Autodesk® Topobase™
White Paper

Autodesk Topobase Water Technical Overview

Autodesk®

Autodesk® Topobase™

Autodesk® Topobase™ software brings engineering design data and geospatial data together in a centralized database environment so that organizations can share and use spatial information more easily. By integrating previously disparate islands of CAD and GIS data into a common, centralized framework, Topobase enables organizations to improve the efficiency of business processes and reduce the redundancy of information. Organizations no longer have to "throw data over the wall" between departments and re-create data due to incompatible formats. With Topobase, data is available, accurate, and synchronized across the organization.

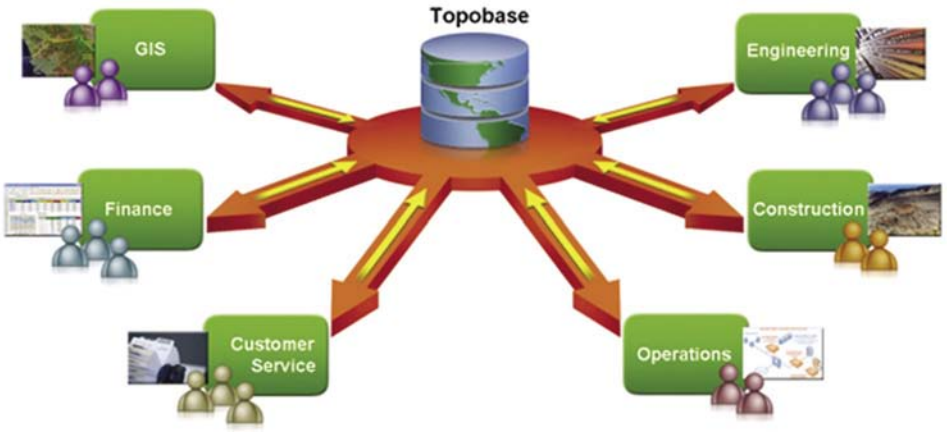


Figure 1: Autodesk Topobase is an infrastructure design and management solution that provides integrated, organization-wide access to spatial information for engineering, GIS, operations, and business processes.

The Benefits of Topobase

Using Autodesk Topobase, organizations gain a comprehensive view of infrastructure assets, which helps to improve decision making and all asset management processes. Organizations enhance efficiency and data quality by using the same applications to create and manage spatial information across departments. When all departments in an organization can use the same set of business rules to access and analyze data, the organization reduces manual and duplicate data entry and minimizes data conversion processes. Topobase also streamlines data editing and creation while making those processes more efficient with rule-based design and process automation. Perhaps most important, Topobase enables organizations to securely share spatial information with employees, such as field staff and business decision makers, who have traditionally lacked access to this kind of data.

The Topobase Architecture

Topobase is architected to store spatial data in a central database and to integrate with other business systems. Topobase is built on Autodesk Map® 3D and Autodesk MapGuide® Enterprise software applications. Autodesk Map 3D is a leading platform for creating and editing spatial data. It combines the familiarity of AutoCAD® software-based design applications with GIS functionality.

Autodesk MapGuide Enterprise allows organizations to publish map and design information internally or over the web. Using industry-standard development tools, organizations can create online applications that blend spatial and alphanumeric information from business systems on user-friendly maps. This makes sharing valuable infrastructure data with non-CAD and -GIS users seamless and cost-effective.

Topobase uses Oracle® Spatial, the world's leading spatial database, to store spatial data. Based on open standards, Oracle Spatial provides vendor-neutral GIS capabilities, which allows organizations to use preferred applications to carry

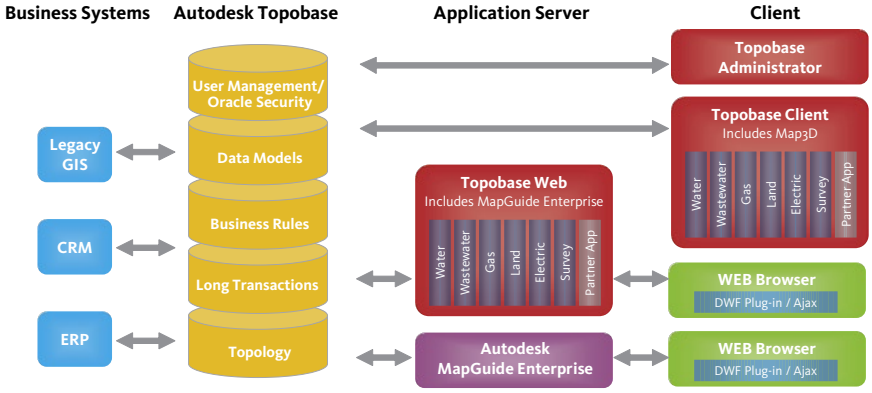


Figure 2: The Autodesk Topobase architecture delivers data integration, sharing, creation, and management capabilities along with superior database performance.

out geospatial analysis. It leverages Oracle Spatial's native GIS capabilities for storing spatial data and performing spatial tasks, and it includes the renowned and proven Oracle database management and tuning features that help to ensure superior database performance over time. Organizations can use standard IT tools along with SQL to access information in Topobase for reporting or to integrate with business and IT systems (such as CRM and ERP) or legacy GIS systems from other vendors.

Extending the value and capabilities of Autodesk Map 3D, Autodesk MapGuide Enterprise, and Oracle Spatial, each Topobase implementation includes a set of standard components:

- Topobase Client—A desktop application that streamlines design within a familiar interface and automatically stores asset data in Oracle Spatial.
- Topobase Web—A web application that uses Autodesk MapGuide Enterprise to share asset information over the web.
- Topobase Administrator—An application that enables organizations to change or extend data structures in Oracle Spatial, create business rules, design user forms and reports, and regulate access to the Oracle Spatial database.
- Industry-specific applications—Modules designed for managing specific types of infrastructure, such as electric, water, gas, wastewater, sewer, and land assets.

These components, a powerful architecture, and advanced technical features make Topobase the ideal infrastructure asset management solution for organizations that manage dynamic infrastructure networks. For more detailed information on how to create, edit, share, and manage data using Topobase Client, Topobase Web, and Topobase Administrator, please see the Autodesk Topobase White Paper.

An Overview of Topobase Water

As an industry-specific application within Topobase, Topobase Water delivers best-of-breed CAD and GIS functionality using an Oracle enterprise database that has been specifically tailored for use by the water utilities industry. This allows water utilities to use CAD tools to design and manage water distribution networks and infrastructure. In the process, they create rich information that contains attribute data associated with their assets—such as pipes, values, and fittings—which makes engineering design information GIS-ready and incorporates a dynamic utility model that enables on-the-fly topology and analysis abilities such as network traces. Water utilities are then able to maintain their infrastructure data in the Topobase enterprise solution built on an Oracle database, which can be accessed across the organization and used by business teams in ongoing network and asset management.

Topobase Water comes with a water-specific data model that contains the most commonly requested and used water-specific data schema, object relationships and associations, business rules, and workflows found in the water industry today—and each area is user-definable or customizable to fit specific needs. For example, the data model on the database contains industry-specific business rules to help protect the integrity of spatial information, increasing the quality of data. Topobase Water workflows are designed to be comprehensive and streamline common activities related to creating and maintaining water networks. In fact, many users can rely on the extensive library of workflows to perform their daily tasks—without needing to understand the entire data model. And if needed, Topobase Water allows users to customize or add new attributes, relationships, and feature classes to support the management of specific water distribution networks and assets.

With Topobase Water display model style templates, executives, customer service agents, field crews, and other employees can view the utility's spatial data to carry out their work functions. These preconfigured layer styles allow users to focus on and work with the subset of the enterprise database they require to complete job-related tasks efficiently. For example, a network engineer might want access to network data to view underground information, as-built infrastructure, and network conditions for design work, and an operations manager might want to view assets color-coded according to maintenance schedules.

Along with infrastructure asset data management tools, Topobase Water offers features that allow departmental domain experts to use advanced CAD and GIS functions to accelerate workflows and increase the integrity of infrastructure data.

In this white paper, we will explore the basic components of Autodesk Topobase Water: workflows and business rules, the database model, and display models.

Autodesk Topobase Water enables water networks and utilities to:

- Gain a more complete view of all network infrastructure and assets.
- Make vital asset information accessible across the organization.
- Reduce data redundancy and duplicate systems while improving data quality by enforcing business rules and using workflows to meet data quality standards.
- Minimize time-consuming data conversion processes when moving data between departments and job functions.
- Maintain engineering design accuracy throughout the project lifecycle from conceptual design to as-built stages.
- Share information internally and externally more securely, easily, and cost effectively.

A Closer Look: The Technical Features of Topobase Water

Autodesk Topobase Water delivers the advanced spatial data creation, sharing, and management capabilities water utilities require to document, maintain, and present their water network information. The Topobase Water application contains comprehensive workflows and business rules, robust water-specific data models, and customizable display model style templates for graphic data representation. Combined, these features support optimal database performance, facilitate efficient design and data management, and enhance the integrity of network data.

Workflows and Business Rules

One of the most important features of Topobase Water is that users have the ability to establish a comprehensive set of workflows to streamline business processes based on the water utility's current way of doing business. These workflows help guide users through common tasks and govern the way information is entered into the database. Workflows—and related business rules that are working behind the scenes—also prevent designers from leaving out required elements, choosing incorrect materials, or including incorrect material sizes, thereby reducing the scope of error during design and data updates.

Workflows within Topobase Water consist of a sequence of procedures or steps that the user is required to follow while performing a routine task. Business rules are actions executed automatically when a change is made to the database. For example, if a pipe is moved, the execution of a business rule will cause the connected valve to move. Business rules automatically correct data according to predefined algorithms and perform complex consistency and dependency checks. Once business rules are established, dialogues within Topobase Client include only valid elements for the designer to select, streamlining the process and increasing accuracy.

For example, in the process of creating a hydrant, the workflow automatically prompts the user to connect the hydrant to an existing pipe. And the business rule for connecting two pipes ensures that a fitting is automatically inserted at the connecting point. Organizations can also define common sets of materials and data standards—and both can be linked to a workflow, such as adding a new connection to the network or replacing an old pipe.

Workflows and business rules help users save time by collapsing several steps into one, automatically checking for errors, and helping ensure that all relevant information is entered into the database. Users can easily create their own custom workflows or use one of four types of workflows within Topobase Water.

Workflow Type	Description
Acquisition	Create network points, pipes, house connections, fire hydrants, structures, facilities, and more.
Analysis	Trace the network from a designated start and stop point.
Cable Acquisition	Create control cables and control cable points.
Report	Generate and print predefined and customized reports and export the report into ASCII, Crystal Reports, and HTML files.

Within each area, Autodesk Topobase Water contains the following workflows:

Acquisition workflows

- Network point creation—create any of the network point types.
- Network pipe creation—create network pipes with or without casing or anode protection.
- Network pipe with fitting point creation—create a non-ending pipe for situations in which the water network does not continue beyond a certain point.
- House connection creation—connect the house connection to the main pipe either with an auto-calculated shortest pipe or by drawing a polyline.
- Fire hydrant creation—create a fire hydrant that directly connects to the main pipe either with a straight line or by digitizing a polyline. Create an armature on the main pipe or a valve on the pipe.
- Site or facility creation—create a site or a facility feature with detail geometry.
- Facility creation—create and name a new structure or add facilities to an existing structure.
- Damage creation—place a damage point feature on a pipe or create an armature such as a strap at the damage location. If an armature is created, the pipe is soft split. Damage points can only be placed on a pipe. If the damage is not created on a pipe, the system displays a warning message.
- Pressure zone creation—digitize pressure zones to subdivide the water network into sections of similar pressure.
- Protection creation—add casing or anode protection to a pipe.

Analysis workflows

- Find connected—support network tracing by selecting one or more start features and optional stop features. The network tracing begins from the start location and stops when all stop features have been reached.
- Find connected with stop conditions—provide the same tracing functionality as the find connected workflow with the added benefit of using attribute-dependent stop conditions.

Topobase business rules and workflows allow you to:

- Improve productivity, quality of data, and efficiency by combining multiple steps into a single workflow.
- Check, validate, and maintain data quality at all points within the organization across all levels of users.

- Find non-splitting point on section—find all point features on a pipe section which are not splitting.

Cable acquisition workflows

- Control cable creation—create control cables.
- Control point creation—create control cable points, connect them to a site, and digitize control cabinets.

Report workflows

- Report generation—print predefined and user-defined reports.

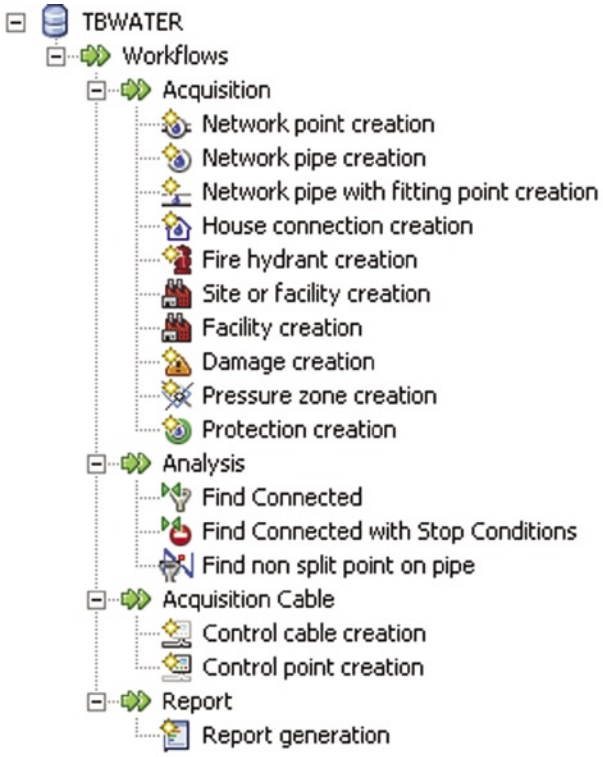


Figure 3: Workflows within Topobase Water

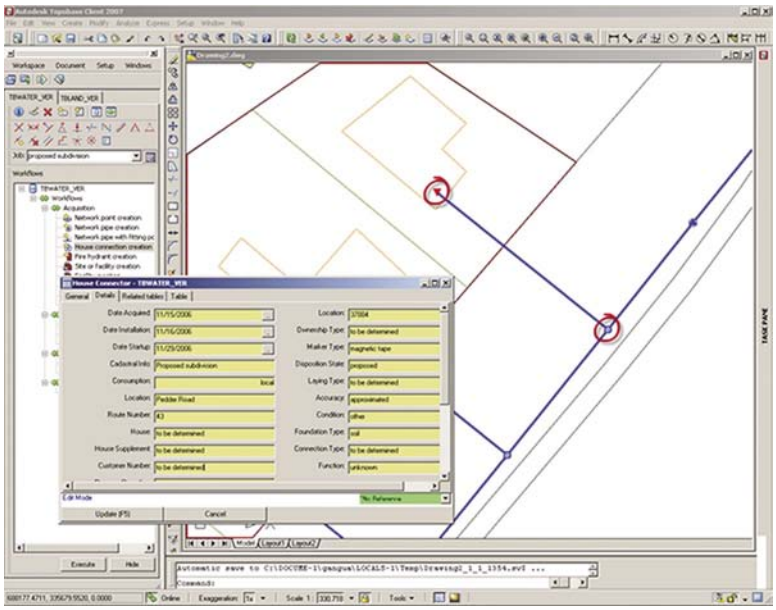


Figure 4: Business rules help to ensure asset information is maintained according to an organization's standards.

The built-in water specific data model allows you to reduce deployment time and realize better ROI with the built-in water-specific database schemas, workflows, and business rules.

Example workflow: House Connection Creation

Let's take a closer look at a typical Topobase Water workflow: house connection creation. Using the workflow for digitizing a house connection, the user connects the house connection to the main pipe either with a straight line or by drawing a polyline. If the user selects the straight pipe, a business rule prompts him to select the main pipe in the drawing. The connection is created as an orthogonal projection on the main pipe. The user can digitize an armature on the main pipe at the position where the house connection is attached to the main pipe and add a valve on the pipe. As the user adds a valve, the business rule triggers the automatic connection of the new asset and splits the pipe at the point of connection with the valve.

If the user does not create an armature, the system creates a fitting at the location where the house connection is attached to the main pipe. This behavior is caused by a business or feature rule that is enabled in the standard water data model. The house connection creation workflow includes the following steps:

1. Start the workflow explorer.
2. Specify a reference record to automatically apply predefined values for attributes without having to enter them manually.
3. Choose the main pipe connection type, straight or manual free-form digitized
4. Specify whether to add an armature.
5. Specify whether to add a valve.
6. Complete digitize operation and repeat for next house connection.
7. Exit from the workflow when finished digitizing all house connections.

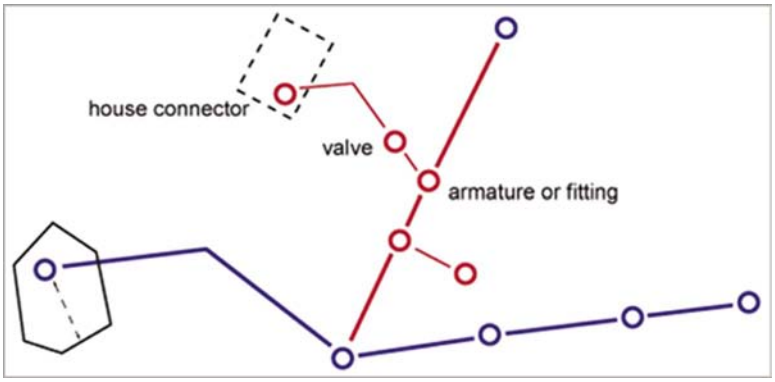


Figure 5: Illustration of house connection workflow

Topobase Water Data Model

Topobase Water comes preconfigured with an Oracle data model that is designed to capture the exact data needed by the water industry. It is configured to manage attribute information appropriate to assets common in the industry, such as pipes, valves, fittings, hydrants, pumps, and meters. Additionally, the data model is designed to capture all the underlying attributes relevant to each feature, such as size, dimension, age, condition, pressure, and connection. The data model also maintains the relations between features. This means, for example, that a house connection exists between a house and city water line.

The water data model can be further customized with the Topobase Administrator to meet the exact data requirements of individual water distribution networks. And because the water data model is preconfigured based on the most common needs of the water industry—these customizations are typically completed rapidly, helping organizations realize the return on their Topobase investment sooner.

The Topobase Water data model is comprised of ten types of elements and associated functions. Each of these is referred to as a “topic.” The ten primary topic areas are:

- Administration: Manage contacts, customers, locations, manufacturers, and item models.
- Control cable: Maintain control cables and cabinets based on the utility model.
- Dimension: Create user-defined markups and label measurements.
- Facility: Support facility management.
- Miscellaneous: Store information about maintenance work and physical markers.
- Pipe: Store, view, and edit feature attributes and data on water pipes.
- Point: Store utility points of the water data model in separate attribute feature classes, one for each point type. These point features, which contain all associated attribute information, are used in conjunction with the point geometries for analysis.
- Protection: Display and manage water network protection.
- Site: Represent the location or site of a specific water network asset such as a valve or a fitting.
- Utility: House geometry related to the point and pipe feature classes. Allows Topobase to generate on-the-fly analysis such as network traces using complex stop conditions and perform hard and soft splits of network assets.

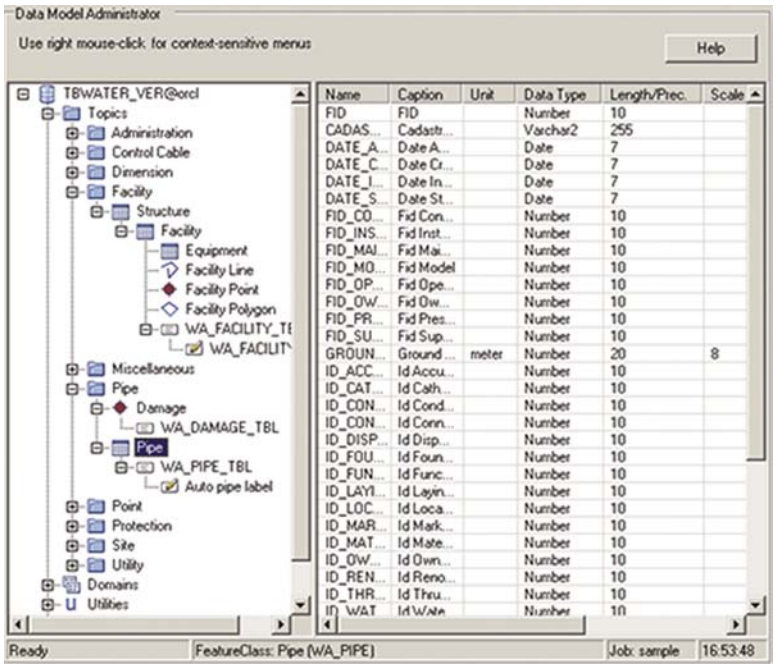


Figure 6: Water data model supports the streamlined management of control cable, facilities, pipes, and other features specific to water networks.

Let’s take a closer look at the individual components of the water data model.

Administration

The Administration topic contains attribute feature classes that manage information about contacts, customers, dimensions, locations, manufacturers, and item numbers related to network assets. In addition, the Administration topic includes feature classes for meter areas, pressure zones for each facility and pipe, protection zones, and supply zones for each pipe. Captured data includes

geometry, area, date creation, name, narrative, and user flag. The Administration topic includes the following feature classes:

- Pressure zone—defines areas within the network where system pressures are within a specific range.
- Meter area—defines an area that is downstream of the meter.
- Supply zone—describes the supply zone used to group water utility items.
- Protection zone—describes a visually grouped protection zone.
- Manufacturer—captures manufacturers for all materials and assemblies.
- Dimension—captures item dimensions, such as length or pipe diameter.
- Location—stores location of item, such as neighborhood or district.
- Contact—captures relevant contact information, such as company address, contact name, and email address.

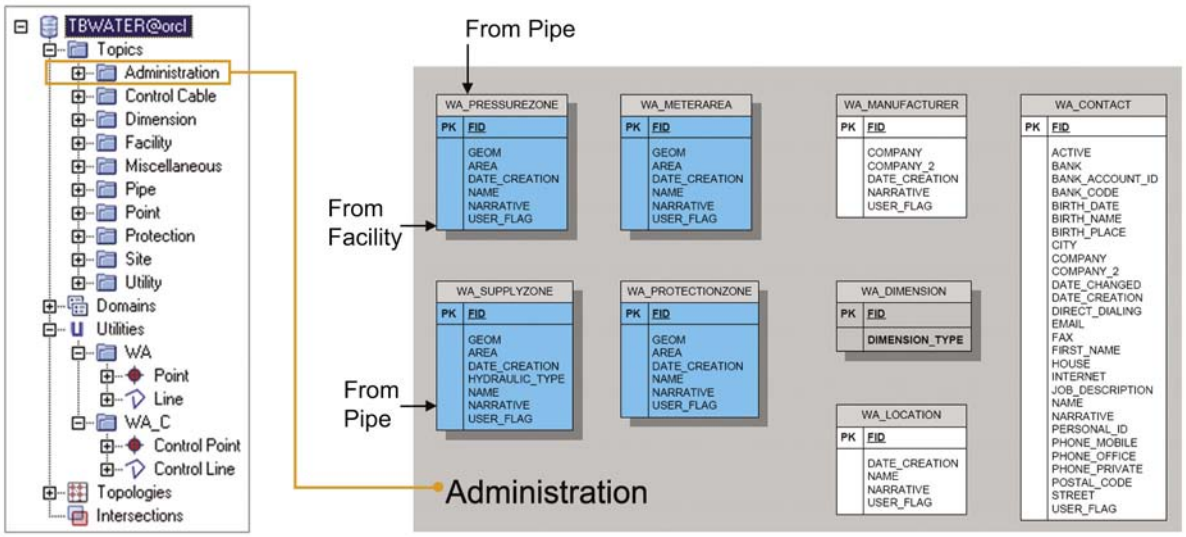


Figure 7: Topobase Water Administration topic

Control Cable

The Control Cable topic contains information about wires, cables, and electronic system controls that are deployed throughout the water network. The Control Cable topic is where information such as sensory control and data acquisition (SCADA) on the cable point, control cabinet, and cable is stored. It includes the following feature classes:

- Control cable—a cable used to transmit electricity or information to system controls.
- Control cable point—a cable point that represents an electrical node.
- Control cable cabinet—a cabinet for the cable where electrical nodes are located.

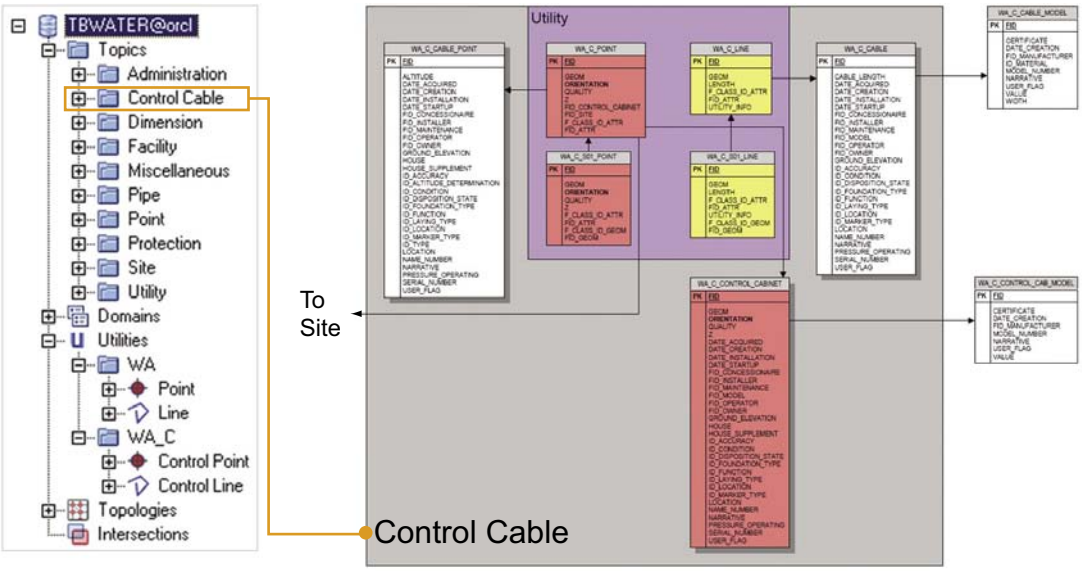


Figure 8: Topobase Water Control Cable topic

Dimension

The Dimension topic enables users constructing and editing the water network to store transient data on asset dimensions. Use it to create user-defined markups and label measurements, such as the option to measure and label the distance between two pipes.

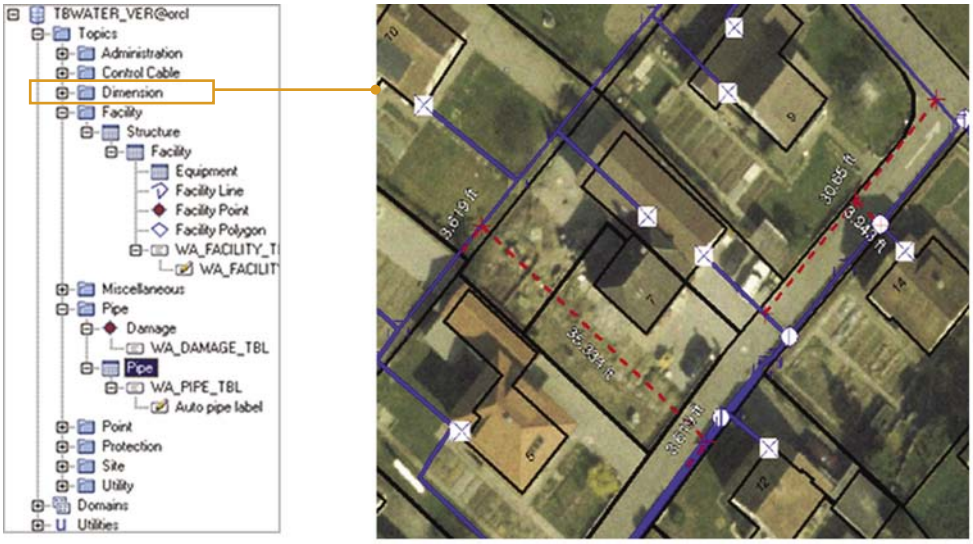


Figure 9: Topobase Water Administrator view of Dimension topic

Facility

The Facility topic is where data on facilities and equipment, such as point, polygon, and line objects, is captured and stored and includes:

- Structure—represents factories or facilities.
- Facility—contains large construction used for water, such as a treatment station or conveyor.
- Equipment—equipment used in a facility.
- Facility line—line object to represent facility objects.
- Facility point—point object to represent facility objects.
- Facility polygon—polygon objects to represent facility objects.

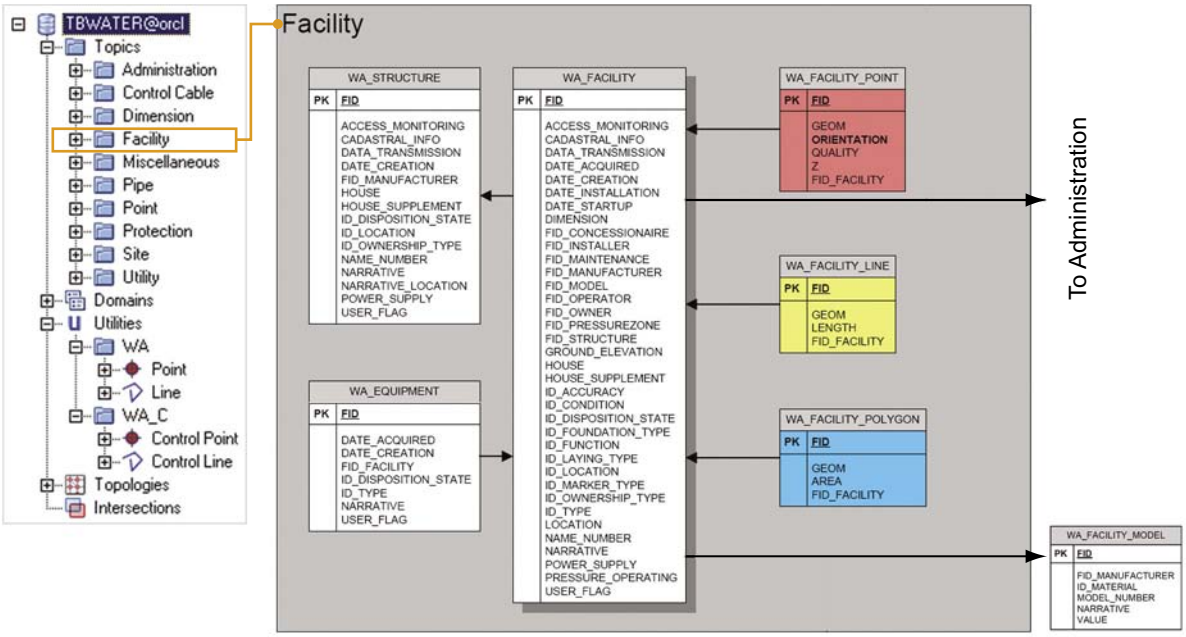


Figure 10: Topobase Water Facility topic

To further illustrate the Facility topic, a water company can establish a structure to represent a building with rooms containing equipment such as computers, desks, and chairs. The facility has geometry, structure, and equipment, as shown in Figure 10. The facility feature class might be used to maintain equipment that is within a building (such as a pump house) within rooms, as shown in Figure 11, where the yellow line and orange dot might represent schematics or actual equipment.

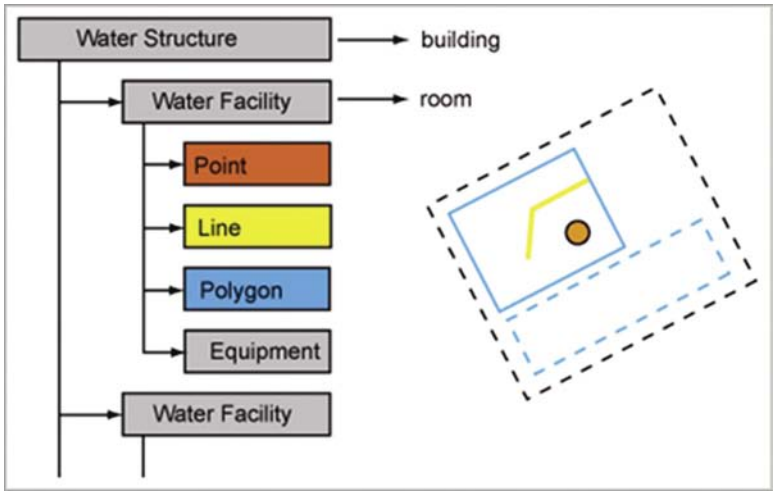


Figure 11: Topobase Water Facility diagram illustration

Miscellaneous

The Miscellaneous topic stores information about maintenance work and physical water line markers. It contains two feature classes:

- Maintenance—captures data on general maintenance activities.
- Marker—contains data on signs or concrete monuments installed either directly above or immediately adjacent to underground lines, bends, or fittings to indicate the presence of water.

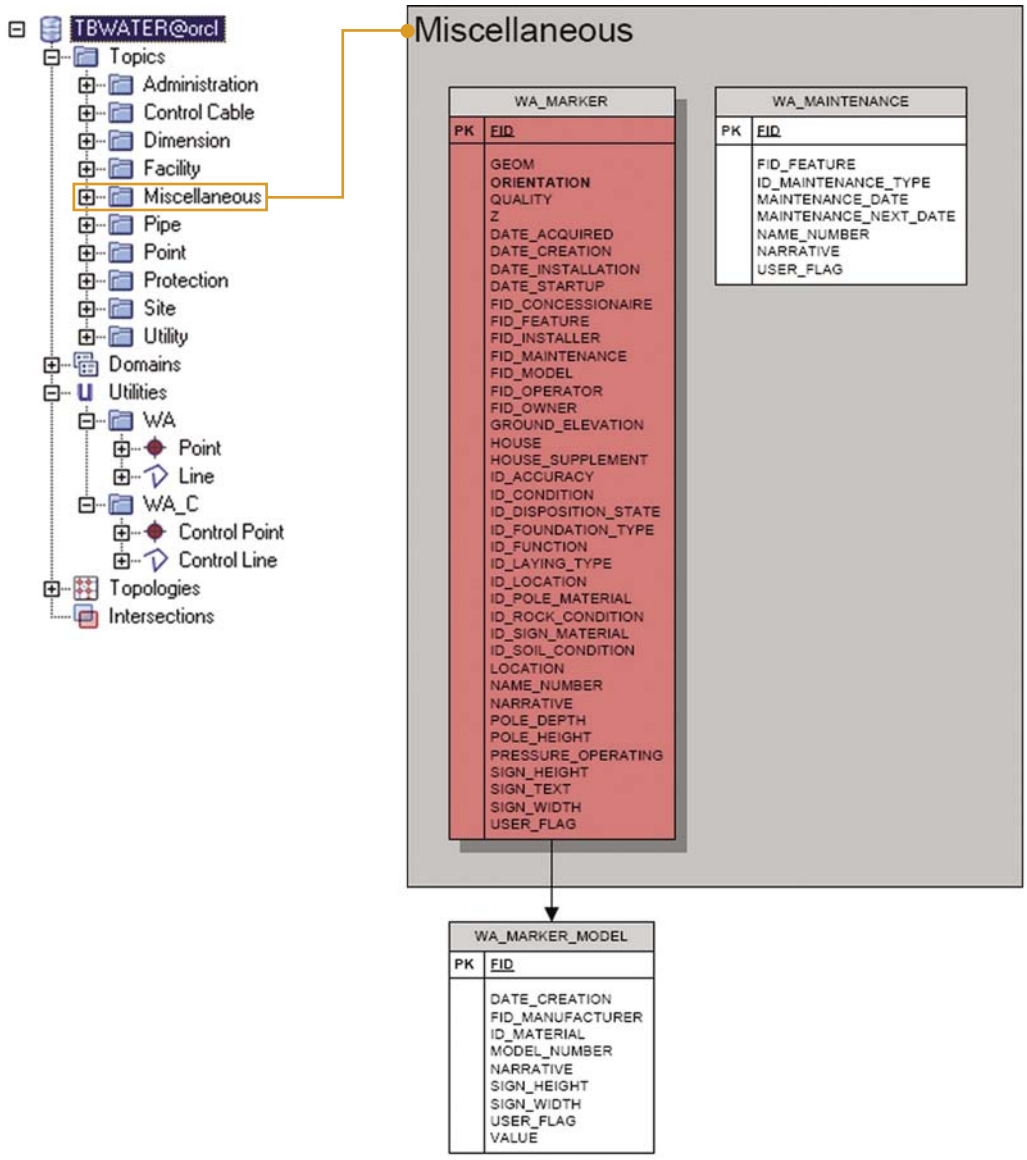


Figure 12: Topobase Water Miscellaneous topic

Pipe Features

The Pipe Features topic contains information about the pipe assets in a water distribution system. The Pipe Features topic contains the following elements:

- Pipe—any conduit that carries water, including main lines, laterals, pressurized mains, and gravity mains.
- Damage—any location where damage has occurred throughout the network.

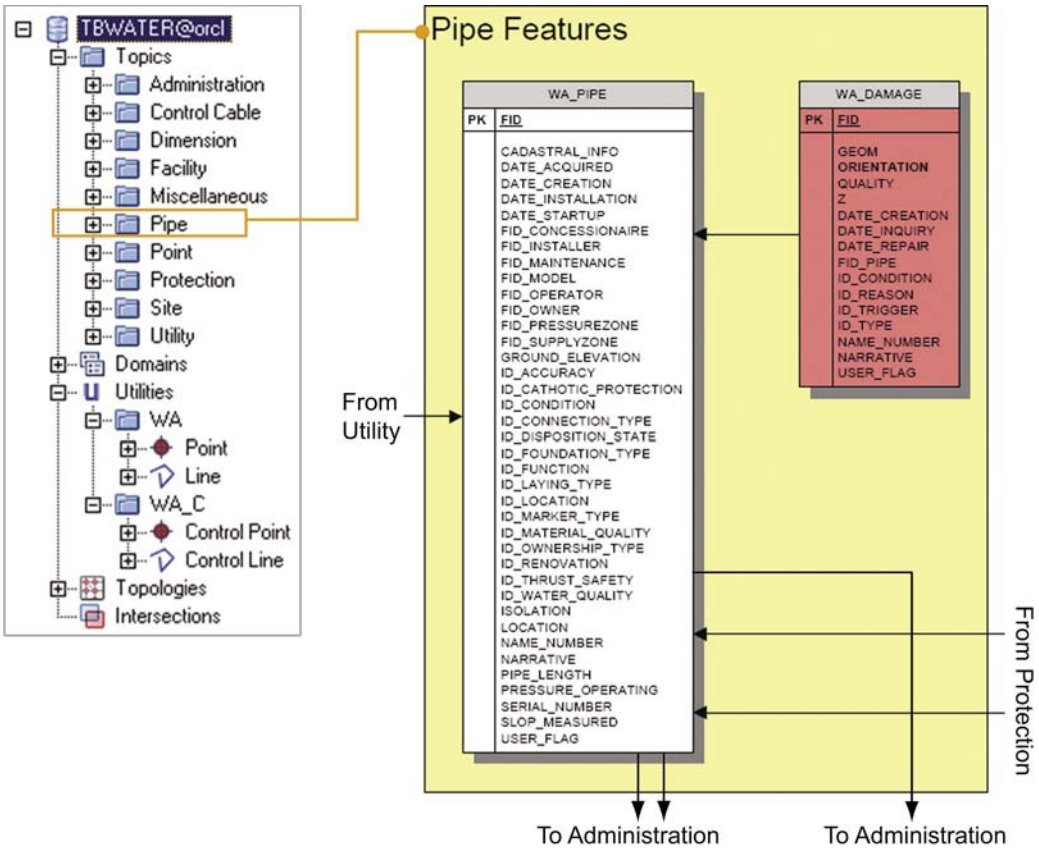


Figure 13: Topobase Water Pipe Features topic

Point Features

The Point Features topic contains information about the point assets in the water distribution network. All the features that can be represented geometrically and symbolized as point features have been grouped under the Point Features topic. These point features contain associated attribute information that is used in conjunction with point geometries for analysis and stored in separate attribute feature classes, one for each point type, as follows:

- Armature—part of an assembly that can open or close a route through which water can flow when an electrical current is applied or removed.
- Emitter—a device in a drip irrigation system that dispenses water above, on, or below the surface of the soil at a very low rate.
- Fitting—an item used to connect, cap, plug, or otherwise alter a water pipe.
- House connector—the last point of a water network usually on or inside a building that represents the connection between the network and the customer.
- Hydrant—an apparatus with a spout or nozzle that dispenses water, usually used by firefighters.
- Meter—a device installed in a line for measuring the quantity or rate of water flowing to a facility or through a section of pipe.
- Pig launch—point to insert a pigging device to clean out the pipe.
- Pressure reduction—an item that decreases downstream pressure.
- Pump—a mechanical device that moves water through a distribution system, usually from a lower pressure to higher pressure.
- Reservoir—a body of water which supplies water to a water distribution system, such as a lake or pond.

- Sample—a point location where one or more water samples are collected from a water utility or system.
- Source—the location where water supplied to the water network originates, such as a reservoir.
- Tank—an above- or below-ground grade receptacle or chamber used for holding water on a temporary basis prior to transfer or use.
- Valve—a fitting or device used for shutting or throttling flow through a water line.
- Vent—a valve installed in a line to either release air trapped in the line or to allow air into a line to relieve a vacuum condition.

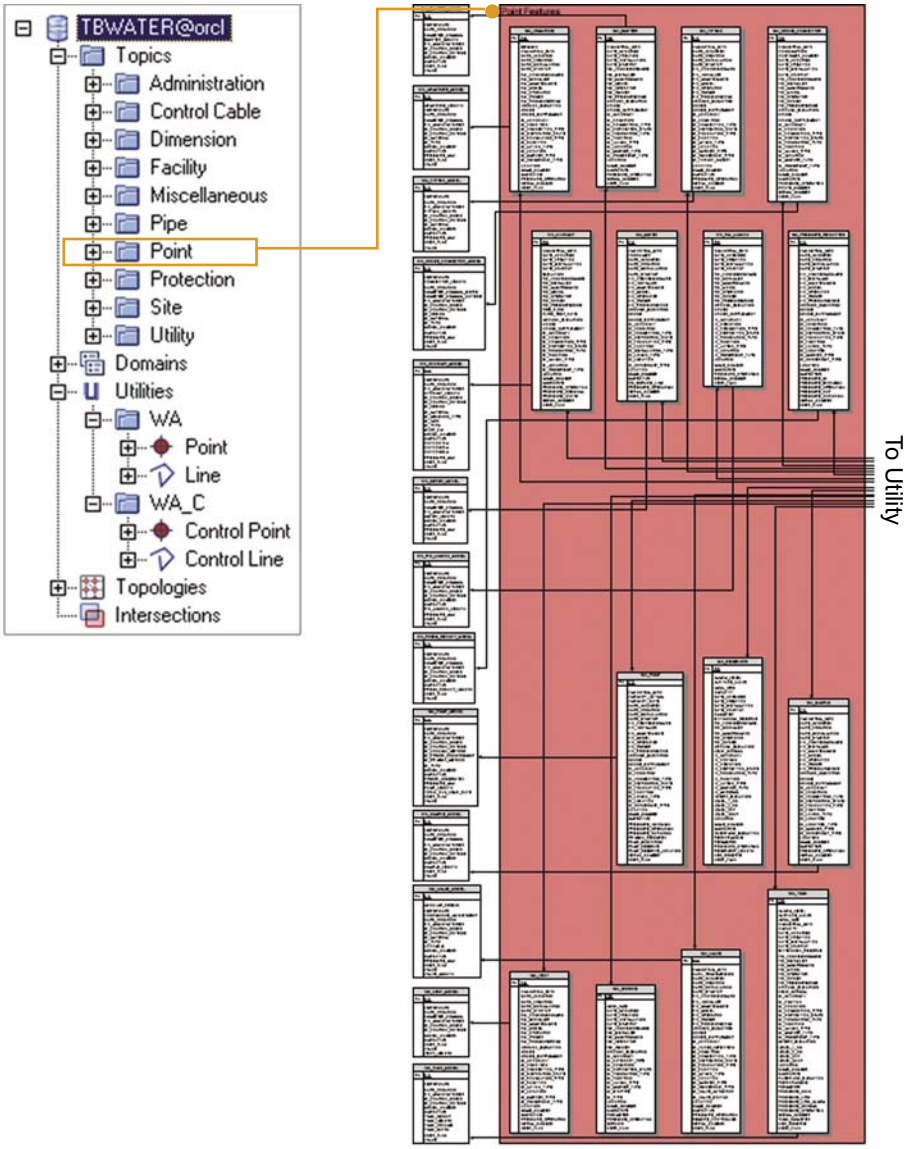


Figure 14: Topobase Water Point Features topic
(see the entire Topobase Water Data Model in Appendix A)

Protection

The Protection topic contains information about applications used to extend the life of the water pipeline. Two types of protection are provided: anode protection and pipe casing.

- Anode—a method for protecting a pipeline that involves installing sacrificial nodes (usually magnesium or zinc) underground and connecting them to the pipe with insulated copper wire to minimize the effect of external corrosion on existing ductile and cast iron pipelines.
- Casing—a method of protecting a pipeline segment by surrounding it with a larger diameter pipe.

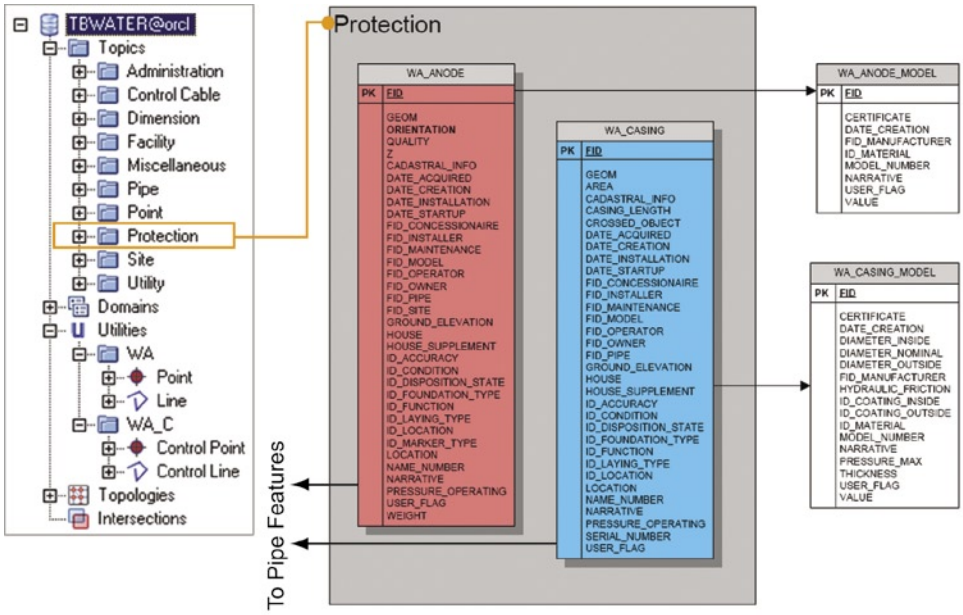


Figure 15: Topobase Water Protection topic

Site

The Site topic contains point, line, and polygon geometry that can be used to relate water features together. For example, a site like a pump station can be used to group several point features (e.g., pumps and valves) into one object that can be more easily distinguished in a map window. Representing the location or site of a group of water network assets such as valves or fittings, the Site topic contains:

- Site—site used to enclose assemblies and make them reachable.
- Site line—line objects for site.
- Site point—point objects for site.
- Site polygon—polygon objects for site.

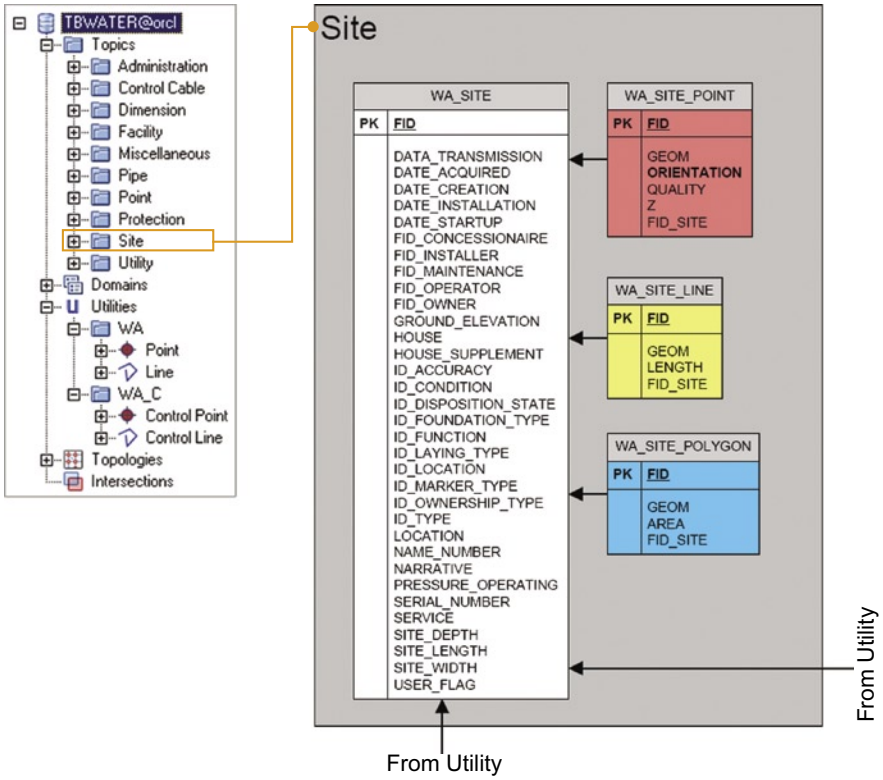


Figure 16: Topobase Water Site topic

Utility

The Utility topic houses basic network topology components related to the point and pipe feature classes and allows Topobase users to generate on-the-fly analysis such as network traces using complex stop conditions. Topobase uses system-generated tables to maintain a utility network model which references the point and linear features to make up a network topology. The Utility topic includes:

- Point—to geometrically represent point features that constitute the utility model.
- Line—to geometrically represent linear features that constitute the utility model.

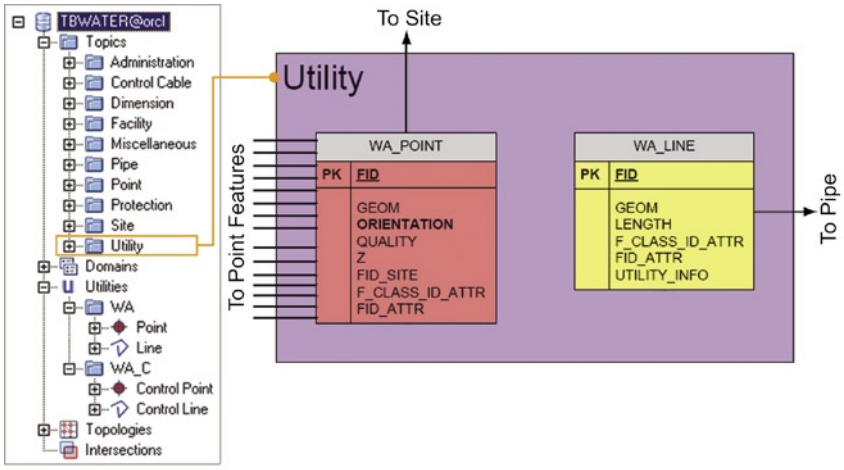


Figure 17: Topobase Water Utility topic

Display Style Templates

With Topobase Water preconfigured layer styles, many different users or groups of users—such as executives, customer service agents, or field crews—can access and view the facility data specific to their requirements in a customized view designed to meet their unique work functions. These style templates allow users to view relevant information using the scale, symbols, and formatting most relevant to their job, allowing them to complete job-related tasks efficiently. For example, water network designers will be interested in knowing where the existing pipes are below the street, but maintenance and operation personnel might be more interested in seeing the same data represented according to physical state, throughput, and damage sites.

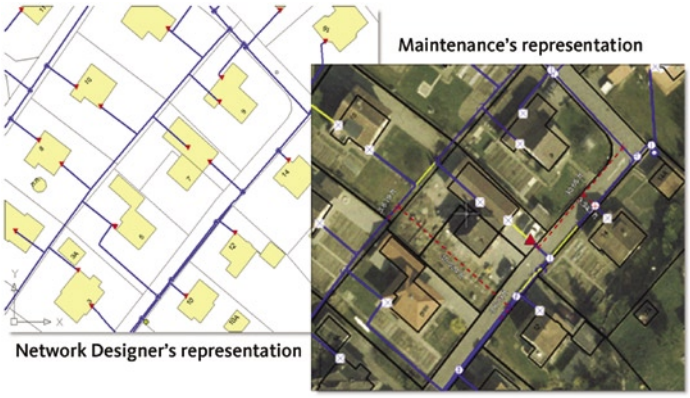


Figure 18: Display style templates showing different graphic representation depending on the job function

Conclusion: Autodesk Topobase Water Delivers Results

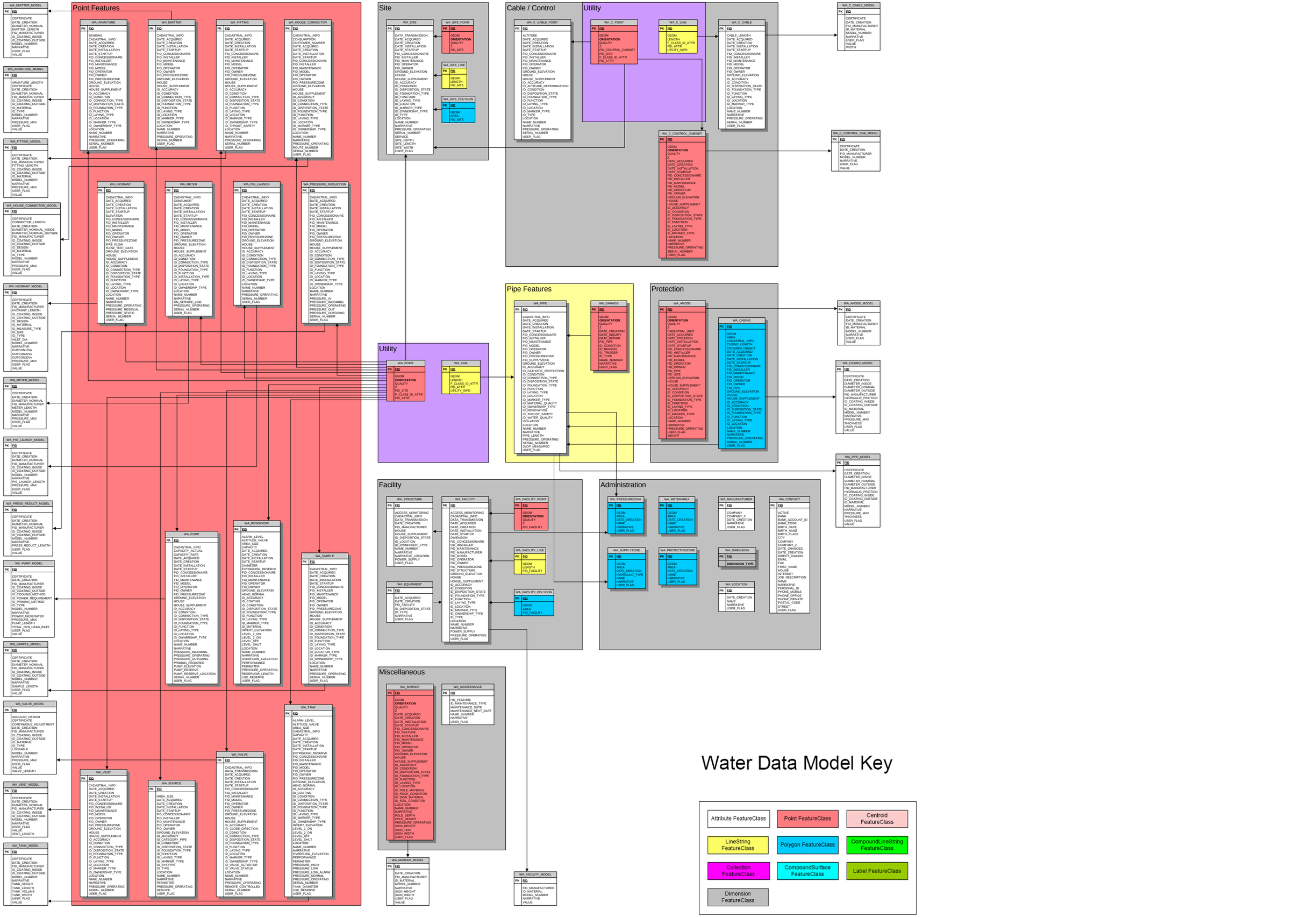
Infrastructure design and management impacts the success and accuracy of water distribution networks and utilities. For too long, water utilities have conducted processes using disparate applications that generate data in proprietary formats and store data in independent, siloed databases. This lack of integrated asset management has resulted in duplicated work, increased risk of errors, limited visibility into assets as a whole, and a myriad of time-consuming workarounds, such as data conversions. Autodesk Topobase Water provides the architecture, water-specific components, and technology features that enable water utilities to overcome these challenges.

By providing centralized access to spatial data and enhanced processes, Autodesk Topobase Water improves the way vital tasks get done throughout water organizations. Employees in every department save time, boost productivity, and are empowered to work more independently. Predefined data models, workflows, and business rules speed processes within the organization and help ensure that water-related data is easily—and accurately—shared among departments.

With Topobase Water, organizations:

- Gain a big-picture view of water distribution network and related assets.
- Streamline common processes and tasks using automated workflows.
- Improve data quality and accuracy using embedded business rules.
- Minimize data conversions.
- Share asset data more seamlessly.
- Implement quickly and cost effectively.

Find out more about the benefits of Autodesk Topobase Water by visiting www.autodesk.com/topobase today.



Water Data Model Key

Attribute FeatureClass
Point FeatureClass
Centroid FeatureClass
LineString FeatureClass
Polygon FeatureClass
CompoundLineString FeatureClass
Collection FeatureClass
CompoundSurface FeatureClass
Label FeatureClass
Dimension FeatureClass