotechnical conditions as a major source of risk to the successful delivery of transportation projects, exacerbated for projects utilizing ACM versus traditional contracting methods. Leveraging insights from archival and interview analyses, this study presents a series of commonly identified challenges to successful project delivery, in addition to a series of best practices identified by practitioners for the effective identification, allocation, mitigation, and management of utilities and geotechnical risks.

UTILITIES RISKS

Interview participants often identified similar issue sets, but they varied in their perspective depending on the project delivery network position they occupied (e.g., public versus private, contractor versus subcontractor, etc.) In an email responding to follow-up interview questions, one senior vice president of a major design–build contracting firm neatly summarized the contours of utility risk concerns from the private sector:

> "Utility issues (e.g. location, relocation agreements, relocation timing and cost) are among the most problematic risks for DB contractors for horizontal surface transportation projects. DB agreements have evolved to shift most of the risk of utility identification, agreement negotiation, and relocation to the DB contractor with no reliance on owner provided preliminary utility information. When taken together with other onerous contract terms (e.g. schedule float treated as a shared resource), this has become an unmanageable risk for DB contractors."

Embedded in that statement are allusions to several commonly identified categorical risks, namely: (1) the scope, quality, and reliability of utility investigational information provided in the pre-award phase; (2) the distribution of utilities risks, especially as they govern conflicts that emerge in the construction phase; and (3) communication and coordination issues between STAs, DBTs, and third parties (e.g., utility owners). The following sections treat each category in turn, detailing the challenges posed to successful delivery with evidence from the diverse perspectives garnered through SME interviews.

1. Pre-Let Investigative Scope and Reliability

Researchers commonly encountered themes related to the quantity, quality, and contractual reliability of utilities information provided by the owner. By definition, ACMs feature an incomplete project design at the time of procurement. While this affords a private designer the flexibility to innovate efficient solutions to cost and schedule, it also precludes the owner from performing a complete investigation and delineation of utilities facilities. Lacking both a completed asset design and a completed utilities investigation, a completed register of conflicts cannot be identified. The incompleteness of the utilities investigation can prove especially problematic with respect to subsurface assets, which evade easy visualization and may have poorly maintained records. Utilities manager SMEs from multiple STAs noted how these challenges are exacerbated by the high complexity and compressed development timelines of ACM projects; while an ideal SUE program would follow a sequence of desk study (QL-D/C) investigations, followed by universal QL-B investigations and selective QL-A investigations, this level of comprehensiveness may not be achievable given constraints to schedule and budget.

As a result of incompleteness to project design and site investigation, some STA administrators expressed reticence to attach contractual reliability to utilities information by including such information as a contract document. STAs regularly elect to submit preliminary utilities information as an RID instead, waiving their organizational liability as to its accuracy and lowering their exposure to requests for relief and compensation or more costly legal arbitration. In the case of GDOT, for example, a typical contract specifies that so long as a utility is identified on the Department's preliminary investigations and its location is depicted with "reasonable accuracy," design–build teams are ineligible to recuperate unexpected costs associated with its relocation and accommodation. Because the contract fails to provide a legal standard for "reasonable accuracy," however, this language introduces ambiguity into the adjudication of later disputes. Although an STA may prefer to leave this accuracy standard open-ended, as a means of self-protection, this approach may result in undesirable outcomes. In the context of a costly change order, parties are unlikely to agree as to the reasonableness of provided utilities information; in the words of one design consultant SME, "'reasonable' leads you straight to the courtroom." Similar sentiments regarding conflict resulting downstream of incomplete and unreliable utilities information proved commonplace in private-sector SME interviews.

2. Risk Allocation and Conflict Resolution

Frustrations about utilities information reliability may be better understood when examined within the larger context of risk allocation between partners in large ACM projects. Private-sector SMEs commonly invoked sentiments of STAs having "shoved all the risk" resulting from utilities or geotechnical or other factors onto DBTs on projects since the 2010s. In recounting such trends, one frequently used metaphor conjured the image of a "pendulum of risk," swinging back and forth over time between public and private partners to shift the allocation of risk responsibilities across successive ACM projects. Where once the STAs shared risks on ACM projects, the sentiment goes, STAs have eliminated their exposure by “swinging the pendulum” to the DBT side. Respondents supported these claims by pointing to the ubiquity of “exculpatory language,” also called “weasel words,” embedded within contracts to disclaim STA responsibility for project site conditions. Such language is typically included in the opening contract sections, stating that submission of a proposal constitutes acknowledgement and acceptance of any site conditions and resulting complications. An excerpt from a recent contract from New York State DOT (NYSDOT) is representative of the larger dynamics encountered by the researchers (I-81 Central Viaduct Project, Phase 1 Contract 2; NYSDOT 2022):

> “…the Proposer agrees that it has examined the contract documents and the site of the Work and has fully informed itself from personal examination of the same regarding the quantities, character, location and other conditions affecting the Work to be performed including the existence of poles, wires, pipes, ducts, conduits, and other facilities and structures of municipal and other public service corporations on, over or under the site.
>
> The Proposer agrees that its proposed contract prices include all costs arising from existing conditions shown, or specified in the contract documents, and/or readily observable from a site inspection during the procurement period available under this contract, and/or generally recognized as inherent in the nature of the Work. The Proposer shall take no advantage of any apparent error or omission in the RFP documents…
>
> The locations of utilities or other underground man-made features were ascertained with reasonable care and recorded in good faith from various sources,

including the records of municipal and other public service corporations, and therefore the location of known utilities may only be approximate…"

Multiple interviewed legal expert SMEs called into question the legal enforceability of such clauses when viewed in coordination with other contractual measures, the particulars of a given project's context, and extensive court precedent state to state. Regardless, in addition to post-let complications, SME interview participants suggested the ineffectiveness of such a strategy to protect owner interests in so far as it discourages competitive procurement dynamics. Wary of their exposure to utility risks as a result of incomplete and nonguaranteed spatial information, design–build firms may elect not to participate in procurement. The remaining firms in competition, now relatively empowered, may elect to submit bid prices inflated with large contingency budgets for utilities risk mitigation.

Of course, utilities are not the only risk vector contributing to macro-level trends of decreased private interest in large ACM projects, and interviewed builder–contractor and design consultant SMEs demonstrated near unanimity in citing the lack of informational reliability and "inappropriate risk allocation from owners to design–builder" as significant impediments to participation in lump-sum alternative delivery procurement. Alternative delivery administrators from three STAs acknowledged these dynamics, noting trends toward fewer and more expensive bid submissions, with one stating that they sought to "strategically accept risks" back from DBTs to encourage full participation even while limiting agency exposure. Another STA administrator disputed the premise of a "pendulum swing" allocating inappropriate risk to DBTs, however, and instead pointed to insufficient "risk understanding" within private-sector conceptualizations of project responsibilities. Collectively, across public and private sectors and project delivery network positions, interviews reflected broad consensus as to the perception of contractual risk allocation being a point of friction impeding system-level transaction efficiency. Utilities represent one highly significant risk exposure folded into this larger context.

3. Inter-Party Communication and Coordination

SME interviews revealed broad agreement within the private DB sector regarding utility company interactions as a major vulnerability to ACM project success. The presence of utility facilities introduces not only physical engineering conflict to a project but also the potential for third-party relational conflict. Bottlenecks to third-party communication and coordination channels can pose significant threats to each phase of a project, from impeding the finalization of design to disrupting the planned sequence of construction activity.

Particularly in geographies unaccustomed to ACM construction, utility companies may lack the experience to understand its multiplicity of actors and areas of overlap in procurement, design, and preliminary construction timelines. Instead of interfacing solely and directly with an STA through the completion of engineering design, utilities must learn to navigate a disaggregated network of prospective bidders, each with individualized design approaches implicating different technical constraints and challenges. Multiple design and builder–contractor SMEs referenced an unwillingness on the part of utility companies to meet during the procurement period or respond to questions regarding preliminary design and utility-related Alternative Technical Concepts (ATCs). A senior STA administrator affirmed this perception, lamenting utility companies' reluctance to "play ball" with DBTs or STAs, and noted that STAs have "no hammer to make them move." This third-party reticence may be understandable from a transaction cost perspective, however; with knowledge that only one prospective bidder will be selected by the STA, a utility company with constraints to administrative capacity may not see the value in coordinating with multiple teams in pre-award phases. An SME from a major telecommunications company confirmed this dynamic and commented that the usefulness of pre-award coordination meetings is often diminished as a result of DBTs' unwillingness to "show their hand" on design specifics.

To the extent that DBTs must seek the consultation and approval of utility owners for their facility accommodation plans in post-award phases, the risk of unanticipated schedule delay may increase without active intervention and management of third-party relationships. Several design consultant SMEs noted the intensification of these coordination risks in urban settings featuring a high density of overlapping facilities belonging to independent utility companies. Depending on the utility-imposed constraints to the timing of facility shutoffs or the eligibility of "pre-approved" subcontractors to perform accommodation work for a specific utility company, delays to the relocation of one facility may compound and spread to other facilities in highly disruptive ways. Mitigating the potential for cascading utility transaction costs therefore requires the strategic, programmatic initiation and maintenance of third-party partnerships.

GEOTECHNICAL RISKS

1. Scope, Quality, and Typology of Geotechnical Investigations

While every STA is familiar with the procedures and timing of geotechnical investigation for traditional DBB delivery, the constraints imposed by ACM delivery can pose technical and logistical challenges to an STA's ability to perform a comprehensive site investigation program. Most importantly, by definition, ACM delivery entails the procurement of a private designer–builder before the project design is completed. This incompleteness of information with respect to project alignment, means, and methods introduces uncertainty to the scope and typology of geotechnical investigations that would be most prudent and efficacious. Knowledge of the final engineering design to foundations and retaining wall structures, for example, might implicate differing depths and methods of geotechnical exploration. One interviewed geotechnical expert noted this incongruence by referencing the FHWA's Circular No. 5, which outlines the standards for the evaluation of soil and rock properties. Whereas Circular No. 5 recommends that "conditions should be confirmed at each shaft location" of drilled shafts and deep foundation elements (Loehr et al. 2016), the SME reported that precise shaft locations are not finalized until design reaches 90 percent completion. ACM delivery therefore precludes this level of investigative comprehensiveness, and thus requires a modification of existing practice.

An analysis of STA programmatic manuals (e.g., design–build manuals, geotechnical manuals of construction) reflects this reality; in 8 out of 12 reviewed STAs, the programmatic manuals contained specific directives for geotechnical exploration in ACM contexts, though among these the level of detail in the discussion varied considerably. Generally speaking, the scope of preliminary investigation follows the recommendation of a geotechnical engineer associated with the project on the owner's side, either as an STA employee or subcontracted through a general engineering consultant (GEC). For example, the Utah DOT (UDOT) *Geotechnical Manual of Instruction* (UDOT 2022) indicates that a "geotechnical design representative" provides the requirements and elements to be provided in the RFPs. The recommendation of the engineer is based on the consideration of available historical data, the anticipated risks present in the project scope, and resource considerations such as cost and schedule, as agreed by the sponsor. Although the investigation will necessarily deviate from standardized manuals by accounting for such contextual factors, it will nevertheless address a common set of questions aimed at preparing both STA and prospective partners for the procurement process. The "Alternative Contracts and Consultant Oversight" section in Caltrans' *Geotechnical Investigations Manual* (Caltrans 2020) reflects these aims, stating, "The purpose of the pre-bid geotechnical investigation is to review archived information, and in some cases perform a limited site investigation (e.g., drilling, sampling, preparation of Boring Records and the Geotechnical Data Report) in support of the RFP."

Ultimately, geotechnical investigations represent investments to cost and schedule which STAs weigh against their likelihood of lowering the incidence and magnitude of geotechnical risks in post-let phases. While a comprehensive investigation might be preferable in a vacuum, on-the-ground constraints including costs, lack of right-of-way (ROW) access, and insufficient schedule may preclude its implementation. Schedule considerations can particularly impact the scope of investigations pursued; relative to traditional DBB projects, ACM projects may face additional pressure to "bring to procurement" as quickly as possible. SMEs from multiple STAs noted how the typically large footprint, complex design, and expedited project development phase of ACM projects can exacerbate the challenges to complete the geotechnical investigation. STA practices regarding the scope, quality, and typology of geotechnical investigation in ACM projects thus emerge as a critical point of inquiry for their impacts on perception and performance in the surface infrastructure construction industry.

2. Contractual Reliability

The mechanisms by which the above pre-award geotechnical investigations can significantly impact post-award outcomes are coordinated through the coordination measures, which affix responsibility for the accuracy of investigative data to particular project partners. Nearly every SME from every discipline and network position made reference to the contractual "reliability" of information provided with RFPs during procurement. The exactitudes of a contract's language mediate the transfer of geotechnical information from public to private partner, and with it the responsibility for disruptions and scope changes that might result in the event of its inaccuracy.

Because DBTs must furnish a bidding design document—and in most cases a lump sum price—from the combination of pre-award investigations and preliminary design provided by the STA, the specific language delineating responsibility for the accuracy of that investigation becomes paramount.

Geotechnical risk dynamics are better understood within the larger context of broad risk transfer from public to private partners in ACM arrangements. Private-sector SMEs routinely complained of STAs "shoving all the risk" onto DBTs by removing all of the contractual reliability attached to procurement information. Specifically, this is achieved by bundling information and investigation results (whether related to geotechnical conditions, utilities, etc.) not as a "contract document" (e.g., as an Appendix to the design–build agreement [DBA], or section within Contractual Technical Provisions), but rather as an RID presented "for informational purposes only." In conjunction with "exculpatory clauses" folded into the opening contract paragraphs, which broadly relieve STAs from anomalies that emerge within project site conditions, the packaging of site information within non-guaranteed RIDs may offer STAs considerable protection from geotechnical risk. While one geotechnical design subcontractor warned that STAs may have a "false sense of security hiding behind exculpatory clauses" that are "unenforceable" in court, the perception of undue risk transfer proved sufficiently problematic to receive widespread condemnation from private-sector interviewees. For their part, STA SMEs generally acknowledged private sector dissatisfaction while maintaining that the transfer of subsurface risk is a natural result of transferring design responsibility and is sufficiently handled through competitive procurement dynamics. Some STA interviewees indicated a desire to strategically accept risks back from the private sector through the use of targeted risk-sharing mechanisms, discussed further below.

To this end, SMEs consistently pointed to DSC dynamics as critical to discussions of risk mitigation and risk sharing between public and private partners. As discussed, 23 CFR 635.109 gives latitude to STAs to shape the inclusion, exclusion, and boundaries of any applicable DSC clauses in ACM settings. Out of a total 39 projects in 10 states evaluated during archival analysis, researchers found that DSC clauses offering risk protection for Design Build Teams were present in 32 projects and 8 states, with Georgia and North Carolina as the excepted states with no DSC inclusion. Despite this near universal alignment, further inspection reveals considerable variation in the contractual approaches to DSC formulation among projects within and between STAs. The specific contours of these DSC formulations, along with SME insights pertaining to their application, advantages, and disadvantages, are presented in the discussion of mitigative strategies in the next chapter.

CHAPTER 4. MITIGATIVE STRATEGIES

UTILITIES RISK MITIGATIVE STRATEGIES

1. Expansions to Utility Informational Scope

As discussed, contractual terms that limit the reliability of STA-provided utility information may discourage competitive bidding dynamics through the inclusion of high contingencies. One strategy to limit these negative outcomes, therefore, is an expansion of the scope and contractual reliability of utility information generated by the STA during project development and provided during procurement.

The most logical expansion to investigative scope would entail an increase to both the number and the quality level of SUE investigations pursued for a given project. Prior research has consistently reported positive returns on investment for SUE programs, with project data from Virginia DOT (VDOT), North Carolina DOT (NCDOT), Ohio DOT (ODOT), Texas DOT (TxDOT) and Pennsylvania DOT (PennDOT) analyzed to find ROIs spanning from $4.62 to $22.21 for every $1.00 spent on SUE investigations (Lew et al. 1997, Sinha et al. 2007, Jung 2012). SME interviews revealed broad consensus between STA project managers, STA utility administrators, design–build contractors and designers, and utility owners and contractors as to the efficacy of SUE and its potential for conflict avoidance. Despite this, multiple SMEs highlighted the insufficiency of utility investigations prepared for RFP documentation, suggesting this may be a result of the compressed timeline for ACM project development relative to traditional delivery. One utility contractor SME suggested tethering the completion of a QL-B program to the completion of a topographical survey at no later than 5–10 percent design completion. Interview subjects broadly supported measures to expand and improve SUE program implementation in the pre-let phase.

To this end, the Colorado state legislature passed into law Senate Bill 18-167 (Colorado General Assembly 2018), "concerning increased enforcement of requirements related to the location of underground facilities." The law established minimum SUE investigational requirements for certain public transportation infrastructure projects. This law formally tethers these requirements to the ASCE 38 standard, stating that investigations must "meet or exceed" ASCE 38, and "attempt to achieve ASCE 38 Quality Level B or its successor utility quality level on all utilities within the proposed excavation area unless a reasonable rationale by a licensed professional engineer is given for not doing so." It furthermore requires a QL-A investigation of "gravity-fed" systems like sewer and stormwater drainage facilities. Although prior to the law, official Colorado DOT (CDOT) policy had been to pursue utility designation on most facilities inside a project footprint, its passage raised the urgency of the practice and cemented the standards of execution; what was formerly a goal is now a requirement. During an informational interview, CDOT utility SMEs reported increased confidence in SUE data as a result of the law's implementation. Even absent the passage of analogous laws, other STAs may find improved outcomes in utility conflict prevention through the increase of SUE investigative scope and quality. For example, one STA utility SME highlighted the efficacy of identifying "hot spots" where utility conflict will be unavoidable in post-award phases, even after allowing for innovative ATCs and pursuing QL-A investigations for inclusion with RFP documents.

2. Expansions to Utility Informational Reliability

Programmatic improvements to investigative practice may foster confidence in STAs to strategically attribute greater levels of contractual reliability to utility data. STAs may limit their liability exposure by layering contractual language that specifies the boundaries of applicability for utility information reliability. The most common protective clauses encountered through content analysis were spatial "tolerances" providing discrete footprints within which the STA attests the utility is located (table 3). These may be directly tethered to the quality level of the SUE investigation achieved. For example, an administrator from Minnesota DOT (MNDOT) informed the researchers that the department issues a 2-ft horizontal and vertical tolerance for the locational accuracy of QL-A SUE data relative to the utility position encountered in the field, a 2-ft tolerance for horizontal accuracy only for QL-B and QL-C data, and no spatial tolerance for QL-D data. Some states that provided explicit tolerances to provided utility information restricted this usage to SUE QL-A.

Table 3. Spatial tolerances for utility informational accuracy within reviewed ACM project documents

				Spatial Tolerances for Utility Informational Accuracy			
Project Name	**Owner Agency**	**Contract Year**	**Contract Type**	**Relief for Unidentified Utilities**	**SUE QL-A Investigations**	**SUE QL-B Investigations**	**Diameteric Designation**
Purple Line Project	MDOT & MTA	2016	DBFOM	Yes	2 feet horizontal; 1 foot vertical	5 feet horizontal; No vertical	(+/-) graduated percentages
M-32 - Linden Church Rd to I-70	MDOT	2018	DB	Yes	"the Department will stand behind" its information	3 feet horizontal; No vertical	Reference only
Southeast Connector	TxDOT	2021	DB	Yes	"Materially different"	Reference only	Reference only
SR 167/I-5 to SR 509 – New Expressway Project	WsDOT	2021	DB	Yes	10 feet horizontal; No vertical		(+/-) graduated percentages
202 South Mountain Loop	ADOT	2016	DBM	Yes	No mention		No mention
I-16 & I-95 Interchange	GDOT	2018	DB	Yes	"Reasonably Accurate"		No mention
Central 70 Project	CDOT	2017	DBFOM	Yes	10 feet horizontal		(+/-)12 inches
I-95 Phase 3C	FDOT	2017	DB	No mention			
I-26 Widening	SC DOT	2018	DB	No mention			

MDOT = Maryland DOT, MTA = Maryland Transit Authority, TxDOT = Texas DOT, WsDOT = Washington State DOT, ADOT = Arizona DOT, FDOT = Florida DOT, SC DOT = South Carolina DOT. DBFOM = Design–build–finance–operate–maintain, DBM = Design–build–maintain.

The tolerances themselves displayed considerable variability in size, orientation, and type, both within and between agencies. For example, Maryland DOT (MDOT) on one project provided a 2-ft horizontal tolerance and a 1-ft vertical tolerance for the positioning of utilities in the field relative to SUE QL-A data, and a 5-ft horizontal tolerance for positions relative to SUE QL-B data (Purple Line Project; MDOT 2016). On a different project (M-32 – Linden Church Rd to I-70; MDOT 2018), MDOT granted a 3-ft horizontal tolerance for locations based on utility designation information (approximately SUE QL-B), but for locations based on test hole data at single point locations (e.g., SUE QL-A) it stated that "the Administration considers this information Engineering Data and will stand behind its accuracy at the locations that it is taken." While this narrower tolerance for QL-A data shifts the responsibility for inaccuracy onto MDOT, it also reflects a strategic willingness to do so that results from having executed a higher quality level SUE investigation. As one administrator at a different STA stated, "when the data is signed and sealed and my name is next to it, I have confidence in it."

Other STAs, like Washington State DOT (WsDOT), provide no vertical tolerance and a much wider horizontal tolerance of 10 ft. One STA administrator remarked that the selection of tolerance values will exert significant influence on the practical applicability of the mechanism for a design–build contractor in the field, with larger tolerance values allocating more risk to DBTs. For example, relative to its encountered position, the indicated position of a particular utility on SUE plans will be inaccurate by 10 ft with much lower frequency than by 2 ft. Depending on an STA's risk appetite, and the schedule availability to perform a high-quality SUE program during pre-let phases, an STA may tailor a set of tolerance values to promote aggressive bidding from the private sector while maintaining an acceptable level of risk exposure. WsDOT furthermore provides tolerances with respect to the indicated and encountered diameters of the utilities. Because the size, nature, and typology of a utility facility will have implications for the means and methods of its accommodation and relocation, even a correctly located facility can prove problematic if these characteristics are documented inaccurately.

Spatial tolerances for informational accuracy may be contractually limited to those locations wherein inaccuracies become material to project schedule and budget. If a SUE investigation appears inaccurate in the field, for example, the design–builder may not automatically claim damages. Due to subsurface anomalies, an encountered utility may be aligned inside of provided tolerances for one portion but outside of tolerances for another. The design–builder must therefore demonstrate both that a SUE inaccuracy exceeds any spatial tolerances, and that this occurs at a location that generates conflict. In this way, the STA is protected against arbitrary claims of damages for deviations from SUE plans that do not interfere with project processes. A typical CDOT contract captures this sentiment, stating that if a SUE investigation fails to meet the "reasonable accuracy" standard only for a portion of a given utility, then a change order "shall be allowed only… with respect to that portion of such Utility" (US 550/160 Connection, DB Contract Book 1, 6.2.1.5; CDOT 2019).

Indeed, many of the reviewed contracts differentiate "Identified" from "Unidentified" utilities, where, generally, the former appear on the utility information provided during procurement and the latter do not. For example, the General Conditions of recent TxDOT design–build contracts (Southeast Connector Project; TxDOT 2022) precisely define the means by which a utility facility qualifies as "Identified," including: depiction of position or typology on the TxDOT-prepared "Utility Strip Map"; presence of aboveground facilities, or appurtenances like manholes and pedestals, even if such appurtenances are not depicted on the map; or co-location of a utility within an Identified Utility trench or conduit. The General

Conditions further specify that “if a Utility falls within any of the categories listed above, then it is an Identified Utility regardless of any discrepancy between (i) the information provided on the Utility Strip Map, and (ii) the actual characteristics of that Utility with respect to its size, its horizontal or vertical location, its ownership, its type (e.g., gas, water, communication, electric), or any other characteristic.”

This delineation becomes critical insofar as the risks and materialized damages of utility conflicts may be mediated according to the categorization of a given utility along this identification divide. Extending the materiality requirement for inaccurate SUE information, if an unidentified utility does not conflict with project construction, then a design–builder will not be awarded relief or compensation. Unidentified and conflicting utilities may be accommodated using a variety of risk-sharing contractual mechanisms, as discussed below, but more generally become the fiscal responsibility of the owner-STA. By comparison, the STA is significantly more protected in the case of Identified Utilities, for which design–builders must meet additional conditions before relief and compensation are disbursed. The consistent execution of a thorough SUE program therefore emerges as a critical strategy to reduce STA exposure to utility risks.

3. Advance Relocation of Utilities

As explored, during the project development phase an STA will typically undertake a desk study to identify the utility facilities that intersect and conflict with the future footprint of the constructed project. This information, of varying quality, is submitted to DBTs to support their relocation and accommodation planning, design, and construction (switch phrases). Relocation of conflicting utilities is specified within the contractual scope of work.

One approach for strategic risk rebalancing would remove this scope of work and, instead, return the responsibility for relocation of certain utilities to the STA. These arrangements may be referred to as "advance relocations," wherein the STA personally performs or otherwise compels a utility relocation in advance of the procurement process. Certain identified utility facilities are thus accommodated to the new infrastructure alignment before it reaches final design and construction.

This practice carries the potential for significant efficiency gains. By performing an advance relocation, STAs may liberate the project critical path and expedite construction activity in post-procurement phases. The STA may contract with a specialized utility subcontractor or directly with the utility owner to execute the relocation process, taking advantage of these parties' greater familiarity with the asset relative to bidding design–build teams. Similarly, by engaging directly with utility owners it encounters in project after project, an STA can leverage long-standing relationships to reduce the communication and coordination bottlenecks encountered by design–build teams.

It may be argued that relocating a conflicting utility in this fashion would cut against a motivating principal of utilizing an ACM, namely, to facilitate the generation of creative design and engineering solutions through the private sector. If an STA relocates a utility before private developer teams may appraise the project, it forgoes the possibility of a novel approach that might avoid the conflict altogether, eliminating the need for relocation and reaping significant savings to schedule and budget. One STA administrator extended this perspective further, saying that advance relocations "stifle the design" approaches eligible to designers by "forcing our developer to design around where those relocations will be."

More commonly, however, interviewed SMEs expressed support for such a strategy, emphasizing that by relocating a utility in advance an STA may reduce project complexity, along with the risk of complication and delay. Especially for projects in urban built environments, filled with preexisting design constraints, an advance-relocation utility could present "just another prior" to be accommodated within the design envelope. Compared to the risk of utility-based delays threatening the project critical path, the risk of not capitalizing on a potential design innovation may prove more palatable.

Altogether, 17 of 25 questioned SMEs expressed full support for the practice of advance utility relocation, while the remaining 8 expressed conditional support depending on project contextual factors. Further specification of these results reveals overwhelming support within private sector respondents and conditional support in public sector. Indeed, while one former STA ACM administrator alluded to an "appetite" in the private sector for advance relocations, it was noted that this enthusiasm is to be expected at the prospect of removing a major source of project risk from the scope of design-build work. Conversely, some STA SMEs expressed hesitations about assuming this risk exposure, and considered utility relocation to be part and parcel of the contracting responsibilities the private sector has always assumed.

Advance relocation is not universally suitable; thus, calibrating the contextualized costs and benefits of relocation timing for each identified utility emerges as an important process during project development phases. Interviewed SMEs offered valuable perspective on the relevant considerations for this decision-making process, synthesized below into "Suitability Characteristics" and "Concerns."

Suitability Characteristics for Advance Relocation

Certainty of Conflict

The most important characteristic in selecting a utility for advance relocation is the certainty of its conflict with construction of the transportation asset. As discussed, STAs may elect to allocate to the DBTs the responsibility for relocating those utilities that might conceivably be avoided through design innovation. Depending on the horizontal and vertical clearance between assets, and the means and methods selected, different teams may reach different conclusions about whether, where, and how a utility might be relocated. In other instances, however, a utility's physical conflict (i.e., surface or subsurface intersection) or operational conflict with an infrastructure asset may be unambiguous and unavoidable. STAs should engage in a utility conflict mapping exercise as part of the project development process, documenting these spatial and operational conflicts in addition to the expected complexity and costs of performing the relocation. Depending on its personal capacity and risk preferences, in addition to those of the expected bidding teams, STAs may elect to relocate utilities that meet a given threshold of conflict certainty.

High-Risk Utility Typology

Multiple respondents indicated a preference to relocate in advance those utilities that pose higher levels of physical, personal risk to the construction workers performing the labor. Examples included high-voltage electricity transmission lines and oil pipelines. Compared to lower-risk utilities like fiber-optic cable, these utility typologies require higher levels of practitioner expertise to relocate safely and effectively, and respondents reported lower levels of comfort in personally directing such relocation efforts. Such utilities are well-suited for advance relocation agreements utilizing specialized utility subcontractors rather than standard DBTs and schedules.

Long Lead Times

Respondents in favor of advance relocation almost universally invoked concerns about long lead times with certain utility typologies. If significant potential for delays exists in the materials procurement or environmental permitting processes, for example, early initiation of these activities may avoid compounding delays and costs during the construction phase. This is particularly relevant for seasonally restricted utilities; due to demand constraints primarily resulting from heating, ventilation, and air conditioning (HVAC) usage, certain electric-transmission lines may be ineligible for relocation during winter and summer months. One respondent reflected on a project wherein a particular utility transmission line was only available for decommissioning and relocation in the month of October. In the event that delays resulted in missing this critical window, the project could have been delayed an entire year. The accommodation of such constraints requires meticulous planning and coordination well in advance of the relocation event, which may prove challenging on a condensed ACM schedule. By electing to expedite a utility relocation in advance of procurement, an STA may manufacture additional lead time within the schedule and reduce the risk of cascading delays.

Advance Relocation Concerns

Clearly Specified Schedule Terms

Interviewed SMEs emphasized the importance of clearly specifying the schedule requirements and expectations for the party responsible for the advance relocation. Expediting a utility relocation ahead of design–build procurement is of little benefit and, indeed, can introduce extra costs if delays drag the operation past expectations and into the design–build schedule. Every effort should be made to avoid such delays, with penalties and remedies clearly outlined in the event they do materialize. For example, a 2021 WsDOT design–build contract (SR-167/I-5 to SR 509; WsDOT 2021) states that "if the Utility Owner fails to complete a Prior Relocation on or before the date of issuance of the NTP2 then the Design–Builder shall be entitled to: (a) An increase in the Contract Price on account of any increased costs of the Work directly resulting from such failure; (b) An extension of the Contract Time to the extent that any delay in a Critical Path is directly attributable to such failure."

As a rule, advance relocations should be selected, planned, and initiated with sufficient time to ensure completion or near-completion by the time of procurement. This goal may be challenging for ACM projects with compressed development schedules. If project timing constraints (e.g., a firm deadline for completion) do not accommodate an extended lead time or this type of coordination, it may be preferable to instead incorporate the activity into the scope of the main project.

Relocation Positioning

Similarly, multiple SMEs noted the potential risk of an advance relocation moving a utility to a location that ultimately conflicts with the alignment and methods selected by the DBT. In this case, an initial relocation would subsequently require a second relocation to be performed by the DBT, completely negating any purported benefit. STAs considering advance relocations must carefully assess the proposed design for its potential to interfere with the approaches it anticipates the DBTs may consider. Assessments of relocation positioning may be evaluated in conjunction with the assessment of "certainty of conflict"; in selecting and executing an advance relocation, STAs should have confidence that the existing utility would conflict with design–build construction, in addition to confidence that, once relocated, it would not conflict. The position and design of advance relocations should be clearly communicated in both procurement documentation and in-person meetings so as to avoid unexpected conflicts in the post-procurement phase.

4. Contractual Risk-sharing Mechanisms

In order to prudently and effectively divide utility risks, a number of STAs have implemented contractual mechanisms that assign specific financial and schedule responsibilities to public and private partners in the event of conflict. These risk-sharing mechanisms are pursued with an interest in curbing design–builders' tendency to "bid the risk." With the means and magnitude of utility risk costs clearly delineated, design–builders may more confidently lower the utility contingency costs folded into their bid price. STAs have developed and implemented a variety of such risk-sharing strategies as the ACM marketplace has evolved over the last decade. For the purposes of this paper, researchers investigated the contours and apparent advantages of two approaches: (1) deductibles and (2) scope validation periods.

Risk Deductibles

One strategy involves the creation of "deductible" and "cap" structures that assign discrete limits to the unexpected utility accommodation and relocation costs associated with a given project. Within TxDOT, a pair of contractual mechanisms known as the Unidentified Utility Deductible (UUD) and the Unidentified Utility Deductible Cap (UUD Cap) have been utilized for ACM projects since 2017 (Design–Build Agreement: SH 249 Project; TxDOT 2017), and respectively account for the individualized and aggregate utility costs encountered over the project lifetime. A typical contract sets the UUD at $50,000. For each identified conflict, therefore, the design–builder is responsible for all costs from $0 up to $50,000, above which the relocation costs are assumed by TxDOT. Each time this deductible value is exceeded, $50,000 is added to an aggregate cap sum. If this aggregate cap reaches the UUD Cap value, then "the amount of the Price increase in any Change Order thereafter issued under Section 4.6.9.2 for a Utility Adjustment of any Unidentified Utility for which the Basic Costs are in excess of the Unidentified Utilities Deductible shall be equal to the Basic Costs for that facility" (DBA General Conditions: Southeast Connector Project; TxDOT 2022). In this way, the design–builder's unexpected utility costs are capped, and subsequent utility conflicts will entitle the design–builder to a Change Order, subject to several important conditions in the preceding phrase.

First, the utility in question must be contractually characterized as Unidentified. Second, the general conditions state that "in no event shall DB Contractor be entitled to a Change Order for increased costs due to Utility Adjustments for Unidentified Utilities for which the Basic Costs are equal to or less than the Unidentified Utilities Deductible, regardless of whether the Unidentified Utilities Deductible Cap is reached." If the UUD Cap for a project has been reached, therefore, in order for the Basic Costs of relocating a utility facility to be recompensed, those costs still must exceed the specified Utility Deductible value of $50,000. If the UUD Cap has not been reached, the costs of utility relocations that do not exceed the UUD value will not contribute toward fulfillment of the aggregate UUD Cap. Cost estimations supporting Change Order requests must be supported with detailed and reasonable documentation. Collectively, this contractual design disincentivizes design–builders from submitting Change Order requests and claims for minor utility relocation expenses, and it may reduce the associated administrative workload required of an STA as a result. It should be noted that in its procurements since 2017 TxDOT has adjusted the UUD Cap value according to the size and complexity of the project, ranging from $250,000 (DBA: Oak Hill Parkway Project; TxDOT 2019) to $1,000,000 (Southeast Connector Project; TxDOT 2022). On these projects, the fulfillment of the UUD Cap, and the subsequent contractual activation of protections for the design–builder against future Unexpected Utility adjustments, would respectively require 5 and 20 adjustments with costs in excess of the UUD.

In addition to price adjustments, the TxDOT contract specifies a risk-sharing mechanism for the schedule impacts resulting from Unexpected Utility adjustments. This schedule risk-sharing is organized in "banded" fashion, with the costs of schedule delay allocated differently between public and private partners depending on their cumulative magnitude. Specifically, the contract states that "DB Contractor shall bear 100% of the risk of the first 60 cumulative days of Unidentified Utility Delays," the risks of the 61st to 120th cumulative days are "borne equally by each Party," and all subsequent delays are borne solely by TxDOT (Southeast Connector Project; TxDOT 2022). In this way, while the STA is protected against minor conflicts that only add a few days of delay, the contractual Completion Deadline may be amended and extended in the event of major utility conflicts accruing over the lifetime of a project.

Other STAs have experimented with banded utility risk deductible configurations. In 2017, CDOT configured an "Unexpected Utility Condition Event" such that the first $5 million in costs were shared equally with the design–builder, above which costs were assumed by the STA (Central 70 Project; CDOT 2017). In 2016, MDOT and the Maryland Transit Authority (MTA) utilized a Utility-Related Relief Event structure pursuant to Materially Inaccurate Utility Information (Purple Line Project; MDOT 2016). The contract was structured such that the "Concessionaire shall bear the first $2,750,000 of aggregate Incremental Costs that would not have been required had the information provided been accurate," with the next $2,750,000 increment shared equally, and costs above $5.5 million borne solely by the STAs. The out-of-pocket additional costs borne by the design–builder for eligible conflicts are therefore capped at $4,125,000, increasing its cost certainty at time of procurement, while those of the STA are technically uncapped. Here again, the magnitude of STA risk exposure is bounded by the thoroughness of its SUE program. When accompanied by a comprehensive SUE program to identify and locate utility facilities, a risk deductible and cap mechanism offers the STA substantial protection.

Scope Validation Periods

While risk-sharing mechanisms may be made exclusive to utility conflicts, they may be duplicated or extended to other domains as well, with subsurface geotechnical risks providing the most notable example. In one strategy utilized by VDOT and MDOT, the STA implements a Scope Validation Period (SVP) contractual mechanism to accommodate most risk vectors associated with any given project, including utility risks. The SVP assigns a discrete duration beginning after procurement with issuance of Notice To Proceed 1 (NTP1), within which the DBT is entitled to report to the STA all newly identified conflicts within the project footprint. Conflicts reported within the SVP are eligible for relief and compensation consideration, whereas conflicts reported after the conclusion of the SVP are not eligible. For example, a typical MDOT SVP definition (M-32 – Linden Church Rd to I-70; MDOT 2018) specifies that "Design–Builder shall be deemed to have expressly warranted that the Contract Documents existing as of the end of the Scope Validation Period are sufficient to enable Design–Builder to complete the design and construction of the Project without any increase in the Contract Price or extension to the Contract Time(s)."

In this way, the DBT is incentivized to expeditiously perform all additional site investigations during the earliest post-award period and discover any latent conflicts that threaten to change or expand the scope of work it is expected to perform. For example, DBTs may need to adjust construction means and methods to accommodate a utility or geotechnical scope change, which can precipitate lengthy delays due to permit revisions or equipment procurement lead times. The early identification of conflicts, and especially conflicts which impact the Critical Path, enables strategic shifting of scheduling and resource attribution to improve the performance of their resolution.

From the perspective of the STA, this risk-sharing approach reduces the risk of “last-minute” change order submission deep into a project’s life cycle. The SVP duration may vary according to the size and complexity of the given project, but is commonly set to 90 or 120 calendar days. Multiple DB contractor SMEs noted the potential insufficiency of 90 days to perform all requisite investigations, particularly for projects of significant complexity. Interviewed STA administrators rebuffed this argument, stating that “if the design–builder does what he is supposed to, he should have no problem.” Recent contracts containing SVPs (VDOT, 2018) provide exceptions for scope changes encountered in project areas outside of the ROW acquired at time of NTP1; as new ROW is secured, design–builders are granted a limited SVP, typically 30 days, to investigate for the presence of conflicts. Collectively, this approach contains the magnitude and duration of STA change order risk exposure, and as a result it may facilitate more confident cost estimation during project development phases.

The researchers here note that eligibility for relief and compensation is distinct from entitlement to the same. MDOT DB emphasize that the “Design–Builder shall have the burden of proving that the alleged Scope Validation Item could not have been reasonably identified prior to the Price Proposal Submission Date and that such Scope Validation Item materially impacts its price or time to perform the Work.” In submitting its SVP claim, the design–builder is required to provide documentation of the assumptions made during the development of a bid proposal. MDOT retains the authority to adjudicate these assumptions against the information contained within the RFP Documents and the nature of the conflict claimed. Similarly, VDOT SVP definitions maintain that “The term ‘Scope Issue’ shall not be deemed to include items that Design–Builder should have reasonably discovered prior to the Agreement Date.” In coordination with generalized avoidance waivers, this language clearly specifies DBT responsibility for site characterization and protects STAs from exaggerated DSC claims during the SVP.

5. Third-party Communication and Coordination Mechanisms

Interviewed SMEs from both public and private sectors routinely stressed the importance of communication occurring "early and often" between all three parties to a utility accommodation: the Owner's Team, the Delivery Team, and the Utility Owner. One builder–contractor SME emphasized the broad portfolio occupying the attention of utility company administrators, noting that these companies may not be actively monitoring the STA construction developments that threaten to interrupt their operations. STAs should therefore initiate communication channels with utility companies in advance of procurement. By actively informing of upcoming conflicts, STAs can prime utility firms with an understanding about the scope, timing, and duration of cooperation that will be required. The GDOT *Design-Build Manual* (GDOT 2018a) captures this sentiment, stating "the preparation of utility agreements can be one of the more time-consuming processes of a Design–Build project. Consequently, GDOT should contact utility owners during the development of the RFP to plan activities, discuss the project, discuss risks and possible mitigation strategies, and to obtain [Memoranda of Understanding (MOUs)]."

Preparing such MOUs can serve to bridge gaps in understanding between the evolving infrastructure delivery industry and legacy utility companies accustomed to interfacing directly with STAs. In combination with MOUs, vocal intervention by STA personnel to encourage multilateral engagement during pre-award phases or compel it in post-award phases through contractually mandated coordination meetings may extend a portion of its public legitimacy to private partners and result in smoother outcomes. The GDOT *Design-Build Manual* emphasizes the criticality of a proactive partnering approach, stating "it is important to incorporate right-of-way, railroads, and utilities as project partners (rather than adversaries) and to develop win-win solutions to issues involving potential delay or cost increases.” A contractor–builder SME echoed this comment, citing the need to engage with utility partners as a “client” to be handled with utmost responsiveness.

One strategy employed on reviewed projects from multiple STAs (Arizona DOT [ADOT], CDOT, GDOT, and MDOT) to proactively identify and plan for utility accommodations is the construction of a utility conflict matrix (UCM) A UCM is a table prepared collaboratively by the Owner’s Team and Delivery Team, utilizing software like Microsoft Excel, which systematically outlines the relevant details of every utility facility present within the construction footprint. These utility facility details may include: the typology (e.g., gas, water, telecommunications), size (i.e., physical dimensions, carrying capacity), ownership, age, location, and orientation. Perhaps most importantly, the UCM identifies the nature of the conflict with preliminary engineering designs, along with a proposed remedy and cost estimate. These estimated costs are to be revised as design is finalized, and associated accommodation activities may be slotted into a utility adjustment schedule (UAS) work plan. On one example UCM from GDOT (DB Utility Coordination Workshop; GDOT 2014), the matrix identifies a spatial conflict between a support column foundation and a concrete-encased 4-inch telecommunications duct bank, and provides an estimated utility relocation cost of $250,000. The UCM denotes all utility facilities, even those not anticipated to conflict with construction (estimated accommodation costs: $0). Particularly in ACM settings where procurement occurs before design finalization, exhaustive identification of facilities can mitigate the risk of later design changes precipitating a conflict; in combination with clear, legal differentiation between Identified and Unidentified Utilities, and contractual risk-sharing mechanisms like those already discussed (Scope Validation Periods, Deductibles, etc.), STA and Delivery Team collaboration to produce an exhaustive UCM in early partnership offers the significant upside for conflict avoidance in later phases.

As projects progress from procurement to post-award phases, the implementation of MOUs, UCMs, and other coordinating mechanisms requires the concerted coordination of all partners, particularly as those documents evolve through design finalization. SME interview results demonstrated broad agreement from public and private sectors as to the importance of designated points of contact between partners. Concentrating the communication streams with multiple utility partners through a single DBT liaison, for example, limits the opportunity for breakdown and conflict.

Despite this attitudinal alignment from SMEs, content analysis of contractual documents demonstrated considerable variance with respect to STA requirements for designated utility coordination personnel. Some STAs, like WsDOT, are contractually silent on utility coordinator requirements (SR 167/I-5 to SR 509 – New Expressway Project; WsDOT 2021). A recent NYSDOT contract specifies, "The Design–Builder shall coordinate, cooperate, and work with the contact person designated by the utility owner," but makes no reciprocal requirement for a designated DBT contact (I-81 Central Viaduct Project; NYSDOT 2022). A typical GDOT contract mandates the designation of a "Worksite Utility Coordination Supervisor" (WUCS) to be "the primary point of contact between all of the Utility companies, the DB Team and GDOT" (I-16 & I-95 Interchange Project; GDOT 2018b), but does not elevate the WUCS to a Key Personnel position. In contrast, major public–private partnership (P3) projects from ADOT and CDOT elevate Utility Accommodation Manager and Utilities Manager positions to Key Personnel roles, respectively (202 South Mountain Loop Project: ADOT 2016; Central I-70

Project: CDOT 2017). Interviews with CDOT and FHWA personnel emphasized the importance of this Key Personnel position for third-party alignment and coordination on projects with significant utility conflict. The contractual mandate for a utilities coordinator position, potentially at the Key Personnel level, thus emerges as a critical strategy for utility risk reduction.

This communication network must be established for each utility conflict implicated by preliminary design, again highlighting the importance of a thorough SUE investigational program to identify every facility within a project footprint. Unidentified Utilities pose a significant challenge to construction not only through their physical presence but also through the opportunity cost of squandered schedule for negotiation and coordination. Utility companies must make contingency arrangements to ensure uninterrupted service provision to their customers in the event construction will temporarily shutter a facility. If an Unidentified Utility is discovered and belongs to a utility company not otherwise implicated in the project (i.e., through the presence of multiple conflicting facilities), that company must be hurriedly informed about project specifications and "brought on board" to sign agreements of cooperation with construction activity. Delays to this process can threaten project schedule.

GEOTECHNICAL RISK MITIGATIVE STRATEGIES

1. Expansions to Investigative/Informational Scope

The essence of ACM delivery, often featuring an expedited development timeline and complex scope in addition to incomplete design, dramatically complicates geotechnical investigative programming in pre-award phases. Despite these challenges, STAs understand the need to provide prospective partners with geotechnical information upon which bidded design and valuation may be based. Provision of comprehensive data improves the mutual understanding of site characteristics and, in turn, the appropriateness and accuracy of submitted bid designs and prices. Establishing subsurface conditions, including the presence of subsurface variability, can further serve STA interests by diminishing exposure to post-award DSC claims.

As part of its requirements for advertising design build RFPs (2023), VDOT details how the potential for DSC claims poses a severe risk for ACM projects and how, as a result, it is in the best interest of the Department to carry out sufficient investigations to form a detailed geotechnical baseline characterization. VDOT acknowledges that the development of such a document requires considerable resources and should be carried out as soon as possible. WsDOT similarly maintains that "Past experience has demonstrated that an inadequate project geotechnical investigation can lead to excessive risk both in terms of schedule and cost. Therefore, it is important to do the right amount of geotechnical investigation to provide the subsurface information needed to help mitigate those risks" (*Geotechnical Project Development, Reports and Support for Design-Build Projects*; WsDOT 2020).

What constitutes the "right amount of geotechnical investigation" can prove a difficult measure to triangulate, however. Geotechnical SMEs from private design firms and construction firms agreed that RFP documents must include enough information "to support conceptual design" and the "basis of design." On a project including a simple bridge structure, one geotechnical subcontractor SME suggested the STA should provide a preliminary bridge foundation investigation in addition to "the generalities of site geology." One SME with legal expertise in geotechnical claims cautioned against establishing rigid guidelines for a minimum level of investigation (e.g., boreholes spaced no more than 1000 ft apart) and instead favored variable, project-based targets based on geological setting and scope. Rigid targets may tilt behavior toward only satisfying minimum levels of investigation, rather than the level implicated by best practices and the subsurface conditions encountered. Conversely, multiple design firm SMEs advocated for minimum standards, suggesting that those protected both sides from schedule and cost pressures that might otherwise sideline appropriate geotechnical investigation.

Given the incompleteness to design concepts provided in ACM RFP documents and, therefore, the uncertainty surrounding a project's precise footprint, shaft locations, and other engineering elements, one strategy employed by multiple STAs is to provide prospective bidders with latitude to perform supplementary investigations during the procurement phase. If a DBT intends to pursue an ATC that requires subsurface information in a location not anticipated by the STA, for example, RFP provisions may be specified to allow that DBT to execute on-site investigations before bid submission. While this option may be the most attractive from the perspective of STA administrators, the researchers note that private-sector designer, builder, and legal SMEs all voiced disapproval of the practice. These SMEs maintained that timing and access constraints (e.g., permitting requirements, ROW acquisition) effectively negate this approach, and furthermore that it can lead to redundant supplemental investigations performed by different DBTs on the same parcel of land. As an alternative, RFP provisions may allow for DBT submission of supplemental investigation requests. The STA may then aggregate and selectively fulfill these requests, and make the results available to all bidders. In aggregate, this approach may lower geotechnical investigative costs, though one STA SME cautioned that it may incentivize excessive supplemental requests if not handled carefully.

It is important to distinguish between the percentage completion of design versus the percentage completion of geotechnical investigation. To the extent that the latter informs and shapes the former, the 15–30 percent level of design, which is typical for STAs to furnish in RFP documents, may require a relatively more advanced level of investigative completion. For example, the *Geotechnical Project Development* guide from WsDOT (2020) suggests that "to produce a [Geotechnical Data Report] and [Geotechnical Baseline Report] to support a 15 to 30% project design, a 50 percent or greater level geotechnical subsurface field investigation (including any existing [historical] borings that can be relied upon) is typically needed relative to a full PS&E level geotechnical investigation for final design."

Archival and interview investigation suggests that this degree of investigation is greater than average relative to peer STA practice; multiple design and construction firm SMEs reported that WsDOT provides "more [geotechnical information] than most," and approved of WsDOT's program. More thorough completion of geotechnical investigation facilitates greater confidence in developing preliminary subsurface characterizations and determining the essential elements required for the installation of subsurface structures. WsDOT's stated objectives of the investigations are to "consider the amount of information necessary to develop the Conceptual Design for the DB project and also to provide the appropriate level of confidence in baseline statements and thereby reduce the risk of differing site condition claims."

The WsDOT Geotechnical Project Development report outlines 10 goals for preliminary geotechnical investigation in ACM contexts:

> "1. Identify the distribution of soil and rock types for the Conceptual Design and assess how the material properties will affect the design and construction of the project elements.
>
> 2. Define the ground water and surface water regimes for the project concept design. It is especially important to determine the depth, and seasonal and spatial variability, of groundwater or surface water. The locations of confined water bearing zones, artesian pressures, and seasonal or tidal variations should also be

identified. The geotechnical investigation will not be sufficient to fully define these groundwater issues but should be enough to identify potential groundwater problems and risks.

3. Identify and consider any impacts to adjacent facilities that could be caused by the construction of the Conceptual Design.

4. Identify and characterize any geologic hazards that are present within or adjacent to the project limits (e.g., landslides, rockfall, debris flows, liquefaction, soft ground or otherwise unstable soils, seismic hazards) that are already known or discovered during the baseline configuration geotechnical investigation that could affect the Conceptual Design as well as adjacent facilities that could be impacted by the construction of the Conceptual Design.

5. Assess the feasibility of the proposed alignments, including the feasibility and conceptual evaluation of retaining walls and slope angles for cuts and fills, and the effect the construction of the Conceptual Design could have on adjacent facilities.

6. Assess potential project stormwater infiltration or detention sites with regard to their feasibility, and to gather at least one year of groundwater data in accordance with storm water regulations if possible within the project development schedule.

7. Identify potential suitability of on-site materials as fill, and/or the usability of nearby materials sources.

8. For structures including, but not limited to, bridges and cut-and-cover tunnels, large culverts, walls, bored tunnels, trenchless technology, provide adequate

subsurface information to assess feasibility of the Conceptual Design and to help quantify risks.

9. For projects that may include ground improvement to achieve the project Concept Design, provide adequate information to assess feasibility and to assess the potential impacts to adjacent facilities due to the ground improvement.

10. For projects that may include landslides, rockfall areas, and debris flows, provide adequate information to evaluate the feasibility of various stabilization or containment techniques."

Geophysical Techniques and Cone Penetration Testing

Although SMEs consistently viewed borehole drilling to be the "bread and butter" of geotechnical investigative programs, a considerable number referenced the usefulness of alternative approaches and, in particular, geophysical techniques and cone penetration testing (CPT), to supplement such programs and enhance the overall quality of site characterizations. As a result, the researchers pursued additional interview and archival analysis to explore network actor perceptions of such investigative techniques, their relative advantages and disadvantages, and the context and extent to which they are implemented in ACM settings.

Although specific techniques vary, geophysical exploration typically involves the utilization of electrical and other wave energy to measure and interpret subsurface conditions. The UDOT *Geotechnical Manual of Instruction* (UDOT 2022) states that geophysical investigation "is recommended to supplement subsurface explorations," particularly in the pursuit of the following objectives:

- "Evaluating variations between explorations

- Locating possible anomalies
- Investigating conditions underlying difficult terrain
- Obtaining shear wave velocity data
- Developing modulus properties
- Assisting in the placement of other explorations
- Locating voids, utilities or substructures
- Characterizing depth to bedrock, depth to groundwater and rippability of rock."

The Caltrans *Geotechnical Investigations Manual* (Caltrans 2020) contains similar recommendations and further evaluates the feasibility and utility of geophysical investigation in different scenarios, suggesting that they might be used to evaluate targeted in situ conditions for smaller projects and to assess the uniformity of subsurface conditions along the extended footprints of larger projects.

Geotechnical SMEs from both the public and private sectors echoed these points, noting how geophysical investigations can provide a wealth of data to interpolate between borehole investigations in large and complex project environments. One geotechnical subcontractor described the techniques as "raising a red flag" for the presence of significant conditions between boreholes and, by extension, for the need to pursue additional boreholes in those locations. In addition to strengthening and augmenting site characterizations resulting from standard borehole testing, therefore, geophysical investigations may assist STAs in determining the scope of requisite borehole investigations to limit subsurface risk. This determination may be useful to establish the boundaries of preliminary investigations during pre-award contractual phases or to establish geotechnical requirements for additional borehole investigations performed by the DBT during post-award phases.

Strategic screening in this fashion may increase the confidence of subsurface characterization while preserving the investigative budget. For example, in evaluating subsurface conditions to facilitate the design of noise barrier wall foundations, one STA SME advocated using seismic refraction surveys in shallow or variable rock areas. While a dense borehole approach results in better confidence levels, using geophysical techniques allows a useful characterization at a fraction of the cost. Geophysical methods may allow for the faster, cheaper, more continuous determination of certain subsurface profiles for long linear projects (e.g., depth to the top of subsurface rock layers along a highway expansion).

Interviewed SMEs also cautioned about the technical and practical limitations of geophysical techniques, however. Geophysical investigations should not be pursued in isolation but instead as a complement to traditional techniques. STAs may also encounter difficulty in procuring, either inside or outside the organization, both the specialized equipment and qualified personnel necessary to perform sophisticated geophysical testing. Furthermore, because geophysical test results require a greater degree of professional but subjective "interpretation" compared to borehole tests, some STAs, wary of post-award DSC claim exposure, may feel uncomfortable utilizing geophysical techniques for inclusion in procurement documents. As a result of these sum constraints, SME interviews demonstrated significant variation in STA utilization of geophysical techniques, with GDOT reporting very seldom usage and MassDOT reporting usage in more than 75 percent of ACM projects.

The U.S. Environmental Protection Agency (USEPA) has developed and published a collection of geophysical methods to enhance awareness and educate practitioners for wider adoption (USEPA 2023). In keeping with research interview findings, the agency cites technical limitations of the contracting community, a lack of mature standards, and liability exposure as major impediments to widespread usage of geophysical investigative techniques. To counter such limitations, the USEPA has developed three decision support tools for identification of suitable geophysical methods for different objectives, made available on its website:

- Fractured Rock Geophysical Toolbox Method Selection Tool (FRGT-MST)
- Groundwater/Surface Water Method Selection Tool (GWSW-MST)
- Geophysical Remediation Monitoring Method Selection Tool (GRM-MST)

The USEPA has supplemented these tools through the publication of forward models and inverse models of geophysical investigation techniques. Respectively, forward models are predictive models that help the designers predict geophysical responses given limited site information and provide answers for "What if? Scenarios," whereas inverse models may be utilized to translate geophysical data to physical properties. These models echo academic literature findings indicating the potential for modern statistical and machine learning techniques to strengthen geophysical investigative results and improve data-driven site characterization (Phoon and Zhang 2023).

CPT investigative techniques, which utilize an instrumented cone to push through subsurface layers and delineate soil stratigraphy, feature a similar set of advantages, disadvantages, and constraints. CPT dramatically increases the granularity of collected data compared to traditional standard penetration test (SPT) methods, providing centimeter-by-centimeter analysis. Because of this superior precision, one geotechnical SME advocated for a "CPT first" approach, in contrast to the typical approach, which prioritizes SPT and borehole investigations. Other SMEs disagreed, citing the inability to use CPT in rocky areas and the widespread lack of qualified equipment and contractors. One STA SME suggested this latter challenge may be mitigated through the STA purchase of CPT machines to increase the capacity and familiarity with the technique.

Geophysical and CPT investigations should not be viewed as a “replacement” for traditional borehole techniques, which provide insights into the actual soil stratigraphy; in the future, it is expected that SPTs will be used mainly for sample collection if needed. For meaningful interpretations, SPT should be used only if energy correction is considered. Geophysical and CPT techniques should be used as a standard, as these techniques demonstrate the potential to identify and significantly mitigate subsurface risks. Particularly in ACM contexts featuring incomplete design, STAs should consider utilizing geophysical methods to characterize subsurface conditions across a wider footprint and reduce exposure to post-award DSC claims.

Archival Data

A “desk study” of a proposed project site often reveals that a wealth of information is already known about the subsurface conditions in the area. Particularly for projects located in developed urban and suburban areas, or those expanding or modifying major highways, records of geotechnical investigations in support of preceding infrastructure construction may have been retained. This archival data can prove an invaluable asset at the disposal of both public and private engineers during project development and bidding phases, respectively. The data may be leveraged to evaluate the site for the likelihood of specific subsurface conditions, and it can provide insights into the historical approaches pursued to alleviate site-specific challenges. STAs, primed with an approximation of subsurface conditions, may embark upon a tailored investigative program to confirm and expand upon that understanding. The early investigation of archival sources for geotechnical data can therefore serve as a low-cost intervention to reduce the risk of differing site conditions in later phases.

Although these dynamics and the advantages of reviewing archival data are broadly understood, comprehensive access to such data often proves more difficult to attain. Interviewed SMEs recounted how significant portions of historical geotechnical records may have been lost or destroyed whenever STAs relocated office locations over the decades. Other geotechnical data might be retained but stored in physical filing cabinets distributed through a given STA's regional offices. Even where records are aggregated in an accessible place, they may lack uniformity in data formatting that diminishes their usefulness. Interviewed SMEs stressed the importance of assessing archival data for a documented consistency in both investigative technique and the vertical datum benchmark utilized. Altogether, the management of archival data plays a crucial role in the ability of the engineers to leverage it effectively to characterize subsurface conditions.

In order to aggregate archival geotechnical data in a single accessible repository, the California Department of Transportation (Caltrans) has developed an online platform known as GeoDOG (Digital Archive of Geotechnical Data). These archival data were made available to the public in 2017 (Caltrans 2017). Archived data are converted to digital format geolocated according to its respective project of origin and are added to a single repository. The Caltrans *Geotechnical Manual* explicitly instructs engineers to review the information presented in the GeoDOG system when assessing subsurface conditions for a given project, in addition to regional subsurface characteristics (e.g., seismic faults, liquification maps, fault maps, soil surveys) made available by various local, state, and federal entities. Section 3.4.1 of the Caltrans "Alternate Contracts and Consultant Oversight" section in the Caltrans *Geotechnical*

Investigations Manual (Caltrans 2020) states that the following data are to be archived on the GeoDOG system if developed on the project:

- "Geotechnical reports,
- Log of test borings, test boring layouts and boring records,
- Laboratory test results,
- Geotechnical data such as instrumentation monitoring, and
- As-built reports and records (information developed during construction like pile driving records and design changes)."

A review of STA websites revealed analogous digital repositories in many states across the country, including Washington, Utah, Ohio, New Jersey (see figure 5), Alabama, and Florida. Rsearchers with Alabama DOT (ALDOT) generated a report detailing the steps by which an STA might convert desktop-based, archival geotechnical data into a dynamic and centralized repository of real-time data (Graettinger et al. 2011). The report highlighted the many efficiency advantages of a relational geographic information system (GIS) database and traced the history of ALDOT's development of its "GeoGIS" platform. Interviewed SMEs from the public and private sectors strongly agreed that access to such a system would be helpful, but they acknowledged that the conversion of historical geotechnical data from paper to digital format would require significant labor effort. STAs seeking a next-best approach may consider the creation of a repository to aggregate modern data in a dynamic way, thereby building an archival database for the future.

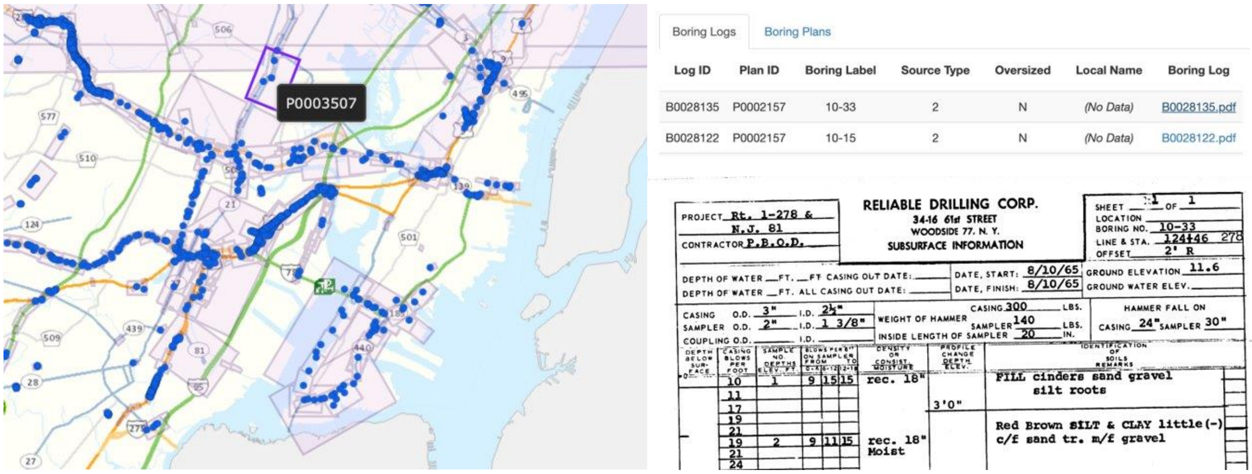

Figure 5. Map. New Jersey DOT Geotechnical Data Management System (GDMS) (https://www.nj.gov/transportation/refdata/geologic/).

Geotechnical Data Reports and Geotechnical Baseline Reports

After pre-award geotechnical investigations (and archival data desk studies) have been performed, an STA must determine the documentary vehicle by which it prefers to communicate the resulting data to DBTs. In conjunction with decisions regarding the degree of contractual reliability it wishes to affix to a particular data set and typologies (discussed in the following section), STAs may elect to divide geotechnical information into different documents. One such documentary vehicle commonly employed by STAs is a geotechnical data report (GDR).

A GDR states the objective results of the broad geotechnical investigative program, test by test and location by location. A GDR typically contains information pertaining to the entire project footprint, but it may also be circumscribed for use for a single design element. For example, in 2021, GDOT utilized a geotechnical subcontractor to prepare a bridge foundation investigation (BFI) GDR for a multi-stage DB project north of Atlanta (GDOT 2021). For subsurface conditions at geolocated points, coordinated with proposed bridge structure locations, the BFI GDR conveys the results of field and laboratory testing. The report details the machines and standardized procedures by which field borings, groundwater level tests, and SPT were performed. Soil classification was performed by a trained professional and then confirmed through a series of tests, each of which indexed to an American Society for Testing and Materials (ASTM) standard: Grain Size Analysis, Moisture Content, Atterberg Limits, Unconfined Compressive Strength of Rock, Soil Resistivity, pH of Soil, Chloride of Soil, and Sulfate of Soil. A "brief general geology" and map of the area are also provided, along with disclaimers pertaining to subsurface variation:

> "The boundaries between zones of soil, partially weathered rock [PWR], and bedrock are erratic and poorly defined. Weathering is often more advanced next to fractures and joints that transmit water, and in mineral bands. Boulders and rock lenses are sometimes encountered within PWR or soil matrix. Consequently, significant fluctuations in depths to materials may occur over short horizontal distances."

In all cases, whether project-wide or otherwise, a GDR should be limited to the objective reporting of technical, procedural outcomes. Field and laboratory instrument readings are provided inside the boundaries of accepted best practice, with limited to no professional interpretation.

By contrast, a geotechnical baseline report (GBR) is an explicitly interpretive document. The creation of a GBR takes the contents of the GDR as its input and produces a subjective, albeit highly vetted and expert-produced, characterization of baseline conditions for the project site. According to the ASCE *Manuals and Reports on Engineering Practice No. 154, Geotechnical Baseline Reports: Suggested Guidelines* (2022b): "Baseline statements in the GBR are representations of certain anticipated subsurface conditions that the parties agree to use for purposes of risk allocation and contract administration. The baselines should be realistic, clear, fair to both parties, and consistent with the information contained in the Geotechnical Data Report (GDR)." A GBR may address wide-ranging subsurface conditions including expectations of soil stability, the relative percentages of hard rock material, the number of large boulders or voids to be encountered, and much more. Whereas a GDR captures the encountered conditions at specific horizontal and vertical positions within boreholes, the GBR provides the expectation set to interpolate the conditions between boreholes. ASCE Report No. 154 recommends brevity, clarity, and an affirmative tone for baseline statements, along with an explicit ordering of documentary precedence such that ambiguity and conflict between subsurface depictions is avoided.

Production of a GBR can facilitate considerable benefits to pre- and post-award phases. As described by one geotechnical and legal SME, a skillful GBR provides a clean and clear answer to the question implied by the phrase *differing site conditions*: "differing… compared to what?" Because reasonable geotechnical experts can (and do) disagree in their interpretation of the data presented in a GDR, negotiation over the exact contractual terms and baselines in a GBR provides a venue for public and private partners to arrive at professional alignment and a mutual understanding of each other's assumptions. Geotechnical and senior administrative SMEs at WsDOT stressed that inclusion of a GBR does not lower the burden of proof required for a DBT to obtain relief under a DSC claim; rather, it provides clarity to the baseline, average conditions against which a claim of differing conditions might be adjudicated. Establishing shared expectations among project partners renders the judgment of any aberrant encountered conditions more consistent, whether performed by internal or external (dispute resolution boards, legal arbitration/suit) parties and processes.

While the post-award presence of such baselines may improve the efficiency of dispute resolution processes, the direction of that resolution—that is, in favor of the STA or of the DBT, respectively—will hinge dramatically upon the precise baselines determined during procurement. The researchers encountered a variety of approaches through archival analysis and conversations with SMEs. One geotechnical design expert strongly advocated for the approach detailed in ASCE Report No. 154, utilizing a two-phased approach of GBR-B (for bidding) followed by a GBR-C (for contracting). According to this strategy, the STA prepares a set of baselines for a GBR-B featuring strategic "gaps" in the language pertaining to critical assumptions or design intentions. These gaps are to be filled in by the prospective bidders, after which the STA may negotiate individualized GBRs with each DBT or aggregate submissions into a collective GBR. Upon procurement of a private partner, this bidding document becomes a formal, legally enforceable GBR-C. Critically, according to the SME, requiring DBT participation in the formulation of the GBR allows the document to account for the assumptions and means and methods of the private partner and to protect the STA from post-award assertions that the DBT failed to understand a particular clause of the document. Different design and construction decisions (around, for example, earthworks elements) will implicate different equipment usage and, by extension, different DBT relationships with particular subsurface conditions.

Other SMEs, most notably from WsDOT, disagreed with this approach and instead advocated for what might be considered a "unilateral" GBR produced by the STA following completion of the preliminary geotechnical investigation. WsDOT SMEs reported that project GBRs are consistent for every bidder and remain unchanged throughout procurement. Alone among STAs with its universal utilization of GBRs for ACM projects, this WsDOT approach is emblematic of GBR usage in the United States.

2. Expansions to the Contractual Coordination and Reliability of Geotechnical Information

In discussing the ideal scope of geotechnical information provided for ACM projects, one interviewed WsDOT geotechnical SME reflected, “There are four documents in an ideal world: a Geotechnical Baseline Report, a Geotechnical Data Report, Historical Data, and Conceptual Recommendations.” Indeed, the presence and content of such documents can vary dramatically from project to project both between and within STAs, with considerable effect on post-award performance, and this has been the primary focus of the preceding analysis. As alluded to, however, perhaps more important than the literal content of the geotechnical investigation are the contractual coordination mechanisms that allocate responsibility for its accuracy, interpretation, and reliance in usage. STAs are afforded broad latitude to arrange contract terms, and content analysis of project documentation reveals significant variation in both the distribution of geotechnical information across document types and the contractual languages utilized to organize the relationships between project documents and partners. Together with insights gathered from SME interviews, this section reviews these relationships, beginning with a discussion of generalized avoidance clauses, followed by GBRs, GDRs, and RIDs in turn.

Generalized Avoidance Clauses

The opening paragraphs of an ACM contract almost invariably establish generalized waivers of risk responsibility for the STA owner. These avoidance clauses, also known as exculpatory clauses, state that DBT submission of a bid constitutes an explicit acceptance of project site conditions and any post-award complications arising thereof. By participating in the procurement process, the clauses hold, a DBT acknowledges that the STA granted it sufficient duration to perform a full site inspection to supplement whatever information (contractual, reference, or otherwise) was included in the procurement documentation. As a result, the DBT accepts responsibility for all conditions encountered, including subsurface conditions, and the STA avoids the potential liability. One waiver from a Florida DOT (FDOT) DB RFP (SR 70 from Lorraine Road to Bourneside Boulevard, 2023) is representative of such dynamics, particularly with reference to the interpretation of boring data:

> "The Design–Build Firm shall examine the Contract Documents and the site of the proposed work carefully before submitting a Proposal for the work contemplated and shall investigate the conditions to be encountered, as to the character, quality, and quantities of work to be performed and materials to be furnished and as to the requirements of all Contract Documents…
>
> The Design–Build Firm shall examine boring data, where available, and make their own interpretation of the subsoil investigations and other preliminary data, and shall base their bid on their own opinion of the conditions likely to be encountered. The submission of a proposal is prima facia evidence that the Design–Build Firm has made an examination as described in this provision."

The UDOT Design Build Template (UDOT 2020) assumes a similar posture:

> "The Design–Builder has, prior to submitting its Proposal, in accordance with prudent and generally accepted engineering and construction practices, reviewed the boring logs provided in Part 8 (Engineering Data), inspected and examined the Project Site and surrounding locations, and undertaken other appropriate activities sufficient to determine the surface conditions and subsurface conditions affecting the Project, to the extent the Design–Builder deemed necessary for submittal of its Proposal…

> As a result of its review, inspection, examination, and other activities, the Design–Builder is familiar with and accepts the physical requirements of the Work and the risk allocations associated with such Work set forth in the Contract Documents”

In this way, despite its position as the party with earlier involvement and having generated the preliminary geotechnical investigation, STAs may utilize generalized risk waiver clauses to broadly reduce geotechnical risk exposure by allocating to DBTs the responsibility for performing a “reasonable site examination” and the assessment of associated risks. Multiple private-sector SMEs (i.e., designers, builders, geotechnical subcontractors) expressed dissatisfaction with such arrangements, insisting that “the state must own the ground” it seeks to develop. If an STA provides neither comprehensive scope of investigation nor mechanism for informational reliance nor other means of remedy, these SMEs maintain, risk allocation may become sufficiently imbalanced as to dissuade private-sector participation in lump-sum ACM procurement altogether; facing thin margins and elevated risk of financial loss, firms will simply exit the market.

Generalized waivers do not operate in isolation, however, but rather interact with the rest of the contractual landscape to allocate risks on an itemized and contextual basis. For example, many contracts carve exceptions for “reasonable site examination” clauses for project “parcels that [STA] lacked title or access to prior to the Proposal Due Date” (I-2/I-69C Interchange Project; TxDOT 2018). Exculpatory clauses may thus be seen as laying a foundational set of assumptions tilting risk toward the DBT, upon which particular elements may be excepted through targeted clauses in subsequent contract sections. One WsDOT RFP (SR 167/I-5 to SR 509 – New Expressway Project; WsDOT 2021) demonstrates this dynamic (emphasis added):

> "The Design–Builder is solely responsible for all Site conditions discoverable from a reasonable Site examination. The Design–Builder further acknowledges and agrees that changes in conditions at the Site may occur after the date hereof, and that the Design–Builder shall not be entitled to any increase in compensation or time extension in connection therewith **except as specifically permitted by the Contract.** Proposal submission will be considered conclusive evidence that the Proposer has determined that it has performed a reasonable Site investigation."

Thus, to the extent that DBTs predicate their proposal design and price on a project's geotechnical risk profile and distribution between partners, understanding the whole-of-contract interplay between different allocative mechanisms emerges as critical.

Geotechnical Baseline Reports

As described, geotechnical baseline reports provide a specific interpretation of the expected baseline conditions to be encountered across a project footprint. In Washington State, STA SMEs reported that GBRs are utilized for nearly every ACM project, and where included, they are always made Contract Documents. Contractual inclusion of the GBR enables the DBT to rely upon WsDOT's stated subsurface characterization as it submits formal claims for relief. SMEs noted that the GBR does not guarantee protection for problems encountered as a result of the DBT's specific selected means and methods—the Department identifies a baseline condition without requiring or recommending means and methods to accommodate said condition. WsDOT contracts further distinguish between the baseline conditions explicitly stated in a GBR versus any DBT interpretation thereof (SR 167/I-5 to SR 509 – New Expressway Project; WsDOT 2021):

> "When the RFP includes a GBR or GDR, including any supplements to a GBR or GDR, WSDOT makes no representation or warranty expressed or implied that:
> 1. The Design–Builder's interpretations from the GBR or GDR are correct.
> 2. Moisture conditions and groundwater elevations will not vary from those identified in the GDR. 3. The ground and subsurface conditions as represented in the GBR and GDR have not been physically disturbed or altered after the documents were prepared."

An STA drafting a GBR may thus draw boundaries around its applicability or otherwise limit GBR contents to those conditions about which it feels most confident in its assessment. It may coordinate the GBR with additional geotechnical documents like a GDR, where applicable. The researchers note that one legal SME cautioned that ambiguity in the distribution of information contained between documents, and reliability thereof, can generate complicated legal questions of enforceability. Relatedly, legal scholar David Hatem has posited questions about the unsettled nature of case law addressing the GDR–GBR relationship, and in particular the principle of "universality" by which the GBR is "the sole (or singular) contractual source and basis for (a) *all* subsurface conditions risk allocation and (b) the evaluation and determination of *all* DSC claims" to the exclusion of all other documents (Hatem 2021). Whereas international organizations like the FIDIC[2] advocate for this legal interpretation, industry entities in the United States, including ASCE, adopt a framework that allows coordinating Contract Documents to serve as the basis of DSC evaluation for those areas not addressed in a GBR. A recent appeals case in Washington State has affirmed this latter interpretation, providing clarity to the standard a

[2] International Federation of Consulting Engineers.

nd facilitating STAs' strategic coordination of geotechnical documents in ACM settings (Hatem 2022).

Geotechnical Contract Documents

Geotechnical data reports contain the basic results of geotechnical exploration without the interpretative elements typical of a GBR. The soil classification results of field sampling activities may be provided, for example, with neither interpolation of subsurface conditions between sampling locations nor recommendations for engineering responses to the materials identified. A GDR may be submitted as a Contract Document, rendering the data within legally reliable, subject to certain limitations.

The language of geotechnical Contract Documents commonly restricts the reliability of included data and conditions to the precise horizontal and vertical positions designated by the sample or test. Recent NYSDOT contract documents (I-81 Viaduct – Phase 1, Contract 2; NYSDOT 2022) reflect this approach:

> "[Geotechnical Data] is made available to Proposers so that they may have access to the same information available to the State. It is presented in good faith, but as with all subsurface information it represents only a small fraction of the total volume of material at the site. The Department represents that, to the best of its knowledge, the information represented by the borings and tests taken by the Department are accurate at the location of the tests. Any extrapolation of such information to other locations by the Design–Builder shall be at Design–Builder's risk."

Pursuant to this clause, a DBT might be eligible for DSC relief if it could demonstrate the factual inaccuracy of GDR data (e.g., a borehole record) at the *exact* "location of the tests" recorded (a

Type I DSC claim). Discussions with SMEs in NYSDOT confirmed this interpretation, which was found to be commonplace among STAs in the course of archival and interview research. One GDOT SME recounted a recent DB project wherein a DBT was found ineligible for DSC relief after it reported site conditions differing from those indicated on an adjacent GDOT-provided borehole record. Because the differing conditions were not "at the actual boring holes identified in the geotechnical reports" but instead represented an erroneous DBT extrapolation of those stated conditions, the DSC claim was denied. Several private-sector SMEs objected to such an approach, arguing that an owner "standing behind its data" should extend to conditions encountered in close proximity to provided records. To this end, some SMEs suggested provision of explicit "tolerances" to the accuracy of geotechnical records (e.g., conditions guaranteed within a discrete horizontal radius of an STA borehole). This approach was utilized by the New York State (NYS) Thruway Authority for the Tappan Zee Hudson River Crossing Project (NYS Thruway Authority 2012, Contract Part 2,) and is discussed in further detail in later report sections.

Geotechnical Reference Information Documents

In contrast to Contract Documents, RIDs contain information explicitly excluded from contractual reliance. DBTs are ineligible for relief or compensation for cost and schedule complications that result from reliance on information contained within RIDs. An FDOT RFP (SR 70 from Lorraine Road to Bourneside Boulevard; FDOT 2023) demonstrates these dynamics clearly, outlining a list of reference documents for the project and stating:

> "The following documents are being provided with this RFP. Except as specifically set forth in the body of this RFP, these documents are being provided for reference and general information only…

> No information contained in these documents shall be construed as a representation of any field condition or any statement of facts upon which the Design–Build Firm can rely upon in performance of this contract. All information contained in these reference documents must be verified by a proper factual investigation. The bidder agrees that by accepting copies of the documents, any and all claims for damages, time or any other impacts based on the documents are expressly waived."

In this example from Florida, this list of documents notably includes the GDR, highlighting the importance of unambiguous assignment of legal reliability to each document. Ultimately, the title of the geotechnical document (GDR or otherwise) is insignificant; the legal designation of the document (Contractual or Reference) governs its usage and the associated allocation of risk between partners. RID data, irrespective of its subject matter or configuration, are broadly excluded from consideration in DSC claims or other risk-sharing mechanisms. As captured by the UDOT DB Template (UDOT 2020), this protection is commonly extended to factual errors and omissions in RID data, unless identified by the DBT during the proposal phase and uncorrected by the STA:

> "[DBT is ineligible for relief resulting from] Errors, omissions, inconsistencies, inaccuracies, deficiencies or other defects in the Design Documents (including errors, omissions, inconsistencies, inaccuracies, deficiencies or other defects traceable to errors, omissions, inconsistencies, inaccuracies, deficiencies or other defects in the Information Only Material), except to the extent that the Department fails to act reasonably to approve corrections thereto proposed by the Design–Builder."

Despite these disclaimers, it should be noted that RID data are not, definitionally, of a lower quality than data in Contractual Data. The decision to package information as a RID can be motivated by a variety of factors, including the sourcing and nature of the data in question. For example, in every case identified (i.e., WsDOT, Massachusetts DOT [MassDOT], NYSDOT, and FDOT), the results of geophysical exploration were incorporated into RID data rather than Contract data. This was a result not of an inferiority of geophysical investigation (to the contrary, the benefits of such a program have already been outlined), but rather because the interpretive nature of the techniques utilized could introduce the potential for unwelcome risk exposure. Notwithstanding this, the STAs still felt that geophysical data provided value to DBTs as a reference document. Likewise, relevant archival evidence was nearly always packaged within RID data, except in rare cases where a historical borehole record met internal standards for procedure and documentation.

STA SMEs stressed that all information, regardless of Contractual or Reference designation, should be presented in a fashion that provides utility to the proposing teams. For example, rather than agglomerating all archival records into a single unsorted document, STAs should parse, label, and present the data in a manner that facilitates usage for design engineering and estimation. This approach prioritizes the thoughtful curation of data to maximize efficiency and diminish transaction costs (i.e., time and budget) during proposal-phase engagement with private partners.

Flexibility to Geotechnical Documentary Configuration

The availability of different documentary vehicles for geotechnical information (i.e., GBRs, Contractual GDRs, and RIDs) provides immense flexibility to STAs for strategic, project-based customization of risk allocation profiles. Depending on a project’s scope, geological context, and development timeline, an STA may enter the procurement period with differing levels of confidence in the comprehensiveness and appropriateness of the geotechnical investigation. While maintaining an acceptable level of risk exposure, in conjunction with a desire to cultivate a competitive bidding environment (i.e., with smaller geotechnical contingencies), STA officials must determine whether to package the information in a document with greater or lesser contractual reliability.

A WsDOT geotechnical SME reflected on these dynamics, stating that the baselines contained in the GBR may be calibrated slightly more conservatively for projects with shorter lead times constraining the comprehensiveness of investigation. Rather than giving explicit quantities or percentages of soil classifications, for example, the baseline might characterize subsurface conditions with more generalized language. Alternatively, a particular baseline condition might be omitted from the GBR in favor of only reporting the relevant test result in the GDR, or even in the project RIDs. The SME emphasized that all useful, practicable STA information should be shared with DBTs, in one documentary form or another: "we don't want to hold back anything that might be of use." Analysis of recent contracts demonstrates the utility and uptake of this approach by STAs with active ACM portfolios; a 2021 VDOT DB project (I-81 MM 48 Acceleration Lane Extension; VDOT 2021) provides a GDR as a Contract Document, supplemented by "review information data" provided as an RID for which "the [DBT] is at sole risk for any conclusions drawn from such data, either expressly or by implication." Once data have been designated, the specified mechanisms of interplay between Contract and Reference Documents can be quite sophisticated. For example, a 2018 TxDOT Project (I-2/I-69C Interchange Project; TxDOT 2018) states:

> "Portions of the Reference Information Documents are explicitly referenced in the Contract Documents for the purpose of defining requirements of the Contract Documents. The Reference Information Documents shall be deemed incorporated in the Contract Documents solely to the extent that they are so referenced, with the same order of priority as the Contract Document in which the reference occurs; provided, however, that DB Contractor shall only be entitled to rely on portions of the Reference Information Documents for increases to the Price and extensions of Completion Deadlines to the extent identified in Exhibit."

By strategically stratifying available data into different tiers of documentary reliability, an STA can optimize its geotechnical risk exposure while increasing the confidence and competition of its prospective partners. Private-industry SMEs were consistently aligned in their assessment that STAs should "stand behind their data" by extending greater degrees of contractual reliability to geotechnical information. STAs seeking to engage such entities with a "partnering" posture may consider the tactical elevation of certain RID data elements into Contract Documents. The creation of a GBR through the clarification of select baseline conditions may simultaneously facilitate competition during procurement phases and alleviate post-award DSC claim resolution.

3. Geotechnical Risk-sharing Mechanisms

The preceding report sections have detailed the means by which STAs produce geotechnical information for provision in procurement documentation and the mechanisms by which that provision is made contractually reliable, or not, to DBTs generating proposal designs and valuations. The extent to which that informational reliability is made material to project outcomes, however, is subject to the interplay between historical precedent and the evolving, evaluative mechanisms of contract language that set the boundaries of post-award change order and conflict resolution. By far, the most important among these contractual mechanisms is the differing site conditions clause. In some states, DSC clauses work in further coordination with supplementary risk-sharing mechanisms such as deductibles or SVPs. This section examines the observed variation in STA approaches to these critical risk management practices.

Differing Site Conditions Clauses

Described by one interviewed STA SME as "the king" of geotechnical contract administration, the DSC clause provides legal remedy to a private partner if the encountered subsurface environment satisfies either of two conditions, by: (1) differing significantly from those indicated on project documentation during procurement, and/or (2) presenting "an unusual nature, differing materially from those ordinarily encountered." 23 CFR 635.109 formally defines the boundaries of DSC clause eligibility and requires its inclusion on projects receiving federal financial aid. Both public- and private-sector SMEs consistently pointed to the central importance of DSC formulation and implementation on performance in both traditional and ACM contract settings. Part (c) of the same regulation lifts the DSC clause requirement for ACM projects, however, and instead holds that STAs "may consider" the usage of DSC and "significant changes in the character of work" clauses. STAs are thereby granted broad latitude to conform DSC clause formulation according to their risk preferences and project contexts.

The "Alternative Contracts" section of the Caltrans *Geotechnical Manual* addresses 23 CFR 635.109 (c) head on, stating:

> "This clause exempts D–B projects from the typical DSCs clauses required by Federal Highway Administration in federal-aid projects. The typical DSC contract clauses need to be revised to allocate risk and assign responsibilities between the design–builder and the owner. There are a few options to avert the overuse of

> Type II DSC. The most common is setting an expiration date for filing Type II DSC claims, such as within two weeks after the design–builder completes a geotechnical investigation at the site. This option may encourage the design–builder to perform a more detailed geotechnical investigation."

Employing such a technique—not dissimilar to the SVP approach utilized by VDOT and MDOT—enables Caltrans to integrate DSC clause inclusion with the post-award geotechnical requirements already expected of the DBT, even as it contains its own risk exposure to a specified two-week duration.

The adaptation of DSC clauses to ACM settings is logical given the incompleteness to investigation and design inherent to the delivery method. The DSC clause is adjusted to ensure synergy with the other informational and risk-sharing mechanisms employed to accommodate ACM constraints; for example, a typical WsDOT contract (SR 167/I-5 to SR 509 – New Expressway Project; WsDOT 2021) defines a Type I differing condition as "actual subsurface or latent physical conditions encountered at the Site that are substantially or materially different from the baseline conditions identified in the GBR and the data in the GDR, or the [supplemental] GDR (if any) as set forth in Section 1-02.4(2) and which are not discoverable from a reasonable investigation and analysis of the Site." Notably, this definition is preceded by language excluding ATCs from DSC relief. STAs were consistent in this approach, maintaining that DBTs that choose to innovate for savings—especially using means and methods that deviate from the STA geotechnical investigation footprint—sacrifice coverage as a result. An analysis of TxDOT contracts found that the precise eligibility requirements for DSC relief are adjusted between projects to account for subsurface geological variation across the state; the DSC clause for the I-35 NEX Central Project (TxDOT 2021) in San Antonio explicitly excluded the eligibility of claims resulting from “karst or the discovery of Karst Features,” whereas this provision was not included for major projects in the Houston region.

Two examined STAs, GDOT and NCDOT, have exercised their latitude under 23 CFR 635.109 (c) to remove DSC clauses from ACM contracts altogether. Recent NCDOT DB contracts (I-2513 B&D, 2023: NCDOT 2023; RC-5777C – US-70, 2022: NCDOT 2022) unequivocally state that “The Design-Build Team shall have no claim for additional compensation or for an extension of contract time for any reason resulting from the actual conditions encountered at the site differing from those indicated in any of the information or documents furnished by the Department,” effectively waiving all liability for subsurface conditions irrespective of the scope and accuracy of provided investigation. Correspondence with an NCDOT SME confirmed this interpretation, though it was noted that on rare occasions the Department will partition one DB project into multiple zones and guarantee conditions in those zones for which the Department has “signed and sealed plans.”

GDOT SMEs maintained that the Department is precluded from DSC inclusion by state statutory requirement. Specifically, Georgia Code §32-2-60 (b)[3] holds that GDOT by mandate “does not in any way guarantee the amount or nature of subsurface materials which may be encountered” and “shall not provide compensation above the amount bid on such project solely due to the encountering of subsurface or latent physical conditions at the site which are different from those anticipated by the bidder.”

Relatedly, in a comparative analysis of contractual change order eligibility clauses, GDOT contracts were found to be distinct in their explicit delineation of risk responsibility for “Existing Improvements and Latent Defects.” Leveraging a similar mechanism to the generalized

[3] Official Code of Georgia Annotated §32-2-60 (2010). Retrieved from https://law.justia.com/codes/georgia/2010/title-32/chapter-2/article-4/32-2-60.

avoidance clauses already discussed in other state contexts, GDOT contracts assume a posture of global risk transfer, then define specific standards for DBT remedy through relief and compensation events. For example, a recent Design Build Finance Agreement (I-285/I-20 East Interchange Project; GDOT 2022) establishes that:

> "Developer accepts the Existing Improvements on the Right of Way as is, with all faults, known and unknown, suspected and unsuspected, and without any Authority (or GDOT) obligation to reconstruct, rehabilitate, renew, replace, renovate, or repair any Existing Improvement... Developer shall be responsible for all work and... all costs associated with a latent defect in Existing Improvements."

Through this arrangement, the DBT assumes responsibility for the condition of "the existing highway, bridge, and related improvements" on the Right of Way.

Subsequently, subject to requirements for a reasonable prior investigation and timely notice, related to Existing Right of Way and State Proposed/State Acquired Right of Way, the contractual definitions for relief and compensation events provide remedy for "latent defects discovered in the Existing Improvements to the extent affected or impacted by the Work and as and to the extent materially and adversely affecting the completion of Work on those Parcels identified." GDOT SMEs emphasized that this contractual arrangement was an extension of pre-existing contractual dynamics establishing the DBT's obligation to perform prior investigation and discharge of burden of proof for the event , rather than a supplementary transfer of risk. The SMEs maintained that such contractual language outlining a process for making a claim allows for a fair and streamlined resolution of post-award conflict, while ensuring that GDOT remains in compliance with the statutory code referenced above that governs DSC.

STAs elsewhere have leveraged the flexibility of ACM DSC formulation to extend tailored risk-sharing mechanisms to private partners. As part of the Tappan Zee Hudson River Crossing Project (NYS Thruway Authority 2012), the NYS Thruway Authority crafted a DSC clause granting explicit spatial tolerances for informational accuracy:

> "Grounds for a differing site condition claim also exist if the Design–Builder's pile tests conducted within 100 feet of an Authority [Pile Installation Demonstration Project] pile test location and using comparable pile installation equipment, pile types and pile dimensions as the PIDP demonstrates that the results of the Authority's PIDP were not representative of actual conditions in the area and the PIDP data resulted in inaccuracies in assumptions regarding site conditions made by the Design–Builder, provided that Design–Builder had no actual or constructive knowledge of such conditions as of the Proposal Date.

Although the contract expressly waives responsibility for interpretation and interpolation between borehole locations, this spatial tolerance approach provides some degree of assurance to DBTs in geographies with significant subsurface variation. For ACM projects with similar geological risk factors, or expedited procurement periods which limit prospective DBTs' ability to perform supplemental investigations, providing targeted expansions to DSC clause eligibility factors may represent a palatable risk-sharing strategy for both public and private partners.

Scope Validation Periods

While risk-sharing mechanisms may be made exclusive to utility conflicts, they may be duplicated or extended to other domains as well, with subsurface geotechnical risks providing the most notable example. In one strategy utilized by VDOT and MDOT, the STA implements an SVP contractual mechanism to accommodate most risk vectors associated with any given project, including utility risks. The SVP assigns a discrete duration beginning after procurement with issuance of NTP1, within which the DBT is entitled to report to the STA all newly identified conflicts within the project footprint. Conflicts reported within the SVP are eligible for relief and compensation consideration, whereas conflicts reported after the conclusion of the SVP are not eligible. For example, a typical MDOT SVP definition (M-32 – Linden Church Rd to I-70; MDOT 2018) specifies that "Design–Builder shall be deemed to have expressly warranted that the Contract Documents existing as of the end of the Scope Validation Period are sufficient to enable Design–Builder to complete the design and construction of the Project without any increase in the Contract Price or extension to the Contract Time(s)."

In this way, the DBT is incentivized to expeditiously perform all additional site investigations during the earliest post-award period and discover any latent conflicts that threaten to change or expand the scope of work it is expected to perform. For example, DBTs may need to adjust construction means and methods to accommodate a utility or geotechnical scope change, which can precipitate lengthy delays due to permit revisions or equipment procurement lead times. The early identification of conflicts, and especially conflicts that impact the Critical Path, enables strategic shifting of scheduling and resource attribution to improve the performance of their resolution.

From the perspective of the STA, this risk-sharing approach reduces the risk of last-minute change order submission deep into a project's life cycle. The SVP duration may vary according to the size and complexity of the given project, but it is commonly set to 90 or 120 calendar days. Multiple design–build contractor SMEs noted the potential insufficiency of 90 days to perform all requisite investigations, particularly for projects of significant complexity. Interviewed STA administrators rebuffed this argument, stating that "if the design–builder does what he is supposed to, he should have no problem.” Recent contracts containing SVPs provide exceptions for scope changes encountered in project areas outside of the ROW acquired at time of NTP1; as new ROW is secured, design–builders are granted a limited SVP, typically 30 days, to investigate for the presence of conflicts. Collectively, this approach contains the magnitude and duration of STA change order risk exposure, and as a result it may facilitate more confident cost estimation during project development phases.

The researchers here note that eligibility for relief and compensation is distinct from entitlement to the same. MDOT DB emphasize that the “Design–Builder shall have the burden of proving that the alleged Scope Validation Item could not have been reasonably identified prior to the Price Proposal Submission Date and that such Scope Validation Item materially impacts its price or time to perform the Work.” In submitting its SVP claim, the design–builder is required to provide documentation of the assumptions made during the development of a bid proposal. MDOT retains the authority to adjudicate these assumptions against the information contained within the RFP Documents and the nature of the conflict claimed. Similarly, VDOT SVP definitions maintain that “The term ‘Scope Issue’ shall not be deemed to include items that Design–Builder should have reasonably discovered prior to the Agreement Date.” In coordination with generalized avoidance waivers, this language clearly specifies DBT responsibility for site characterization and protects STAs from exaggerated DSC claims during the SVP.

Deductible Structures

Deductible structures configured to share utilities risks are easily adapted to accommodate geotechnical risks, particularly in coordination with STA formulation of DSC clauses from project to project. Content analysis of STA contract documents confirms the flexibility of this mechanism. For example, TxDOT replicated its UUD to include a Differing Site Conditions Deductible and Deductible Cap for the Southeast Connector Project in the Dallas–Ft. Worth area (TxDOT 2022). As with utilities, the project General Conditions specify the exact eligibility requirements for individual DSC incidents to trigger coverage under the deductible and cap. Encountered TxDOT DSC Deductible and Cap values differ between projects, but they typically range \$50,000–\$75,000 and \$500,000–\$750,000, respectively (Example: Oak Hill Parkway Project; TxDOT 2019). Other STAs, like WsDOT, do not include incident-level threshold requirements for contribution to project deductibles (SR 167/I-5 to SR 509 – New Expressway Project; WsDOT 2021), instead stating:

> "The Design–Builder shall be entitled to an equitable adjustment adjusting the Contract Price only for the actual, reasonable cost increase resulting from Differing Site Conditions, which in the aggregate exceeds \$500,000. The responsibility for the first \$500,000 worth of Differing Site Conditions shall rest solely with the Design–Builder."

In essence, therefore, subject to limitations pertaining to reasonable site investigation and the foreseeability of subsurface conditions, prospective bidders in Washington State can evaluate contract language in pre-award phases to assess their total potential geotechnical risk exposure in post-award phases. In providing the DBT surety in geotechnical risk valuation, WsDOT accepts a theoretically uncapped risk but also receives bid values with smaller geotechnical contingencies. Critically, WsDOT can have confidence in this approach as a result of its comprehensive geotechnical investigative program and GBR composition. As expressed by interviewed SMEs, depending on its relative confidence in subsurface characterization for a project, the Department can calibrate the specificity of its GBRs and DSC deductible value to arrive at a comfortable and competitive equilibrium. In all cases, the burden of proving DSC lies with the DBT, and subsequent adjustments are negotiated, if approved.

Several SMEs alluded to the inclusion of risk-sharing mechanisms for individualized subsurface design elements. For example, geotechnical SMEs from two different STAs advocated for a "threshold" approach to sharing the risk of variable drilled shaft or pile depths. Included in a Contractual geotechnical report are the STA estimations of depth required for drilled shafts or piles in particular locations. If the true depths encountered in the field exceed these estimations, the DBT may be entitled to a financial adjustment. These depth thresholds may be evaluated on an individual or aggregated bases. Depending on the preferences of the STA, the contract may allow for decreases to project award amounts (recouped in full or shared with the DBT) in the event that shaft depths are found to be shallower than a predetermined threshold. A legal SME agreed that such arrangements would allow public and private partners to share in the inherent risks endemic to subsurface construction before finalization of design.

CHAPTER 5. CONCLUSIONS

This study is proposed to offer guidance to GDOT on strategies for the effective identification, allocation, mitigation, and management of geotechnical and utilities risks in ACM settings. Decades of ACM delivery have demonstrated its ability to expedite the design and construction of complex transportation infrastructure. This notwithstanding, the decision to pursue alternative delivery introduces significant geotechnical and utilities risk throughout the life of the project. Much of this risk stems from the inherent conflict between an incomplete design—and, most often by extension, an incomplete investigation—paired with a lump-sum bidded contract price. With some exceptions, DBTs are responsible for executing a project's scope, without further entitlement, irrespective of unanticipated conditions encountered in the construction phase. Private-sector partners have vocalized discontent at their perception of excessive risk transfer, and STA officials have acknowledged these dynamics and sought to strategically mitigate and manage said risks while retaining a competitive procuring environment. This research therefore seeks to identify common utilities and geotechnical challenges and synthesize the diversity of strategies developed by STAs and project networks to address those challenges.

To achieve these ends, researchers engaged in a mixed-methods approach, blending archival content analysis of STA documentation and semi-structured interviews with subject matter experts from across the country. This method of investigation enabled a holistic evaluation of ACM problems and practices, as SMEs contextualized the strategies encountered in archival analysis and provided their on-the-ground perspective of the issue profile. A diversity of professional experience was sought to capture differences in opinion within and across the policy implementation network. A summary of results is captured in table 4.

Table 4. Results summary.

	Challenges	Strategies
Utilities	1. Pre-award utility investigative scope 2. Contractual reliability of pre-award information 3. 3rd party communication and coordination	1. Increases to SUE program scope, espescially Quality Level A 2. Explicit spatial tolerances for SUE data accuracy 3. Risk-sharing mechanisms like Deductibles, SVPs 4. Increased execution of advanced utility relocation 5. Utility Manager as Key Personnel
Geotechnical	1. Pre-award geotechnical investigative scope 2. Contractual reliability of pre-award information	1. Increases to geotechnical investigative scope, including geophysical and CPT techniques 2. Provision of archival data in a dynamic repository 3. Contractual provision of an interpretive Geotechnical Baseline Report 4. Provision of a Differing Site Conditions clause 5. Risk-sharing mechanisms like Deductibles, SVPs

The collective research results, both challenges and resulting strategies, may be organized into two main thrusts: topics addressing (1) the scope, quality, and typology of pre-award investigations and information; and (2) the legal coordination of that information as mediated through contract and auxiliary documents. Private-sector SMEs advocated for increases to investigative scope paired with increases to the contractual reliability of that information in post-award phases. STA SMEs acknowledged the need for balanced risk allocation, but they differed in opinion on the fine details of implementation. For example, some states routinely generate a Geotechnical Baseline Report as a Contract Document, whereas others exclusively supply geotechnical data as part of Reference Information Documents. Pre-award advance relocation of utility facilities, in addition to the execution of MOUs for Utility–DBT cooperation, can mitigate the potential for post-award conflict while lubricating the management of the residual risk. These strategies, together with a healthy partnering environment, help lay the foundation of successful, strategic risk sharing between public and private partners in ACM project settings. In synthesizing these insights and best practices from across the country, this research provides guidance to STAs as they manage geotechnical and utilities risks in an era of fast-growing ACM utilization.

APPENDIX

Interview Protocol Template for Utility SMEs

1) Compare and contrast the utility risk profiles of DBB projects versus ACM projects.
    - *i) What are the largest sources of utility risk for ACM projects?*
2) Describe the allocation of utilities risks in a typical ACM project.
    - *i) Do you feel this allocation is appropriate?*
        - *(1) If not, why?*
        - *(2) What factors should be considered in determining the allocation of utilities risks?*
    - *ii) Has utility risk allocation evolved over time?*
        - *(1) If yes, how?*
3) What are best practices to minimize and mitigate utility risks in the:
    - a) pre-award project phase?
        - *i) Describe the role of subsurface utility engineering (SUE) investigations*
            - *(1) What factors are considered to decide the scope and quality level (ASCE 38-22) of SUE investigations pursued for a project?*
        - *ii) Describe the role of STA-managed advanced utility relocations*
            - *(1) What factors are considered to determine the suitability and need for advanced relocation?*
    - b) post-award project phase?
        - *i) Describe the utilities risk-sharing policies or contractual mechanisms you have encountered in ACM projects*
            - *(1) What risk-sharing policies are effective for managing utilities risks? Ineffective?*

(2) *What are the advantages and disadvantages of explicit spatial tolerances for utility information provided in the pre-award phase? How should they be structured?*

(3) *What are the advantages and disadvantages of a Scope Validation Period (SVP) policy? How should it be structured?*

(4) *What are the advantages and disadvantages of a utility deductible policy? How should it be structured?*

4) Describe the nature and importance of communication and coordination activity between STAs, Design-Build Teams, and 3rd Parties.

(1) *How do communication and coordination activities introduce utility risks to ACM projects?*

(2) *What best practices effectively manage these risks?*

Interview Protocol Template for Geotechnical SMEs

1) Compare and contrast the geotechnical risk profiles of DBB projects versus ACM projects.

i) What are the largest sources of geotechnical risk for ACM projects?

2) Describe the allocation of geotechnical risks in a typical ACM project.

i) Do you feel this allocation is appropriate?

(1) *If not, why?*

(2) *What factors should be considered in determining the allocation of geotechnical risks?*

ii) Has geotechnical risk allocation evolved over time?

(1) *If yes, how?*

3) What are best practices to minimize and mitigate geotechnical risks in the:

a) pre-award project phase?

i) Describe the role of subsurface geotechnical investigations.

(1) How would one determine an appropriate scope of investigation?

(2) What are the advantages and disadvantages of geophysical exploration methods?

(3) What are the advantages and disadvantages of archival geotechnical information?

ii) Describe the factors that should be considered regarding the 'contractual' inclusion or exclusion of geotechnical information in procurement documentation.

(1) What are the advantages and disadvantages of generating and contractually-including a Geotechnical Baseline Report?

b) post-award project phase?

i) Describe the geotechnical risk-sharing policies or contractual mechanisms you have encountered in ACM projects

(1) What risk-sharing policies are effective for managing geotechnical risks? Ineffective?

(2) What are the advantages and disadvantages of a Scope Validation Period (SVP) policy? How should it be structured?

(3) What are the advantages and disadvantages of a geotechnical deductible policy? How should it be structured?

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