Meeting the Civil Engineering Challenges of a 3000+ Home Residential Development

Autodesk AutoCAD Civil 3D helps Comuna design earthworks, water supply, storm water and sewer networks in 1/2 the time

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>
> **—Diego Rojas**
>   Project Manager
>   Comuna Ingenieria, S.A. De C.V.

Image courtesy of Comuna Ingenieria, S.A. De C.V.

Project summary

Comuna Ingenieria, S.A. De C.V., Guadalajara, Jalisco, Mexico, is a civil engineering firm that was commissioned to design the infrastructure of a 3311-unit residential development in Tlaquepaque, Jalisco, Mexico. The development area is unique in that it is bisected by a stream and consists of different types of soil. The northern portion of the development area consisted of mainly clay while the southern half is rockier. After construction began, it was determined that the soil was much rockier than expected based on the initial soil mechanics study. Over the course of the project, levels needed to be changed five times in order to avoid excessive grading expenses. Even a minor change in level impacts the earthworks design as well as storm flow and as a result, a high number of changes were required during the design process. To complete a project with this many changes using the company's previous civil engineering software tools, the project would have taken about three months to complete, resulting in a substantial cost overrun that would have forced Comuna to take a loss on the project.

Prior to the taking on the project, Comuna had switched to Autodesk® AutoCAD® Civil 3D® software. "Civil 3D made it possible to make level changes more quickly," said Diego Rojas, Project Manager for Comuna. "When we changed the level, Civil 3D dynamically updated the profiles and adjusted the grading throughout the model. We used add-on products to help calculate the effects on the drinking water, storm water and sewer networks and perform pressure and flow calculations. We were able to complete the project on time and on budget in only one month despite the many changes that we head to deal with during the project. The construction company was so happy with our work that it hired us to perform civil engineering for a new 4052-unit development."

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Challenge

The original housing development was based on a survey and master plan whose accuracy was later called into question. For example, when construction got underway, the graders reported that hills were much rockier than expected and reducing their height to the level specified in the master plan would have been impractical from a cost standpoint. Comuna engineers were forced to raise the level of the hill, which had many cascading impacts on grading throughout the project. As other similar situations in which the actual working conditions did not match the master plan were encountered in the construction phase, Comuna engineers were required to make many additional changes to the earthwork calculations.

The water network in the project also presented major challenges. The changes in levels increased the complexity of the water network design. In addition, the pumping station was over one mile from the furthest house in the project, which challenged the designers to maintain the pressure over this extended distance. The designers were also hindered by limitations in the master plan that didn't accurately represent pressures and flows throughout the network and proposed a relatively inefficient distribution approach.
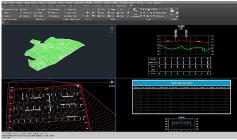
"This was a very difficult project and it would have been much harder using our previous software tools," Rojas said. "I estimate that using manual methods it would have taken 3 months and using our previous civil engineering software it would have taken two months to complete the design."

Solution

"We switched to AutoCAD Civil 3D because of its ability to provide an end-to-end digital lifecycle solution for our projects and its ability to deliver the functionality that supports productivity that we need to help handle our increasing project load and continuing cost constraints," Rojas said. Civil 3D provides a wide range of features that automate many aspects of the civil engineering process that are generally performed manually such as corridor design, pipe pressure networks, gravity pipe networks, grading, parcel design, base map creation, surface modeling, storm and sanitary analysis, river and flood analysis and many more.

"Civil 3D made it easier to change levels in the project," Rojas said. "When the construction crew found a rocky zone, we created a rocky surface on the Civil 3D profile. This information was then available to the entire design team and made it easier to make the needed changes. When the team changed the source data, the surfaces and references were automatically updated, which helped save time and reduce errors."

Comuna engineers designed the water network in Civil 3D. They used various Civil 3D features to calculate flow paths and catchment areas and used the AutoCAD Civil 3D Hydraflow Hydrographs Extension to help determine runoff from historical and synthetic storms and model drainage basins and model flood control measures. They simulated the network using EPANET, a public domain software package that models the hydraulic and water quality behavior of water distribution piping systems. The simulation provided the pressure and flow throughout the network and was used by Comuna engineers to determine the diameter of pipe needed in different areas of the network.

Results

"The project is finished and the customer is very happy with our work," Rojas concluded. "After the design changes were completed, the construction went very smoothly. Civil 3D helped us get the job done in only one month, considerably less than would have been required with either manual methods or the civil engineering software that we used in the past. Much of these time savings can be attributed to the wide range of time-saving features in Civil 3D and to the fact that changes ripple through the entire database, minimizing the need for a considerable amount of manual effort. The end result is that we can produce high quality work in less time which makes us more valuable to our customers and helps us win new business. For example, the success of this project has led to additional work with the construction company, which is one of the largest in the state of Jalisco."

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