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Modernizing Utility Infrastructure Management

Research Project Results for:

Early Identification and Location of Utility Facilities within Iowa DOT Project Footprints

2023

Report Prepared by:

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16. Abstract:

Identification of utilities within Iowa Department of Transportation (Iowa DOT) project footprints requires proactive documentation of utility infrastructure within Iowa DOT right-of-way (ROW) based on:

1) A standard for recording utility infrastructure, such as the new ASCE/CI/UESI 75-22 "*Standard Guideline for Recording and Exchanging Utility Infrastructure Data*"

2) Lifecycle asset management practices for all facilities installed within Iowa DOT ROW including:
   a. systematic permitting to regulate and monitor all changes and construction activities affecting utility infrastructure; and
   b. a federated utility data GIS collaboration portal that functions like a secure repository, built around ASCE/CI/UESI 75-22, and based on shared standardized data from systems of record.

3) Systematic capture and management of standardized data when installations are newly installed, exposed for construction or maintenance purposes, investigated for project development needs (such as by subsurface utility engineering methods in accordance with ASCE/CI/UESI 38-22 "*Standard Guideline for Investigating and Documenting Existing Utilities*"), or proposed for permitting approval.

Compliance with ASCE/CI/UESI 75-22 is essential: 1) ASCE/CI/UESI 75-22 has been designed for capturing sufficient spatial and attribute data on utilities to enable creation of an accurate 3D digital twin; and 2) the Open Geospatial Consortium (OGC) has adopted ASCE/CI/UESI 75-22 as key input to their Modeling Underground Data Definition and Integration (MUDDI) standard, which means emerging software applications will be able to accept, visualize, and share digital 3D models of utilities seamlessly. ASCE/CI/UESI 75-22 is designed to manage ASCE/CI/UESI 38-22 data in digital format and is scalable to accommodate the most primitive record data. Concurrently, Iowa DOT to implement ASCE Utility Engineering best practices to leverage utility data in manner that mitigates project risk, optimizes project delivery, and upholds public interest and welfare from a holistic stance. Iowa DOT return on investment factor for projects alone is estimated to average between 10 and 20.

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Utility Engineering, Utility Investigations, Subsurface Utility Engineering, Surveying, Planning and Design, Construction, Transportation, Infrastructure, Sustainability, Implementation, Utilities, Utility Infrastructure Data, Utility Installations, Utility As-built, Utility Permitting, ASCE 38, ASCE 75, Utility Engineering and Surveying Institute, Utility Risk Management, Federated Utility GIS Collaboration Portal, Utility Data Repository, Point 25 Process, Utility Infrastructure Management, Optimized Project Delivery, Utility Conflict Matrix, Conflict Resolution Engineering, Utility Coordination, Digital As-built Data, Utility Asset Management, Utilities in Iowa DOT Right-of-Way (ROW)		Not restricted.		
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1) The Iowa Department of Transportation (Iowa DOT) includes officials from Research, Right-of-Way, Utilities, Design, and Construction divisions.

2) Private and public utility infrastructure owners that operate systems residing within Iowa DOT public right of way.

3) Contractors that perform construction work for Iowa DOT.

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Executive Summary

This Iowa Department of Transportation (Iowa DOT) funded research focused on policies and processes necessary to get reliable information on utility infrastructure residing within a project footprint early in the design development stage. Iowa DOT right-of-way (ROW) managers, design engineers, utility agents, construction engineers, geographic information system (GIS) and internet technology leads, design consultants, construction contractors, and private and public utility infrastructure representatives were among those interviewed to understand existing practices, issues, and perspectives. A Technical Advisory Committee (TAC) composed of representatives from utility owners, contractors, consultants, and Iowa DOT participated in regular progress meetings and provided feedback on research findings.

The research encompassed relevant best practices, policies, and standards employed by local governments and state transportation agencies within the United States and by government agencies in Canada and promoted by entities including, but not limited to, the U.S. Department of Transportation Federal Highways Administration (FHWA), the Transportation Research Board (TRB) Utilities Committee (AKD60) of the Academy of Sciences, and the American Society of Civil Engineers (ASCE) Construction Institute (CI) and Utility Engineering and Surveying Institute (UESI). In addition, emerging technologies, and newly published standards for acquiring, managing, leveraging, and securely sharing utility infrastructure data were evaluated for Iowa DOT needs.

A fundamental factor behind the need for this research effort is the simple fact that a "utility as-built" record standard specification has never-before existed in the U.S.; that changed in July 2022 when ASCE published ASCE/CI/UESI 75-22[1]. This new "utility as-built" standard can be utilized within regular Iowa DOT business activities to record utility data, including positional coordinates, dimensions and geometry, and feature attributes, on utility infrastructure during road design and road construction efforts, and whenever new utility infrastructure is permitted and installed within Iowa DOT ROW.

A "SWOT" analysis was performed to identify Strengths, Weaknesses, Opportunities, and Threats related to migrating from the "as-is" situation to an achievable "to be" scenario which enables existing and emerging best practices and technologies. The results indicate utility infrastructure data can be routinely captured and securely shared, enabling a myriad of beneficial uses for Iowa DOT projects and ROW management. Reaching this goal simply requires: 1) enacting relatively straightforward changes to existing Iowa DOT business processes, including utility permitting; 2) utilizing affordable data acquisition technologies and existing geographic information system (GIS) applications; and 3) implementing newly published ASCE standards for investigating, documenting, and recording digital data for utilities.

The strategy will: 1) streamline utility information exchange and reduce data handling requirements; 2) shift responsibility to the "systems of source" (i.e., utility facility owners) to acquire, manage, and securely share data as required; and 3) effectively decrease Iowa DOT resources required to pursue and reckon with utility infrastructure data deficiencies while enabling utility engineering best practices that

[1] *Standard Guideline for Recording and Exchanging Utility Infrastructure Data*, American Society of Civil Engineers Construction Institute and Utility Engineering and Surveying Institute, (ASCE/CI/UESI 75-22), Reston, VA July 2022

expedite project delivery, decrease costs, improve ROW management, and enhance the public welfare. Existing FHWA policy and Iowa DOT statutes support the recommended practices and implementations.

The research effort produced a "road map" for modernizing Iowa DOT business practices and corresponding technology landscape to acquire and manage data on utility infrastructure residing within Iowa DOT ROW. A staged implementation strategy is recommended. The research did not develop a new utility accommodation manual for Iowa DOT nor recommend utility coordination practices for projects; these are being addressed through two separate, concurrent Iowa DOT research efforts: 1) SPR-RE22(011)-8H-00 *Best Practices for Utility Management in the Public Right of Way*, and 2) SPR-RE22(012)-8H-00 *Project Development and Utility Coordination as a Partnership*. However, the recommendations herein directly correlate and are in harmony with the recommendations from those projects.

Executive Overview of Problem and Solution

Times Have Changed

*Swelling **public demand** to utilize public ROW to accommodate utility infrastructure has escalated Iowa DOT ROW corridor congestion. **Projects and utility systems are much more complex today.***

***Moving utilities out of the way for Iowa DOT projects is often no longer a simple matter and often not the best option** (regarding project schedule, project cost, public disruption, societal cost, public interest).*

Iowa DOT policies, procedures, and technologies for Managing Utilities in Iowa DOT ROW need updating.

Numerous Iowa DOT right-of-way (ROW) management policies and procedures were established during an earlier era when:

- Roadway systems were simpler and less congested.
- Utility systems were much less complex (e.g., overhead) and there were only a few service providers.
- ROW and easements were less expensive and easier to obtain.
- Utility materials (e.g., pipes, valves, transformers, switch boxes, poles, cables) were primarily U.S. manufactured and supplies relatively abundant.
- Implications of utility conflicts discovered before and during construction were relatively easy to identify and manage.

Figure 1. Highway 51 near Lansing (circa 1930)

Since that time, however, utility related issues on Iowa DOT projects have become increasingly problematic due to evolutions that improve infrastructure resilience and environmental, public safety, social and business conditions, while increasing demand for and congestion of public ROW.

These changes include:

- Population growth and urbanization, triggering new facilities and added capacity.
- Public preferences for buried cables and pole removal.

- Utility deregulation leading to multiple and rival service providers (yielding greater services at competitive pricing, while creating fiercely competitive business environments and leaner operating margins).
- Aging infrastructure that are decommissioned, abandoned-in-place, bypassed and/or replaced with new installations in the same vicinity (which confuses the subgrade environment).
- Arising renewable energy sources (e.g., wind farms, solar parks) and corresponding infrastructure to gather, transform and transmit electric power.
- Mandates to make our utility infrastructure more resilient (e.g., buried) and secure (e.g., locked and off-limits, data not shared).
- Arising electric vehicle usage requiring high voltage transmission and charging stations.

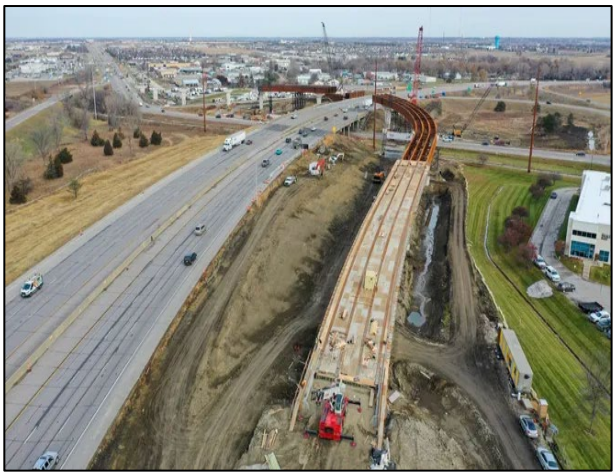


Figure 2. Hwy 141 Flyover at I-35/I-80 – Urbandale (circa 2023)

- Equity and inclusion directives to install broadband to reach underserved communities.
- Ubiquitous skyrocketing rise in internet and 5G cellular usage and dependence.
- E-commerce industry and telecommuter boon along with corresponding internet demand.
- Migration from internal network server systems to commercial data centers and cloud hosting, and the growth of large data centers, such as owned by Google, Microsoft, Amazon, Facebook, etc., which require dedicated private fiber networks to their facilities.
- Migration to offshore manufacturing and international trade agreements (which has resulted in a reduction of U.S. built utility infrastructure equipment and supplies).
- Increasing complexity and specialized nature of utility control equipment (which now require microchip processors and internet service to operate – valves, switches, sensors require specialized parts and manufacturing skills not prevalent anywhere, let alone within the U.S.).
- "Buy America Build America" (BABA) mandates associated with Federally funded projects (which result in supply shortages, backlog orders for made-in-USA products, lengthy exemption applications and approval efforts, and corresponding project delays).
- Skilled technical and trade labor shortages (which result in utility relocation related project delays).

The explosion of technologies that enhance and enable daily commercial, government, and private citizen activities (e.g., artificial intelligence, autonomous and electric vehicles, security systems, renewable energies, ecommerce, etc.) is occurring because of public demand and interest, therefore consideration for these assets falls under the auspices of the Iowa DOT. Utility infrastructure owners today encompass a diverse array of private banking, insurance, warehouse and distribution centers, and data management entities in addition to conventional utility companies. Large insurance and banking companies, for example, are often required to have redundant systems which include fiber optic

installations to offsite data centers. These entities are simply not accustomed, staffed, or prepared for typical Iowa DOT project development utility coordination activities.

The summary impact of these evolutions is as follows:

1. **Swelling public demand to utilize public ROW to accommodate both private and utility infrastructure has escalated Iowa DOT ROW corridor congestion.**
2. **Moving utilities out of the way for Iowa DOT projects is often no longer a simple matter and often not the best option (with regard to project schedule, project cost, public disruption, societal cost, public interest)**.

Not only is it more challenging to design a relocation, but the relocation process is greatly complicated and delayed by limited easement availability, labor and material shortages, skyrocketing costs, and efforts which require multiple years of advanced planning and scheduling. Without change, utilities will increasingly impact the critical path for project schedules.

These trends are expected to continue and corresponding ramifications for error are expected to become further problematic. This situation is not unique for Iowa, but true for all state and local roadway corridors nationwide.

There is need for all agencies responsible for managing public ROW, including Iowa DOT, to modernize utility infrastructure management.

Better Data (ASCE 38 / ASCE 75) and Engineering (Utility Engineering) are Required.

***Utility owners are rarely contractual parties to the infrastructure project development process**, yet their existing pipes, cables, and support structures have significant effects on project risk, schedules, and budget.*

*Finalizing designs with non-standardized, unreliable utility data and **addressing utility issues with belated, reactive measures during construction is more disruptive and costly, and less efficient** than leveraging proactive, predictive, and sophisticated analytical and problem-solving strategies developed by professionals with reliably qualified utility data during design development.*

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

***ASCE** has developed two data **standards**, to assist engineers in managing risk associated with utility infrastructure. **Utility Engineering** is the process of integrating utility infrastructure with project development.*

Utility related problems in design and construction are nearly always the result of:

1. inadequate (i.e., readily accessible, reliable, complete, current and standardized) information (e.g., spatial, pedigree, ownership, operational, and regulatory data) on existing infrastructure; and
2. insufficient (cross-disciplined, experienced, and available) engineering staff and supporting resources to perform required conflict analytics, conflict mitigation design, utility coordination, and utility adjustments. (This often true for both the utility owner and design team representation.)

The combination of the above leads to unsophisticated project development practices with pitfalls. Utilities tend to be treated as an administrative activity with blanket low-tech relocations applied. An engineering evaluation of time, schedule, cost, risk and societal impacts, and value achieving alternative resolutions is rarely performed. Overlooked are value-achieving opportunities to optimize the overall project critical path and expedite project delivery.

Moreover, without exception, finalizing designs with non-standardized, unreliable utility data results in designs that require belated, reactive adjustments during construction that **are more disruptive and costly, and less efficient** than that achieved through leveraging proactive, predictive, and sophisticated analytical and problem-solving strategies developed by professionals with reliably qualified utility data during design development.

The common issue of inadequate utility data is rooted in the fact that: 1) the Iowa DOT (indeed, nearly if not all public agencies managing ROW) have never specified and enforced the documentation of standardized "as-built" data for utilities at the time of installation; and 2) until recently (July 2022) a published standard for utility "as-built" data did not exist in the U.S. Accordingly, utility owners most often lack necessary procedures and do not retain accurate, standardized utility as-built data that is useful and shareable for Iowa DOT design needs.

This is the primary reason why attempts to make utilities responsible for providing accurate, design grade data on their installations, along with using threats and lawsuits to force compliance repeatedly fail to resolve the problem. This legalized "**big stick approach**" needlessly strains tenuous, and often creates adversarial, relations between utility infrastructure owners and DOT management; moreover, the results yielded come at a cost that is often not in the public's best interest as ratepayers and taxpayers, commonly the same entity, end up footing the bill. In response, the engineering community through an international effort has focused to provide a more sophisticated and effective "carrot approach".

The American Society of Civil Engineers (ASCE) has developed a specialized multi-discipline engineering function that is based on systematic data acquisition, conflict and critical path analytics, and effective risk mitigation and project delivery optimization (i.e., Utility Engineering). The following abstract for an ASCE webinar[2] presented by the in August of 2022 provides an applicable summary of the situation and solution:

> *Utility owners are rarely contractual parties to the infrastructure project development process, yet their existing pipes, cables, and support structures have significant effects on project risk, schedules, and budget. Reliance upon utility owner records for design base conditions has proven insufficient as these are often inadequate or incompatible with designer needs, especially within congested urban corridors. Historically, engineers delegated the problem, through disclaimers and onerous contract language, onto the contractor. This escalates project costs as contractor contingency rises to reactively address unforeseen utility issues, but more importantly, engineers forgo opportunities to proactively and strategically address base conditions that affect public health, safety, and welfare (such as worker safety, integrity and operations of vital utility services, traffic and commercial disruption, public discomfort, and societal costs) in the planning and design stages. ASCE developed two standards, ASCE/UESI/CI 38-22[3] (ASCE 38) and ASCE/UESI/CI 75-22 (ASCE 75), to assist engineers in managing risk associated with utility infrastructure. Although a non-mandatory consensus standard it is considered a best practice in many states and Colorado (with minor additional language), has turned ASCE 38 into a statutorily[4] required standards for all public projects disturbing more than 1,000 square feet and 2-feet of depth. The results from Colorado have*

[2] Anspach, James H. and Philip J. Meis, Abstract - ASCE Government Relations Presentation on ASCE 38 and ASCE 75 - Reduced Time and Cost Force Multiplier for IIJA Projects, August 22, 2022

[3] *Standard Guideline for Investigating and Documenting Existing Utilities*, American Society of Civil Engineers (ASCE) Construction Institute (CI) and Utility Engineering and Surveying Institute (UESI), Reston VA July 2022

[4] 811 Law – Colorado Damage Prevention Law: TITLE 9 SAFETY - INDUSTRIAL AND COMMERCIAL ARTICLE 1.5 Excavation Requirements (C.R.S. 9-1.5-101) crs2018-title-09.pdf (colorado.gov), 2018

Pennsylvania and other states following suit. The Engineers Joint Committee on Contract Documents (EJCDC) consisting of ASCE, NSPE, and ACEC also reference these standards as a basic engineering service[5]. ASCE 38 and ASCE 75, along with new technologies for cloud-based data management and geophysical methods for seeking out utilities, are driving new and untapped risk management strategies for project development.

ASCE 38 - Standard Guideline for Investigating and Documenting Existing Utilities

ASCE 38 is an engineering standard that provides for a professional utility investigation and documentation effort conducted under the direct oversight of a competent professional specialized in this unique discipline considered a branch of civil engineering. The following excerpt from the ASCE 38 standard Preface provides an appropriate synopsis:

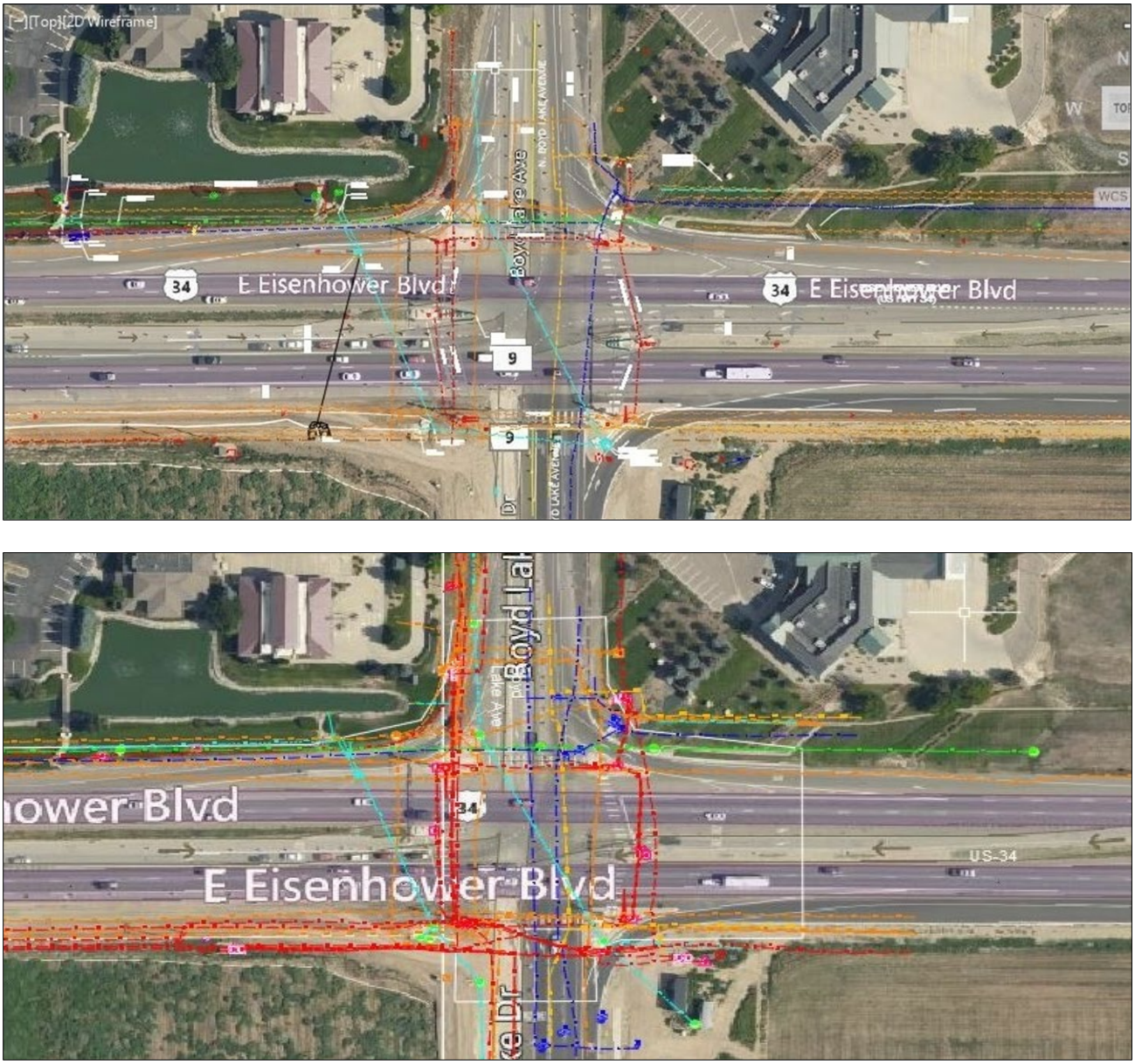
ASCE 38 is a combination of a prescriptive standard and a performance standard. As a prescriptive standard, it sets forth a series of minimum actions necessary to achieve Utility Quality Level Documentation. As a performance standard, it describes the significant professional judgment exercised by the professional to determine the appropriate timing, sequencing, location, and scope of a Utility investigative effort to achieve the goal of reduced Utility issues during Project Delivery. This engineering standard is developed to safeguard the public welfare by providing guidance on performing Utility Investigations and documenting results in a standardized fashion, which in turn empowers the design engineer to address two objectives: (1) design so as to have minimal Utility related issues; and (2) protect engineers, project owners, Utility owners, and the public against Utility related claims that might arise during Project Delivery. ASCE 38 minimizes issues that might otherwise arise from using incorrect and incomplete Utility data. Moreover, ASCE 38 compliant data clearly conveys, through graphical and written documents, the relative, nonquantifiable uncertainty associated with the Utility's existence and location. Throughout Project Development, understanding the uncertainty assigned to a documented Utility allows engineers to make better risk-based decisions regarding placement of design elements, protecting or relocating utilities, and public safety issues.

An ASCE 38 data set provides significantly better information because it involves a methodical utility investigation that employs sophisticated geophysical tools, qualified personnel, a rigorous quality management program, professional judgement and is performed under the direction and direct oversight of a competent professional who is subject to the ethics and statutory obligations established to regulate the practice of professional engineering. That competent professional must understand the physics behind the technologies employed and corresponding capabilities, limitations, and pitfalls. Additionally, that professional's expertise must include the principles and practices associated with engineering survey, utility systems and construction, utility accommodation policies, civil engineering and construction, and corresponding risks arising from the presence of utility infrastructure within the project footprint.

[5] E570-2020-Summary-of-Changes.pdf (ejcdc.org)

Figure 3 provides a typical example comparing a depiction based on historic utility record data and Call 811 markings verses an ASCE 38 investigation. Note differences in alignments and quantity of utilities. Use of ASCE 38 often produces 20% to 30% more linear feet of depicted utility infrastructure than achieved through historical utility record transcription and survey of Call 811 field markings.

Figure 3. Colorado Department of Transportation Case Study: US-34, from Denver Avenue to Boyd Lake Avenue: Top - Utility Depiction Based on Record and Call 811 data, Bottom – ASCE 38 Utility Depiction



Case study depictions provided courtesy of Utility Mapping Services, PC

The case study example in Figure 3 is reinforced by a current Iowa State University investigation[6] comparing "One Call" and "Subsurface Utility Engineering (SUE)" data; (ASCE 38 is often referred to as the "SUE Standard").

The following is an excerpt from the draft report results section:

The comparative study between the One Call and SUE records highlighted substantial discrepancies in the reported utility linear footage. These discrepancies emerged across various utility types, such as over-head power cables, power cables, telecommunications, gas, and water lines. Table 1 illustrates these differences, with the percentage difference column showing the variation between utility footages recorded by the One Call system and the SUE investigations.

Table 1: Comparison of Utility Linear Footages in One Call Records and SUE Investigations

Utility Types	One- Call record (ft)	SUE record (ft)	% Difference
Over-head power cable	7602	32690	330%
Power cable	10756	14577	36%
Telecommunications	6920	40003	478%
Gas	4802	6164	28%
Water	8653	9680	12%

…

The findings underscore the importance of incorporating SUE practices early in the project development stages to ensure reliable utility data for design decisions. By conducting in-depth investigations and assigning quality levels to utilities, SUE practices offer a systematic approach to reduce utility-related risks and conflicts. Our study demonstrated that SUE investigations identified a higher quantity of utility linear footage compared to the One Call records, with differences ranging from 12% to as high as 478% for various utility types.

Use of ASCE 38 on projects has historically produced a documented return on investment (ROI) factor averaging 4.52[7]; however, recent progressions utilizing conflict analytics and innovative engineering and construction has pushed this ROI to between 10 and 20 times the cost[8] .

[6] Adebiyi, Jeremiah A., James H. Anspach, Roy E. Sturgill, Ph.D., P.E., Evaluating Utility Data Reliability: A Comparison of One Call and Subsurface Utility Engineering (SUE) Records, Draft Report, Dept. of Civil, Construction, and Environmental Engineering, Iowa State University, June 2023

[7] Purdue University Department of Building Construction Management. Cost Savings On Highway Projects Utilizing Subsurface Utility Engineering. Prepared for the Federal Highway Administration.1999. FHWA Contract Number DTFH61-96-00090

[8] Quiroga, Cesar, Ph.D., PE, Texas Transportation Institute of Texas A&M, Personal Communication regarding implementation of SHRP2 R15C Identification of Utility Conflicts and Solutions at the Texas Department of Transportation, January 12, 2023

Iowa DOT Point 25 Process – A Good Start

*The **Point 25** process provides administrative steps and timelines for managing utility infrastructure during Iowa DOT project development; however, the process **lacks critical engineering activities**.*

*The concept of **Utility Engineering (UE)** in which utility infrastructure is fully integrated within the project design effort, **has developed since Point 25 was put into action**. With some minor amendment, Point 25 fits well within the UE Utility Coordination function (next section).*

*Iowa DOT project development activities need **revising to include Utility Engineering (UE). UE requires cross discipline expertise***

In 1999, the Associated General Contractors of Iowa (AGC) requested Iowa DOT arrange a meeting between AGC contractor membership, Iowa DOT, and utility representative. This meeting convened on February 1, 2000, and involved primary parties involved in utility relocations on transportation construction projects. The focus of the meeting was to emphasize the necessity to relocate utilities earlier to avoid unnecessary project delays. The primary concern expressed by AGC members at the meeting was limited coordination between Iowa DOT and utilities prior to the start of construction.

In response Iowa DOT reorganized in 2000 and, as part of that, the responsibility for utility coordination was assigned to each district's District Utility Coordinator (DUC). Iowa DOT also began having annual meetings with utility owner representatives throughout the state. In addition to improving relationships through annual meetings and the assignment of the utility coordination to the district, Iowa DOT reviewed and rewrote its administrative rules regarding the accommodation of utilities on highway right-of-way. A new policy was developed for the adjustment of utilities on construction projects. This "Point 25" policy and process is outlined in Iowa Administrative Code 761--Chapter 115.25. The policy allows for a window of time, where possible, for the adjustment of utilities in the Project Development Process.

The Point 25 process was originally pushed out in 2003 with the code section 306A.3 and then IA Administrative Code Chapter 761.115.25 through 761.115.30. The policy was revised in 2005 to incorporate the Point 25 through Point 30 IAC sections, but it took five years, until after 2010, for Iowa DOT to really begin using the Point 25 process.

However, while **Point 25** (Iowa Administrative Code 761 Chapter 115[9]) addressed utility coordination administrative activities and corresponding timelines for the utility relocation process in a comprehensive manner, it **lacked specifications for critical engineering activities**; this in turn led to inconsistent results and often missed opportunities to optimize project delivery. For project development the Code simply stipulates the following key items along with related notification, procedural and timeline criteria:

> 115.25(3) **Adjustment of a facility occupying highway right-of-way.** If adjustment of an existing utility facility occupying the right-of-way is required due to highway construction, the utility owner shall adjust the facility without cost to the state and, *whenever possible*[10], in advance of the highway work.
>
> 761--115.26(306A) **Notice of project.**
>
> 115.26(1) **Determining affected utilities.** The department shall make a reasonable effort to determine what utility facilities are located within the project limits of a state highway improvement project by researching permit files, through field investigations or contacts with one-call locating services, and through contacts with local government units.

Missing are specifications for essential engineering efforts required to: 1) fully investigate and reliably depict utilities in accordance with a published professional standard; 2) systematically identify and assess design impacts to utilities and utility impacts to design; 3) rigorously analyze resolutions; and 4) develop and execute a utility plan that mitigates risk and optimizes project delivery while holding public interest paramount. For example, the integration of utility adjustments concurrently within mainline project construction reaps tremendous value and efficiencies associated with having traffic control established, pavement torn out, and rough grading established. While efforts to develop basic concepts and practices for managing utilities on projects have been occurring over the past 40 years, the formal bundling and categorizing of these activities under a specialized discipline of civil engineering entitled **Utility Engineering** or **UE** is recent.

Over the past decade UE has been adopted and championed by entities including the American Society of Civil Engineers (ASCE), Federal Highways Administration (FHWA), and the Transportation Research Board (TRB) of the National Academies of Science, Engineering and Medicine. The fact that Iowa DOT did not include UE within the Point 25 process is understandable. Until as recently as 2021, formal training in UE at the university level has simply been non-existent within any of the civil engineering

[9] *Accommodating and Adjustment of Utilities on the Primary Road System*, Revised and Implemented December 2005, Revised Section 115.1(306A) January 2012, Revised Appendix E1 through E12 in accord with Iowa Administrative Code 761 Chapter 115 (306A) Available On-Line: http://www.dot.state.ia.us/traffic/index.htm , Revision (A)Feb 2012

[10] The "whenever possible" part of the code needs to be defined better. It is generally possible for most relocations to take place prior to construction as long as the DOT has any new right of way secured. However, it us usually more practical to complete the relocations during the construction project since traffic control is in place, pavement has been removed, and rough grading has taken place. In my experience, in most cases the utility companies would like to complete their relocations during the roadway construction. Technical Advisory Committee Review Comments, Gabriel A. Nelson, P.E., Civil Engineer, Snyder and Associates, June 12, 2023

curriculums in the U.S. or worldwide. In fact, it was Drew F. Markewicz, P.E., PMP, Current Director of Highways and Utilities at NV5 in New Jersey, who gave an original presentation at the 2011 AASHTO Utilities and Right of Way Conference in St. Louis and again at the 2012 Transportation Research Board Utilities Committee in Washington DC, and later published[11] in which he identified that a "cross-discipline" specialized engineering gap existed.

Mr. Markewicz described the Utility Technical Discipline Void with the following points:

To Bridge the Gap…

- *Must Understand BOTH Agency and Utility Needs*
- *Be Knowledgeable of BOTH Agency and Utility Owner Policies, Procedures, and Requirements*
- *Have "Cross Discipline" Design Experience in BOTH Transportation and Utilities*
- *Experience in Identifying, Prioritizing, and Mitigating Risks for BOTH Transportation and Utilities*
- *Have a Design Understanding of Highways, Drainage, Structures, Traffic, Right-of-Way, etc.*
- *Experience in Resolving Utility Field Construction Issues*
- *Ability to Perform Constructability Reviews involving BOTH Transportation and Utilities*
- *Understand Construction Staging and Sequencing for BOTH Transportation and Utilities*
- *Ability to Establish Relationships, based on Mutual Understanding and Trust*
- *Ability to Recognize Time and Cost Innovative Utility Solutions*

To address this cross discipline "gap" in civil engineering practices, ASCE launched their ninth institute in 2015[12], the ***Utility Engineering and Surveying Institute*** **(UESI)**. UESI is supporting appropriate research and guidance for UE and has formed committees for developing corresponding manuals of practices, certifications for engineers and technologists, and supporting standards. UESI's Utility Risk Management Division (URMD) is currently focused on establishing UE standards of practice with committees for utility investigations and subsurface utility engineering, conflict analytics and utility coordination, and standardized utility "as-built" documentation, data exchange, security and management. UESI has helped to develop Utility Investigation Schools which provide training for utility investigations performed in accordance with the ASCE/CI/UESI 38-22 standard (discussed below) and is developing a certification program to qualify individuals conducting the various specialized UE activities.

In addition, Texas A&M and Iowa State University (ISU) have introduced UE into their civil engineering curriculum. [Note: The University of Texas Arlington and Purdue are currently introducing related trenchless technology (i.e., horizontal directional drilling or HDD) programs but working toward introducing full UE curriculum into their civil engineering programs.]

[11] Markewicz, Drew, P.E., PMP, Senior Project Manager, Highways and Utilities, RBA Group, *Why do Utilities Continue to Adversely Impact Transportation Projects … or Do They?*, Ask the DP Pro Section, Damage Prevention Professional Magazine, dp-pro.com, Spring 2014, pages 8-9

[12] *UESI was officially authorized by ASCE to operate as a "Provisional Institute" in 2015 and an Institute in 2018.* James (Jim) H. Anspach, PG (r), Dist.M.ASCE, NAC, Affiliate Assistant Professor, Iowa State University, 2017-18 UESI Chair. Personal communication 07 April 2023

Roy E. Sturgill, Jr., Ph.D., P.E., assistant professor for ISU's Civil, Construction and Environmental Engineering Department and current TRB Utilities Committee (AKD60) Chair, and James (Jim) H. Anspach, PG (r), Dist.M.ASCE, NAC, Affiliate Assistant Professor, currently lead UE research and academic efforts at ISU.

Utility Engineering

Iowa DOT Project Development activities and procedures currently result with ***inconsistent efforts to identify and address utility infrastructure issues****. Iowa DOT ROW management practices* ***do not adequately consider lifecycle management of utility assets*** *located within Iowa DOT ROW.*

Newly defined ***Utility Engineering (UE) activities encompass both project development and asset management efforts*** *that effectively eliminate utility related issues and better serve public interests.* ***Required, however, is reliable, standardized utility data.***

UE **Utility Investigations** for project development will **produce reliably qualified utility data through ASCE 38 standardized process for investigating and documenting previously installed existing infrastructure.** This enables risk mitigation and optimize project delivery. UE **Utility Asset Management** will ensure **utilities are accurately recorded at the time of installation or when exposed. The ASCE 75 standard is used push all utility data into a common digital format.**

Cesar Quiroga, Ph.D., P.E., F. ASCE, Senior Research Engineer for Texas A&M Transportation Institute is currently the Manager for the Utility Engineering Program at Texas A&M University.

While Chair for the TRB Utilities Committee (AKD60) and serving on the ASCE UESI Utility Risk Management Division Executive Committee (URMD), Dr. Quiroga formulated the definition of Utility Engineering as based upon the following "Six Pillars" as shown in Figure 4. The UE pillars are summarized as follows:

- **Utility Coordination:** Techniques and procedures to provide effective coordination between project owners and utility stakeholders (including preparation, execution, and management of utility agreements, as well as management of utility-related documents in bid packages)

- **Utility Investigations:** Professionally investigated and documented utility data in accordance with ASCE/CI/UESI 38-22. This is a prescriptive standard for investigating existing utilities using a variety of sophisticated geophysical and engineering methods by competent professionals to establish and depict the presence of existing utilities. The depictions are qualified with a reliability attribute to facilitate usage for project development, conflict analytics, value engineering, utility coordination, and construction. **ASCE 38 data can be pushed into digital format (per ASCE/CI/UESI 75-22)** to enable a myriad of virtual design and construction (VDC) and digital project delivery methods, and facilitate subsequent ROW management, damage prevention, emergency response, maintenance, and future project needs.

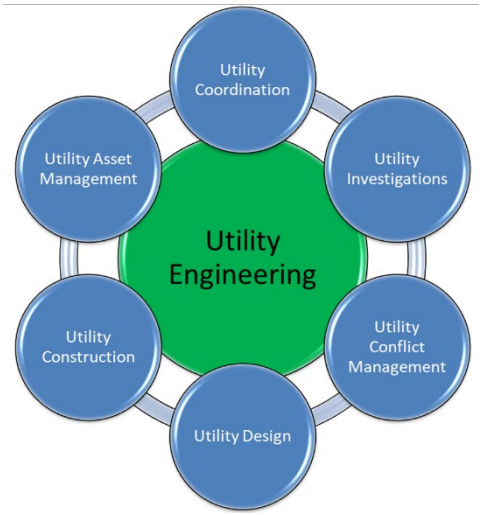


Figure 4 The Six Pillars of Utility Engineering as outlined by Cesar Quiroga, Ph.D., P.E., F.ASCE

- **Utility Conflict Management:** Professional, multilateral assessment of conflicts and best solutions consistent with SHRP2 R15B[13] recommended practices and processes, including project schedule critical path analytics.
- **Utility Design:** Design (including preparation of plans, specifications, schedule, and cost estimate) by a P.E.[14] of utility relocations and protect-in-place measures (for existing facilities that remain in place) with attention toward integrating utility infrastructure adjustments with mainline project work. The design work is specialized and executed by individuals or a team that understand(s) the "ins and outs" of both utility design and construction and transportation design and construction. The design goal is to specify strategies that optimize the project delivery with minimal disruption to the project, utility services, commerce, and the public. Proposed utility designs and relocations are included within the utility design effort.
- **Utility Construction:** Techniques and procedures for monitoring, inspecting[15], and surveying utility installations at the job site, as well as recording and production of quality, utility digital as-built data in accordance with ASCE/CI/UESI 75-22.

[13] The 2nd Strategic Highway Research Program (SHRP2) Report S2-R15B-RW-1 *Identification of Utility Conflicts and Solutions*, National Academy of Sciences Transportation Research Board, 2012 www.TRB.org/SHRP2
[14] Professional Engineer or under the direct supervision of a responsible Professional Engineer

[15] Utility infrastructure installations need to be inspected just like other important elements of the roadway construction. We have encountered numerous issues arising with utilities that were relocated, but not in accordance with the approved plan. Utility companies generally have very little oversight of their construction crew operations. Technical Advisory Committee Review Comments, Gabriel A. Nelson, P.E., Civil Engineer, Snyder and Associates, June 12, 2023

- **Utility Asset Management:** Techniques and procedures for accommodating, permitting, managing, documenting, and assessing utility facilities within the right of way over their entire lifecycle. Utility Asset Management includes recording and managing digital utility as-built data on proposed and newly installed utility infrastructure in accordance with ASCE/CI/UESI 75-22.

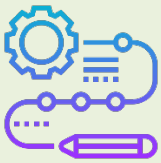
UE assures utility issues are identified, addressed, and resolved in a consistent and optimal manner for projects. Moreover, Iowa laws and codes specifically support these activities which fall under UE:

- Coordination, cooperation with utilities
- Use of ROW subordinate to the transportation facility
- DOT management of the ROW asset
- Collection of location data
- Cooperation with 811 system
- Facilitating timely relocations and adjustments
- Enforcing compliance

Each of these UE "pillars" or activities require and/or generate utility data. This project research focuses on achieving standardized utility data for Iowa DOT projects and identifying opportunities within routine project development and daily ROW management business activities for collecting and sharing utility data. To that end, adoption of UE recommended practices for acquiring, sharing, and leveraging standardized utility infrastructure data within Iowa DOT workflows is a logical and beneficial evolution that will resolve the challenges with attaining reliable utility data early in a project while proactively addressing complications associated with hosting utility infrastructure within Iowa DOT ROW.

For this research project, the UE Utility Asset Management pillar is of particular interest for supporting the acquisition, management, and sharing of standardized digital utility infrastructure as-built data.

Utility Asset Management



Utility data is readily available through project development, project construction, and ROW management activities, but ***Iowa DOT lacks procedures to ensure data is collected, managed and subsequently made accessible****.*

Implementing UE Utility Asset Management system and practices will enable ***data to be collected through a variety of existing Iowa DOT business practices*** *(e.g., design, construction, permitting).* ***New technologies make collection, management and sharing of standardized digital utility data a simple process****.*

Interest*. Existing software technologies, web services, published standards, and GIS protocols make* ***establishing a Utility Asset Management system relatively easy for both Iowa DOT and utility owners****.*

The UE categories outlined above (Figure 4 and related text) are intertwined; each category requires utility data management. Therefore, for this specific Iowa DOT research effort, *Utility Asset Management* is of primary interest. Though with a slight twist, the concepts for conventional asset management readily represent and support a modified approach in which an agency managing public ROW, such as Iowa DOT, extends consideration toward utility assets owned by 3rd parties which are occupying public ROW. The fact that these assets are owned by others is academic, for, no matter how the cards are cut, in the end utility infrastructure serves the public interest. Moreover, through proper utility asset management practices Iowa DOT can begin to achieve better usage of public ROW (e.g., move more goods and services while decreasing vehicle traffic[16], decrease individual carbon footprints and other environmental impacts, decrease pavement wear, improve social equity, and bolster infrastructure resilience) while greatly enhancing Iowa DOT planning, design, and project delivery. In short, utility asset management will enable Iowa DOT to better serve their clients – i.e., the citizens of Iowa.

Utility asset management is the process of the **public ROW owner supporting the utility owner's efforts, and utility owners' supporting the public ROW owner.** The goal is to ensure utility assets are **efficiently**: 1) positioned, protected, operated, maintained, and replaced over their lifecycle to provide reliable services to customers and ensure regulatory compliance; and 2) accommodated and managed during public ROW project development, construction, and maintenance activities. It's a symbiotic relationship (as opposed to a setting that is too often adversarial) in which ROW owners and utility infrastructure owners work proactively to take care of each other's interests and needs.

The Federal Highway Administration (FHWA) the American Association of State Highway and Transportation Officials (AASHTO) published salient guidance[17] on asset management that is fully applicable for Utility Asset Management. In essence, utilities installed within Iowa DOT public right-of-way need to be:

1) **reliably documented and recorded** [if existing, investigated and documented per ASCE/CI/UESI 38-22, or if newly installed, observed and recorded per ASCE/CI/UESI 75-22]
2) **inventoried** in an appropriate data management geographic information system (GIS) using the ASCE/CI/UESI 75-22 digital data standard; and
3) **attached to an asset management system** to make logical system wide decisions on each type of infrastructure.

Accordingly, **a utility asset management system will enable Iowa DOT to make better decisions from a societal stance** by weighing in on the impacts and opportunities Iowa DOT projects impose to the wide array of utility infrastructure hosted within Iowa DOT ROW.

[16] Commercial on-line order and delivery services offered by entities such as Amazon.com, Walmart, ubereats.com, DoorDash.com, etc. (see 13 best grocery delivery services in 2023 for food and essentials (nbcnews.com)) effectively reduce individual travel to stores to obtain goods. Likewise, ability for business owners and employees to work from home (a.k.a., "telecommute") reduce needs for daily office commutes and business travel.

[17] *Asset Management: Advancing the State of the Art Into the 21st Century Through Public-Private Dialogue.* Federal Highway Administration and the American Association of State Highway and Transportation Officials, 1996, page 3.

Federated Geographic Information System Collaboration Portal

*Iowa DOT **does not need to create** a massive hosting service **nor maintain** the mass of utility infrastructure asset data for all the facilities located within Iowa DOT ROW.*

Open Geospatial Consortium

*Nearly all utility owners currently operate OGC[18] compliant GIS inventories for asset management. A **Federated Geographic Information System Collaboration Portal will enable Iowa DOT to securely access utility owner data** hosted on the utility owner GIS.*

*Just need to **implement existing protocols and data exchange standards**. **Utilities manage their own data** and are the source of record. Eliminates versioning errors, security issues; expedites data access and usage.*

Iowa DOT does not need to create a service for hosting a mass of utility infrastructure asset data; there will be exceptions, but in general Iowa DOT **needs to utilize existing web services and have secure access to asset data which is hosted by utility infrastructure owners on their own data servers and services**.

The Iowa DOT utility asset management system architecture needs to allow information to:

1. securely interface with a variety of external utility owner data systems;
2. allow secure data sharing and viewing; and
3. facilitate updates as additional information is obtained through activities including:
    a. **utility permitting** - digital as-designed data on **proposed installations**,
    b. **utility permitting** - digital as-built data (recorded per ASCE/CI/UESI 75-22) from utility owners on **newly installed utility infrastructure**,
    c. **UE for Iowa DOT project development** [including existing (investigated per ASCE/CI/UESI 38-22) and proposed designs (recorded per ASCE/CI/UESI 75-22)],
    d. **UE for Iowa DOT project construction** (inspections, survey observations on exposed infrastructure, and digital as-built data on newly installed utility infrastructure recorded per ASCE/CI/UESI 75-22).
4. Utilize automated procedures and applications which allow data to be collected and flow in from a variety of sources while preventing the entry of malformed data and maintaining standardized metadata that identify source and quality of information.
    a. Automated procedures and applications can ease effort and reduce the opportunity for malformed data to be introduced.

[18] The Open Geospatial Consortium Home - Open Geospatial Consortium (ogc.org)

b. Maintaining standardized metadata per ASCE/CI/UESI 38-22 resulting quality levels and ASCE/CI/UESI 75-22 observation accuracy levels will allow users to understand data quality and appropriate use.
c. Key objective is to avoid data bottlenecks and gatekeeping responsibilities.

An appropriate architecture for this type of utility asset management system can be described as a **Federated Geographic Information System**[19] as shown in the basic diagram in Figure 5 below and discussed in detail below in ***Technology Landscape Findings***.

Federated Geographic Information Systems

A Federated Geographic Information System (GIS) refers to a distributed network of GIS resources or services that are connected and interoperable, allowing for data sharing, analysis, and visualization across different organizations or entities. In a Federated GIS, multiple GIS systems, databases, or services from different organizations or jurisdictions are linked together, allowing users to access and utilize geospatial data and services seamlessly. A federated GIS provides a framework for collaborative geospatial data sharing and analysis across different organizations or entities, while allowing them to retain autonomy over their own GIS security, resources, and services.

The key characteristics of a Federated GIS typically include:

- Distributed architecture: A Federated GIS consists of multiple GIS resources or services that are distributed across different organizations or entities, rather than being centralized in a single location.
- Interoperability: The GIS resources or services in a federated system are designed to be interoperable, meaning they can communicate and exchange data with each other using standardized protocols and interfaces.
- Data sharing: A Federated GIS enables sharing of geospatial data across different organizations or entities, allowing for collaborative data management and analysis.
- Heterogeneity: The GIS resources or services in a federated system may have different hardware, software, and data configurations, allowing for diverse data sources and technologies to be integrated into a unified system.
- Autonomy: Each organization or entity participating in a Federated GIS retains control over its own GIS resources or services, including data ownership, access rights, and functionality, while enabling collaborative data sharing and analysis.
- Scalability: A Federated GIS is designed to be scalable, allowing for the inclusion of additional GIS resources or services as needed to accommodate changing requirements or data sources.
- Security and privacy: Federated GIS typically incorporate security measures to protect data integrity, confidentiality, and privacy, including authentication, authorization, and encryption mechanisms.

[19] Federated System: A federated system is a special type of distributed database management system (DBMS) with one or more data sources, and clients (users and applications) that access the database and data sources. Federated systems - IBM Documentation

Utility Asset Management System

A utility asset management system for a public agency is operated slightly differently than a typical asset management system because it deals with 3rd party assets and requires a collaborative element by which the owners of the 3rd party assets can engage with the public agency host. Therefore, to assert this functionality, the term "Collaboration Portal" has been appended to the name (i.e., Federated Geographic Information System Collaboration Portal).

As pointed out in the FHWA/AASHTO Asset Management Primer, the system needs to be "grown from the 'utility' data up". However, utility data has historically not been acquired, stored and managed in a consistent, standardized, user friendly digital format. Therefore, standardized data acquisition and management practices need to be built into the system and employed for harvesting utility data at every opportunity. Utility data is typically generated or available for gathering during Iowa DOT project development (design), project delivery (construction), maintenance activities, and through Iowa DOT ROW Occupation permitting processes. Acquired utility infrastructure observation data is either gather by, or shared with, utility owners so they can update their "systems of record". Steadily over time, and including redundant observations, data quality, completeness, and statistical accuracy will improve, which will benefit all stakeholders.

Many utility owners operate well established GIS applications for managing assets. Actual as-built utility data will be hosted on utility owner GIS and securely referenced into the Federated GIS Collaboration Portal. Exceptions will be necessary for less sophisticated utilities to allow hosting of utility as-built data on the Iowa DOT GIS. [Commercial-off-the-shelf (COTS) geospatial software already exist for managing utility infrastructure data, so gradually all utilities will have means and desire to have internal GIS with secure data sharing capabilities. Incentives or mandates may be necessary to encourage utilities to transition to applications with required capabilities.]

Secure data sharing protocols are well established and routinely utilized in the banking and financial industries. All primary geospatial data software vendors are OGC compliant and have the capability to securely share data. In most cases, and this includes Iowa DOT which utilizes ESRI software, the stakeholder GIS applications will be able to utilize existing functionality to securely share information in a standardized format.

Federated Geographic Information System (GIS) Collaboration Portal

Because of the statewide need for a utility Federated Geographic Information System Collaboration Portal, it is recommended Iowa DOT initially establish a system that demonstrates the concept, as illustrated in Figure 5, but then allow the Iowa Office of Chief Information Officer[20] (OCIO) to take over and expand the system for statewide use for which Iowa DOT then becomes one of the users. Among its many powers and duties, the OCIO has the authority to establish standards for information technology used by state agencies, direct the work of agency information technology staff, review and recommend approval of information technology staff employment decisions in coordination with the Department of Management, and enter contracts for the receipt and provision of information technology services.

[20] Office of the Chief Information Officer (iowa.gov)

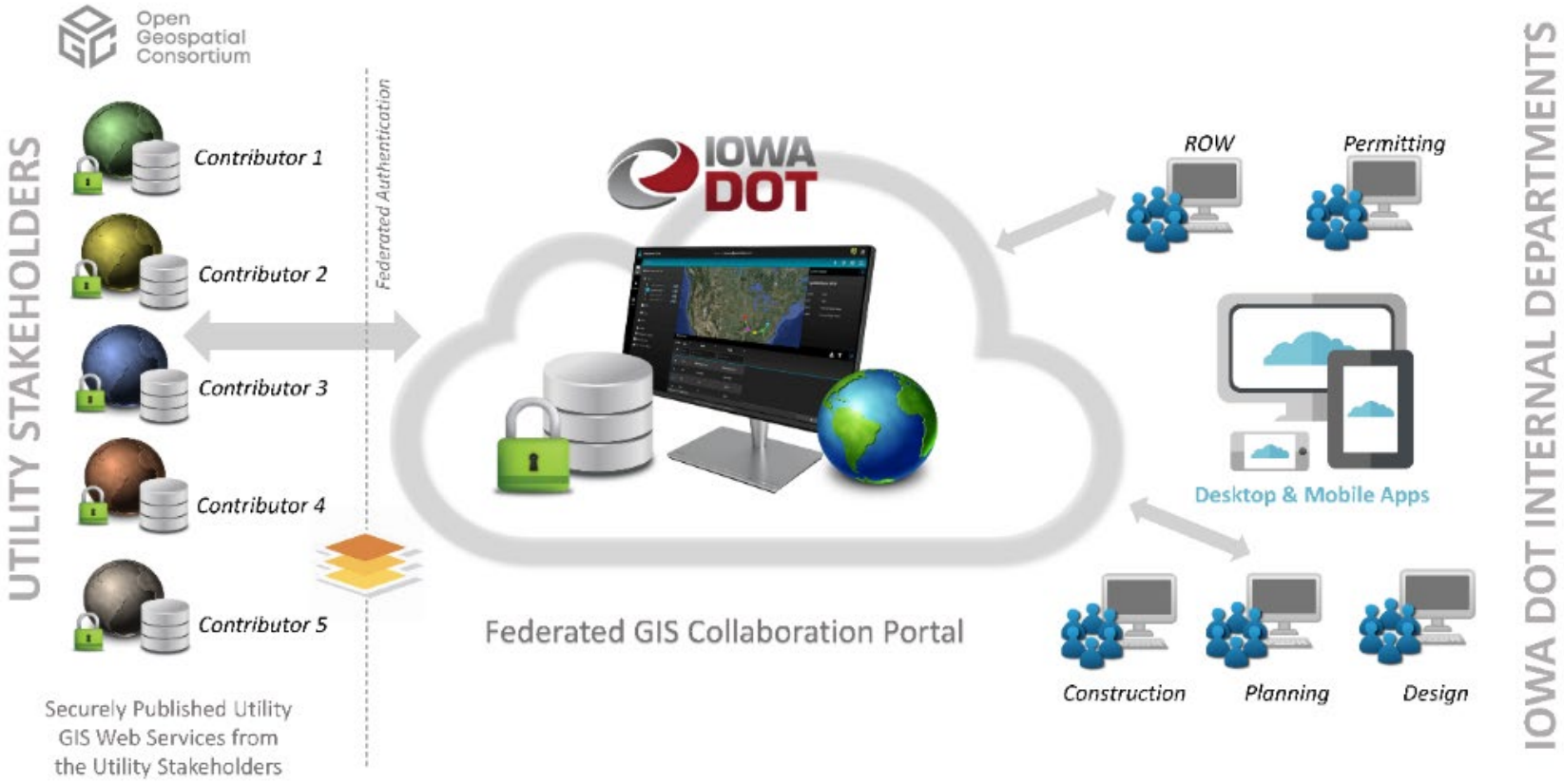
The benefits of a Federated Geographic Information System Collaboration Portal include the following:

- Iowa DOT does not need to increase staff for managing the utility data repository. Automated processes and data standards relieve Iowa DOT GIS staff from onerous data gatekeeper duties.
- The onus for managing utility data is placed on the utility owner or operator.
- Utility owners can effectively manage the "what, who, when, and for how long" with regard to viewing and data access.
- Eliminates versioning issues – there is only one source of utility information.
- Eliminates data transfer; information from the source of record is accessed and viewed in real-time using established OGC compliant web services and protocols.
- Data is standardized, and in a digital format appropriate for design and viewing consumption by OGC compliant software applications (such as ESRI, QGIS, Autodesk, Bentley).

Existing Iowa statutes already allow Iowa DOT to mandate that utility owners capture accurate utility "as-built" data on infrastructure installed within Iowa DOT ROW. However, to avert issues with liability, Iowa DOT should continue to consider historic record "as-built" data on existing utility infrastructure as for informational purposes only and not hold utility owners liable for accuracy. After the Federated GIS Collaboration Portal is up and running and procedures for recording "as-built" data are established and implemented, Iowa DOT should implement and enforce accuracy mandates on "as-built" data for newly installed utility infrastructure.

New data acquisition technologies coupled with compliance to data standards and systematic procedures for capture and management of utility infrastructure data will inherently foster improved data accuracy and reliability. Additionally, metadata on the utility "as-built" data, including equipment, methods, and survey statistics, will enable data users, including utility engineers, to assess data, perform tests, and utilize data appropriately. The ability to capture highly accurate coordinate data at the time of installation is becoming increasingly inconsequential; moreover, the value reaped by having accurate data will lead all stakeholders toward implementing raised standards.

Figure 5. The "Federated Geographic Information System Collaboration Portal" concept for Iowa DOT's Utility Asset Management System



Utility Data Acquisition and Sharing Opportunities within Iowa DOT Business Practices

Opportunities already exist *within established Iowa DOT business practices for collecting, managing, and sharing utility infrastructure data during design, construction, and ROW management (permitting) operations.*

The newly published ***ASCE/CI/UESI 75-22*** *standardizes data collection and exchange.* ***New LiDAR*** *and photogrammetric technologies make accurate 3D spatial observations simple and low cost.* ***New data management internet technologies*** *make sharing information securely an easy process.*

Iowa DOT needs to ***require and enforce utility data collection*** *and include a process for checking newly acquired data within Iowa DOT business practices (e.g., ROW occupation permit for proposed and newly installed utilities, ASCE 38 submittals for designs, construction as-builts on Iowa DOT projects). Utility owners must use newly acquired data on their facilities to improve their existing utility records.*

The Pillars of UE provide a template for **utility data acquisition and sharing opportunities** within Iowa DOT business practices (e.g., project development, project construction, maintenance, ROW management). There are many "low-lying-fruit" opportunities for harvesting utility data during permitting, design, and construction operations. ASCE/CI/UESI 75-22 is used to create standardized, digital as-built data on all **existing, proposed, and newly installed** utility infrastructure. Key points regarding the UE activities are presented below along with, as applicable, discussion on the flow for acquired standardized utility data into and within the **Federated GIS Utility Collaboration Portal** for the various Iowa DOT business practices.

Utility Investigations Data

Key points:

1. Poorly defined existing utility depictions and characterization result in missed opportunities to identify and implement sophisticated engineering strategies to avoid relocations, abate project risk, expedite project delivery, and reduce project costs.
2. ASCE/CI/UESI 38-22 provides standardized investigative procedures and reliably qualified data on existing utility infrastructure within a project footprint.

a) This standard is best implemented at the beginning stages of project development so reliable utility data can be used to layout preliminary alignments (e.g., 0-10% design).

b) Newly developed geophysical acquisition and processing technologies greatly enhance the information derived through ASCE/CI/UESI 38-22 utility investigations.

c) ASCE/CI/UESI 38-22 effectively addresses the problems associated with incomplete, inadequate, non-standardized utility records for utility facilities located within the project footprint.

d) As the ASCE/CI/UESI 38-22 investigation is completed, all changes and new installations thereafter within Iowa DOT ROW, including the project footprint, can be accurately tracked and documented through Construction As-Built submittals and the ROW Occupation Permitting process utilizing ASCE/CI/UESI 75-22 digital as-built data standard. This effectively preserves the value of the utility investigation and SUE effort beyond the project.

3. ASCE/CI/UESI 38-22 data can be pushed into digital format compliant with the ASCE/CI/UESI 75-22 standard to enable a host of emerging, value adding digital design and conflict analytic technologies, as well as facilitate digital project delivery methods. Moreover, the data can be shared back to utility infrastructure owners for improving their internal geospatial records. ***All acquired ASCE/CI/UESI 38-22 data must be managed and exchanged in accordance with the ASCE/CI/UESI 75-22 standard***.

4. ASCE/CI/UESI 75-22 ensures standardized digital as-built data compatible with Open Geospatial Consortium (OGC) compliant software applications including ESRI, Autodesk, and Bentley.

Utility Conflict Management Data

Key points:

1. In addition to straight-forward hard-clash detection between proposed designs and existing utility infrastructure (which is a simple and straight forward process provided ASCE standardized utility data is utilized), conflict identification includes recognizing a myriad of other conflict and risk issues that can adversely affect utilities, the project, and/or the public. These issues can involve construction methods, material staging, and operations sequencing, affecting schedule, cost, and safety.

   For example, geotechnical factors such as subsidence, collapsing soils, void formation, trench stability, seismic shock, groundwater inundation, can put a nearby utility asset at risk of sustaining damage and consequently put field crews and adjacent members of the public at risk from a health and safety (HAS) perspective. Additionally, a myriad of “regulatory” issues associated with work on or in the vicinity of utility infrastructure can create conflicts of a different sort, but which have very real impacts to the project cost and schedule. These types of conflicts include: utility service contractual obligations; material and labor shortages; environmental restrictions; clearance criteria, property rights, prior rights, maintaining access for servicing utility assets, Buy America constraints, and national security mandates.

The professional effort includes assessing all impacts existing/proposed utilities bring to proposed designs/construction, **and** assessing all impacts proposed designs/construction bring to existing/proposed utilities. Proposed designs and related construction activities associated with geometrical, geotechnical, hydrological, structural, environmental, cultural, safety, traffic, and right-of-way improvements are analyzed. Practical design alterations and construction strategies to mitigate conflicts and affects are recommended and evaluated. Conflicts requiring more complex or more sophisticated solutions are taken to an elevated level.

2. The "solutioning" effort is a collaborative undertaking that includes the project design team and utility infrastructure engineers to optimize project design and delivery from a holistic perspective and in a manner that holds public welfare (**including commerce activities and commercial interests**) paramount. The **mantra behind this work is "avoid, minimize, accommodate, and then, as a last resort, relocate"** existing utilities in a minimally disruptive manner.
3. **This work cannot be executed effectively without: a) standardized and reliably qualified data on existing, designed, and proposed utility infrastructure, normally achieved through a professional effort in accordance with ASCE/CI/UESI 38-22**; and b) a professional team with cross discipline expertise in both road and utility infrastructure design and construction.
4. This work typically includes populating a utility conflict matrix (UCM) to track all potential conflicts through resolution. The UCM often guides where survey grade ASCE/CI/UESI 38-22 QL A test hole observations and additional QL B 2D and 3D data are required to complete assessments of conflicts and explore design alternatives. All evolving project design changes need to be reviewed to update the UCM and to assess associated impacts to proposed resolutions and project design and construction. Pushing project based ASCE/CI/UESI 38-22 data into ASCE/CI/UESI 75-22 digital format enables automated processes that simplify managing and updating the UCM as design changes occur.

Utility Design Data

Key points:

1. The professional (or professional team) executing the resolution engineering ("Utility Design") must have established working knowledge and experience with designing and building **both**: a) transportation projects, and b) utility infrastructure systems of the type impacted.
2. The professional (or professional team) must adhere to an ethical stance that holds the public interest paramount to all others. Utilities serve the public[21] and exist because of public demand. The ratepayer and taxpayer are in general the same entity, therefore the public interest includes the wellbeing of utility infrastructure owners and their clients as well as the Iowa DOT project.
3. To the extent achievable, the utility design should be incorporated within bid documents and specifications to enable the prime contractor to control, manage, value engineer, and when

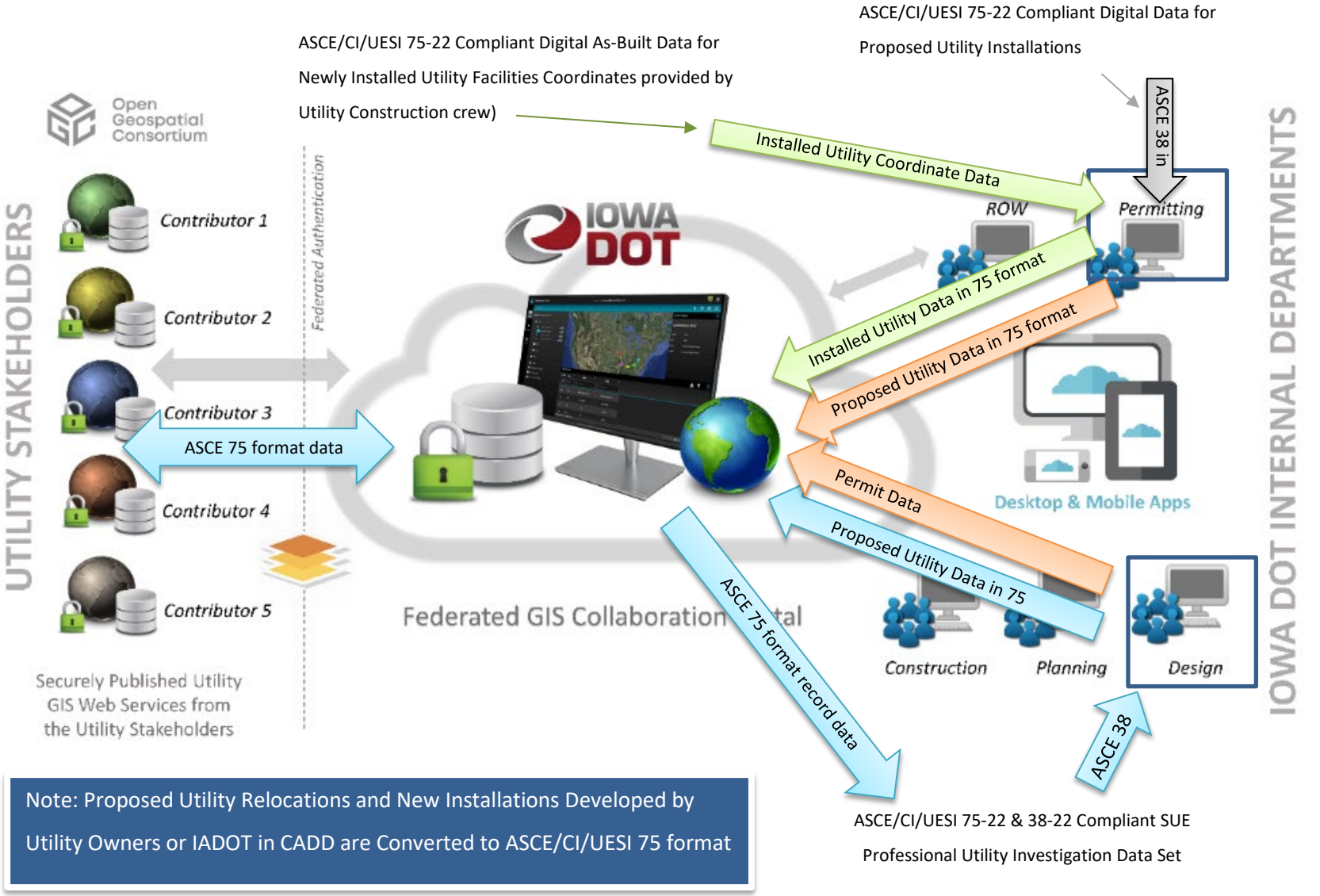
[21] Even private sector utility installations that serve data centers and banking are providing services that benefit commercial and individual interests that encompasses a wide sector of the public.

possible, include and perform (either directly or through a prime/subcontractor arrangement) the utility adjustments as part of the mainline effort. This is achieved through innovative contracting and multi-tiered (Master and Supplemental) agreements. Minimal public disruption is often best achieved if critical path utility construction work is integrated with and occurs seamlessly **within the mainline construction** effort, not before or after.

4. ***Proposed* utility designs** *(e.g., adjustments, relocations, new installations, abandoned-in-place, removed, etc.) must be compliant with ASCE/CI/UESI 75-22 to facilitate data exchange especially with the utility infrastructure data management system discussed next under "Utility Asset Management".* This is essential to assure **all stakeholders are aware of proposed changes** and can plan geospatially coincident activities accordingly.
5. Design of relocations, adjustments, and new installations for project development needs are managed within Iowa DOT ProjectWise™ in the form of MicroStation™ DGN files which can be visualized into the Federated GIS Collaboration Portal and/or be converted to ASCE/CI/UESI 75-22 format for exchange and import into the utility owner data management GIS systems.

Utility Investigations, Utility Conflict Management, and Utility Design all fall under Project Development. Figure 6 illustrates how utility data flow occurs during project development (design) efforts.

Figure 6. Flow of Data into and within Federated GIS Utility Collaboration Portal during Project Development (Design)



Utility Construction Data

Key Points:

1. The best, easiest, and **often the only time to acquire accurate, comprehensive 3D digital as-built data on utility infrastructure is at the time of utility construction**.

2. Recent technologies have made recording of accurate 3D spatial data a trivial effort. Moreover, many new technologies utilized for pipeline asset integrity, open trench, and horizontal directional drilling[22], direct bury installations, etc. have and already are using the ability to generate spatially accurate positioning data. Figure 7 presents an example of the Pix4Dcatch application synchronized with a ViDoc Real Time Kinetic (RTK) attachment to an Apple iPad to generate digital as-built models. Iowa State University is currently completing a study[23] documenting the pronounced efficiency, ease, and cost effectiveness of this tool. Preliminary results indicate the Pix4D method can be used to scan an open trench in a few minutes and derive resulting 3D positional accuracies of +/- 0.03 feet.

   Figure 8 presents an example of Vermeer's Projects application which generates 3D coordinates for horizontal directional drilling (HDD) operations. Capturing HDD data along with standardized attribute information is now an inconsequential effort; in fact, there really isn't a reasonable excuse for not doing it. Several well-established technologies for 3D documentation of utilities are discussed in a Wisconsin DOT study *3D Utility Survey Practices*[24]

Figure 7. Pix4D is easy to deploy and readily provides spatially accurate, high resolution digital as-built positional and geometric data of open trench and surface utility installations.

Images courtesy of Pix4D www.pix4d.com

   Low-cost mobile field applications and tools can be provided by Iowa DOT with a simple work-flow process to enable any user to document new or exposed utility installations in accordance with the ASCE/CI/UESI 75-22 standard and protocols needed to upload into Iowa DOT utility data management system.

[22] Vermeer Projects for Bore Planning and HDD Job Management

[23] Sturgill, Roy, Ph.D., PE, Emerging Technology for Capturing Digital As-builts of Underground Utilities, Draft Report, Dept. of Civil, Construction, and Environmental Engineering, Iowa State University, June 2023

[24] Meis, PJ, et. al., *3-D Utility Survey Practices*, Project ID 0656-23-09, Wisconsin Department of Transportation 4802 Sheboygan Ave., Room 451, Madison, WI 53707 September 10, 2014

3. Utility construction is constantly occurring. The only sure and well-established means to monitor and manage utility construction work is through Iowa DOT ROW Occupation permitting (as described in ***"Utility Asset Management"***). Through the permitting process standardized and accurate digital as-built data can be acquired on all proposed and newly installed Iowa DOT owned utility infrastructure:

    a. Iowa DOT ROW Permitting should be adapted to include an "**internal permit process**" for ROW occupations that involve Iowa DOT "utility" assets. This would be a very simplified process in which **ASCE/CI/UESI 75-22 feature attribute and proposed alignment information is captured through data entry forms** completed by maintenance, traffic operations or whomever is ordering the work effort.

    b. **When work occurs the contractor or Iowa DOT maintenance crew or inspector collects digital as-built positional data per the required ASCE/CI/UESI 75-22 accuracy level**.

    c. The Iowa DOT Asset Management System or the Iowa DOT Enterprise GIS (presuming modules exist for all types of Iowa DOT utility assets) serves as the data repository and system of record for Iowa DOT utility assets.

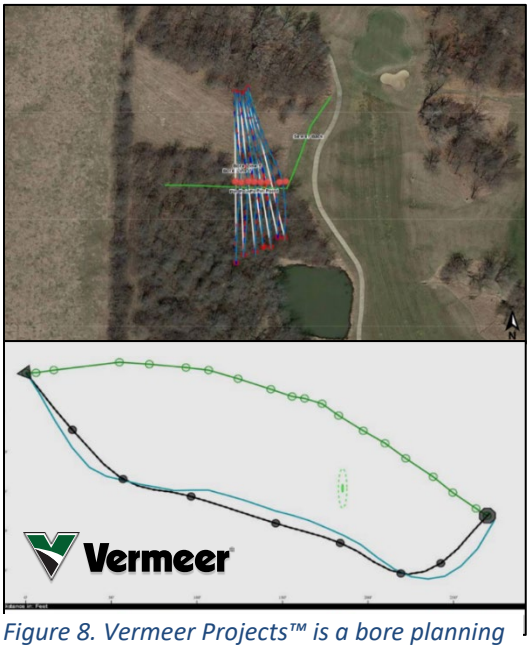


Figure 8. Vermeer Projects™ is a bore planning and job record management system built to organize and share important installation reports seamlessly.

Image courtesy of Vermeer Corp. www.vermeer.com

4. Contractors involved with utility installation work (whether for 3rd party utility assets occupying Iowa DOT ROW or Iowa DOT owned utility assets) are only required to acquire and upload survey observations in accordance with special provisions on new installations. These positional data are subsequently merged with design specifications to achieve the final digital as-built data set. Field modifications that vary from design specifications can be documented at the time of installation via a mobile field application/tool and simple workflow. (Note: Actual coordinate data should be compared with design positions before approving work. The process can be easily performed by the permitting agent using existing GIS tools enabled within the permitting system along with a minor procedure that can visualize both the proposed and actual alignment data. Excessive and unauthorized deviations from the approved design alignment can trigger appropriate measures to address and rectify. Iowa DOT may include independent inspection observations to verify installation work is compliant with the permit.)

5. Contractors exposing existing utility infrastructure can be equipped with a mobile field application/tool with simple work procedure for documenting exposed infrastructure in accordance

with the ASCE/CI/UESI 75-22 standard. (This has the added benefit of providing documentation should damage claims arise later.)

Figure 9 illustrates how utility data flow occurs during project construction which includes: 1) new utility construction work; and 2) contractor exposure of existing infrastructure.

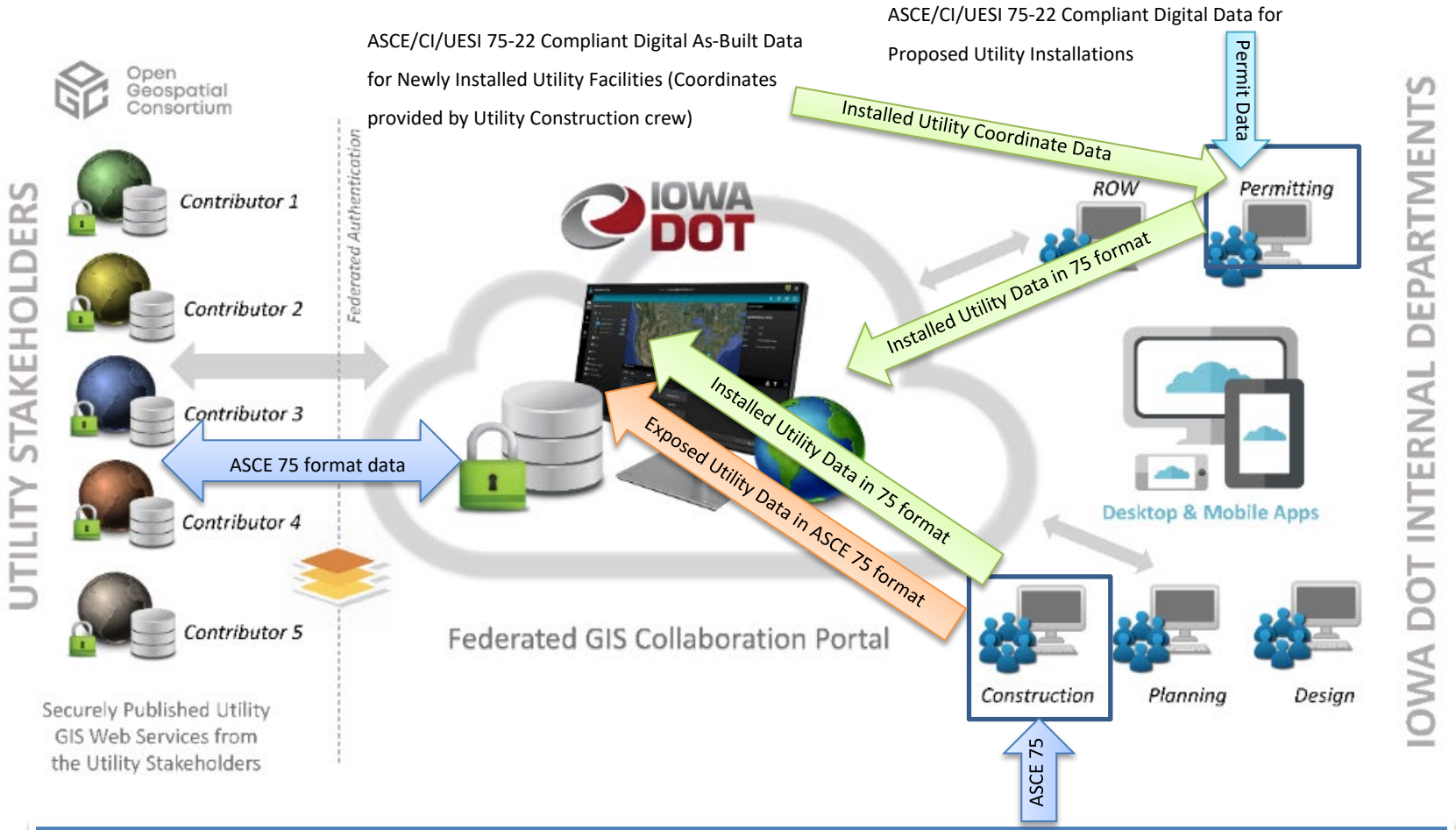
Note: Figure 9 does **not** illustrate data flow associated with capture of utility paint markings and flagging resulting **from 811 ticket requests** and "locate responses" by utilities and their contract locators. 811 ticket responses are considered reflections of utility record information and are solely intended as a time sensitive damage prevention means to protect a utility from excavation strikes; accordingly, there are inherent gaps within the 811 process which precludes usage as a substitute means for utility data collection.

In practice, the flow of data depicted in Figure 6 and Figure 9 illustrate how utility stakeholder record information continually improves from information received through ongoing Iowa DOT permitting, design, and construction activities. Reliable and standardized **utility record information can accordingly be used to enable GNSS navigation to enhance utilities' and their contract locators' efforts to provide more reliable field markings.** The combination of GNSS navigation information derived from GIS stores with affirmative responses from pipe and cable locator (PCL) equipment will greatly enhance 811 responder efforts.

Emerging usage of locators with GNSS and internet uplink technologies are allowing 811 responders to record positional coordinates of field markings and monitor field locator performance parameters (e.g., how receiver is held, magnetic field symmetry checks, applied gain, achieved signal strength, conductor current flow, etc.) as "field locates" are executed. 811 responder performance will improve over time because:

- 811 field responders will be monitored for technique and performance;
- Field locates will be guided by GNSS;
- Field locates can be recorded and redundant field locates can be evaluated for consistency and statistically significant deviations; and
- Reliable and standardized utility data obtained through use of the ASCE 38 and ASCE 75 standards will provide the basis from which 811 responder performance can be gaged.

Figure 9. Flow of Data into and within Federated GIS Utility Collaboration Portal during Project Construction



Note: ASCE/CI/UESI 75-22 compliant utility attribute data acquired during permit application is merged with ASCE/CI/UESI 75-22 compliant positional coordinate data acquired at the time of installation by field construction crews or inspectors.

Utility Asset Management Data

Key points:

1. ASCE/CI/UESI 75-22 can be implemented **in conjunction with Iowa DOT permitting** practices to **require utilities** and their contractors **to collect standardized, accurate digital as-built data. Iowa DOT will then be able to track all changes and new installations within their ROW.**
    a. **Utility permitting captures standardized attribute information and positional and alignment information on proposed utility installations in accordance with ASCE/CI/UESI 75-22.** (Note: Alignment and positional coordinates are proposed during initial permitting and updated with actual positioning coordinates during construction.)
2. **Iowa DOT and Utility owners will both benefit by enabling usage of a host of Open Geospatial Consortium (OGC) compliant applications for GIS, CADD, BIM, augmented reality viewing, etc.** Implementation of ASCE/CI/UESI 75-22 effectively assures that utility records will be standardized, digital, complete, user friendly, and contain positional accuracy criteria. This advent will introduce a paradigm shift that will greatly facilitate utility investigation efforts and corresponding design and construction projects.
3. **In addition to enabling the capture of accurate digital as-built data on utilities, an advanced permitting system will also provide Iowa DOT with a "crystal ball" for knowing past, current, and planned ROW occupations. With GIS and web capabilities, Iowa DOT will have a valuable ROW occupation management system for improved oversight of ROW**, including: 1) regulating occupations as priorities arise (such as for vehicle accidents, emergency repairs, etc.); 2) coordinated inspections; 3) prevention of unauthorized traffic control measures and ROW occupations; and 4) a tool for checking if installations were placed as permitted, and when identified, a means for addressing how to managed non-compliance.[25]
4. With the aid of a relatively low-cost field tablet and simple-to-use software applications, Iowa DOT construction or maintenance crews can capture and access ASCE/CI/UESI 75-22 digital as-built data on exposed existing and newly installed utility infrastructure.
5. Though intended for damage prevention, it is now feasible to capture locator markings originating from One-Call (Call 811) tickets using similar existing technologies. (Note: Unaided 811 markings are unqualified by ASCE standards but may be useful for documenting 811 responses and assessing problematic field "locator" issues. ASCE/CI/UESI 38 was developed to address the fact that 811 markings are considered as non-standardized utility record data and therefore unsuitable for design needs.) Recorded 811 markings can be used to identify and rectify where 811 responses produce inconsistent positional field markings. On the flip-side, the Federated GIS Collaboration Portal can be used to improve utility records and enable 811 responders to navigate to where utilities lie (based on records) and then verify the position

[25] The Montana DOT uses a similar process to monitor for new utility installations that did not comply with permit criteria and the agreed geospatial positioning. In such cases, depending on the infraction and the impact to subsequent planning, design, and operations, the status of the permit may be altered, and a utility owner may be required to relocate and/or shoulder subsequent cost impacts arising from not being installed as permitted.

based on pipe and cable locator technologies. This practice will momentously improve 811 services, speeding up responses while greatly enhancing damage prevention and safety.

6. Emerging digital and internet technologies and data sharing standards enable a "**Federated Geographic Information System Collaboration Portal**" whereby each stakeholder (in particular each utility infrastructure owner) manages their data on their server system (cloud hosted or physical) and can reference their data, securely and with viewing permissions, into a remote collaborative portal for Iowa DOT project development and delivery needs. This resolves a number of issues, including, but not limited to:
    a. Versioning – information is coming live from the source-of-record (i.e., the utility infrastructure owner)
    b. Security Mandates and Proprietary Information Concerns – Federal and internal security measures are sustained by controlling chain-of-custody (when, what, and where data is shared, to whom, and for how long).
    c. Utility owner responsibility and criteria are established for managing and sharing standardized digital as-built data on their existing and proposed assets.
    d. Mechanism for sharing data corrections and new updates from a variety of sources to stakeholders (including facility owners) is established. Utility owners can utilize data to correct records and improve data quality over time.
    e. Enhancing utilities' and their contract locators' ability to respond to 811 ticket requests by enabling GNSS navigation along with pipe and cable locator detection technology. Likewise, 811 responses can be better monitored by recording responder efforts (using locators with GNSS and internet uplink technologies) which can be used to verify ticket responses and check for inconsistencies between field markings and utility owner digital records.
7. The Federated GIS Collaboration Portal can be used to conflate utility data with design, topographic, and other project data (geotechnical, hydraulic, ROW, etc.) to facilitate:
    a. Communication, collaboration and coordination between the project design team, utility owners, commercial and public interests, Iowa DOT ROW managers, and construction stakeholders.
    b. Conflict and risk analytics and resolution engineering.

Benefits

A cost-benefits analysis regarding readily available utility digital as-built data is well documented in the recent National Cooperative Highway Research Program (NCHRP) Project 20-07, Task 418 study entitled *An Impact and Value Analysis of Requiring Geospatial Locations for Utility Installation As-Builts*[26]. A Federated GIS Collaboration Portal system integrated with on-line ROW occupation permitting enables the following:

1. Standard procedures for acquiring and submitting standardized digital as-built data (positional, geometrical, and attribution data) on utility infrastructure situated within Iowa DOT ROW.
2. A digital data portal for uploading, maintaining, and accessing utility infrastructure data.
3. A system for proactively analyzing and resolving issues between planned transportation improvements and proposed and existing utility infrastructure.
4. A permitting system for managing and documenting changes and additions to the existing utility infrastructure residing within Iowa DOT ROW (also for tracking all ROW occupations and activities).

The outlined Federated GIS Collaboration Portal provides the foundation for collecting, storing, maintaining, analyzing, and disseminating utility data in a manner that allows pro-active planning for permitting, design, maintenance, damage prevention, homeland security and emergency response tasks. This portal will, over time, diminish costs for utility investigations for future projects, and shift costs for providing information on new infrastructure to facility owners.

The system is highly versatile because it is independent of, yet compatible with, all OGC compliant geographic information systems (GIS), computer aided design and drafting (CADD), and mapping (e.g., Google Earth™, Microsoft Bing™ Maps) platforms. OGC has adopted ASCE/CI/UESI 38-22 and 75-22 standards into their new Model for Underground Data Definition and Integration (MUDDI) designed to enable live 3D referencing and data exchange.

The proposed Federated GIS Utility Collaboration Portal integrates well with current utility permitting business practices. There are well-established Off-the-Shelf (OTS) utility permitting applications (as discussed below in ***Utility Permitting Findings***) available that provide an active, collaborative environment for the applicant and public agency officials to engage in the application, review, and approval process.

Geodetic referencing of permit applications and corresponding installation information will aid the process by facilitating convenient on-line or CADD based map viewing. Stakeholders can have real-time access to the system with the ability to respond with salient information, expediting the entire application process. All new facilities will be systematically documented, resulting in long-term benefits

[26] Meis, Philip J., Roy Sturgill, P.E., Ph.D., et. al., National Cooperative Highway Research Program (NCHRP) Project 20-07, Task 418 *An Impact and Value Analysis of Requiring Geospatial Locations for Utility Installation As-Builts*, NCHRP Transportation Research Board of The National Academies of Sciences, Engineering, and Medicine, June 2020

through an increasingly comprehensive data set. The permit module will transform the Federated GIS Utility Collaboration Portal into a veritable "cradle-to-grave" utility infrastructure asset management system.

Summary of Improvements

1) Migrate from paper-based as-built plans to useful, state-of-the-art digital as-built virtual repository.
2) Establish consistent standards and procedures for acquiring digital as-built data of newly installed utility infrastructure.
3) Transfer cost, labor and responsibility for utility data acquisition and management to the facility owners utilizing public right of way. (Note: Most facility owners are now actively collecting as-built data for their own GIS asset management systems; accordingly, the proposed architecture can readily export data to facility owner GIS systems, eliminating the need for data double handling.)
4) Reduce utility record recovery and field rediscovery cost and time (such as utility correspondence, field reconnaissance, field meets, 811 locates, utility designating and locating (i.e., vacuum excavations), and location surveys. Spend less money and time in the field figuring out what is out there, who owns it, where it lies, easement details, etc. and migrate to desktop environment in which designers and coordinators immediately focus on using 3D analytical tools and conflict matrices to identify and address conflicts with new designs, and derive optimal, value engineered resolutions.
5) Provide limited, yet readily available data anywhere, anytime to those with approved rights (e.g., DOT maintenance, ROW managers, designers, planners, contractors, emergency management personnel) by hosting information through a secure web application.
6) Enhance conveyance of information into CADD platforms by actively geo-referencing database content (e.g., ownership, facility type, size, permit, easement type, images) using URL hyperlinks imbedded in the CADD cells and polylines which depict utilities. Hyperlinks effectively transform standard CADD platforms commonly used for design work into GIS viewers.
7) Empower non-CADD equipped stakeholders such as contractors, emergency responders, maintenance workers, or utilities by referencing utility data into readily available mapping software, (such as Google Earth™, ExpertGPS™, or Microsoft MapPoint™).
8) Compile existing utility data residing as historical documents, paper and Mylar maps, CADD files, portable document format (PDF) files, reports, and GIS into one easily searchable system.
9) Conveniently store and preserve data from publicly funded, project-based SUE investigations.

Collaborative Environment

10) Minimize travel and time required to connect with and engage project design staff, consultants and utility owners through real-time access to installation and conflict data.
11) Promote more sophisticated treatment of conflicts with road improvements through an environment in which stakeholders can systematically:
    a. identify and address constraints such as schedule, constructability, prior rights, relocation easements, preferences, maintenance of service, governances and requirements;
    b. accommodate proposed betterments;

c. plan and coordinate joint trenches and utility corridors[27];
d. address complex construction staging;
e. assess costs and payment responsibilities;
f. develop concise quantity tables, detail drawings, instructions to proposers, and special provisions for construction planning and bidding;
g. budget, advertise, review and select contractor, schedule work, and
h. coordinate and oversee construction, receive and review as-builts, approve work, administer payments as required, and produce federal reimbursement documentation.

12) Reduce utility relocation costs (and related stresses) for all parties.
13) Improve planning, scheduling and execution of service reroutes to bypass construction zone.
14) Invoke consistent, standardized treatment of utilities during project development and delivery.

Iowa DOT Administrative and Management Tool

15) Establish rigorous utility data management system and procedures for acquiring, storing and maintaining standardized digital as-built data.
16) Plan transportation improvements with reliable, comprehensive utility infrastructure data.
17) Improve assessment of permit applications for new utility infrastructure installations.
18) Clearly document DOT efforts to accommodate and include utility infrastructure in the process to identify and resolve conflicts with proposed transportation improvements.
19) Reduce DOT project risk to:
    a. utility damage and corresponding costs
        i. emergency repairs
        ii. service disruption and associated disruption to dependent commerce
        iii. environmental cleanup
        iv. legal counsel involvement
    b. contractor delay claims, change orders, and force account expenditures.
    c. traffic disruption
    d. public and worker health-and-safety
20) Eliminate unplanned conflicts during construction including delays and emergency relocates.
21) Enhance damage protection during construction and maintenance operations.
22) Enhance environmental protection.
23) Enhance worker safety.
24) Halt unplanned outages and utility service disruptions (impacts to commerce, loss of revenue, customer dissatisfaction).
25) Reduce costs for legal counsel and curtail insurance settlements.
26) Document and store pertinent spatial, facility, and related project information (institutional knowledge on the why and how things transpired) forever.

[27] Iowa Administrative Code 115.13(7) *Multiduct Systems* already establishes that the Iowa DOT may require installation of a multiduct system to be shared with others.

27) Reduce associated DOT labor and costs while providing a “cradle-to-grave” tool which greatly aids DOT officials in their efforts to accommodate utility infrastructure residing within or passing through public right of way.

Technology Landscape Findings

The core purpose of this research effort was to identify and introduce best practices, data standards and methods for the Early Identification and Location of Utility Facilities and by leveraging a standard approach for documenting utility infrastructure, (ASCE 75) "Standard Guideline for Recording and Exchanging Utility Infrastructure Data".

This study provides guidance for improved collection and use of utility location data for project development decision making and an improved process to align and integrate project design and utility coordination. These efforts stand to streamline project development and reduce delays and added costs of utility-related issues.

Iowa DOT looks to modernize utility data management, collection, aggregation, and stakeholder project collaboration with ultramodern interactive map-based technologies. The research team has outlined ways to organize, manage, and administer project data providing seamless stakeholder collaboration. The following technology enhancements described are designed to modernize Iowa DOT with the next generation of geospatial project management and location-based mapping technologies.

The following bullet points focus on the modernization of technology and best practices to achieve these goals. The following sections of this report outline the key findings, recommendations, and the reasoning behind this modernization approach.

- Federated DOT Utility Repository: A utility data repository and integration platform in the cloud that manages the business rules for geospatial data integration, data aggregation, data publishing, security, user administration, connectivity, routing, queuing, messaging, data transformation, application integration, reporting, etc.
- Federated GIS Data Portal: A web-based project, data analytics and collaboration platform with an interactive map- based interface with intuitive dashboards. Allows users to organize, manage and administer their data based on projects and to seamlessly collaborate within their organization and externally to third parties.
- Federated Conflict Management: An extension to the GIS Data Portal that provides a conflated conflict management view of all stakeholder project-related files into one single and seamless user interface. Interaction with project stakeholders can be simplified to automate the identification and workflows associated with identified conflicts and to auto populate the utility conflict matrix within a single shared mapping collaboration experience.

Iowa DOT Geospatial & CAD Technology SWOT

Working with Iowa DOT, through a series of breakouts, the research team performed a geospatial technology SWOT analysis. A SWOT analysis is a strategic planning and strategic management technique

used to help organizations identify Strengths, Weaknesses, Opportunities, and Threats related to business or project planning.

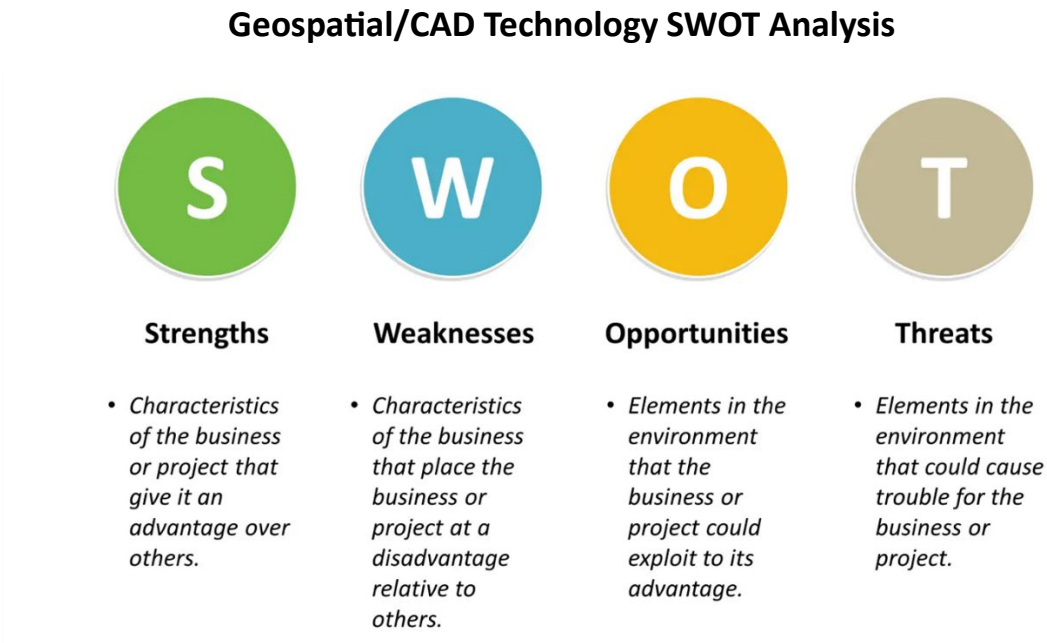


Figure 10. Geospatial/CAD Technology SWOT Analysis

This technique is designed for use in the preliminary stages of decision-making processes and used as a tool for evaluation of the strategic technology position of organizations. It is intended to identify the internal and external factors that are favorable and unfavorable to achieving the objectives. Users of a SWOT analysis often ask and answer questions to generate meaningful information for each category to make it useful and identify advantages. SWOT has been described as a tried-and-true tool of strategic analysis.

Every DOT organization is unique, and each solution must be tailored specifically for each to enhance their existing workflow processes and where possible leverage the current client technology landscape and investments. The research team executed the Geospatial Technology SWOT analysis by focusing on the following key areas:

- Stakeholder Breakouts
- Technology Landscape Review
- Understanding People & Processes
- Identification of Internal/External Data Sources
- Identify Gaps, Bottlenecks & Duplication
- Define Business & Functional Needs
- Understand Desired Technology Features

High-Level Technology SWOT Results

The following contains the high-level findings of the research team's SWOT analysis. In short, the results were positive, and the overall existing technology infrastructure is a solid foundation that is scalable to address the weaknesses and threats identified through modernization of the DOT technology eco-system.

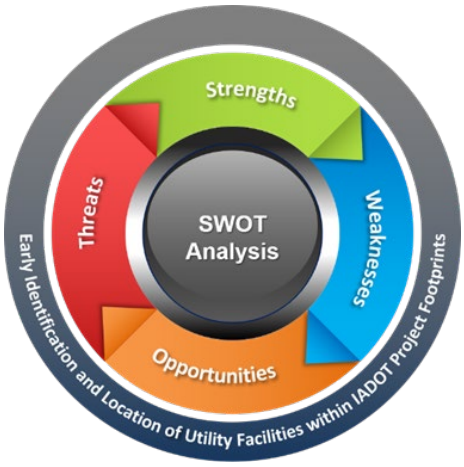


Figure 11. SWOT Analysis Workflow

Identified Strengths

1. Leveraging OGC Compliant Industry COTS Solutions for both GIS and CAD
2. Established initial GIS feature database schema compliant with ASCE 75-22
3. Set up to consume and publish OGC web services and REST services.
4. Knowledgeable and experienced GIS leadership

Identified Weaknesses:

1. Limited GIS resources to scale and manage utility repository. Adding additional tasks to the GIS department in addition to the normal day-to-day operations are expected to create additional burdens.
2. Data sharing from utility stakeholders is minimal.
3. Managing contributed utility data updates via duplication and replication of utility member repository data can render data inaccurate. Where data is shared, it is currently a snapshot or copy of the data at a moment in time, which can lead to data becoming out of date. Management of the data is duplicated by Iowa DOT and the contributing utility stakeholder.
4. Various smaller to mid-size utility companies do not have the capability or GIS technology to publish to a federated and shared GIS.

Identified Opportunities:

1. Solving GIS Resource Allocation Issues: Reduce GIS resources needed for importing utility stakeholder data that currently do not have the technology or expertise to publish federated web services.

    a. Automation: Automating workflows & leveraging asynchronous data transformations within ESRI ArcGIS will enable task efficiencies with automation configuration tools to streamline complex data processing tasks for GIS administrators. Provide an administrative tool within the ESRI ArcGIS user interface to capture, manage and configure the parameters required for processing large volumes of data from multiple sources and contributors and streamline the process of mapping the data to and from the source to the ASCE 75-22 destination data model. Customize field mapping parameters, target attribute value verification with a one-time set up that remembers and stores the configuration so that Iowa DOT can run and repeat the process easily and efficiently as needed.

b. Team as a Service Option: Distribute workload among an external team. A Team as a Service (TaaS) is a dedicated team comprised of various specialists that are contracted to help drive application needs, configuration, and other digital transformation efforts and allows the distribution of workload among an external team, which leaves the internal team free to focus on the core functions without getting overburdened and overwhelmed. It's an ongoing relationship between an organization and a team that can provide enormous benefits throughout its life cycle. TaaS allows business leaders to utilize continuous skills and support to keep the software and technology process running smoothly. This can include anything from building new software from the ground up to monitoring and maintaining existing platforms, workflows, and services, among other integral business tools.

2. Improve Utility Stakeholder Data Sharing: Utility stakeholders are strong advocates for exchanging data through federated web services and see many benefits in doing so.
    a. Subsurface Utility Investigation (SUE) data captured by the DOT is of major interest and value to utility stakeholders and serves as a quality check on as-built data and can be leveraged to update the stakeholder's system of record with qualified and reliably documented data.
    b. The ability for the utility stakeholder to administer data security and permissions from the IT system of record is a welcomed approach for addressing security issues. Utility stakeholders are strong advocates for the IT adoption of industry standards for securing data with roles and permissions for utility data collaboration in accordance with federal and state guidelines.
3. Address Sensitive Security Information (SSI); Address all the defined threats below by deploying a federated secure GIS repository and portal for utility stakeholders to share sensitive data securely without having it reside in the DOT Repository. Data stays with the System of Record and is managed by the utility stakeholder, not the DOT. No replication. Supply the ability to comply with security directives that govern the maintenance, safeguarding, and disclosure of records and information that is determined to be Sensitive Security Information (SSI) under federal regulations and directives.
4. Leverage ASCE 38 and 75 standards: Enable public right of way owners (and their designers and contractors) the ability to invoke advanced 3D digital technologies and proactive and predictive engineering (i.e., conflict analytics, BIM/CIM) to greatly enhance accommodation, advanced coordination, avoidance design, damage prevention, and expedited construction by employing attribution for CAD Design and SUE deliverables.
5. Utility Infrastructure Owners within public right of ways see benefit from advanced 3rd party coordination (e.g., HDD operations in vicinity of gas mains), expedited approval and permitting and grossly reduced construction risk, time, and costs on their projects.

Identified Threats

1. SSI Sensitive Security Information. IT directives and regulations from federal and state agencies that limit the ability to share as-built data.
2. Liability concerns for utility stakeholders regarding data completeness and accuracy.
3. Competitive concerns of sharing data.

Our research has found that Iowa DOT is well postured to collaborate and scale with their GIS and CAD technology applications and to collaborate data with utility stakeholders and to address security, liability, and competitive concerns. Some configurations and processes will need to be updated; however, as previously mentioned the overall technological infrastructure is solid and can be scaled to modernize and address these identified threats.

Leveraging ESRI ArcGIS Enterprise Solution

Iowa DOT is currently a licensed user of ESRI products. The research team recommends leveraging the ArcGIS Enterprise Solution. ArcGIS Enterprise is a family of client, server, and online geographic information system (GIS) software developed and maintained by ESRI.[28] ArcGIS works in 2D and 3D for cartography and visualization and includes software for web map consumption and publishing using proprietary REST APIs and OGC Open Standards (WMS, WFS, WPS, etc.).

Figure 11 is an overview of ESRI's ArcGIS Enterprise technology landscape verses a standalone ArcGIS Server.

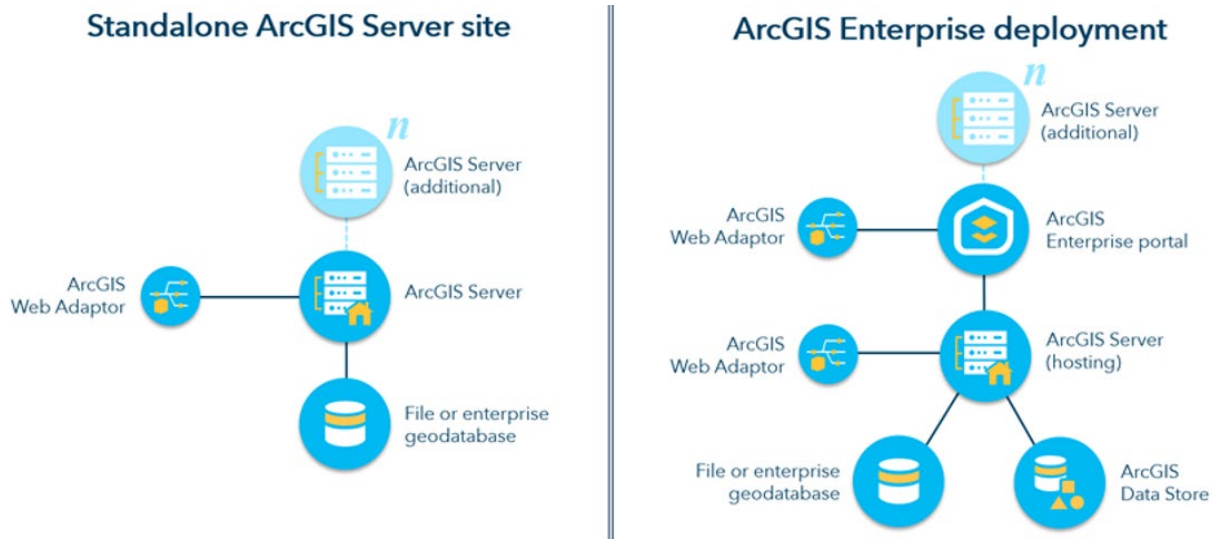


Figure 12. ESRI's ArcGIS Enterprise technology landscape verses standalone ArcGIS Server (images courtesy of ESRI)

[28] https://en.wikipedia.org/wiki/ArcGIS

Though ArcGIS Server can be deployed as stand-alone software, integrating ArcGIS Server with the ArcGIS Enterprise portal will enable efficient, powerful workflows for Iowa DOT. There are three ways in which ArcGIS Server can be used by the ArcGIS Enterprise portal:[29]

- You can federate one or more ArcGIS Server sites with the portal to integrate its security and sharing models.
- You can assign a federated ArcGIS Server site to act as the portal's hosting server, allowing users to publish data and maps to a wider audience as web services.
- You can register individual services from any ArcGIS Server site with the portal, whether it is federated or not (or even if it is your own server).

ACSE 75-22 - Standard Guideline for Recording and Exchanging Utility Infrastructure Data

The research team consulted with Iowa DOT's GIS department lead regarding the implementation of the ASCE 75 schema into the ESRI geodatabase schema. The purpose of the ASCE 75-22 Standard Guideline is to specify essential elements for recording and exchanging data about the location, size, orientation, function, ownership, and other attributes of underground and aboveground utility infrastructure, with a focus on newly installed, repaired, or otherwise exposed or accessible utility infrastructure.

This standard guideline establishes minimum, optional, and conditional elements of spatial and nonspatial attribute data associated with utility infrastructure. The standard guideline also provides recommendations for effective practices to facilitate data exchange among project stakeholders. The guideline is critical to capture, document, and exchange utility data for project scoping, planning, design, construction, operation, and long-term management of utility systems as well as the management of public right-of-way and properties throughout which utility infrastructure are installed. It is also essential to facilitate interaction among stakeholders for managing utility and other civil infrastructure.

Iowa DOT ASCE 75-22 Minimum Compatibility Matrix Assessment

Table 2. Iowa DOT Utility Point Feature Data Schema ASCE 75-22 Compatibility Matrix

Iowa DOT Field Name	ASCE 75-22 Alias	Compliant
objectid	OBJECTID	n/a
utility_id	Utility ID	☑
pin	PIN	☑
phase_number	Phase Number	n/a
row_phase_number	ROW Phase Number	n/a
permit_id	Permit ID	n/a
agreement_number	Agreement Number	n/a

[29] https://enterprise.arcgis.com/en/server/latest/deploy/windows/about-using-your-server-with-portal-for-arcgis.htm

size	Size of Line or Pipe (cm)	☑
data_source	Data Source	☑
relocation_cost	Utility Relocation Cost for Project	n/a
notes	Notes	n/a
owner	Owner	☑
utility_type	Utility Type	☑
utility_subtype	Utility Subtype	☑
conveyance_function	Conveyance Function	☑
underground_status	Underground Status	☑
operational_status	Operational Status	☑
horizontal_spatial_reference	Coordinate System	☑
vertical_spatial_reference	Vertical Datum and Geoid Model	☑
accuracy_units	Accuracy Units	☑
xy_relative_position	XY Relative Position	☑
quality_level	Quality Level	☑
linked_file	Linked File	☑
date_data_collected	Date Data Collected	☑
data_sensitivity_level	Data Sensitivity Level	☑
material	Utility Material	☑
conveyance_method	Utility Conveyance Method	☑
conduit_number	Number Conduits	☑
date_updated	Date Written from CAD	☑
z_relative_postition	Z Relative Position	☑
horizontal_accuracy	Horizontal Accuracy	☑
vertical_accuracy	Vertical Accuracy	☑
shape	SHAPE	n/a

Table 3. Iowa DOT Utility Line Feature Data Schema ASCE 75-22 Compatibility Matrix

Iowa DOT Field Name	ASCE 75-22 Alias	Compliant
objectid	OBJECTID	n/a
utility_id	Utility ID	☑
pin	PIN	☑
phase_number	Phase Number	n/a
row_phase_number	ROW Phase Number	n/a
permit_id	Permit ID	n/a
agreement_number	Agreement Number	n/a
size	Size of Line or Pipe (cm)	☑
data_source	Data Source	☑
relocation_cost	Utility Relocation Cost for Project	n/a
notes	Notes	n/a
owner	Owner	☑
utility_type	Utility Type	☑
utility_subtype	Utility Subtype	☑
conveyance_function	Conveyance Function	☑
underground_status	Underground Status	☑
operational_status	Operational Status	☑
horizontal_spatial_reference	Coordinate System	☑
vertical_spatial_reference	Vertical Datum and Geoid Model	☑
accuracy_units	Accuracy Units	☑
xy_relative_position	XY Relative Position	☑
quality_level	Quality Level	☑
linked_file	Linked File	☑
date_data_collected	Date Data Collected	☑
data_sensitivity_level	Data Sensitivity Level	☑
material	Utility Material	☑
conveyance_method	Utility Conveyance Method	☑

conduit_number	Number Conduits	☑
date_updated	Date Written from CAD	☑
z_relative_postition	Z Relative Position	☑
horizontal_accuracy	Horizontal Accuracy	☑
vertical_accuracy	Vertical Accuracy	☑
shape	SHAPE	n/a

Leveraging Iowa DOT's Bentley Systems MicroStation / ProjectWise

MicroStation is a CAD software platform for two- and three-dimensional design and drafting, developed, and sold by Bentley Systems and used in the architectural and engineering industries. It generates 2D/3D vector graphics objects and elements and includes building information modeling (BIM) features. The current version is MicroStation CONNECT Edition. ProjectWise is a suite of engineering project collaboration software from Bentley Systems designed for the architecture, engineering, construction, and owners/operator (AECO) industries. It helps project teams design, manage, review, share, and distribute engineering project content all within a single connected data environment (CDE).[30] ProjectWise is a file and vendor agnostic solution capable of managing any type of CAD, BIM, geospatial and project data. All well, direct CAD integration is available for Bentley applications and other vendors and software titles including Autodesk & Microsoft Office.

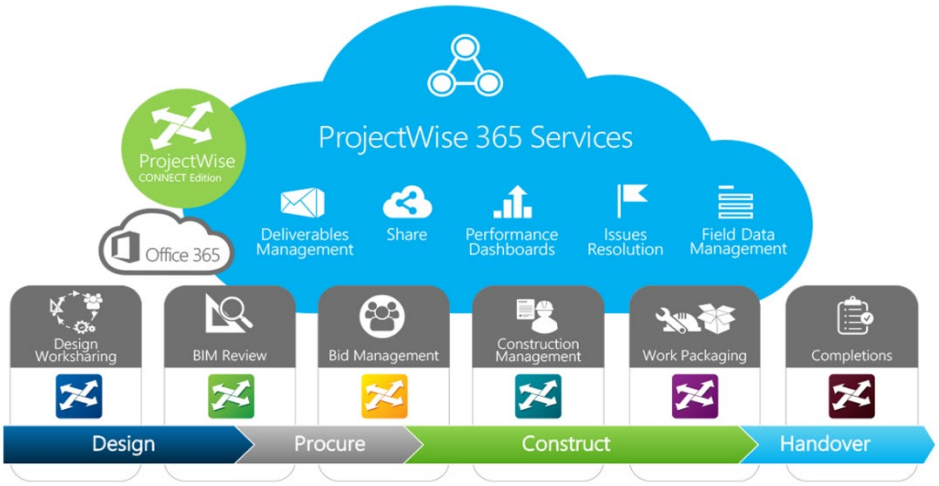


Figure 13. Bentley Web Services Gateway is the server that enables mobile application users to connect with Bentley enterprise services. (Image courtesy of Bentley Systems, Incorporated.)

[30] https://en.wikipedia.org/wiki/ProjectWise

Feature Attribution within Bentley MicroStation

The research team strongly advises moving to an attributed feature CAD model. In Bentley MicroStation, you can add attributes to objects using the "**Element Information**" tool. This is a powerful feature of Bentley MicroStation that allows you to view and manage important attribute information about the elements in your design and SUE data. Adding standard attributions based on ASCE 38 and 75 to elements in Bentley MicroStation provides several advantages. Dynamic labeling refers to the process of assigning properties or characteristics to CAD objects or entities where the annotation labels are dynamic and populated by the data attributed in each element, whereas simple annotation involves adding just text on the drawing using leaders. Attributes can be customized to fit your specific needs. You can define your own attribute types and values and attach them to elements in your design and SUE data as needed. This allows you to tailor your data management and communication processes to fit your unique requirements and to standardize them to adhere to both ASCE 38 and 75.

Overall, adding attributes to elements in Bentley MicroStation can help you to work more efficiently, manage your design and utility data more effectively, and improve communication with others involved in the design, SUE, utility conflict management and construction processes. Here are some advantages of using attribute labeling over simple annotation in CAD.

Attribution vs. Simple Annotation: It is important to start using attribution in CAD instead of simple annotations. Using attribution in CAD provides several advantages over simple annotations, including improved data management, increased efficiency, consistency, customization, interoperability, and improved analysis. By using attribution, you can more effectively manage and utilize the data within your CAD drawings, improving the quality and accuracy.

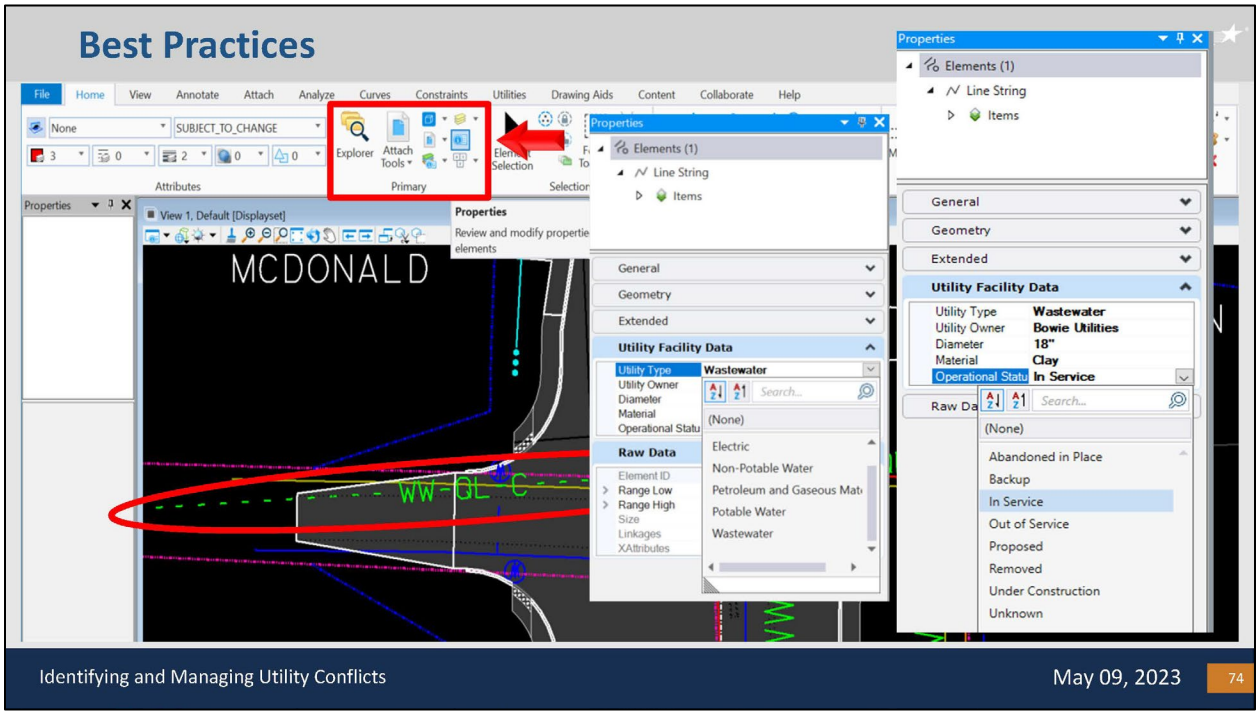


Figure 14. CAD Attribution Sample Courtesy of Texas Transportation Institute of Texas A&M.

It is important for many reasons, including:

- Improved Data Management: Attribution allows you to store data as attributes, which are associated with CAD objects or entities. This makes it easier to manage and organize data within your CAD drawing, and to extract and use the data for other purposes.
- Increased Efficiency: Attribution saves time by allowing you to assign properties to multiple objects or entities simultaneously. This is particularly useful for large or complex drawings with many objects.
- Consistency: Attribution ensures that information associated with an object or entity is consistent. This is important when you need to label multiple objects with the same information or when you need to update information for multiple objects simultaneously.
- Customization: Attribution allows you to customize the properties or characteristics associated with objects or entities, making it easier to tailor the information to your specific needs. This provides more flexibility than simple annotations, which are limited to text and symbols.
- Interoperability: Attribution facilitates interoperability between different CAD and GIS software applications. By using standardized attributes, it becomes easier to share and exchange data between different software platforms.
- Improved Analysis: Attribution enables advanced analysis and data processing within CAD and GIS applications. For example, if you assign a specific material property to an object in a CAD drawing, you can use that attribute to calculate the object's weight, cost, or other physical properties.

In addition to modifying individual attributes, you can also use the "Element Information" tool to query and filter elements based on their properties and attributes. For example, you can use the tool to find all elements of a certain type and material, or to search for elements with specific attribute values.

Leveraging CAD (Computer-Aided Design) feature attribution within Bentley MicroStation allows for a more seamless experience for sharing data with GIS (Geographic Information System) can provide several benefits.

- Improved Data Integration: CAD and GIS data can be integrated to provide a more complete and authentic representation of the real world. By adding attribution to CAD features, such as owner, material, and size, etc., and sharing that data with GIS, it becomes easier to analyze and visualize the data in the context of its geographic location.
- Better Decision-Making: By combining CAD and GIS data, it's possible to perform complex spatial analysis and make more informed decisions. For example, by overlaying CAD data of building footprints with GIS data of population density, it's possible to determine the most suitable location for a new hospital or school.
- Increased Efficiency: Attribute labeling saves time by allowing you to assign properties to multiple objects or entities simultaneously. This is particularly useful for large or complex drawings with many objects.

- Enhanced Visualization: By adding attribution to CAD features, it's possible to create more detailed and of the built environment. For example, by adding information about the rendering of ASCE 38-22 Quality Levels, it's possible to create more reliable and realistic 3D models of underground infrastructure.
- Enhanced Data Management: Attribute labeling allows you to store information about objects or entities within the drawing, making it easier to manage and organize data. By attaching attributes to objects, you can easily search and filter information within the drawing and extract data for other applications.
- Improved Consistency: Attribute labeling ensures that information associated with an object or entity is consistent and thorough. For example, if you need to label multiple objects with the same information, attribute labeling allows you to apply that information automatically, reducing the likelihood of errors.
- Customization: Attribute labeling allows you to customize the properties or characteristics associated with objects or entities, making it easier to tailor the information to your specific needs. This provides more flexibility than simple annotation with leaders, which are limited to text and symbols.
- Improved CAD and GIS Collaboration: Attribute labeling makes it easier to share and collaborate on CAD drawings with others. By storing information about objects or entities within the drawing, all users have access to the same information and can work with the same data. In addition, CAD and GIS data can be shared and accessed by multiple users in real-time, which can improve collaboration and reduce errors. By adding attribution to CAD features, it's easier to assign, share and maintain standardized data across different platforms and applications.

In summary, attribute labeling in CAD provides several advantages over simple annotation with leaders, including enhanced data management, improved accuracy, increased efficiency, customization, and improved collaboration. Moreover, attribute labeling is simpler and less time-consuming for CAD operators than usage of conventional text leaders.

Technology Landscape Recommendations

Federated GIS Data Portal

The research team strongly recommends leveraging a Federated GIS Data Portal (FGDP). FGDP is a geospatial meta-database management web portal that synchronizes and data maps to multiple autonomous GIS and CAD database systems via web services and REST APIs into a single conflated federated GIS database.

A federated GIS is a distributed network of multiple Geographic Information System (GIS) systems that work together as a unified system to provide access to and manage geospatial data from multiple sources. In other words, it is a network of GIS systems that are connected and work together to provide a centralized view of geospatial information and is designed to overcome the limitations of a single GIS system, which may not be able to manage the complexity and volume.

It is a distributed system that allows different GIS systems to be connected and accessed as a single system. In a federated GIS, each GIS system maintains its own data and services, but users can access and use the data and services from all connected systems seamlessly. The key feature of a federated GIS is its ability to share data and services across different systems while maintaining data integrity, security, and privacy. This allows users to access and analyze data from different sources, perform spatial analysis, and create new maps and applications.

A federated GIS typically consists of multiple GIS servers, each of which hosts its own GIS services and data. The system is managed by a central administrator who sets up the connections between the servers and controls access to the data and services.

One of the main benefits of a federated GIS system is that it allows organizations to share data and services without having to consolidate all data into a single system. This reduces the cost and effort required to manage data and services while still allowing users to access the information they need. Overall, a federated GIS system is a powerful tool for managing and sharing geographic information across multiple systems and organizations.

The constituent databases are interconnected via a web network and may be geographically decentralized. Since the constituent database systems remain autonomous, a federated database system is a contrastable alternative to the task of merging several disparate databases. A federated GIS database, or virtual database, is a composite of all constituent databases in a federated database system. There is no actual data integration in the constituent disparate databases because of data federation.

Figure 14 illustrates the mechanisms / resources (constituent databases), data inputs, controls and standards, and the desired outputs for the Iowa DOT utility data repository.

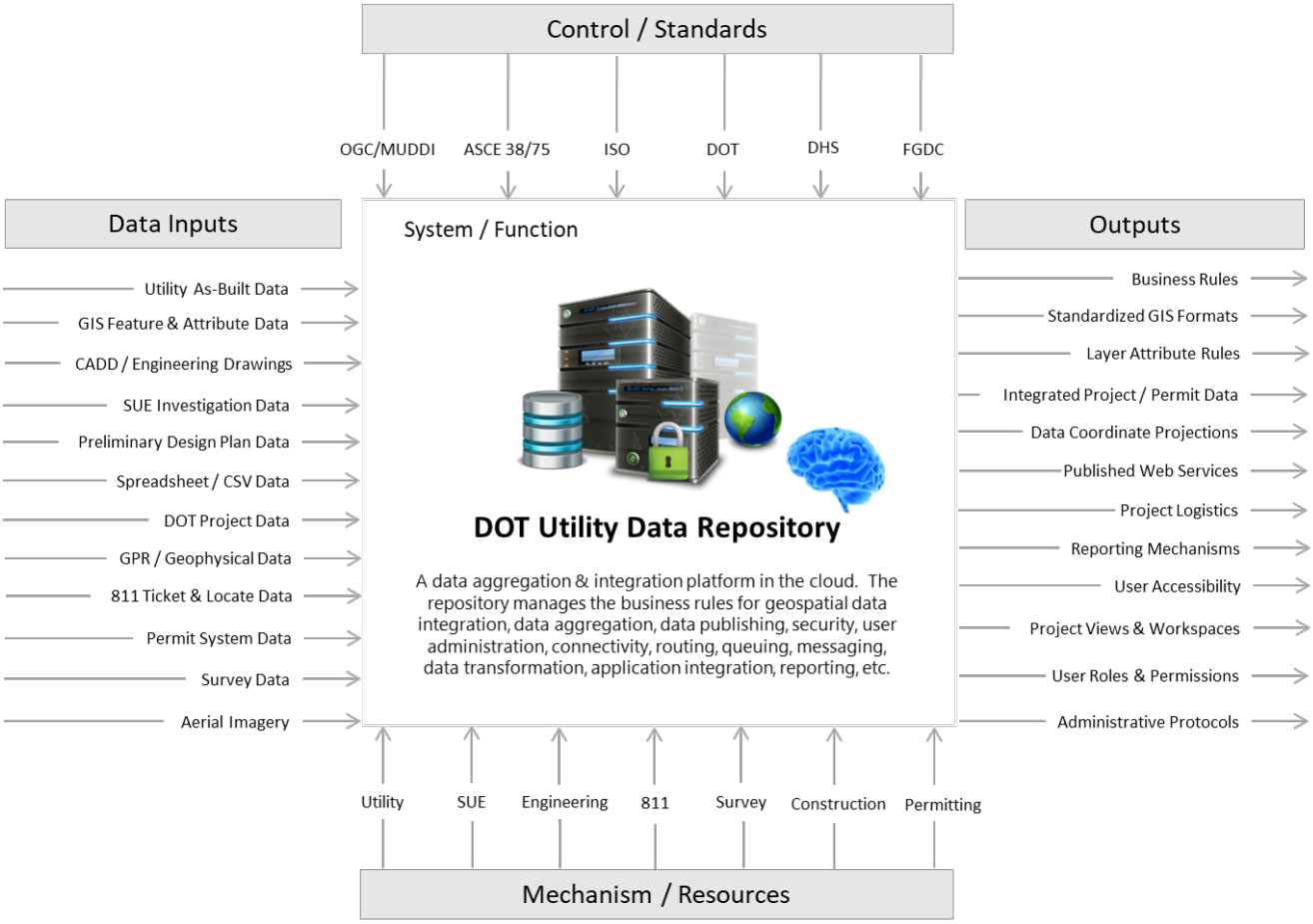


Figure 15. Mechanisms / resources (constituent databases), data inputs, controls and standards, and the desired outputs for the Iowa DOT utility data repository. (Diagram courtesy of Utility Mapping Services, P.C.)

Through data abstraction, federated GIS database systems can provide a uniform user interface, enabling users and clients to store and retrieve data from multiple noncontiguous databases with a single query, even if the constituent databases are heterogeneous. To this end, a federated database system must be able to decompose the query into subqueries for submission to the relevant constituent data sets, after which the system must compose the result sets of the subqueries. Because various database management systems employ different query languages, federated database systems can apply wrappers to the subqueries to translate them into the appropriate query languages.

Leveraging Open Geospatial Consortium (OGC) Interface Standards

Web Feature Services (WFS) and Web Map Services (WMS): In computing, the Open Geospatial Consortium Web Feature Service (WFS) Interface Standard supplies an interface allowing requests for geographical features across the web using platform-independent calls. One can think of geographical features as the "source code" behind a map, whereas the Web Map Service (WMS) interface or online tiled mapping portals like Google Maps return only an image in the form of Web Map Service (WMS), which end-users cannot edit or spatially analyze. The

XML-based GML furnishes the default payload-encoding for transporting geographic features, but other formats like shapefiles can also serve for transport using the OpenGIS GML Simple Features Profile, this profile is designed both to increase interoperability between WFS servers and to improve the ease of implementation of the WFS standard.

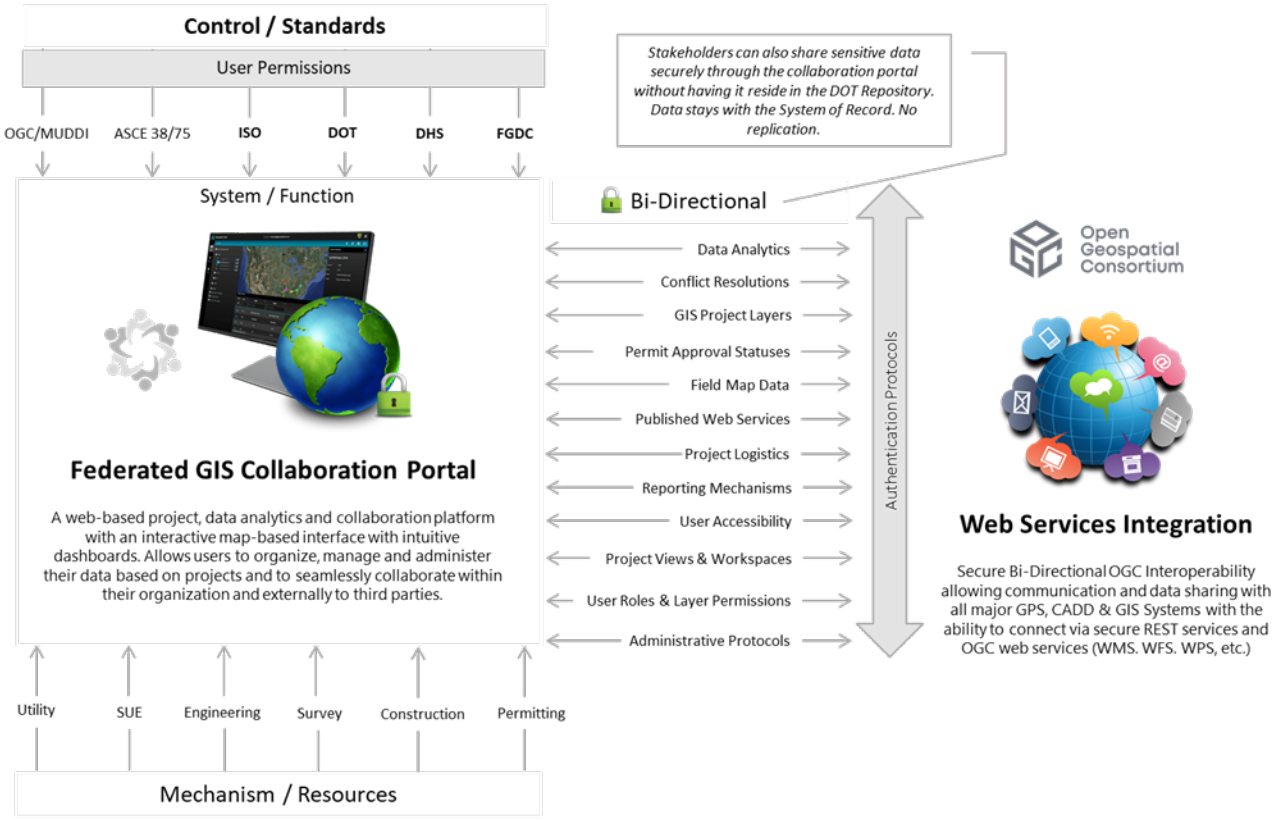


Figure 16. Federated GIS Collaboration Portal Enables Bi-Directional Secure Data Sharing Using OGC Protocols and Standards. (Above diagram is courtesy of Utility Mapping Services, P.C)

Both WFS and WMS are widely supported OGC open standard formats for maps and GIS data accessed via the Internet and loaded into client-side GIS software. Major commercial GIS and mapping software used by the transportation industry that support WFS/WMS include, but are not limited to:

- Autodesk's Map 3D and Civil 3D products
- Bentley Systems' MicroStation, Bentley Map, desktop, and server-based GIS products
- ESRI's ArcGIS products

Require and Enforce CAD Attribution Standards in Design and SUE Deliverables

The research team strongly advises requiring the use of the Element Information Tool in Bentley MicroStation. It is a powerful feature in Bentley MicroStation that allows you to view and edit properties associated with elements in your CAD drawing, filter and process elements in bulk, and extract data for analysis and reporting purposes. Using attribution in CAD provides several advantages over simple

annotations, including improved data management, increased efficiency, consistency, customization, interoperability, and improved analysis. By using attribution, you can more effectively manage and utilize the data within your CAD drawings, share with other technology solutions such as GIS, and improve the accuracy and quality of your information.

Stay Current on OGC Industry Standard Trends:

Model for Underground Data Definition and Integration (MUDDI)

The research team strongly advises Iowa DOT to continue to stay current on industry standards and geospatial technology trends. The Open Geospatial Consortium is continuing to advance in this area with the development of the Model for Underground Data Definition (MUDDI). The MUDDI model is a modular approach to 3D representation of underground infrastructure.

The MUDDI model is a comprehensive integration model for underground information which takes a modular approach, with a conceptual core that covers basic geometric representations of underground assets, and several extension modules that add more specialized capabilities as well as interfaces with existing models. OGC-MUDDI has adopted ASCE 38 “Existing Utility” and ASCE 75 “As Installed Utility” Standards as key input data for their MUDDI initiative.

MUDDI is a representation of classes that serve as the basis that serve as the basis of integration of datasets that utilize different information models in the representation of underground objects and is meant to be comprehensive and provide sufficient level of detail to address application use cases, including but not limited to the following:

- Routine Street Excavations
- Emergency Response
- Utility Maintenance Programs
- Large Scale Construction Projects
- Disaster Planning
- Disaster Response
- Smart Cities Programs

MUDDI serves as an excellent basis for conformant and interchangeable logical and physical implementations, such as GML (Geographic Markup Language) or SFS (Simple Features SQL).

This OGC Standard provides the full set of MUDDI conceptual models and their requirements.

The following paragraphs describing the MUDDI model are contributed by Ordnance Survey (OS) https://www.ordnancesurvey.co.uk/

The following italicized text is contributed to this research project from the MUDDI Standards Working Group (SWG) and is derived from an OS news article entitled **"A MUDDI path towards a clearer underground."** [31]

> *Engineers across the world suffer regular headaches over infrastructure buried underground. Whether it is the stress of making sure their team avoids striking hidden utilities, not knowing where ageing assets are during disaster responses, or costs soaring after stumbling upon unexpected, buried infrastructure, having a clearer picture of what lies under the surface leads to better situational awareness.*
>
> *For years a group of leading data scientists at the Open Geospatial Consortium, an international panel of experts, have been grappling with this problem and how to solve it. They formed a working group to create a concept – the Model for Underground Data Definition and Integration – known as MUDDI for short. Its purpose was to create an international standard for exchanging geospatial data of underground features. The model visualizes subsurface infrastructure assets and characterizes the underground environment that contains them, then defines a data store for it all. This information can then be shared easily among all parties working in the same underground space.*
>
> *The MUDDI model was developed from existing geographic data standards INSPIRE, CityGML, ASCE 38 and 75, and the International Standardization for Organization, and will eventually become an international standard.*
>
> *The first chance to prove the MUDDI model worked came with pilot testing for the National Underground Asset Register (NUAR), a program led by the UK Government's Geospatial Commission. Two pilots were successfully user tested in both Northeast England and London, and work has started to build the system to roll out nationally under the leadership of engineering consultants Atkins. The national roll out of NUAR will involve developing a UK profile of the MUDDI model, focusing on the safe digging use case.*
>
> *Data has been collected by OS from over 650 asset owners, which is delivering the data transformation and data ingestion part of the process. The development team is shaping the harmonized NUAR data model, based on MUDDI, as well as building the data store and creating the platform that will serve up the transformed infrastructure data through a map-based user interface that will give people in the field a tool where they can draw an area on the map for where they are planning to dig up a road, to reveal the pipes and cables that they need to know are already there in a clear, uniform way.*
>
> *"The NUAR pilot was based on an earlier version of MUDDI, and the feedback we got from the pilot phase has fed into a new iteration of the MUDDI model, and that is now forming the basis of the national roll out of NUAR." says ordinance surveyor and MUDDI key contributor - Chris*

[31] https://www.ordnancesurvey.co.uk/news/a-muddi-path-towards-a-clearer-underground

> *Popplestone. "There has been a lot of international involvement and that is being looked at very carefully for other international projects that are also planning to follow a similar approach."*

Sensitive Security Information (SSI)

Sharing sensitive security data should be done with utmost care and precaution to avoid any unauthorized access or exposure. Here are key best practices to consider:

- Limit access: Share the sensitive security data only with those who need to know. Limit the number of people who have access to the data and ensure that each person has the necessary clearance and authorization.
- Use secure communication channels: Use a secure communication channel, such as a VPN or a secure file transfer protocol (SFTP), to transfer the sensitive data. Avoid using public Wi-Fi networks or unsecured email services.
- Use two-factor authentication: Implement two-factor authentication to ensure that the person accessing the data is authorized to do so. This can include using a password and a one-time code sent to the recipient's mobile device.
- Define access policies: Define access policies and procedures for managing sensitive data. These policies should include guidelines for data storage, transmission, and disposal.
- Monitor and audit access: Regularly monitor and audit access to the sensitive data to detect any unauthorized access or data breaches.
- Use secure storage: Store the sensitive data in a secure location, such as an encrypted database or a secure file server.

Overall, the key to sharing sensitive security data is to use a combination of these best practices to ensure that the data is secure throughout its lifecycle, from creation to disposal.

Leveraging Security Assertion Markup Language (SAML)

Security Assertion Markup Language (SAML) is an open standard for exchanging authentication and authorization data between an identity provider and a service provider. SAML is an XML-based markup language for security assertions (statements that service providers use to make access-control decisions). The SAML protocol simplifies password management and user authentication in a federated system.[32] It uses Extensible Markup Language (XML) to standardize communications between multiple systems.

[32] https://learn.microsoft.com/en-us/azure/active-directory/fundamentals/auth-saml

Federated System Authentication

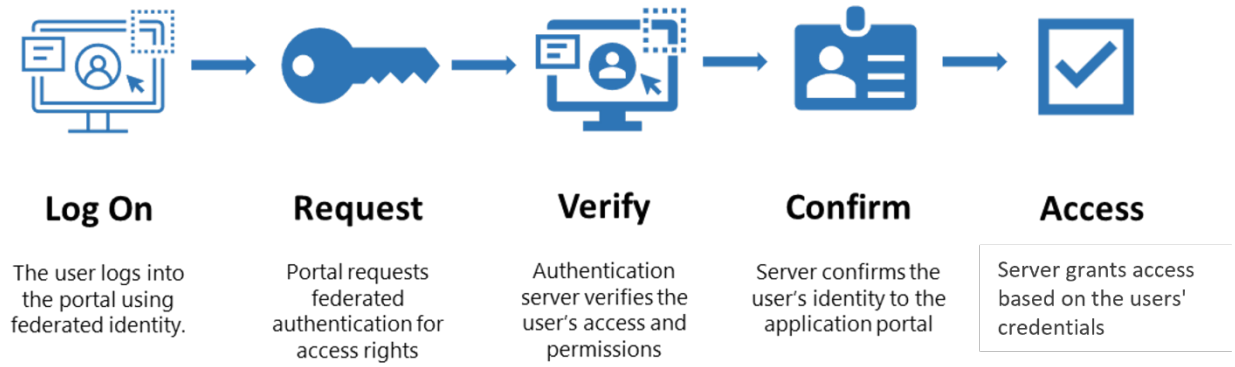


Figure 17. Federated System Authentication (Diagram courtesy of Utility Mapping Services, P.C.)

An important use case that SAML addresses is web-browser single sign-on (SSO). Single sign-on is easy to accomplish within a security domain (using cookies, for example) but extending SSO across security domains is more difficult and results in the proliferation of non-interoperable proprietary technologies. The SAML Web Browser SSO profile was specified and standardized to promote interoperability.[33]

The SAML specification defines three roles: the principal (typically a human user), the identity provider (IdP) and the service provider (SP). In the primary use case addressed by SAML, the principal requests a service from the service provider.[34] The service provider requests and obtains an authentication assertion from the identity provider. Based on this assertion, the service provider can make an access control decision, that is, it can decide whether to perform the service for the connected principal.[35]

At the heart of the SAML assertion is a subject (a principle within the context of a particular security domain) about which something is being asserted. The subject is usually (but not necessarily) a human. Before delivering the subject-based assertion from IdP to the SP, the IdP may request information from the principal—such as a username and password—to authenticate the principal. SAML specifies the content of the assertion that is passed from the IdP to the SP. In SAML, one identity provider may provide SAML assertions to many service providers. Similarly, one SP may rely on and trust assertions from many independent IdPs.

SAML does not specify the method of authentication at the identity provider. The IdP may use a username and password, or some other form of authentication, including multi-factor authentication. A directory service such as RADIUS, LDAP or Active Directory that allows users to log in with a username and password is a typical source of authentication tokens at an identity provider.

[33] https://blog.matrixpost.net/overview-of-existing-sign-in-and-authentication-protocols/
[34] https://pdf.wecabrio.com/use-case-specification-use-case-name-oasis.pdf
[35] https://www.miniorange.com/what-is-saml

Federated Utility GIS Data Management Scenarios:

Scenario One: The following diagram illustrates an interim federated GIS solution administered by Iowa DOT.

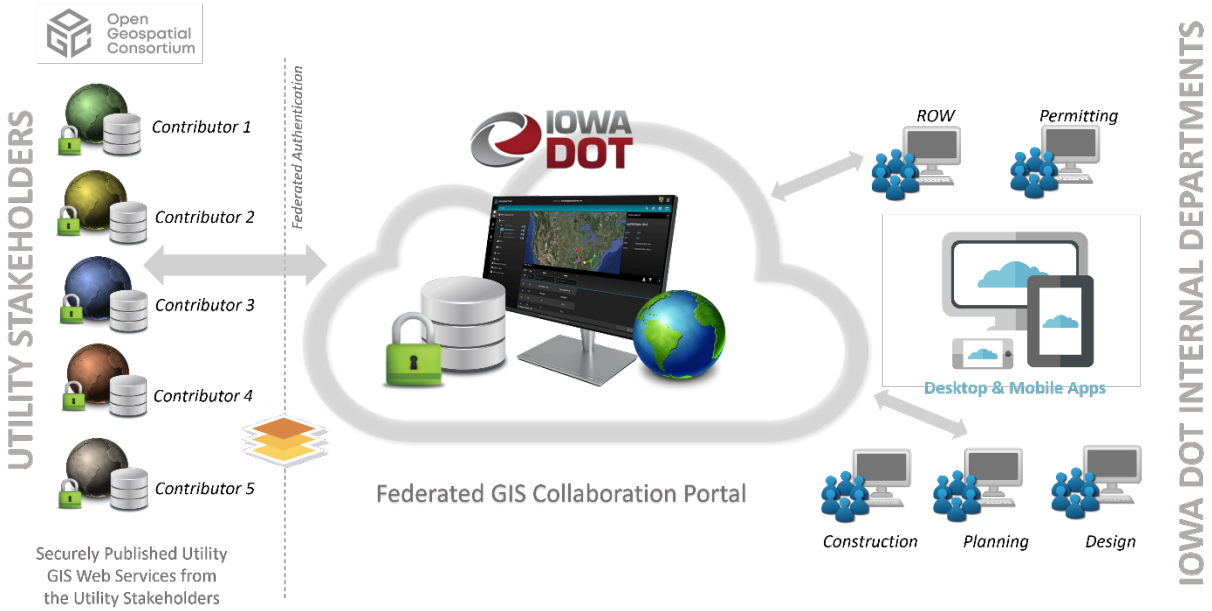


Figure 18. Interim federated GIS solution administered by Iowa DOT. (Above diagram is courtesy of Utility Mapping Services, P.C.)

In the above scenario one, Iowa DOT would leverage ESRI's ArcGIS Enterprise portal to administer a federated server. With this configuration, the utility stakeholders manage their published services from their respective GIS server and share web services directly with Iowa DOT. Instead of acquiring and replicating the utility GIS data and managing it in a separate Iowa DOT GIS repository, a federated approach allows utility stakeholders to share, publish and consume data securely directly from the utility GIS system of record. The GIS data is maintained at the system of record, ensuring the data stays current is not out of date. No replication.

When federation occurs, any users, roles, and permissions are determined by portal members, roles, and sharing permissions. The portal offers viewer, user, publisher, administrator, and custom levels of privilege.

Scenario Two: The next diagram illustrates a state managed federated GIS solution administered by the Iowa Department of Management's Office of the Chief Information Officer (OCIO). The research team highly recommends this approach as the OCIO is best positioned to federate and secure these services across all public stakeholders, such as state, county, and local municipality agencies that need access to utility data for numerous reasons, including disaster preparedness and emergency response activities. In addition, entities such as Iowa DOT, Iowa One Call and Iowa 911 become part of the entire ecosystem to share, consume and publish secure services to and from the federated GIS portal.

Figure 19. Federated GIS solution administered by OCIO. (Above diagram is courtesy of Utility Mapping Services, P.C.)

Traditionally when entities and agencies need to acquire utility data, they reach out to each respective utility member individually. This is not only a time-consuming process for the requestors, but also for the data grantors as well. Through research breakouts with various utility stakeholders, this approach is well received as it allows utility stakeholders to securely publish their data to a single federated portal where it can be securely accessed by all of those who need it. This eliminates the need for utility stakeholders to respond to multiple data sharing requests, especially in emergency response situations.

The Office of the Chief Information Officer was created as an independent agency for the purpose of leading, directing, managing, coordinating, and providing accountability for the information technology resources of state government. The mission of the office is to provide information technology and business solutions to government and citizens through guidance, service delivery and partnerships. Their vision is to enable the digital transformation of government through collaboration and innovation, to deliver citizen-centric solutions. Among its many powers and duties, the OCIO has the authority to establish standards for information technology used by state agencies, direct the work of agency information technology staff, review and recommend approval of information technology staff employment decisions in coordination with the Department of Management, and enter contracts for the receipt and provision of information technology services.

Technology Landscape Reasoning

Based on the research findings, Iowa DOT is well postured to scale using a combination of automated workflows & asynchronous data transformations combined with federated GIS technologies. This modernization goal is within grasp and can be realized by focusing on these key areas.

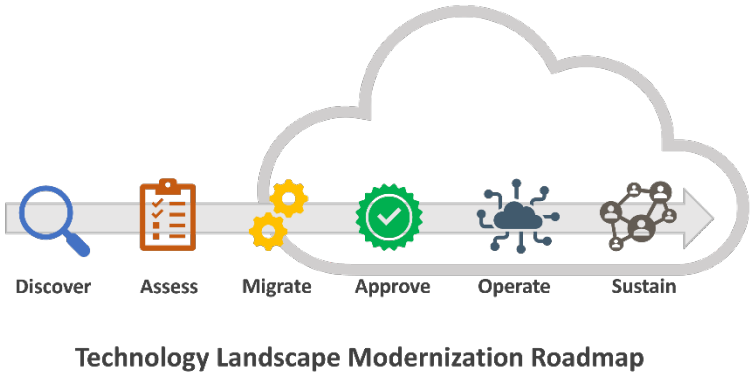


Figure 20. High Level Technology Roadmap

As the utility industry moves toward significant technology and digital transformation, the overarching DOT strategy should embrace modernization as well. The goal is to unite systems to communicate spatial asset data from the various systems of records responsible for managing stakeholder assets, not by replicating them. By strengthening work and utility asset management collaboration, it allows the DOT the ability to monitor the ever-changing status of utility networks, identify issues that may affect projects in a proactive verses' reactive manner. Modernizing the GIS technology landscape will not only improve how the DOT manages utility stakeholder assets, but it will integrate and federate previously siloed systems. Through federation, several paradigm-shift improvements occur. Federated and Integrated GIS can consume and publish the utility network systems using web services. It can also provide simulations for predictive analytics. With ACSE 38-22 and 75-22 compliance the DOT can manage the utility network within the ROW based on real-world qualified and standardized attributes, whether electric, gas, water, storm, sewer, telecommunications, etc., and quickly analyze and identify utility assets which may conflict with DOT project designs to either accommodate, protect in place, or potentially relocate those assets. As Iowa DOT scales from departmental GIS to a federated spatially enabled enterprise, it will accelerate access to utility data. The DOT can take data from traditional GIS, combine it with CAD, and live data feeds through web services to consume them into a single, conflated, and seamless view that incorporates location analytics and geospatial data for decision-making and situational awareness. Power-driven 2D and 3D GIS visualization stands to improve utility stakeholder collaboration, streamline project development, and reduce delays and added costs of utility-related project issues. The elimination of manual data migration processes improves the value and timeliness of the information needed. Stakeholders can access, view, and interact with multiple projects in different phases, including planning, engineering, design, construction, and maintenance.

Organizations should modernize their technology landscape to keep up with the ever-changing business landscape and to remain competitive. Here are some key reasons why modernizing technology is important:

- Enhanced Efficiency: Modern technologies such as automation, artificial intelligence, and cloud computing can help organizations streamline their processes, reduce manual effort, and increase productivity.
- Better Customer Experience: Modern technologies can help organizations deliver a better customer experience by offering personalized services, faster response times, and 24/7 support.

- Improved Security: Modern technologies offer better security measures to protect against cyber threats and data breaches. These technologies can help organizations prevent and detect potential security threats, ensuring the safety of sensitive data.
- Scalability: Modern technologies are scalable, which means they can grow with the organization's needs. This allows organizations to handle larger workloads and support more users without having to constantly invest in new hardware and software.
- Cost Savings: Modern technologies can help organizations save costs by reducing manual effort, eliminating the need for expensive hardware, and reducing energy consumption.
- Competitive Advantage: Organizations that modernize their technology landscape gain a competitive advantage by being able to quickly adapt to new trends, deliver new products and services, and respond to market demands.

Overall, modernizing the technology landscape is critical for organizations to stay relevant, efficient, and secure in the fast-paced digital world.

Modernizing and building upon the current technology landscape with enterprise GIS federation coupled with workflows & asynchronous data transformations will allow Iowa DOT to not only scale but to stay postured today and well into the future. By embracing industry open standards, Iowa DOT's technology roadmap will provide for:

- System interconnection, electronic data interchange & data integration
- Seamless web & mobile application interfaces
- Real-time visualization, analytics, and reporting
- Reduction and/or elimination of stakeholder data silos
- Automated data transformation processes
- Improved data accuracy, timeliness, and completeness
- Value driven business intelligence (BI)
- Performing utility data analysis, trends & patterns
- Tracking project key performance indicators (KPI's)

Utility Permitting Findings

Initially one might not associate reviewing the utility permitting process with improving Iowa DOT's ability to Identify and specify the location of utility facilities within Iowa DOT Project footprints. The permitting process itself does not; however, it does offer the opportunity to verify or gather accurate utility location data at the time of installation. Moreover, the permit process can serve as an effective ROW management tool, enabling Iowa DOT to manage and track all proposed and executed changes within the ROW.

Obtaining or verifying accurate positional information of utilities when they are installed is critical to being able to effectively manage IOWA DOT rights-of-way. When utility location data and utility metadata are collected and attributed following a data standard or schema, this data can be stored and shared for use in planning and executing IOWA DOT roadway projects in the future.

As part of the overall research project the team was tasked with evaluating IOWA DOTs current utility permitting process to identify strengths, weaknesses, opportunities, and threats.

In addition to reviewing the overall utility permitting process, the team also evaluated Iowa DOT's electronic permitting system under development. To conduct this evaluation the research team created a utility permitting feature functionality matrix (summarized below). The feature functionality matrix was developed based on industry best practices, and our experience with the development and deployment of utility permitting systems with the Montana Department of Transportation and the Texas Department of Transportation.

The following summarizes the results of our review.

Iowa DOT Utility Permitting SWOT

To review and make decisions about whether to deny or approve a utility permit application, the utility permitting process typically gathers the following information:

- Who – who owns or is responsible for the utility and if needed, who will be installing the facility (Utility Company/Contractor)
- What – what type of utility is being installed (electric, communications, water, etc.)? Are there any special rules that apply, or special provisions that might apply. What type of installation is being proposed, open trench, direct drill, etc. What are the attributes of the proposed installation: material, size, type of service.
- Why – why is the utility being installed. Is this a new installation to bring or update services to a community or customer, or is the installation associated with a highway project?
- When – when is the utility being installed. Are there any work moratoriums, are there other planned installations near or in the vicinity during the same timeframe where the installations

could be coordinated to reduce roadway closures or service disruptions. Is there a current roadway project occurring during the planned installation that may impact the project?

- Where – where is the utility being installed in general terms for review and planning purposes. Is the planned installation near a current roadway project or future roadway project? **More importantly**, when installed, collecting actual location data, both horizontally and vertically. These data must be referenced to a known datum and not relative positions to current roadway or other features that may be moved or removed in the future (centerlines, right-of-way limits, etc.) or just based off the proposed installation location.

The permitting process does not end once the permit application is approved. The installation should be inspected to ensure compliance with the provisions of the permit. Was the worksite properly restored? Did the installation comply with any special provisions that may have been specified as part of the application process? Where was the utility installed tied to a known datum and was true as-built data submitted and reviewed?

The desired permitting process must have a means to review and assess if the data can be trusted. The system may require the utility company to review and certify, and/or the Iowa DOT may have an inspection process and an audit process to spot check data to verify accuracy and completeness.

To understand IOWA DOTs process and requirements the research team reviewed documentation and information on websites provided by the IOWA DOT Right of Way Bureau regarding the Utility Permitting Process, permitting documentation requirements, and the availability of data required for submitting permits applications (utility records, right of way boundaries, centerlines, stationing, etc.). Documents and information included in the review:

- Form 810025 - Utility Accommodation Permit
- Form 810051 - Freeway Longitudinal Utility Accommodation Permit
- Form 810028 - Application to Perform Work Within State Highway Right-of-Way
- IOWA DOT Open Data Portal (https://data.iowadot.gov/)
- State of Iowa Open Geospatial Data Portal (https://geodata.iowa.gov/)
- IOWA DOT Permitting Page (https://iowadot.gov/districts/permits)
- IOWA DOT Policy Manuals
    - Administrative Rules on Primary Highway Access Control (Chapter 112)
    - Access Management Manual First Edition
    - Policy For Accommodating and Adjustment of Utilities On The Primary Road System
- IOWA DOT Right of Way Website (https://iowadot.gov/rightofway)
- IOWA DOT Electronic Permitting System Training (https://eps.iowadot.gov/Training/index.html#/)
- Highway Plans and Crosse Section Collections (http://www.mydotdocs.iowadot.gov/)

In addition to reviewing materials and information provided by Iowa DOT, the research team held one on one meetings with IOWA DOT personnel and breakout sessions with Iowa DOT staff and Utility Company representatives. The purpose of the meetings and breakout sessions was to go through the

IOWA DOT permitting process from the perspective of IOWA DOT Right of Way Bureau staff and Utility Companies to identify strengths, weaknesses, opportunities, and threats. It was noted that from the Utility Company perspective, Iowa DOT permits were a small portion of the overall permits they deal with on a regular basis. Most of the utility permits they had to submit were with municipalities and counties that are responsible for approximately 94% of roadway within the state of Iowa[36].

To evaluate and make recommendations on Iowa DOT's electronic permitting system the research team created a Feature Functionality Matrix summarized below:

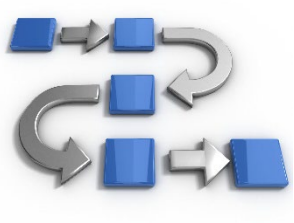
Administrative Functions

- Self-serve role-based configuration and ability to customize roles and permissions.
  - Authorized users can configure and modify roles that manage the information a user can modify, view, or have access to.
- Self-serve form builder with ability to create templates.
  - Authorized users can create forms, fields, data types, messages, and alerts within the system either through simple code (html) or an integrated user interface.

- Self-serve report builder with ability to create templates.
  - Authorized users can create customized views of data which can then be exported, saved, or shared. Alternatively, the data in the system can be exposed for integration with other business intelligence software.
- Self-serve workflow builder
  - Trained and authorized users, through integrated tools, can create new or modify existing workflows to meet new needs or requirements as they are identified post initial implementation.
- Ability to configure auto responses, notifications, and alerts.
  - The system allows modification of responses, notifications and alerts that are generated during the submission, review, and approval process post initial implementation.
- Responsive design that works on desktops and mobile devices
  - The system should be designed to work on desktop and mobile devices. This capability is critical for allowing field inspections during and post installation of utility features.
- Out of the box APIs
  - System should provide APIs or other mechanisms to access and exchange database level information along with developer guides and protocols.

[36] This reinforces the concept of developing a single system that can be utilized by all public agencies managing ROW, including municipalities and counties. There is tremendous value to be reaped for all stakeholders by eliminating redundant activities, providing standardized procedures and forms, enabling a single collaborative environment for securely sharing standardized data, and pooling resources for operations and maintenance.

Workflows



- Allows outside users (no account within the application) to respond to requests for information, reviews, or approvals. Responses are stored within the application (examples: FHWA, Municipal Authorities, internal personnel)
    - Ability to provide users that do not require regular access to the system to provide approvals, reviews, comments, or other recommendations. Groups or personnel from say FHWA, local agencies or other organizations may need to approve or provide input. The system should allow this interaction without having to have an active account.
- Ability to set required or optional information to be entered by applicants and validate required information is provided before the review process.
    - The system should have the ability to make certain fields required or optional and if required should validate that required information is entered and formatted as per requirements.
- Provides ability to amend/modify applications during all phases of the permit process; application, review/approval, and execution (construction/installation)
    - Provides the ability to make modifications and or request modifications during the application, review, and installation if circumstances require. Typically based on the business rules and status of the application. An example would be changes to the planned installation dates.
- Allows setting of automated notifications to identified stakeholders of changes to permits status through the application process: application submittal, review/approval, and execution.
    - Typically driven by the business rules. An Example would be to send a reminder to stakeholders when the planned installation date is approaching. This could be based on the type of utility installation or the location of the installation. An installation on an interstate with traffic control may require a longer lead time than an installation that is along a highway that does not require traffic control or lane closures.
- Capture of inspection information as required by regulations or business rules: images, completion of inspection forms, etc.
    - Ability to customize inspection forms based on the business rules for the type of utility or installation planned. Should include the ability to take picture0, add notes, and record any deficiencies associated with the field inspection.
- Manage and update Utility Company Information associated with completed or in progress applications.
    - Ability to update utility company information either during the application process, review or after the installation is complete. This is tied to the utility repository and being able to identify the current owner in the future if coordination is required.

- Electronic signature internally or through integration with 3rd party applications.
  - Based on the business rules, electronic signature may be required. If so, the system should integrate with electronic signature providers or offer a mechanism to upload documents that have been electronically approved.
- User roles define interface views and available functionality based on business requirements.
  - Connected to the administrative function, this functionality limits access to certain views, information, or tasks based on the user's assigned role.
- Role based creation and modification of workflows post initial deployment.
  - The creation and modification of workflows can be accomplished after the initial release or deployment of the system. The system should provide a test environment or ability to test workflows prior to deploying any modifications or new workflows.
- Self-service capabilities to create custom forms, configuration updates, create/modify workflows post installation.
  - System offers tools or mechanisms for approved users to customize forms, make updates to forms, create and or modify workflows post installation.

Reporting

- Ability to build standardized reports based on business needs.
  - The system should include out-of-the box reports and the ability to create DOT standardized reports and based on the user's role. The system should allow sharing of reports so others can reuse and or modify for their needs.
- Ability to run analytics based on numerous variables.
  - Provides the ability to create reports and provide in a dashboard type environment.
- Allow end users to create custom filtered reports and save preferences.
  - System provides the capability to filter reports that have been created based on data fields specified by the user.
- Integration with 3rd party applications; (e.g., financial systems, human resources, GIS systems, business intelligence, etc.)
  - System includes the ability to support integrations with external systems for direct database integration through APIs, SOAP or other mechanisms.
- Location based reporting (i.e., by roadway, district, county, etc.)
  - Ability to create reports based on a GIS interface (drawing a boundary) or through specifying a location: For example, a report for permits along interstate roadways or along a specific roadway from milepost X to milepost Y.

GIS Integration and Utility Data Repository

- Ability to upload data and to allow submitter to certify accuracy of as-built/installed utility data.
  - System should include tools for importing data using open data standards or common standards (Shapefile, KMZ) with attributes that define the accuracy or data collection method.
- Intersect/interact with agency GIS layers to route applications to the reviewing authority based on business rules (e.g., District, Maintenance Office, Area Office, Environmentally Sensitive Area, etc.)
  - The system should allow users to use a map interface to indicate the proposed installation location which would route the application to the controlling office or district.
- Geospatially query existing permits and utility data within proposed installation location(s).
  - The system provides the capability to intersect previous utility permit installations and utility location data from other sources like SUE investigations.
- Intersect/interact with agency GIS layers to automatically populate required data (e.g. roadway names, reference markers/mileposts, section, township, range, districts, environmentally sensitive area, etc.)
  - The system, based on the planned installation location, can auto-populate fields that are often required for a utility permit to reduce the amount of information the applicant needs to look up or provide manually.
- Ability to track and log any changes to data uploaded to the repository through the permit application. Maintain historical data and information.
  - The system should provide an audit tail to identify the user making any modifications or changes to information in the repository and keep historical data for reference if needed in the future.
- Ability to ingest, store, and manage 3D data from survey files or 3D BIM Models and render it in 2D on permit map.
  - Ability to store the X, Y and Z values of each observation along with metadata about the facility in order to create 3D models of the data.
- Ability to render 3D.
  - The ability to render in 3D is a challenge for web-based systems. This feature is a nice-to-have feature and would likely be handled with a plugin or serving the utility data out to another application that can render in 3D.
- Store and manage utility data in a format that allows automated 3D create of 3D BIM models either directly from a data repository or data exported from the repository. ACSE 75
  - The system should provide the flexibility to incorporate enough fields to be compliant with ASCE 75 standards.

- Publish and consume web services with associated APIs.
  - The system should provide APIs to interface with common GIS applications through APIs or REST services.
- Web services are OGC compliant.
  - The data repository should be configured to be compliant with OGC standards for exchange of information and data.

Results Summary

In addition to rating the Iowa DOT against the feature functionality matrix, the research team reviewed and evaluated several Utility Permitting COTS providers. Of those reviewed, the following providers scored high on the Feature Functionality Requirement Matrix:

Founded in 2001, Flairdocs is an Enterprise Software and solutions company specializing in Right-Of-Way Management, Systems Integration, and Business Process Management. Their solutions provide web-enabled and scalable solutions for document management, workflow management, reporting, system administration, cost estimation, eRecording and integration with GIS. (https://www.flairdocs.com/)

For over 20 years Delasoft has been developing solutions for organizations and agencies to simplify and optimize their permitting processes. Their permitting platform provides a comprehensive solution for managing permits, collecting payments, inspecting event sites, and communicating with permit holders. The platform offers in-office and mobile capabilities, is scalable, includes highly configurable settings, and customizable modules integrated with GIS. (https://www.delasoft.com/)

Since 1999, RTVision solutions have advanced the management, planning, construction, and maintenance of infrastructure through innovative software applications for Transportation, State & Local Government, Water & Utilities, and Consultants. Their OneGov permitting application provides a fully customizable platform that can be used to build unique permits, inspection operations, and workflow processes. (https://rtvision.com/)

High-Level SWOT Results

The following contains the high-level findings of the research team's Permitting SWOT analysis. The results were largely positive. Overall, the permitting process is easy to follow, is timely, and no significant concerns were expressed.

There were some inconsistencies internally regarding what type of permit is required for maintenance of utility facilities already permitted. Information required, such as section, township, range is sometimes left for Iowa DOT to complete. When discussing as-built submission and inspections, there was a consensus regarding concerns about the costs of acquiring this data, processing, exchanging data, and data security.

The research team noted that much of the institutional knowledge about the development and requirements for the electronic permitting system were not available.

Identified Strengths

1. Permitting process understood by all stakeholders.
2. Process for review and approval is timely.
3. Iowa DOT and the State of Iowa have solid GIS systems with much of the data required for permit submission (ROW limits, centerlines, etc.)
4. Open and effective communications between Iowa DOT and Utility Companies

Identified Weaknesses

1. Workflow diagrams that illustrate the overall process and decision points.
    a. There were some differences noted as to what type of Permit is required for maintenance work of existing facilities. Workflow diagrams would specify what type of permit is needed in different situations and could be automated through an electronic system.
2. Data to and from stakeholders conducted through manual process.
3. No single point/view/service for gathering data required for permit review.
    a. Iowa DOT and the state of Iowa have GIS layers of data that are requested to be submitted with or part of a utility permit applications. This information is not consolidated in one easy to access location, view or service for easy access.
4. Iowa DOT limited information regarding the quality or accuracy of data (ROW limits, roadway centerlines, etc.
    a. The data also do not have attributes that speak to the quality or accuracy of the data provided.
5. No repository or portal for sharing or exchanging information.

   a. See technology landscape section for recommendations regarding the proposed data exchange proposals.
6. Internal IT staff supporting development of electronic permitting system.
   a. Difficult to support without dedicated resources or additional resources to develop and then maintain an electronic system. In addition there has been turnover in key positions that were involved in the initial development of the electronic system. Iowa DOT staff were unable to provide or identify the requirements used to develop the electronic permitting system to understand what functionality would be used to determine if the system met the requirement of the Minimum Viable Product (MVP).

MVP – a version of a product that includes the enough features to be useable by early adopters and informs future product development.

7. Permit status or modifications required are communications conducted via email/phone.

Identified Opportunities

1. Define workflows to address different permit types and review requirements.
2. Data portal specific to information required for permit submission.
   a. Some Utility Companies have good CAD/GIS records that could be leveraged to augment the information the state has available.
3. Define Minimal Viable Product (MVP) for an electronic permitting system.
   a. Define minimum set of features to include in early or initial users/adopters.
4. Standardize utility data collection at the time of installation as per ASCE-75

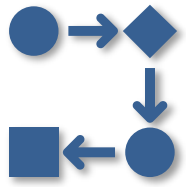
Threats

1. Costs associated with procuring and developing electronic permitting system.
2. Staff time and costs associated with continued development and support of internal system or implementation of a COTS solution.
3. Communicating benefits of requiring as-built information following ASCE-75 vs any additional costs incurred by utility companies and Iowa DOT.
4. Data security (see recommendations for Technology landscape).
5. Iowa DOT permits are a small part of the permits that Utility Companies have to deal with.
   a. Input received during breakout sessions with Utility Companies indicated most of the permits they deal with are not with Iowa DOT. This aligns with the states roadway data that shows Iowa DOT is responsible for about 5% Iowa Roadways. This should be weighed against the costs of continuing the development and implementation of the in-house EPS or a COTS solution.

Our research team found that Iowa DOT is well postured to develop and make improvements and to formalize a transition to a modern electronic permitting system.

Utility Permitting Recommendations

Workflows

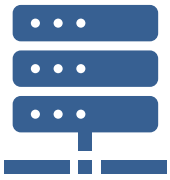


Overall, the Iowa DOT permitting process functions as required according to those interviewed. During the breakout sessions both the Iowa DOT staff and Utility Companies did not express significant concerns regarding submission, review, and approval of a utility permit. This does not mean there are not areas for improvement through developing and defining workflows.

The workflow definition process should include the process from pre-submission (what information is initially needed by utility companies as they prepare to submit an application) through submission, review, review decision points, inspection and closeout. The workflow analysis should include defining and standardizing the type of permit required (new installation, maintenance, project related, etc.). Identification of any decision points along the process where subject matter expert input or review is required; does the permit require a deviation from policy? If so, who needs to approve this deviation?

These workflows would form the basis for fully defining the requirements and features for implementing an online system.

Data/Information Require for Application



Iowa DOT and the State of Iowa have invested resources to develop their GIS data stores (see Technology Landscape). One issue noted was that there is no consolidated map or service the integrates this information to make it easily accessible to applicants.

The Iowa DOT utility permit application was used to understand what information is being requested by Iowa DOT to be included with the permit application. The information included the following:

Work Site Location

- Section
- Township
- Range
- Hwy Number
- General Location
- X miles from
- City, county line, or other landmark
- Specific Location from Milepost
- Highway Station to Milepost
- Highway Station on _____side of highway

The application process includes a checklist specifying the information required for submission of detailed drawings and specifications that accompany the permit application as shown below.

Plans (showing)

- Iowa DOT Centerline
    - Highway Number
    - DOT Stationing
- Right of Way Line with Horizontal Distances from Highway Centerline
    - Including breakpoints and
    - Changes in ROW distances
- ROW Line (construction features/Bore Pits
    - Distance from roadway edge or
    - Distance from centerline
- ROW Lines and Stationing
    - Show all proposed facilities referenced by DOT stationing and distance from centerline.
- ROW Lines
    - Where proposed facility enters or leaves the ROW

The research team recommends Iowa DOT create an interface or service that consolidates the information above into a map and services where applicants could capture the information required and download certain information for use in developing their detailed installation plans. The team also recommends that Iowa DOT review other data layers that may be helpful for applicants and reviewers. For example, having Iowa DOTs planned projects data included for identifying possible opportunities for improved collaboration or for reviewing an application to determine if the proposed installation would impact an ongoing project or planned roadway project.

Providing these maps and services would also help to define some of the data requirements for identifying the MVP for an electronic permitting system. This effort could be a challenge for Iowa DOT with limited GIS resources to develop and manage this functionality. This effort would also require Iowa DOT ROW Division Staff to assist with developing the requirements.

Before full implementation and even without the implementation of an online system, developing such a view or services would identify any gaps. To fully leverage the data, the accuracy of the information needs to be quantified to understand whether it can be used for utility design purposes with regard to ROW boundaries, centerlines and information required by Iowa DOT.

Iowa DOT has a portal of as-built data from prior roadway projects in PDF format. Although this data has limited use it does provide additional information that could be used by the applicants and Iowa DOT when reviewing applications. These datasets could also be georeferenced for sharing/use in the interface described above and made available to applicants as they plan their proposed installations.

Electronic/Online Permitting System

When Iowa DOT first looked at implementing an electronic permitting system there were not many vendors offering a system specific for utilities or were configurable enough to be configured to address utility permitting needs. Some early adopters took systems that were designed for building permits. Today there are numerous vendors that offer COTS systems designed for Utility Permitting or customizable and flexible enough to be configured for utility permitting.

To effectively transition from a paper based permitting process to an online or electronic system requires careful planning and thought. There is a tendency to replicate the paper process in an electronic system. This can work however this tends to limit being able to take advantage of some changes in process and procedures that an electronic system offers.

Advances in technology, especially on the GIS front, have made data sharing and integration with these systems common practice.

Iowa DOT has developed an electronic permitting system internally however they have seen a significant amount of turnover on the business side and within their IT group. They do not have documentation that describes the feature functionality or requirements documentation. As described above, the research team recommends that Iowa DOT defines and documents their workflows and requirements. Further, the research team recommends that Iowa DOT pursues a cloud-based COTS system. The team has provided a feature functionality matrix as a starting point to identify potential features they would require.

In addition to defining their workflows and required feature functionality, the research team recommends that Iowa DOT advertises and selects a COTs provider to implement an electronic permitting system. COTS products are designed to be installed easily and configured to interface with existing systems. A COTS solution typically offers some of the following benefits:

- Lower Costs
- Reduced development time.
- Faster integration of new technologies
- Lifecycle Cost (readily available and up-to-date products

COTS products typically include packaged software that can be adapted or configured to meet the needs of the agency which offers benefits over developing a custom solution:

- **Cost of development, implementation, and maintenance**: Developing a custom requires dedicated IT staff to understand business requirements, write code, configure, test, and implement. Maintenance of the solution can also increase costs while getting less value. A COTS solution offers at a minimum the same but usually more functionality than a custom internally developed system.

- **Systems Integration:** Most DOT permitting applications will likely need to be integrated with current applications being used by the DOT. These systems can include business intelligence software for reporting, digital signature applications for approvals, GIS, and CAD systems, etc. All the systems that were evaluated for this research project have been integrated with major software systems typically used by DOTs. Iowa DOT should understand and evaluate any solutions against their current and potential future requirements.

- **Full-time technical support:** There are multiple COTS solutions that have been on the market and provide mature solutions capable of meeting Iowa DOT needs. These solutions provide dedicated technical support for maintaining and updating the system.

- **Reliable software:** COTS software is thoroughly tested before being released to the market. These systems are very reliable and secure.

As well as the benefits above, COTS providers are continually updating their products as technology evolves and user requirements change, that often increases system capabilities and improves reliability. Custom solutions do not benefit from multiple user communities that drive these changes and often fall behind a COTS solution. Some examples include:

- Updates to other software systems such as the Operating System (OS) require updates to the permitting system to remain compatible. Example: A custom web-based system originally developed by another DOT as a proof-of-concept system, was placed into operation. The system had minimal support and required the user to use Microsoft Edge with additional software to run Internet Explorer Compatibility mode.
- Compliance standards are also updated and must also be maintained. To remain compliant the software tools being used must be updated when revisions occur, which can be a challenge for a custom-built solution.
- Software designs and user interfaces are often an indicator of quality software tools. Dated software and interfaces are frustrating for users. One of the main benefits of a COTS solution is that they compete for customers which often drives additional updates to keep up with the latest technology advancements, industry developments (3D design), and software usability trends.

When first looking at a COTS permitting system, DOTs are often initially looking for very specific features that must be available before selecting a COTS solution. Once assured these features can be met, most will see the breadth of additional capabilities that make a COTS solution much more advantageous and these extra features become apparent making the analyses easier, more efficient and allows savings in time and money.

Require and Standardize As-Built Data

The most critical factor that addresses the ability to Identify and specify the location of utility facilities within roadway project footprints is having accurate utility location data attributed and stored following standards that allow the information to be easily exchanged. Rigorous subsurface utility investigations provide one method to obtain this information with some limitations.

The most reliable method to start gathering this information is to acquire it at the time of installation. Current and new technologies have made obtaining accurate coordinate data a much simpler process while costs have come down. The most difficult challenge is typically coordinating survey activities with construction and installation.

The research team acknowledges there are real costs associated with obtaining this information at the time of installation. Some utility providers are better situated to provide this information with in-house resources from surveying to GIS and data management. Others may need to look to hire additional staff or contract out this work. In addition, it will take time to see a return on this investment as new installations may not be in areas where future roadway projects are planned. Any relocations from a recent roadway project will likely not need to be relocated again soon. Over time and combining as-built utility data with rigorous subsurface utility investigations data, Iowa DOT, Utility Companies, Designers and Construction companies will be able to leverage this data to dramatically reduce costs associated with having inaccurate utility location data available for project planning and delivery.

The Iowa DOT Construction and Utility Involvement

The POINT 25 Process, as previously summarized, concludes with the collection of a detailed plan regarding utility relocation efforts and communicates this plan into the construction phase of the project by way of the Utility Bid Attachment. Again, the Utility Bid Attachment indicates if a project was coordinate using the POINT 25 Process or not, indicates what utilities are within the project footprint, which utilities were relocated prior to construction, which utilities were not relocated based on not being impacted, and utilities to be relocated during construction with the details and dependencies of those relocations. The information is communicated within the bid documents and would be a point of discussion during any preconstruction meeting.

Contextual Background of Iowa DOT Construction Projects and Utilities

While the POINT 25 Process details procedures that some consider effective practice, the Iowa DOT construction environment is experiencing significant delays and disruptions due to utility-related impacts. Like many other state DOTs, as pointed out in previous research, Iowa DOT recognized utility-related impacts as one of their more significant sources of construction delays. This was the impetus for undertaking research to find improvements in this area.

Likewise, many Iowa highway construction contractors also noted negative impacts and delays to their projects as the result of utility issues. This point became emphasized in October 2022 when Olson Construction Law issued, *A Roadmap: How to Minimize Unmarked/Mismarked Utilities and Late Utility Relocation (Iowa)*. This white paper resulted from the Iowa Associated General Contractors (AGC), who represent the majority of large highway contractors in Iowa, noting that change was needed regarding utility impacts. In this letter, Mr. Olson notes:

While contractors have this contractual obligation [utility relocation coordination]*, they lack the ability to effectively coordinate relocation because they do not have a contract with the utilities. The net result is late utility relocation, which delays project completion. Iron sits idle, and when contractors can work, it is often at reduced production rates in having to work around utilities. This also exposes contractors to the assessment of liquidated damages. The question is what Iowa contractors can do differently to minimize utility delays and the related financial impacts.*

Mr. Olson goes on to highlight that the potential solution exists in the POINT 25 process, that more obligation falls to the Iowa DOT or other public owners, and that public owners or utilities not complying with these conditions is effectively negligence of which they are liable for resulting damages.

At the time that Mr. Olson's paper was issued, most of the membership of the Iowa AGC was unaware of the ongoing effort of this project; though a small number of their membership had been involved in group interview sessions to glean the concerns and desires of the contracting community in Iowa. The focus of Mr. Olson's paper and of the contracting community is the later stages of the utility coordination and relocation process; this is where they are heavily involved. While the focus of his *Roadmap* is focused on the later stages of utility coordination, the focus of this research is on the early stages of the process where it is believed higher impact is possible at lower costs. The research team discussed these concepts with Mr. Olson and sought to gain the insights of members of the Iowa

highway construction contracting community. To gain these insights, a virtual brainstorming session was held with members of the Iowa DOT and Iowa highway contractors.

Discussion with Iowa Contracting Community and Iowa DOT Construction Representatives

To collect details regarding challenges and potential solutions regarding utility-related delays during construction, an online exchange was held with members of the Iowa AGC, Iowa DOT construction and utility coordination representatives, and members of the research team. The Iowa AGC members were in consensus belief that the POINT 25 Process can be effective. However, they believe that there is a lack of compliance in following the POINT 25 Process among right of way owners and the utilities companies. It was noted that there are fewer issues experienced on Iowa DOT projects when compared to local agencies, but that the issues experienced are still significant. Additionally, even when relocation needs are known, they are experiencing a lack of, or delayed, response by utility companies to meet their relocation timelines. The Iowa contracting community interviewed believes there is a need for potential penalties to hold the utility companies accountable.

The Iowa highway contracting community has voiced several concerns regarding utility impact on highway construction projects. These concerns are mentioned in Mr. Olson's paper and were mentioned during discussions with this community.

These concerns are summarized in the following:

1. **Utility location information is lacking**

Contractors often find that the utility location information provided within Iowa DOT plans is inaccurate or not detailed; especially with excavation contractors required depths or elevations (even better). Typically, utility information is provided with horizontal locations only. Additionally, the data provided is often inaccurate, incorrect, or missing. Iowa contractors employ the services of One Call and additionally investigate utilities with exposures or potholing at their cost.

2. **Utility records and as-built information is inaccurate or non-existent**

As noted within Mr. Olson's paper, Contractors and court cases have found that utility companies often completely lack records of the locations of their facilities, and certainly do not have records of a quality or accuracy for the support of designing or constructing roadways. Even though permitted accommodations and relocations require current and planned locations, these are not collected or provided to a usable accuracy from the utility companies.

3. **Utility companies do not abide to their relocation schedules and are not responsive**

The Iowa highway contractors also noted that utility companies often do not comply with the relocation schedules provided within the Utility Bid Attachment of projects, and in many cases are completely non-responsive to the contractor for relocation efforts. Contractors also note that utility companies often to not attend project preconstruction meetings and there is little communication regarding relocation efforts. This leave contractors with delays or less than optimal progress in working around utilities and their relocation efforts. Contractors note that penalties should be available to hold utility companies

liable for these delays. As noted in Mr. Olson's paper, he has been successful in getting compensation for these delays from utility companies and right of way owners; though this in not a solution to the problem.

4. **Contractors carry significant risk in utility coordination during construction**

Finally, contractors noted that they feel they carry the burden of risk as it relates to utility delays. It was noted that the issues arise during the design of the highway projects, and there seems to be little effort toward resolution before the responsibility for managing the issues are passed to the contractors.

After a discussion of the challenges faces, the exchange turned to potential paths for solutions.

Potential Solutions from the Construction Community

In the conversation with Iowa DOT utility and construction representatives and Iowa AGC representatives, solutions revolved around discussion of:

- Improved adherence to the POINT 25 Process
- Improved collection and accuracy of utility as-built data within permitting
- Application of penalties for utility company delays, and a
- Cultural shift of the utility coordination process.

Improved adherence to the POINT 25 Process

The construction community noted that POINT 25 projects entail much better information and results than most non-POINT 25 projects. They would like to see all projects be considered POINT 25 projects, and they believe, for Iowa DOT projects, this falls in line with the administrative rule. They believe education may be needed on the POINT 25 process internally to the Iowa DOT, to local agencies and to the utility companies to see improved adherence to this process. Related to the POINT 25 process, the contracting community believes that projects should not reach the construction letting when utility relocations have not been completed. They understand that instances exist where utilities cannot be relocated without some portion of the construction being completed, but more often projects are let where at least a portion of the utilities yet to relocate could have relocated prior to the letting. Additionally, when utilities do necessitate being relocated during construction, there should be considerations of the probable delays applied to the project scheduling requirements so as to provide the contractor additional time for those projects. While the Iowa DOT will often pay for accelerations of work for public convenience accelerations, this is not the correct solution. The contractors believe in the PONIT 25 process and believe if it is followed, utility issues will be minimized.

Improved collection and accuracy of utility as-built data within permitting

The construction community also pointed to the need for improved accuracy, especially related to the elevation of utilities. When relocations are necessary, and utility companies are non-responsive, it can be a challenge to even know what utilities are in the project footprint and where the contractor may be able to safely work. The construction community is requesting that more effort be put into utility investigations and standardized as-built data acquisition as part of the permitting process. The location of the existing utilities should be known and necessary information during the right of way and design stages, as much as the construction stage. The construction community notes that accurate locations of utilities with elevations or at least depths should be collected during original permitting of the utilities in the right of way. If not available from the utility as-builts, it should still be collected by investigations, exposures, and pot holing during design. This solution may entail needed changes to permitting process and required documentation, and the approach may take time to build a comprehensive as-built database, but the exchange parties agreed that is a worthwhile effort to assist in resolving utility-related delays. The discussion of this solution expanded into prescribing an accuracy and format within the permitting process and the potential application of the ASCE 75 standard for as-builts of utilities.

In discussion of improved investigations during design efforts, the exchange discussed applying a decision framework to projects to determine the level of utility investigation a project may warrant. Iowa DOT already selectively uses consultants to expand beyond historic Call 811 markings and contractor potholing methods for achieving better utility position information, but the discussion expanded into the application of the ASCE 38 standard to achieve subsurface utility engineering and professionally judged quality levels of utility location data.

Application of penalties for utility company delays

A repeated theme in conversations with the construction community was a lack of response from the utility companies. There is extensive frustration within the Iowa DOT and Iowa highway contractor regarding utility companies' lack of response to relocation and communication efforts. It seems beyond the control of either party and the discussion of penalties highlights the need to balance risk in lieu of placing responsibilities squarely on contractors. The POINT 25 process was also reiterated and that there should be penalties for non-compliance; especially non-compliance with work plans and schedules. It was noted that the Iowa AGC would support any needed regulatory changes to provide penalties to utility companies causing delays. This is further reiterated in Mr. Olson's letter, which also notes litigation success in seeking damages from utility companies.

While not discussed, it should be noted that the POINT 25 process does entail a discussion of penalties in delay damages and withholding future permits from non-compliant utility companies. This may be a point for considering enforcement of these conditions, though these would be recommended as a last-resort approach.

Cultural shift of the utility coordination process

Likely, a more popular solution among all parties, including utility companies, would be an approach of partnership. This approach entails a cultural shift of the project development process and has been effective when put in place in other states, such as Indiana. The approach is for the project design team to have available thorough and accurate utility location data. This data may be collected through the performance of an ASCE 38 utility investigations or lesser investigations as deemed appropriate by an early assessment of the project in the planning stage to determine the utility investigation needs. The design team needs this level and quality of information to know where utilities are and where the roadway project and associated relocations may go. The mentality in this approach is to avoid utility facilities during design as a first approach; at least where feasible[37]. Further, the design team should understand design impacts to utilities, timelines, and treat utilities as a partner in the right-of-way. This will entail the Iowa DOT educating designers on utility avoidance and understanding the impacts and how those vary by utility type and utility attributes. This approach would establish a more collaborative manner for relationships with the utility companies. Along with establishing the partnership, avoiding utility relocations when feasible and otherwise minimizing impacts to utilities provides an incentive to the utility companies to participate in the project process and the building of relationships that will likely lead to high instances of response. Along with the improved utility investigations, the data collected can then be provided back to the utility companies as as-builts to assist in building the repository of as-built information.

This culture shift of placing a higher value on utility data to include depth, elevation and tolerance will entail a cost, and the exchange group believed that the Iowa DOT should cover such cost for collecting utility location data. It was felt that these upfront expenditures for the more precise locations (realizing that utility companies do also need to keep better information) would help operationally (project could be completed faster open to the public) and entail a justifiable return; thereby lending support to performing in these suggested approaches.

Construction Community Exchange Summary

There are noted issues regarding utility impacts to Iowa DOT construction projects. The consensus solution involved several components but can be summarized as a multifaceted approach inclusive of shift the relocation culture. There is a desire to collect better utility as-built data in the permitting process, conduct more informed utility investigations in planning and design, and the Iowa DOT should be open to paying for this higher quality information so that improved design decisions can be made. This is in the same approach as conducting geotechnical investigations. Further, a focus on avoiding

[37] According to Gabe Nelson of Snyder & Associates, designers "already try to avoid utility relocations, not necessarily because there is concern for the costs to the utilities, but because it greatly simplifies the utility coordination process to not have utility companies relocate. It is a huge cost savings to utility companies when the right of way owners design around their facilities, but it comes at a large cost: identifying accurate utility locations horizontally and vertically and designing a facility around a utility. This could mean increased construction cost to the right of way owner such as larger diameter storm sewer, modified/non-standard structures, or a roadway profile that requires more earthwork. Simply supporting utilities comes at a cost during construction. Should utility companies participate in the project costs when a right of way owner avoids their facilities?"

utilities and building partnerships with utility companies may lead to better response and participation by utility companies overall.

As a last resort, the community feels penalties need to be considered. Doing so may result in better compliance to permitting and the POINT 25 process. The community felt these things could be impactful and could be done right away.

Based on these discussions, a new road map in addition to that proposed by Mr. Olson might include:

PLANNING PHASE

1. Evaluate existing utility complexities / project risks via utility inventory
2. Decide on investigation strategy
    a. ASCE 38-22 QLB
    b. ASCE 38-22 QLC/D
    c. One Call design ticket
3. Begin utility coordination with kick-off meeting

DESIGN PHASE

1. At 0-10% design, implement investigation strategy for horizontal location and critical early vertical locations
2. Communicate existing utility data to project designers – AVOID - MINIMIZE-RELOCATE
3. Iterate investigations as necessary
4. Iterate ASCE 75-22 to document all new, adjusted, or relocated utilities on project
5. Keep project utility drawings up to date through letting
6. Continue utility coordination meetings with solutions assistance for utility owners

PRE-CONSTRUCTION PHASE

1. Communicate utility involvement to potential bidders / selected contractor
2. If existing utilities are complex, provide One-Call “second opinions” before construction begins to mark known unknowns, abandoned, private utilities; and adjudicate incorrect One-Call marks from utility owners

CONSTRUCTION PHASE

1. Document all new utilities via ASCE 75-22

Legal and Policy Analysis

The importance of developing and adhering to policies for the accommodation of utilities in Iowa DOT rights of way is paramount because **today's permit may create the design conflict of tomorrow**. All proposed permit accommodations should consider the following:

- The proposed accommodation must not adversely affect the safety, design, construction, operation, maintenance, or stability of the highway.
- The proposed accommodation must not interfere with or impair the present use or future expansion of the highway.
- Any alternative location would be contrary to the public interest.

Although Iowa DOT strives to accommodate utility whenever possible, the authorized use and occupancy of Iowa DOT right of way for Utility Accommodation purposes is subordinate to the primary interests, safety of the traveling public, and protection of the transportation the facility. Additionally, we believe the Iowa DOT encourages collaboration, cooperation, and joint use among various utilities to be placed within Iowa DOT right of way. The end goal should be to support Utilities and the provide an Asset Management Policy for the Iowa DOT ROW.

Federal Codes

Iowa DOT uses the regulations of the Federal Highway Administration (FHWA) under 23 Code of Federal Regulations (CFR) 645, Subpart B for the basis of accommodation of utilities within Iowa DOT right of way. The CFR includes:

> *The State transportation department's standards for regulating the use and occupancy of highway right-of-way by utilities* **must *include***, *but are not limited to, the following:*
>
> > *(1) The* ***horizontal and vertical location requirements*** *and clearances for the various types of utilities must be clearly stated. These must be adequate to ensure compliance with the clear roadside policies for the particular highway involved.*

For the DOT, managing the ROW asset must be a top priority. While in the past the accuracy of utility locations was not as critical as in today's environment with limited ROW and increasing demands of utility companies to occupy the ROW. With advancing technologies, the quality of location data collected and available management systems this requirement can accomplished.

State Statutes

306.46 Public utility facilities — Public Road Rights-of-Way.

> *1. A public utility may construct, operate, repair, or maintain its utility facilities within a public road right-of-way. The location of new utility facilities shall comply with section 318.9. A utility facility shall not be constructed or installed in a manner that causes interference with public use of the road.*
>
> *2. For purposes of this section, "public utility" means a public utility as defined in section 476.1, and shall also include waterworks, municipally owned waterworks, joint water utilities, rural water*

districts incorporated under chapter 357A or chapter 504, cooperative water associations, and electric transmission owners as defined in section 476.27 primarily providing service to public utilities as defined in section 476.1. For the purposes of this section, "utility facilities" means any cables, conduits, wire, pipe, casing pipe, supporting poles, guys, and other material and equipment utilized for the furnishing of electric, gas, communications, water, or sewer service.

Noteworthy Point: With the emerging new demands on ROW for Broadband, Electric Services, and Data Centers (such as for banking and businesses), the lines between Public and Private utilities are being blurred. New facilities such as electric lines from Solar Farms to the Electric Grid and dedicated communication lines for Broadband includes many Public /Private initiatives which may require a review of these definitions, rights, and methods of occupation of the ROW.

306.47 Utility facilities relocation policy.

*1. **It is the policy of the general assembly that a proactive, cooperative coordination between the department, local governments, private and public utility companies**, and other affected parties is the most effective way to minimize costs, eliminate the need for utilities to relocate facilities, limit disruption of utility services related to federal, state, or local highway construction projects and limit the potential need for relocation of utility facilities.*

*2. All potentially affected parties shall be invited to participate in development meetings at the design phase of a highway construction project to review plans, understand goals and objectives of the proposed project, and discuss options that would limit the impact of the construction on utility facilities and thereby minimize or even eliminate costs associated with utility facility relocation. **All jurisdictions and other Interested parties shall cooperate to discuss strategies and policies to utilize the Iowa one call system in the development of a highway construction project.** Failure of the affected parties to respond or participate during the design phase shall not in any way affect the ability of the federal, state, or local agency to proceed with design and construction.*

2008 Acts, ch 1124, §1 - Referred to in §8C.7A Iowa one call system, see chapter 480

Noteworthy Point: Iowa DOT statutes and policies already promote and require cooperation for the occupation, relocation, and inclusion of utilities in ROW. This basis of cooperation is required to advance and accomplish ROW Asset management and should be utilized. Implementation of "Utility Engineering" practices as promoted by the ASCE Utility Engineering and Surveying Institute assures that Iowa DOT achieves cooperation with utility infrastructure owners in a systematic manner.

PUBLIC UTILITY REGULATION, §476.1 476.1 *Applicability of authority. 1. The utilities board within the utilities division of the department of commerce shall regulate the rates and services of public utilities to the extent and in the manner hereinafter provided. 2. As used in this chapter, "board" or "utilities board" means the utilities board within the utilities division of the department of commerce. 3. As used in this chapter, "public utility" shall include any person, partnership, business association, or corporation, domestic or foreign, owning or operating any facilities for: a. Furnishing gas by piped distribution system or electricity to the public for compensation. b. Furnishing communications services to the public for compensation. c. Furnishing water by piped distribution system to the public for compensation. d.*

Furnishing sanitary sewage or storm water drainage disposal by piped collection system to the public for compensation. 4. This chapter does not apply to municipally owned waterworks, waterworks having less than two thousand customers, joint water utilities established pursuant to chapter 389, rural water districts incorporated and organized pursuant to chapters 357A and 504, cooperative water associations incorporated and organized pursuant to chapter 499, municipally owned sanitary sewage or storm water drainage systems, sanitary districts incorporated and organized pursuant to chapter 358, districts organized pursuant to chapter 468, or a person furnishing electricity to five or fewer customers either by secondary line or from an alternate energy production facility or small hydro facility, from electricity that is produced primarily for the person's own use.

Noteworthy Point: Since this section is under the Department of Commerce, any revisions to definition and policies for a Public Utility must be reviewed and coordinated with appropriate State Departments.

306.22 Sale of unused right of way

3. If any tract of land is sold, the sale shall be subject to the right of a utility association, company, or corporation to continue in possession of a right-of-way in use at the time of the sale

Noteworthy Point: Implementation of an Asset Management Program in place will make it possible to identify and communicate the existence of occupying utilities when unused ROW is sold.

Iowa Administrative Code

IOWA ADMINISTRATIVE CODE 761 CHAPTER 115.2 (306A)

POLICY FOR ACCOMMODATING AND ADJUSTMENT OFUTILITIES ON THE PRIMARY ROAD SYSTEM, Last revision January 2012

115.2(306A) *Definitions*

"Utility"*. A system for supplying water, gas, power, or communications; a storm sewer, sanitary sewer, drainage tile or other system for transmitting liquids; a pipeline system; or like service systems. The term "utility" includes traffic signal systems and street and intersection lighting systems.*

"Utility facility". *Any pole, pipe, pipeline, pipeline company facility, sewer line, drainage tile, conduit, cable, aqueduct or other utility-related structure or appurtenance. However, the term does not include department facilities or the utility lines that service them.*
Utility owner. The owner of a utility facility.

Noteworthy Point: It is noted DOT ITS lines are not included, and Traffic Signals are included. Since ITS and traffic signal operations are related it is recommended this Code be reviewed.

"Freeway". means a fully controlled access primary highway. The rights of ingress and egress from abutting properties have been legally eliminated by the department. Permanent access to the highway is allowed only at interchange locations. A freeway is generally five or more miles inlength.

Noteworthy Point: The term "Interstate" is not included in the code and though out the code only the term freeway is used. Due to different funding sources and categories of highways it is recommended the definitions be reviewed and updated to adequately address the differences in Interstates, Freeways,

and Toll Facilities.

115.4(1) Permit required and exceptions to permit.

a. Permit required.

(1) A utility owner shall obtain permission from the department in the form of a utility accommodation permit before it places its utility facilities in, on, above or below the primary highway right-of-way; attaches its utility facilities to a primary highway structure; or adjusts existing utility facilities occupying the right-of-way.

(2) The purpose of the permit process is to ensure the safety of motorists, pedestrians, construction workers and other highway users; to ensure the integrity of the highway; and to document the location of utility facilities for use in managing the highway right-of-way and in locating the facilities in the future.

b. Exceptions to required permit.

(2) A permit is not required for storm sewers, subdrains, and lighting designed and constructed as part of a department highway construction project.

(2) A permit is not required for service connections within the corporate limits of a city. These connections require city approval rather than department approval; the utility owner shall apply to the city. However, service connections shall meet all other requirements of this chapter.

Noteworthy Points:

- We recommend as a condition of a permit, that utilities acknowledge the requirement to perform design locates for future highway projects. While the 811 requirements may give some assistance, we believe it would be good to require this in the permit to draw attention to Iowa DOT's design needs.
- The Exceptions to a permit should be reviewed as several of these, such as services[38], may be required to be in the asset inventory.

115.4(2) Agreement required.

*For certain utility facility adjustments, **the department may require an agreement** between the department and the utility owner. However, the agreement by itself does not constitute a permit nor does it grant permission to occupy the primary highway right-of-way. The utility owner is responsible for*

[38] Comment by Gabe Nelson of Snyder & Associates: "Services need to be given more thought. Water and sewer services are owned by the property owner, not the utility. There needs to be better definition on who is responsible for relocation of services during construction, not just who maintains services in the GIS database."

obtaining a permit prior to commencing work within the right-of-way. The agreement shall then be attached to and become a part of the permit.

Noteworthy Point: We recommend an agreement be required for all adjustments or relocations to have an enforceable agreement for scope, cost, and schedule of the relocation. Even a minor relocation may cause a significant delay to a highway project.[39]

115.4(11) Noncompliance.

The department may take any or all of the following actions for noncompliance with any provision of this chapter or any term of a permit:

a. Halt utility construction or maintenance activities within the right-of-way.
b. Withhold an adjustment reimbursement until compliance is ensured.
c. Revoke the permit.
d. Remove the noncomplying construction or maintenance work, restore the area to its previous condition, and assess the removal and restoration costs to the utility owner.
e. Place all pending and future permits on hold until the issue is resolved.

Noteworthy Points:

- This section of the Policy is very strong and supports the Iowa DOT Utility Program. We recommended this policy is verified as a tool to require design locates of utility facilities, As-built submissions, and Buy America Requirements. This section may be strengthened with a definition of an "Uncooperative Utility" and if this rule can be utilized when encountered.
- Another action item which may be considered if there is a history of deficient plans or locating of existing utilities is to require a PE seal on plans to assure the conformance to the Accommodation Policy and maintain a safe ROW.

115.4(13) Insufficient capacity of right-of-way.

The department shall deny issuance of a permit if it determines there is insufficient room for additional utility facilities within the right-of-way.

Noteworthy Point: While this statement is strong, how is it determined when there is insufficient room. Should the Department deny the utility's proposed location but not occupancy as they may be able to go deeper or provide another alternative? Can the utility permit contain a provision that the conduit/facility can never be excavated? (For example, a new facility would have to be installed if a repair is needed.)

115.5(3) Number of crossings.

The number of utility facilities crossing the primary highway right-of-way shall be kept to a minimum. The department may require distribution facilities to be installed on each side of the highway to minimize the number of crossings and service connections. In individual cases, the department may require several

[39] Comment by Gabe Nelson of Snyder & Associates: "Totally agree with this point. If the relocation cannot take place beforehand, this would trigger the need for an agreement. On the US 69 in Polk Co there was an agreement with one utility outlining the communication process and timeline for each utility. That process went fairly well. The issues were with a lot of the other utilities who were not required to have an agreement."

facilities to cross in a single conduit or structure. Crossings should be as near to perpendicular to the highway alignment as practical.

Noteworthy Point: The DOT may consider allowing only one set of poles on each side of the road and require co-location on poles when space is available on the poles mirroring the concept of requiring joint occupancy on crossings. If possible, this should be also expanded for longitudinal telecommunications[40]. Understanding multiple manholes may still be required for security.

115.8(3) *Plan.*

Each permit application shall be accompanied by a plan showing the following:

a. Location of the utility facility by route, county, section, township, range, milepost and highway stationing, where these references exist.

b. Highway centerline and right-of-way limits.

c. Location of the utility facility by distance to the nearest foot at each point where the facility's location changes alignment, as measured from the:

i. Centerline of the highway on nonfreeway installations.

ii. Right-of-way fence on freeway installations.

d. All construction details including the:

i. Depth of burial.

ii. Types of materials to be used in the installation.

iii. Operating pressures and voltages.

iv. Vertical and horizontal clearances.

v. Traffic control plan prepared by a person knowledgeable in work zone traffic control, or a reference to a standard traffic control plan of the department.

Noteworthy Point: It is recommended that additions to this section of the policy include:

- Requirement to tie utility plans and installation to the required DOT survey system. Including both Horizontal and Vertical.
- Requirement for Utility to hire a PLS to state ROW if DOT forces not available.
- Compliance of standards/accuracy levels of location delineated and in conformance with ASCE 75-22,
- Required Plan size and formats, file types and sizes, graphical formats, and structures.
- Traffic Control / Phasing sheets- for utility construction, this was a prior requirement of Iowa DOT but was discontinued. Including the Iowa 511, Notification of width or height restrictions included with Utility Permits.

[40] Comment by Gabe Nelson of Snyder & Associates: "YES. Should the DOT explore installing the joint utility trench as part of the project and selling the conduits back to the utilities."

- Designated boundary lines between city/county roads and the State Highway System

115.8(8) As-built plans.

a. Within 90 days after completion of construction, the utility owner shall submit to the district representative an as-built plan or a letter certifying that the actual placement of the utility facility is as described in the original permit.

b. If the utility owner fails to submit the as-built plan or letter within the time required, the department may hire an independent contractor to locate the utility facility and prepare an as-built drawing. All costs associated with this activity are the responsibility of the utility owner.

c. Any costs incurred by the department or its contractors due to incorrect as-built information supplied by the utility owner or deviations in actual placement from that described in the original permit are the responsibility of the utility owner.

Noteworthy Points:

- It is recommended the location requirements, including vertical elevations, be in conformance with ASCE 75-22 and the citation be included in the Code if possible. A graphics file of the as-built should be required also, which can be uploaded into the Asset Management system for future use.
- If a utility does not comply the code should give the DOT the option of withholding permits or other actions as noted in 115.4(11) and 115.30(6). All costs associated with the DOT actions to obtain As-Built information including ASCE 38-22 Levels B and A should be the responsibility of the Utility.

115.8(9) *Transfer of permit. A new utility accommodation permit is not needed when a utility facility is transferred or leased in its entirety. The requirements of the permit and this chapter remain in force for as long as the utility facility continues to occupy the right-of-way and serve its intended purpose. The transferee or lessee shall submit the following information to the appropriate district representative:*

a. The name and address of the transferee or lessee.

b. Geographical area involved in the transaction.

c. *Designated telephone number for notification purposes*.

Noteworthy Points:

- It is recommended this section be expanded to include a change of function or in use. This would include changing from public use to private use.
- Geographical information, if not already in the Iowa DOT system, should be required when updated in conformance with ASCE 75-22.

115.11(306A) Vertical overhead clearance requirements.

115.11(1) Conformance to standards. The vertical clearance for overhead utility facilities and the lateral

and vertical clearances for bridges shall conform to accepted industry standards as well as applicable codes and regulations.
115.11(2) Minimum vertical clearance. In no event shall the vertical clearance be less than 20 feet above the roadway for all overhead utilities.

Noteworthy Point: It is recommended overhead electric lines are not allowed to cross within the approaches of a bridge to maintain OSHA clearances for equipment installing metal beam guard fence in the approach. Additionally, it is recommended to review longitudinal clearance requirements for equipment while performing maintenance to the bridge rail and appurtenances.

115.12(4) *Engineering fee. When a primary highway bridge is in the planning stages and the department designs the bridge to accommodate a requested attachment, the department shall assess to the utility owner an engineering fee. The engineering fee shall reimburse the department for the department's increased costs of design, construction, and inspection due to the attachment. The department shall bill the fee to the utility owner when the department's work is complete.*

Noteworthy Point: It is recommended the Utility be required to use a Profession Engineer and the plans be sealed on bridge attachments. This would be in addition to the Engineering Fee for the review of the attachment plan.

115.13(306A) Underground utility facilities.

115.13(1) *Depth requirements.*

- *a. Minimum cover—roadway. The minimum required cover under a roadway is 48 inches.*
- *b. Minimum cover—other portions of right-of-way. The minimum required cover under other portions of the right-of-way is:*
  - *i. 48 inches for electrical cable.*
  - *ii. 30 inches for communication cable except that 36 inches is required for longitudinal occupancy under freeway right-of-way.*
  - *iii. 36 inches for all other underground facilities.*

Noteworthy Point: It is recommended that a review of the depth requirements of Utilities be completed as the Utility Industry and other states are currently moving to greater depths. Factors being considered are type of utility, need for access, risk of being impacted by other utilities or highway maintenance, and differing requirements for longitudinal or crossing occupation[41].

Noteworthy Point: Another consideration would be if a protection slab could be used if minimum depths cannot be achieved. Especially under ditches where it would provide protection form routine maintenance for drainage.

[41] Comment by Gabe Nelson of Snyder & Associates: "Should address future clearances from other utilities which would help address if there is no longer room in the right of way to approve an installation."

115.13(7) Multiduct systems.

The department may require installation of a multiduct system[42] to be shared with others. Details of the installation are subject to department approval.

a. *The department shall designate a "lead company" for the system. The lead company is generally the first utility owner requesting occupancy. The lead company is responsible for:*
    i. *Design and construction of the multiduct system.*
    ii. *Maintenance of the multiduct system.*
    iii. *Providing all capital required to construct the multiduct system.*
b. *Once a multiduct system has been established, the department shall require future occupancies to be located within one of the unoccupied inner ducts of the system. If all inner ducts are occupied, the department may require the establishment of an additional multiduct system.*
c. *Each occupant of a multiduct system shall share equally in the entire capital costs of the facility. As each new occupant is added to an existing system, the department shall require the new occupant to pay its proportionate share based on the number of inner ducts it occupies.*

Noteworthy Point: It is recommended to include or refence the requirement for each tenant in the multiduct to have an approved permit and provide As-Built information and plans that will be included in the asset management system in conformance with ASCE 75-22.

115.20(1) Notice to department.

Within 90 days after the abandonment[43] or removal of all or a portion of an existing utility facility that occupies the primary highway right-of-way, the utility owner shall submit a written notice of abandonment or removal to the department.

The notice shall include:

a. *Type of facility.*
b. *Location of the utility facility by route, county, section, township, range, milepost, and highway stationing, where these references exist.*
c. *Name of the original utility owner if different than the current owner.*
d. *Original utility permit number and date of approval, if known.*

[42] Comment by Gabe Nelson of Snyder & Associates: "DOT could install with the project and sell space."
[43] Comment by Gabe Nelson of Snyder & Associates: "Abandoned utilities are a problem. An abandoned gas main still smells like gas when you hit it, and an abandoned communication line with 100 shredded wires looks pretty scary to the operator of an excavator. Can the utility companies locate abandoned facilities as well, so the contractor knows they are going to hit something but will be okay?"

Noteworthy Point: It should be the Department's determination if a utility may abandon or remove all or a portion of the utility facility when it is retired or out of use. It is recommended to define the difference in abandoned and idled/in in use facilities. Abandoned normally indicates the utility relinquishes its ownership and responsibilities. This leaves the DOT dealing with the old lines in conflict with new projects and any environmental concerns that exist with the old utility lines. It is recommended to add policy for the DOT determining and approving if a facility can be abandoned or only partially approving if left in place and any related condition to abandonment.

115.25(306A) Utility facility adjustments for highway improvement projects.

Rules 761—115.26(306A) to 761—115.30(306A) establish administrative procedures for utility facility adjustments made necessary by state highway improvement projects. The purpose of these procedures is to adjust utility facilities with minimal delays or added expense.

Noteworthy Point: The addition of a requirement to by Buy America and Build America should be included in this section conveying the consequences of non-compliance for both the DOT and the Utility.

115.27(5) Acceptance of preliminary work plan.

The department shall notify the utility owner of the department's acceptance of the utility owner's preliminary work plan.

a. *If the preliminary work plan is not acceptable to the department, the department shall notify the utility owner that the plan is not acceptable and provide a detailed explanation of the problem.*

b. *The utility owner shall submit a revised preliminary work plan to the department within 30 calendar days after its receipt of notice from the department that the plan was not acceptable.*

c. *The department shall review the revised preliminary work plan. If the work plan is acceptable, the department shall notify the utility owner of the department's acceptance of the plan.*

d. *If the work plan is still not acceptable, the process set out in 115.27(5) "a" to "c" shall be repeated.*

Noteworthy Point: This section allows the possibility of an endless "do loop" if a Utility is uncooperative or is unresponsive to requests from Iowa DOT to make acceptable revisions to the work plan[44]. A clear definition of an uncooperative utility should be referenced and actions to be taken per section 115.4(11).

115.28(4) Acceptance of final work plan.

The department shall notify the utility owner of the department's acceptance of the utility owner's final work plan.

[44] Comment by Gabe Nelson of Snyder & Associates: "Could the work plan be electronic like the permit forms? The preliminary plan can be fairly simple. It may help with compliance by the utilities if the process is simple."

a. If the final work plan is not acceptable to the department, the department shall notify the utility owner that the plan is not acceptable and provide a detailed explanation of the problem.

b. The utility owner shall submit a revised final work plan to the department within 30 calendar days after its receipt of notice from the department that the plan was not acceptable.

c. The department shall review the revised final work plan. If the work plan is acceptable, the department shall notify the utility owner of the department's acceptance of the plan.

d. If the work plan is still not acceptable, the process set out in 115.28(4)"a" to "c" shall be repeated.

Noteworthy Point: This section allows the possibility of an endless "do loop" if a Utility is uncooperative or is unresponsive to requests from Iowa DOT to make acceptable revisions to the work plan. A clear definition of an uncooperative utility should be referenced and actions to be taken per section 115.4(11).

115.30(6) Failure to provide a work plan or to adjust utility facilities.

If a utility owner fails to provide a work plan, fails to comply with the accepted work plan, or fails to complete the adjustment of its facilities, and its failure to perform results in a delay to the highway project or causes damages to be incurred by the department or the department's highway contractor, the utility owner is liable for all costs and damages incurred as a result of its failure to perform. ***The department may withhold approval of permits for failure to comply with the requirements of these rules.***

Noteworthy Point: This section allows the possibility of an endless "do loop" if a Utility is uncooperative or is unresponsive to request from Iowa DOT to make acceptable revisions to the work plan or perform the relocation according to the Utility Relocation Plan. A clear definition of an uncooperative utility should be referenced, and all the alternatives of section 115.4(11) should be referenced, not just the withholding of permits.

Iowa Administrative Code 480 Underground Facilities Information

480.1 Applicability — prohibition.

This chapter applies to any excavation unless otherwise provided by law. A person shall not engage in any excavation unless the requirements of this chapter have been satisfied[45].

Noteworthy Point: It is recommended to amend this code to include a response from utilities for the design and planning of projects.

[45] Comment by Gabe Nelson of Snyder & Associates: "Code should be changed so that all utilities have to participate in the One Call system. Currently, only underground utilities have to participate which leaves out some transmission power companies. Also, require participation on the design information/locate system. It shouldn't be optional."

Other Suggested Additions for Consideration

Other recommendations for additions to the Utility Accommodation Policy would include the following for:

Occupation of ROW

- A Review of existing utility locations and designating more location assignments for different types of utilities on the ROW. Examples include which utility is preferred to be closest to the ROW and which may be closer to the roadway for Longitudinal occupations.
- Requiring ownership markers with contact information at the ROW line for all utility crossings and designated intervals on longitudinal installations.

Highway Project Considerations and Coordination

- Develop a Master Utility Agreement or Memorandum of Understanding which encourages cooperation and collaboration in the DOT/Utility relationship and sets the expectation for responsibilities during a Highway Project.
- Providing a discussion of the various type of Projects and the impacts on the relocation of utilities in the policy.
- Consider setting a Ready to Let Date (RTL) for the utilities to be clear of proposed construction. Setting a date three to four months ahead of the Letting Date allows the highway contractor to bid on the job with minimum risk and save cost.
- Require Subsurface Utility Engineering (SUE) and Utility Investigations in accordance with the ASCE/CI/UESI 75 to identify conflicts including the use of a Utility Matrix to be provided to the Highway Contractor to minimize risks.
- Require the Avoid, Minimize, and Accommodate (AMA) approach in the highway project design phases.
- Requiring a Utility Management Plan for utilities not relocated early and required contractor phasing in specifications.
- A Value Engineering approach to project design evaluating the Total Project Cost including the relocation cost of utilities, regardless of DOT responsibility to reimburse or not.
- Utility Conflict Management must include all disciplines, such as Drainage, Traffic, ITS, Construction Phasing, Bridge, and Construction
- The possibility of including the utility relocations in the highway contract if design phases or schedule would realize a benefit. (Note: The Utah DOT has successfully included utility work in highway contracts for several decades. The process involves master and supplemental agreements through which preferred contractors typically used by utility operators are essentially brought on the mainline contractor's team as subcontractors.)
- Capturing Utility Easement data encumbering the ROW and adjacent to the ROW for future projects and cost estimating.
- Provide more pre-bid meetings to discuss utility issues so all bidders fully understand what needs to happen during construction. Utility companies need to participate in the pre-bid meetings.

Construction and Maintenance of the Utility Facility

- Provide the requirements for including a utility relocation in the highway contract.
- Providing names/signs for the utility owner on the utility project
- Contractors on the project should have Identification information on their trucks.
- Not allowing the cutting of pavement or riprap without an exception request and encouraging a bore in most cases.
- Addressing preservation of trees, vegetation, and cleanup
- Consequences of noncompliance
- Requiring the contractor/utility to have the approved permit and plans on site during all construction activities.[46]

Incentives, currently Iowa can only pay for 2nd relocates due to a redesign.

- Obtain the authority to acquire utility easements[47] in the name of the state to assist in the relocation of utilities and establish a utility corridor.

Exceptions

It is recommended an Exception Process to the Utility Accommodation Rules be developed to clarify the recommendation and approval requirements of an exception to these rules. Normally exceptions are approved at a State Utilities Manager level if the proposed facilities or the work does not:

- Create a hazard or safety issue,
- Impact the roadway or traffic flow,
- Have the potential to damage adjacent facilities, or
- Impact future projects of the state.

[46] Comment by Gabe Nelson of Snyder & Associates: "Also, educate the utility companies' contractors on what has been staked and why the depths/location shown on their drawings is important. We take for granted that utility contractors are not used to reading the information on a stake and may not fully understand the information."
[47] Comment by Gabe Nelson of Snyder & Associates: "There is an issue with this if the roadway is expanded in the future. If the utility is in a utility easement, would the State be responsible for relocation costs?"

Executive Action Summary

Iowa DOT must implement design and construction practices (which include the ASCE 38 *Standard Guideline for Investigating and Documenting Existing Utilities*) to address the fact that Iowa DOT ROW is predominantly occupied with poorly documented utilities. Standardized professional utility investigations will tackle the sins of the past. All future utility installations in Iowa DOT ROW must be documented through a permitting process that includes deriving standardized digital as-built data (in accordance with the ASCE 75 *Standard Guideline for Recording and Exchanging Utility Infrastructure Data*) as utilities are designed and installed.

All utility data collected for design and during construction, and for new utility installations, are to be managed within a Utility Federated GIS Collaboration Portal (utility asset management system), enabling individual utility owners to systematically improve their internal systems of record (GIS inventories), securely share data in real-time, and Iowa DOT to invoke Utility Engineering practices that eliminate risk and optimize project delivery while keeping the public welfare paramount over all other interests.

Phased Approach

Iowa DOT to implement a permitting and a specialized utility data portal (Federated Geographic Information System Collaboration Portal) for managing utility infrastructure within Iowa DOT right-of-way (ROW). After procedures, protocols and standards are established and the proof of concept demonstrated the system can be migrated to the Iowa Office of the Chief Information Officer (OCIO) or a selected contracted 3rd party and broadened for statewide (e.g., state, city, county public and private entities) use.

A phased approach is proposed:

1. Adapt utility ROW occupation permitting process into a full utility infrastructure management system for controlling and capturing standardized data on all proposed and executed changes within IADOT ROW. (Commercial-off-the-shelf (COTS) applications are available for configuration and several other state agencies have already implemented similar solutions.)
2. Implement protocols and standards compliant with ASCE 75 for utility infrastructure owner data management and data sharing. (Iowa DOT has already built out an ASCE 75 compliant layer in their enterprise GIS and is developing data submittal language.)
3. Establish a Federated GIS Collaboration Portal at IADOT (later OCIO) for secure data sharing between authorized stakeholders. Many GIS applications have OGC compliant web service protocols, and enabled for broadcasting in a live, secure manner. (See Technology Modernization and Recommended Implementation section below.)
4. Implement guidelines for contractors to capture standardized utility infrastructure as-built data (compliant with ASCE 75) in the field during new installations or when exposed. (Iowa DOT has draft language under development.)
5. Implement guidelines for SUE providers to submit ASCE 38 data collected for project development. ASCE 38 data to be pushed into digital format compliant with ASCE 75.

a. Establish plan for ASCE 38 compliance on projects – this may be addressed through: a) SPR-RE22(011)-8H-00 *Best Practices for Utility Management in the Public Right of Way*, and b) SPR-RE22(012)-8H-00 *Project Development and Utility Coordination as a Partnership*.
b. Establish CADD attribution standards for utilities on all As-built, SUE and Design CADD submittals.

6. Adopt Recommended Legal and Policy Modifications (see following section)
7. Adopt Enforcement Policies (see Enforcement Policies section below)
8. Adopt Utility Engineering Practices (see Utility Engineering section below)

Recommended Legal and Policy Modifications

1. 306.46 Public utility facilities — Public Road Rights-of-Way: With the emerging new demands on ROW for Broadband, Electric Services, and Data Centers (such as for banking and businesses), the lines between Public and Private utilities are being blurred. New facilities such as electric lines from Solar Farms to the Electric Grid and dedicated communication lines for Broadband includes many Public /Private initiatives which may require a review of these definitions, rights, and methods of occupation of the ROW.
    a. PUBLIC UTILITY REGULATION, §476.1 - *Applicability of authority*: Since this section is under the Department of Commerce, any revisions to definition and policies for a Public Utility must be reviewed and coordinated with appropriate State Departments.
    b. IOWA ADMINISTRATIVE CODE 761
        i. CHAPTER 115.2 (306A), POLICY FOR ACCOMMODATING AND ADJUSTMENT OFUTILITIES ON THE PRIMARY ROAD SYSTEM, Last revision January 2012, 115.2(306A)
            1. Definitions: The term “Interstate” is not included in the code and though out the code only the term freeway is used. Due to different funding sources and categories of highways it is recommended the definitions be reviewed and updated to adequately address the differences in Interstates, Freeways, and Toll Facilities.
        ii. 115.4(1) Permit required and exceptions to permit:
            1. We recommend as a condition of a permit, that utilities acknowledge the requirement to perform design locates for future highway projects. While the 811 requirements may give some assistance, we believe it would be good to require this in the permit to draw attention to Iowa DOT’s design needs.
            2. The Exceptions to a permit should be reviewed as several of these, such as services[48], may be required to be in the asset inventory.

[48] Comment by Gabe Nelson of Snyder & Associates: “Services need to be given more thought. Water and sewer services are owned by the property owner, not the utility. There needs to be better definition on who is responsible for relocation of services during construction, not just who maintains services in the GIS database.”

iii. 115.4(2) Agreement required: We recommend an agreement be required for all adjustments or relocations to have an enforceable agreement for scope, cost, and schedule of the relocation. Even a minor relocation may cause a significant delay to a highway project.[49]

iv. 115.4(11) Noncompliance:
    1. This section of the Policy is very strong and supports the Iowa DOT Utility Program. We recommended this policy is verified as a tool to require design locates of utility facilities, As-built submissions, and Buy America Requirements. This section may be strengthened with a definition of an "Uncooperative Utility" and if this rule can be utilized when encountered.
    2. Another action item which may be considered if there is a history of deficient plans or locating of existing utilities is to require a PE seal on plans to assure the conformance to the Accommodation Policy and maintain a safe ROW.

v. 115.4(13) Insufficient capacity of right-of-way: While this statement is strong, how is it determined when there is insufficient room. Should the Department deny the utility's proposed location but not occupancy as they may be able to go deeper or provide another alternative? Can the utility permit contain a provision that the conduit/facility can never be excavated? (For example, a new facility would have to be installed if a repair is needed.)

vi. 115.5(3) Number of crossings: The DOT may consider allowing only one set of poles on each side of the road and require co-location on poles when space is available on the poles mirroring the concept of requiring joint occupancy on crossings. If possible, this should be also expanded for longitudinal telecommunications. Understanding multiple manholes may still be required for security.

vii. 115.8(3) Plan: It is recommended that additions to this section of the policy include:
    1. Requirement to tie utility plans and installation to the required DOT survey system. Including both Horizontal and Vertical.
    2. Requirement for Utility to hire a PLS to state ROW if DOT forces not available.
    3. Compliance of standards/accuracy levels of location delineated and in conformance with ASCE 75-22.
    4. Required Plan size and formats, file types and sizes, graphical formats, and structures.

[49] Comment by Gabe Nelson of Snyder & Associates: "Totally agree with this point. If the relocation cannot take place beforehand, this would trigger the need for an agreement. On the US 69 in Polk Co there was an agreement with one utility outlining the communication process and timeline for each utility. That process went fairly well. The issues were with a lot of the other utilities who were not required to have an agreement."

5. Traffic Control / Phasing sheets- for utility construction, this was a prior requirement of Iowa DOT but was discontinued. Including the Iowa 511, Notification of width or height restrictions included with Utility Permits.
6. Designated boundary lines between city/county roads and the State Highway System.

viii. 115.8(8) As-built plans:
1. It is recommended the location requirements, including vertical elevations, be in conformance with ASCE 75-22 and the citation be included in the Code if possible. A graphics file of the as-built should be required also, which can be uploaded into the Asset Management system for future use.
2. If a utility does not comply the code should give the DOT the option of withholding permits or other actions as noted in 115.4(11) and 115.30(6). All costs associated with the DOT actions to obtain As-Built information including ASCE 38-22 Levels B and A should be the responsibility of the Utility.

ix. 115.8(9) Transfer of permit:
1. It is recommended this section be expanded to include a change of function or in use. This would include changing from public use to private use.
2. Geographical information, if not already in the Iowa DOT system, should be required when updated in conformance with ASCE 75-22.

x. 115.11(306A) Vertical overhead clearance requirements: It is recommended overhead electric lines are not allowed to cross within the approaches of a bridge to maintain OSHA clearances for equipment installing metal beam guard fence in the approach. Additionally, it is recommended to review longitudinal clearance requirements for equipment while performing maintenance to the bridge rail and appurtenances.

xi. 115.12(4) Engineering fee: It is recommended the Utility be required to use a Profession Engineer and the plans be sealed on bridge attachments. This would be in addition to the Engineering Fee for the review of the attachment plan.

xii. 115.13(306A) Underground utility facilities:
1. 115.13(1) Depth requirements:
    a. It is recommended that a review of the depth requirements of Utilities be completed as the Utility Industry and other states are currently moving to greater depths. Factors being considered are type of utility, need for access, risk of being impacted by other utilities or highway maintenance, and differing requirements for longitudinal or crossing occupation.
    b. Another consideration would be if a protection slab could be used if minimum depths cannot be achieved. Especially under

ditches where it would provide protection form routine maintenance for drainage.

xiii. 115.13(7) Multiduct systems: It is recommended to include or refence the requirement for each tenant in the multiduct to have an approved permit and provide As-Built information and plans that will be included in the asset management system in conformance with ASCE 75-22.

xiv. 115.20(1) Notice to department: It should be the Department's determination if a utility may abandon or remove all or a portion of the utility facility when it is retired or out of use. It is recommended to define the difference in abandoned and idled/in in use facilities. Abandoned normally indicates the utility relinquishes its ownership and responsibilities. This leaves the DOT dealing with the old lines in conflict with new projects and any environmental concerns that exist with the old utility lines. It is recommended to add policy for the DOT determining and approving if a facility can be abandoned or only partially approving if left in place and any related condition to abandonment.

xv. 115.25(306A) Utility facility adjustments for highway improvement projects.

1. Rules 761—115.26(306A) to 761—115.30(306A): The addition of a requirement to by Buy America and Build America should be included in this section conveying the consequences of non-compliance for both the DOT and the Utility.

xvi. 115.27(5) Acceptance of preliminary work plan: This section allows the possibility of an endless "do loop" if a Utility is uncooperative or is unresponsive to requests from Iowa DOT to make acceptable revisions to the work plan. A clear definition of an uncooperative utility should be referenced and actions to be taken per section 115.4(11).

xvii. 115.28(4) Acceptance of final work plan: This section allows the possibility of an endless "do loop" if a Utility is uncooperative or is unresponsive to requests from Iowa DOT to make acceptable revisions to the work plan. A clear definition of an uncooperative utility should be referenced and actions to be taken per section 115.4(11).

xviii. 115.30(6) Failure to provide a work plan or to adjust utility facilities: This section allows the possibility of an endless "do loop" if a Utility is uncooperative or is unresponsive to request from Iowa DOT to make acceptable revisions to the work plan or perform the relocation according to the Utility Relocation Plan. A clear definition of an uncooperative utility should be referenced, and all the alternatives of section 115.4(11) should be referenced, not just the withholding of permits.

c. Iowa Administrative Code 480 Underground Facilities Information

i. 480.1 Applicability — prohibition: It is recommended to amend this code to include a response from utilities for the design and planning of projects.

d. Other Suggested Additions for Consideration:

i. Occupation of ROW
    1. A Review of existing utility locations and designating more location assignments for different types of utilities on the ROW. Examples include which utility is preferred to be closest to the ROW and which may be closer to the roadway for Longitudinal occupations.
    2. Requiring ownership markers with contact information at the ROW line for all utility crossings and designated intervals on longitudinal installations.

ii. Highway Project Considerations and Coordination
    1. Develop a Master Utility Agreement or Memorandum of Understanding which encourages cooperation and collaboration in the DOT/Utility relationship and sets the expectation for responsibilities during a Highway Project.
    2. Providing a discussion of the various type of Projects and the impacts on the relocation of utilities in the policy.
    3. Consider setting a Ready to Let Date (RTL) for the utilities to be clear of proposed construction. Setting a date three to four months ahead of the Letting Date allows the highway contractor to bid on the job with minimum risk and save cost.
    4. Require Subsurface Utility Engineering (SUE) and Utility Investigations in accordance with the ASCE/CI/UESI 75 to identify conflicts including the use of a Utility Matrix to be provided to the Highway Contractor to minimize risks.
    5. Require the Avoid, Minimize, and Accommodate (AMA) approach in the highway project design phases.
    6. Requiring a Utility Management Plan for utilities not relocated early and required contractor phasing in specifications.
    7. A Value Engineering approach to project design evaluating the Total Project Cost including the relocation cost of utilities, regardless of DOT responsibility to reimburse or not.
    8. Utility Conflict Management must include all disciplines, such as Drainage, Traffic, ITS, Construction Phasing, Bridge, and Construction
    9. The possibility of including the utility relocations in the highway contract if design phases or schedule would realize a benefit. (Note: The Utah DOT has successfully included utility work in highway contracts for several decades. The process involves master and supplemental agreements through which preferred contractors typically used by utility operators are essentially brought on the mainline contractor's team as subcontractors.)
    10. Capturing Utility Easement data encumbering the ROW and adjacent to the ROW for future projects and cost estimating.

11. Provide more pre-bid meetings to discuss utility issues so all bidders fully understand what needs to happen during construction. Utility companies need to participate in the pre-bid meetings.

iii. Construction and Maintenance of the Utility Facility
    1. Provide the requirements for including a utility relocation in the highway contract.
    2. Providing names/signs for the utility owner on the utility project
    3. Contractors on the project should have Identification information on their trucks.
    4. Not allowing the cutting of pavement or riprap without an exception request and encouraging a bore in most cases.
    5. Addressing preservation of trees, vegetation, and cleanup
    6. Consequences of noncompliance
    7. Requiring the contractor/utility to have the approved permit and plans on site during all construction activities.

iv. Incentives, currently Iowa can only pay for 2nd relocates due to a redesign.
    1. Obtain the authority to acquire utility easements in the name of the state to assist in the relocation of utilities and establish a utility corridor.

v. Exceptions
    1. It is recommended an Exception Process to the Utility Accommodation Rules be developed to clarify the recommendation and approval requirements of an exception to these rules. Normally exceptions are approved at a State Utilities Manager level if the proposed facilities or the work does not:
        a. Create a hazard or safety issue,
        b. Impact the roadway or traffic flow,
        c. Have the potential to damage adjacent facilities, or
        d. Impact future projects of the state.

Enforcement Policies

1. Adherence to the POINT 25 Process – All projects should follow the POINT 25 process and utilities should be relocated prior to construction. When utilities necessitate being relocated during construction, there should be consideration of the probable delays applied to the project scheduling requirements so as to provide the contractor additional time for those projects.
2. Apply penalties for utility delays – The Iowa AGC supports support this practice and it is noted that the POINT 25 process provides for assessing penalties in delay damages and withholding future permits from non-compliant utility companies. Applying these penalties may be necessary to achieve an improved response from the utility industry.
3. Cultural shift of the utility coordination process – A more popular solution among all parties, is an approach of partnership. This approach entails a cultural shift of the project development process and has been effective when put in place in other states, such as Indiana. The mentality

in this approach is to avoid utility facilities during design as a first approach; at least where feasible. Further, the design team should understand design impacts to utilities, timelines, and treat utilities as a partner in the right-of-way. This approach would establish a more collaborative manner for relationships with the utility companies. With education and improved utility data, this cultural shift could be effective in minimizing utility-related project delays.

Technology Modernization and Recommended Implementation

1. Data Hosting and Sharing:
    a. The initial Federated GIS Collaboration Portal is hosted on a server or service managed by Iowa DOT or a contracted 3rd party.
    b. Sophisticated utility owners serve as the source-of-record for their infrastructure data and provide Iowa DOT real-time access through secure Open Geospatial Consortium (OGC) compliant web services for direct sharing into Iowa DOT's Federated GIS Collaboration Portal.
    c. Unsophisticated utility owners submit records of their installations to Iowa DOT through a dedicated secure on-line process for standardization and GIS data management for the Iowa DOT GIS repository. Automate workflows & leverage asynchronous data transformations within ESRI ArcGIS to streamline the data processing tasks for GIS administrators.

2. Populating Utility Data for the Federated GIS Collaboration Portal with ASCE 75 compliant data.
    a. Data collection opportunities through new Iowa DOT digital permitting process:
        i. Proposed geospatial (i.e., geodetically referenced position, alignment, geometric shape, and size) and feature attributes acquired during application effort (via map drawing tools and pick menus) are hosted by Iowa DOT GIS.
        ii. Permitting process is not closed out until **actual as-built** geospatial coordinate data are acquired and associated with permit information (proposed geospatial and feature attribute data) to validate and approve new installation. [Current technology essentially makes acquisition of accurate (e.g., +/- 0.1 feet) geospatial data a low cost, low impact effort for open trench, direct bury, and horizontal directional drilling installations.]
        iii. Many utility owners operate GIS for managing assets. Standardized utility data [e.g., a) existing utilities investigated and documented per ASCE 38 and pushed into ASCE 75 format, and b) newly installed utilities directly observed and recorded per ASCE 75] will be hosted on utility owner GIS layers, published and securely referenced into the Federated GIS Collaboration Portal. Exceptions will be necessary for less sophisticated utilities to allow hosting of utility as-built data on the Iowa DOT GIS. [Commercial-off-the-shelf (COTS) solutions already exist for managing utility infrastructure data, so gradually all utilities will have means and desire to have internal GIS with secure data sharing capabilities. Utilities can manage and execute data sharing in a much more controlled, expeditious, and reduced labor environment.]

b. Data collection opportunities through Iowa DOT construction projects:
    i. Digital as-built data on new installations acquired as stipulated in contractor bid documents, special provisions, and contract documents.
    ii. Sporadic data on existing infrastructure exposed during construction activities is acquired and submitted in accordance with contractor contract documents.
    iii. Utility as-built observation data acquired during construction activities is hosted on the Iowa DOT GIS and made securely available to respective utility owners to reference for cross referencing and updating their records.
c. Data collection opportunities of existing installations for Iowa DOT design projects:
    i. Utility investigation / subsurface utility engineering (SUE) submittals include a requirement that ASCE/CI/UESI 38-22 data is pushed into ASCE/CI/UESI 75-22 compliant digital format and uploaded into the Iowa DOT GIS.
        1. SUE data is available for Iowa DOT project design, conflict analytics, and utility coordination.
        2. Utility owners can securely reference SUE data with appropriate caveats for cross referencing and improving records. (Note: redundant data improves statistical accuracy and flags malformed data.)
    ii. Topographic survey (direct observations and reduced LiDAR scans) of surface appurtenances and above ground utility infrastructure is managed in the Iowa DOT GIS and available for utility owners to securely reference with appropriate caveats for cross referencing and improving records.
d. Existing utility record data
    i. Iowa DOT uses Federated GIS Collaboration Portal to securely access utility owner GIS for digital as-built data.
    ii. Utility owners lacking GIS will submit records through on-line process for conversion, standardization, and uploading into Iowa DOT GIS so data is available for stakeholder use, including utility owners with data hosted on the Iowa DOT GIS.
    iii. ASCE/CI/UESI 38-22 data acquired for project development will be used to improve existing utility record data.

3. Collaboration Opportunity with Iowa One Call
    a. Iowa One Call (a.k.a., 811 Call-Before-You-Dig) ticket process can be used to monitor activity within Iowa DOT ROW jurisdiction. A wealth of information from the ticket process can be utilized while reducing redundant data entry activities.
        i. Iowa DOT ROW can be notified of the “what, where, when, and why” associated with excavation projects within Iowa DOT jurisdiction.
            1. Dig Ticket can be used to fill out a portion of Iowa DOT ROW Occupation data fields and automatically activate Iowa DOT ROW Occupation permitting process.
            2. Contract locator paint marks can be recorded using COTS technologies and data synchronized with Iowa DOT Federated GIS Collaboration Portal.

3. Excavator exposed infrastructure within Iowa DOT ROW can be observed and documented per ASCE/CI/UESI 75. [Excavator can perform this using low-cost COTS technology (e.g., API, field tablet with GNSS RTK capability) provided by Iowa DOT, or Iowa DOT inspector performs observations.]

[Currently there is a missed opportunity to understand the other notifications associated with 811 dig tickets. A lot of it is the same information. The differences between the Iowa DOT ROW occupation permit and 811 ticket need to be identified. Common data can be used to auto-populate forms. This will facilitate a better experience for the members. The Iowa Code requires the use of 811 notification tickets. Need to understand if doing 811 dig ticket or the ROW occupation permit first. More sophisticated utility companies have boundaries and know what utilities are present. If the 811-dig ticket is done first, the applicant then has a lot of the data required for the permit. Iowa DOT is also a facility operator; APIs exist to bring the 811-dig ticket information into their own ROW Occupation permitting and utility repository system. If an 811-dig ticket has already been submitted, then applicant only needs to enter the Ticket ID and a search is executed to auto-populate all the common data into the Iowa DOT ROW occupation permit application.]

4. Statewide Collaboration

   Once Iowa DOT has the Federated GIS Collaboration Portal system up and running smoothly it can be scaled up for OCIO management and include all cities and counties and state agencies for statewide use. [Note: Utilities have stated Iowa DOT represents only a small portion of their record information distribution efforts. Expanding system for statewide use will greatly facilitate the ability for utility owners to respond to requests for information.]

   a. Shared cost, funds, and responsibility for managing.
      i. Collect fees with permits to fund the system.
      ii. Subscription fees for utilities, contractors, and others to access data to fund the system.
   b. Address Security concerns – minimal amount of data shared to meet needs of general public – users, Cities, contractors, etc.
   c. Implementation of this plan probably best executed through: a) a funded existing agency such as OCIO or Iowa DOT or Iowa One-Call; or b) specialized private entity.

5. Digital Web Based Permitting System

   The research team recommends that Iowa DOT advertises and selects a COTS provider to implement an electronic permitting system. COTS products are designed to be installed easily and configured to interface with existing systems.

   a. Standardize utility data collection at the time of installation as per ASCE-75 and provide the applicant the ability to upload required as-built data as part of the online permit workflow and process.
      i. Define additional workflows to address different permit types and review requirements.

ii. Review that installation complies with any special provisions that have been specified as part of the application process.
iii. Validate that the utility installed was tied to a known datum and that a true as-built data was submitted.

Utility Engineering

In addition to enabling systematic acquisition and access to standardized data for projects, Iowa DOT will adapt design practices and the Point 25 Process to include proactive, predictive "utility engineering" best practices [advocated by the Utility Engineering and Surveying Division (UESI) of the American Society of Civil Engineers (ASCE)] that will promote collaboration between all stakeholders, mitigate utility/design conflicts and utility related project risk, and optimize designs and planning which in turn results in tighter construction bids and expedited project construction. Similar utility engineering (UE) practices have been implemented by transportation departments in Texas and Colorado, achieving documented return-on-investments ranging between 10 and 20 times the cost[50] while promoting positive working relationships with 3rd party utility infrastructure owners which are occupying Iowa DOT right of way. Additionally, UE allows utility infrastructure owners to better focus resources on improving services while their clients (the public) realize cost savings, all of which in turn serves the public welfare and interests.

The recommended utility infrastructure management practices herein are generally consistent with the intent of the existing Iowa statutes and Iowa DOT utility accommodation policies, as well as Federal policies.

[50] Quirogo, Cesar, Ph.D., P.E., Personal Communication, *Identifying and Managing Utility Conflicts*, Course ROW100, Developed by the Texas Transportation Institute of the Texas A&M University for the Texas Department of Transportation May 9th, 2023