MODERNIZING UTILITY PLANNING AND ENGINEERING

A COMPLETE GIS for Water Utilities

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Introduction

Utility engineers face major challenges due to aging infrastructure and the need for network modernization. The infrastructure built today will likewise be around for a long time. Modernizing the network and how it is managed requires innovative tools and methods. Organizations must deliver more–with fewer resources.

To produce efficient work products, design teams require diverse data, ranging from network configurations to environmental impacts. This data often rests in silos, resulting in cumbersome planning, design, and construction workflows.

Crucial engineering systems often start with translated file extracts rather than a steady, authoritative source. These fragmented processes are prone to data degradation, causing mistakes that lead to costly rework.

Reliable information sharpens all phases of every project. Designs not resting on a single source of truth create project risks that affect safety, schedule, and cost. A single source of true design information comes from a modern geographic information system (GIS). A modern GIS extends far beyond simple mapping. It provides a solid foundation of information and communication. This enables utilities to succeed using repeatable solutions to engineering problems.

ArcGIS^{*} is a modern GIS that models networks holistically. Its rich analytics deliver greater understanding and improve decision-making. Versatile role-based apps accelerate communication and collaboration between all participants. The modern capabilities of ArcGIS reinforce excellence for planning and engineering.



Contents

- **04** The Project Life Cycle
- **05** Why Location Technology Matters
- **06** A Holistic Approach to the Network
- 07 Real-World Modeling
- **09** Visualization and Analytics
- **10** Coordination and Collaboration
- **11** The Complete GIS–Supporting Design and Engineering

12 About Esri



The Project Life Cycle

The project process begins with planning and extends through engineering and design and into construction. Teamwork between the office and field is critical for a smooth and costeffective process. Correct as-built information feeds the utility's essential operational and asset management practices. Functions supporting the project can capitalize on the same data and technology platform: ArcGIS.

Information plays a key role throughout the entire project life cycle. ArcGIS goes beyond powerful mapping to unify the necessary data. Reliable engineering builds on dependable data and detailed models of the network that reflect the real world. It relies on state-of-the-art visualization and analytics that communicate engineering trade-offs and decisions. Innovative projects demand flowing coordination and clear collaboration between agencies and departments. Computer-aided design (CAD) software, engineering analysis programs, and graphic GIS tools build on the same GIS network model. In doing so, they increase design efficiency by solving infrastructure optimization challenges and reducing backlog. Capturing mobile data at its source speeds work order closeout and makes as-built information immediately available.

A full work packet includes calculations, drawings, compatible units, estimates, and material lists. ArcGIS integrates seamlessly with common enterprise resource planning (ERP) and enterprise asset management (EAM) systems. It utilizes and updates the appropriate systems without duplicate entry.

With ArcGIS, planning and engineering information is assembled, referenced, and shared across the utility enterprise for use by every stakeholder in the process.

"Esri ArcGIS software has proven to be an invaluable tool for mapping existing infrastructure, conducting field surveys, preparing design documents, conducting technical reviews of new subdivisions, and collaborating [on] designs between multiple consultants."

Kevin R. Yates, Ward Engineering Group





Why Location Technology Matters

Designing utility infrastructure is a locationcentric pursuit, and awareness of place precedes valid work products. Lack of awareness can lead to project delays and added costs, as in the example of construction crews accidentally striking a water main. Understanding existing conditions early helps avoid such problems during construction.

Nearly everything in the design process has to do with where things are now or need to be in the future:

- Where are the existing facilities?
- Where are the conflicts?
- Where are the customers who will be affected?
- Where are the environmental impacts?

Design information fits together in the context of location. ArcGIS grasps how projects fit with system planning objectives and site conditions. It enables a holistic view of capacity needs and constraints, rights-of-way, environmental hazards, and obstructions.

Engineers and designers need to use and understand accurate, location-based information every day. They also need to share it widely with consultants, contractors, and construction forces. ArcGIS connects project tasks using role-based web maps and apps. It goes further by integrating tightly with common design tools using the latest services-based architecture.

Indiana American Water is using ArcGIS to support and improve system acquisition and project delivery planning initiatives. Data intelligence within ArcGIS helps to determine whether a system should be acquired. Once acquired, all system assets and networks are validated using real-time data collection methods. Web apps and dashboards are used for project tracking within project delivery. Staff is able to track and visualize project locations, statuses, inspector workloads, and more. The ability to view all project locations, along with real-time asset GPS data, empowers operations and engineering teams to monitor projects at all times.

Read their story



A Holistic Approach to the Network

ArcGIS uses location technology to hone engineering work and provides an all-inclusive view of the network and its surroundings. Using a modern GIS, utility engineers can see the many factors impacting their work, revealing how they connect with one another. This understanding improves their workflow as well as work products.

Location technology unlocks new sources of value in the project life cycle, thus benefiting engineering analysis, planning, design, construction, and documentation. ArcGIS does this by addressing three needs:

When San Juan Water District's (SJWD) legacy CAD-based GIS lost its functionality to communicate across departments, it created bottlenecks and data silos. Collaboration became a struggle as staff began to rely on disparate datasets, paper map books, and outdated systems. ArcGIS and the Utility Network enabled them to holistically manage their system and ensure a sustainable future.

Read their story

Real-World Modeling

ArcGIS Utility Network captures the realworld characteristics of entire systems—from production to customer delivery. It includes data integrity tools while accounting for 3D and temporal states.

Visualization and Analytics

Compelling analytics and robust tracing actions highlight valuable insights. Schematic views validate design decisions. Integrated tools help determine accurate material and labor demands.

Coordination and Collaboration

ArcGIS provides a seamless environment to leverage digital collaboration. Stakeholders consider impacts; examine alternatives; and make superior, coordinated decisions.

With a holistic approach, designers reduce the time spent collecting data, allowing them to accelerate the project stages. This streamlines review cycles, saving time and money.



Real-World Modeling

ArcGIS models the real-world characteristics of entire utility systems, adding value to each project phase. Contemporary users expect highend 3D visuals. Today, true modeling accounts for greater detail, 3D, and the fourth dimension of time. It also secures high-quality data as part of its inherent functions. Real-world modeling improves outcomes in several ways:

Designs 3D networks from production to customer delivery

From distributed production to customer delivery, ArcGIS Utility Network embraces the best possible representations of reality for entire systems. With a complete model, engineers readily assess the customer impacts of design alternatives. ArcGIS Utility Network also accounts for structures and attachments and represents dense clusters without clutter. By capturing x, y, and z, it supports full 3D visualizations and analysis.

Utility Network models the connection of every element in detail. Operating at scale, it even models multiple commodities together. For example, the impacts of a water outage quickly reveal the customers affected and what hydrants will be out of service. Immediate notifications can go out to all stakeholders.

Manages projects through their life cycle

ArcGIS functions support data enrichment and streamline project delivery, from planning to construction. Esri's extensive partner network brings additional value to ArcGIS by providing interoperability and access to extended toolsets.

Designers deliver data to the right user, at the right time, with the right tool. Project information flows seamlessly between applications. This advanced capability supports the entire project life cycle with simplicity, efficiency, and intelligence.

"Simultaneously managing hundreds of projects worth hundreds of millions of dollars, from strategic planning to design, construction, and maintenance, requires the exceptional visual and data management tools available in our ArcGIS BMP system map application and Enterprise Stormwater Management database, which instantaneously provide the intelligence necessary to drive decisions that meet regulatory compliance, cost-effectiveness, and community progress."

> Jim Lyons, Senior Program Administrator, Prince George's County Government, Department of the Environment





Real-World Modeling (continued)

Enforces rules-based standards and connectivity

ArcGIS Utility Network inherently enforces rules to determine logical and graphic connectivity, which ensures high-quality data. These connections are necessary for accurate modeling. Attribute validation applies quality assurance across all edit sources, on all device platforms—even integrations. Editing templates enable the placement of very complex features with a single, automated action. Enforcing data integrity and reducing entry errors in this way boost effectiveness for all applications.

With this high level of quality control, edits can be safely made directly at data sources, including in the field. Subject only to an organization's preferences, edits to the master network can be made via mobile apps. Such a step forward can save time, and there is no loss in data quality. It also markedly reduces data latency in organizations accustomed to work order posting delays.

Represents past, present, and future states

Utility engineering work requires analysis of past conditions and understanding of current parameters. It includes plans and estimations for the future. Compliance activities rely on accurate knowledge of the past. ArcGIS Utility Network accurately captures time—past, present, and future.

Additionally, the model maintains life cycle attributes. These life cycle states consist of proposed, in-service, abandoned, and under construction. Additional states can be added.

Esri poured years of extensive research and development into its network model. It developed network capabilities to support industry needs and customer requests. These networks are an enabling technology supporting optimal engineering and operation of utility systems.

"ArcGIS Utility Network is next generation technology enabling utilities to achieve their digital transformation targets."

> **Matt Piper**, Industry Solutions Director— Esri Water, Electric, Gas, Telecommunications, AEC





Visualization and Analytics

Industry trends and constraints are placing utility infrastructure under great pressure. Organizations cannot afford to overbuild equipment, so engineering decisions must be based on precise data. Building on a solid data foundation, leading utilities use data science and analytics to discover new insights and optimize designs. In ArcGIS, state-of-the-art visualization brings these design ideas to life through the following capabilities:

Network analysis and tracing

Network analysis in ArcGIS brings sophisticated tracing functions to every user. Tracing enables real-time guidance for common engineering matters like identifying which valves to turn to stop water flow, tracing flow of water through the network, and identifying upstream and downstream direction.

Validation of 3D designs in the context of location

Site location and its surroundings affect every design decision. Location technology allows engineers to readily assess environmental impacts and incorporate field data. Using location for context, ArcGIS users engage 3D capabilities to detect conflicts, make safety provisions, plan jobs, and conduct training.

Network insight by schematic portrayal

Schematic views are built into ArcGIS Utility Network. Engineers need to evaluate highlevel system considerations. To do so, they use schematics derived from the same data foundation.

Optimized use of material and labor

ArcGIS enables real-time data updates. Information about what equipment is being used, where it is being used, and who is using it can be visualized in field applications, online maps, and dashboards. Reliable, current data presented in an easy-to-understand format helps staff to quickly determine accurate material and labor estimates based on actual field conditions.

When expanding its service territory, Central Arkansas Water relies on its GIS team to provide valuable insight with maps and data to show the best and most cost-efficient expansion route. GIS data produced by multiple groups and organizations is utilized to conduct analysis: population projections, number of structures, preliminary design, and residential survey data. Data is geospatially located and visualized. This is used in an iterative process comparing designs and providing the most cost-effective means to provide water to the most customers.

Read their story



Coordination and Collaboration

Design information must be easily accessible to those that use it. Coordination and collaboration begin with a mobile-friendly technology platform. ArcGIS uses web services to reach out across the web and put the right information into the right hands, at the right time.

All users get the information they need to understand impacts and consider alternatives. With it, they can provide input, make superior decisions, and achieve better outcomes. ArcGIS accomplishes these important communication objectives:

Convey projects widely on any device

ArcGIS changes the way field staff connect with engineering. It distributes information, map displays, and even 3D representations on any device. It does this for the office and the field whether connected or disconnected.

The Municipal Authority of Westmoreland County uses ArcGIS to enable real-time data sharing across project teams. The ability to communicate work status instantaneously has increased collaboration and improved efficiency across the organization.

Read their story

Collaborate with internal and external participants

Crews, contractors, and planners alike all need design information like drawings and schematics. Internal and external stakeholders also need to share project updates. ArcGIS provides all members of project teams with the flexible, role-based information products they need to work together.

Distribute design information instantaneously

ArcGIS promotes common understanding by communicating project information immediately. It works at the speed of a services-based architecture. It leverages cloud computing where needed and improves situational awareness at every point along design, construction, and operations workflows.

Solicit community project interaction

Using web-based dashboards and apps, customers easily understand project scope and impacts. They visualize design alternatives and provide feedback. They see schedules and understand the benefits.



The Complete GIS— Supporting Design and Engineering

Most utilities already use GIS in some capacity. Yet how they use it is changing. ArcGIS is a complete GIS, meaning that it contains all the elements needed to meet design and engineering challenges, not just to make conventional maps.

ArcGIS supports real-world modeling. It delivers rich visualization and analytics with artificial intelligence (AI). It enables immediate coordination and collaboration with mobile apps and web browsers. It maintains key information needed for efficient design work. It discovers hidden meaning in data and distributes insights to everyone who needs business intelligence. These capabilities unite all the phases of design and engineering. They combine asset details with network performance and future plans. With location as the centerpiece, a complete design picture helps improve key performance indicators and business results.

Utilities face considerable challenges today and will continue to do so in the future.

ArcGIS brings exceptional value to every utility's engineering design and construction practice.

ArcGIS is an extensive information platform that enables measurable results. Read our e-book *Enabling the Intelligent Water System* to learn more about digitally transforming utilities with a complete GIS.

Read e-book

About Esri

Esri, the global market leader in geographic information system (GIS) software, offers the most powerful mapping and spatial analytics technology available. Since 1969, Esri has helped customers unlock the full potential of data to improve operational and business results. Today, Esri software is deployed in more than 350,000 organizations including the world's largest cities, most national governments, 75 percent of Fortune 500 companies, and more than 7,000 colleges and universities. Esri engineers the most advanced solutions for digital transformation, the Internet of Things (IoT), and location analytics to inform the most authoritative maps in the world.

Esri supports utilities in achieving their performance and visibility goals with skills, knowledge, and resources in the following:

- Mapping
- Spatial analytics
- Data-driven insights
- Real-time situational awareness and alerts
- Visualization

For more information, visit **go.esri.com/WaterUtilities**.



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