

Digital As-Builts: A Single Source of Truth

Transforming the Way the World Works

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About Trimble

TRANSFORMING THE WAY THE WORLD WORKS

Innovation

Founded in 1978 currently in S&P 500: TRMB

\$3.14B revenue in 2020

40+ years of technology innovation with 2,000 patents and **14% yearly revenue re-invested in R&D**

11,500 employees in 34 countries

Market Leaders

Trimble solutions manage >\$400B in **construction**

>70% of top 100 **geospatial** companies use Trimble

>2M **transportation** assets managed with Trimble Solutions

Overseeing 155M acres of **agriculture**

ESG

Trimble solutions estimated to deliver millions of metric tons of **avoided greenhouse gas emissions** annually

Top **10 of companies for diversity and gender** scores (comparably)

Named **Top 50 ESG Best ESG Company** by Investor's Business Daily
WSJ's Management Top 250



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Agenda

- 01** The Advantage of Digital As-Builts
- 02** How Trimble Supports Digital As-Builts
- 03** Empowering Adoption

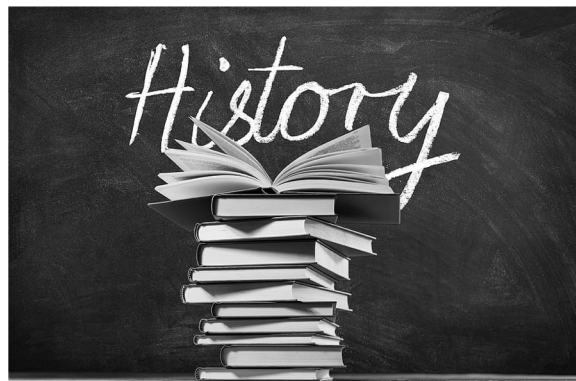


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Current Events

2022 is Historic for Transportation

- Historic Funding Levels
- Historic Construction Costs
- Historic Innovation



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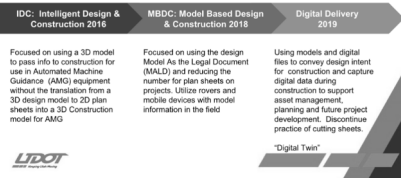
The Advantage of Digital As-Builts



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Digital Delivery-BIM Roadmaps

Evolution of BIM in Utah



Proposed : 3D Design Models as Contract Authority

Moving ahead with 3D Design Models in Contract

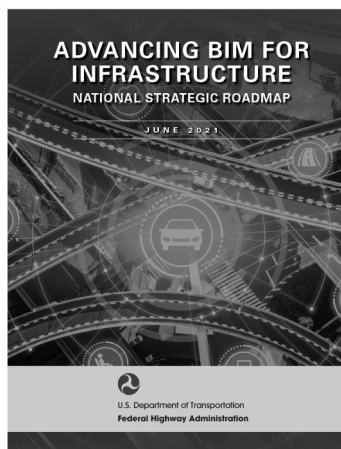
- Set a baseline for models as project deliverables, then test and increase use or purpose as contractor partners agree
- Contractors have practical experience with what is a good field model

Potential

- 2-3 years: 3D Models within contract as reliable data, Sheets govern.
- 3-7 years: 3D Models replacing sheets and become contract authority

Reviewing or Keeping Aware of

- ISO Standards
- AASHTO & IFC Standards



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Building a Smart Digital Delivery Ecosystem

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CENTRALIZE DATA BETWEEN STAKEHOLDERS, ACROSS PHASES

COMMON DATA ENVIRONMENT

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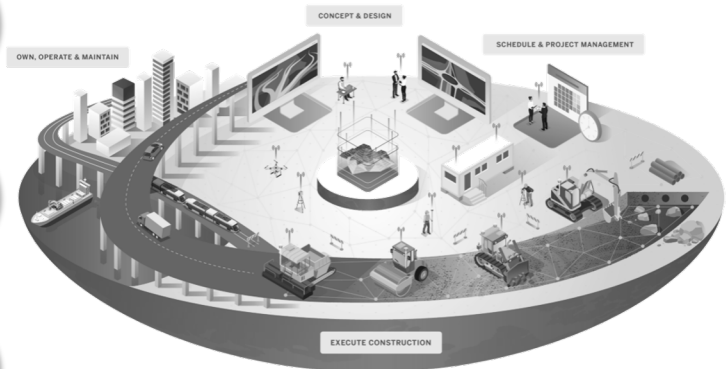
BRIDGE THE GAP BETWEEN DESIGN AND CONSTRUCTION

CONNECTING THE OFFICE AND THE FIELD

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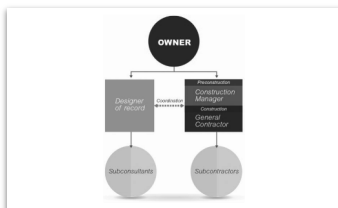
CAPTURE DIGITAL ASSETS FOR FUTURE USE

DIGITAL TWINS AND DIGITAL DELIVERABLES



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Embracing New Opportunities



New contract methods, incentives and funding

- Design Build
- Design Build (Progressive)
- CM at Risk & CMGC
- Public Private Partnerships
- Integrated Project Delivery



Technology coming to the construction industry

- AI & Machine Learning
- Cloud Connected Devices (IoT)
- Business Intelligence Tools
- Augmented, Virtual & Mixed Reality



Evolving technology labor market

- Competitive market
- Lack of skilled labor
- New roles for integrators and data scientists

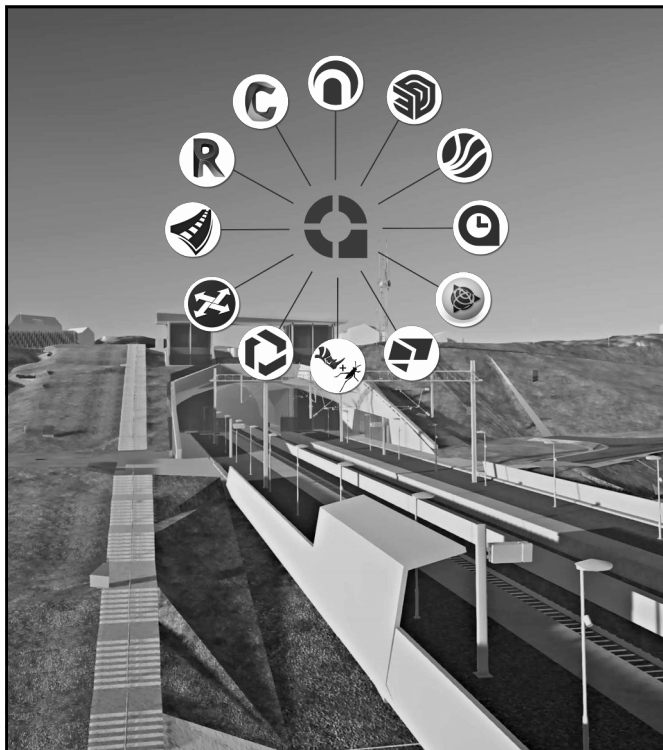


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How Trimble Supports Digital As-BUILTs



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Common Data Environment



CENTRALIZED DATA SET BETWEEN
STAKEHOLDERS, ACROSS PHASES

Centralize

Create models used for intelligent construction technology
Feed information to business intelligence tools for reporting including Project Management, Financial and ERP Systems.

Streamline

Better communication between the hand-off from design and construction where most breakdowns occur
Build automated tasks for faster communication



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Transforming the way the industry works by unlocking the unrealized potential of digital construction

Enable Real-time Collaboration

Enable a dynamic workflow

Multi-User Common Data Environment

Multi-user, multi-disciplined central model enables collaboration throughout the entire construction lifecycle

Object Based 3D Model

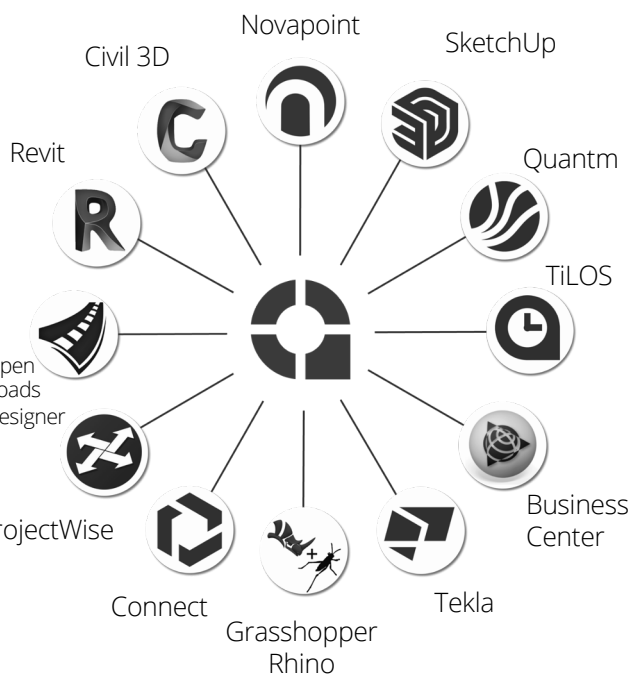
Facilitates near real-time updating of the 3D model without having to wait for full design updates.

Software Agnostic Platform

Allow all stakeholders (i.e. owners, designers, contractors, consultants) to maximize the value of their existing hardware and software technologies and expertise



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Software Agnostic Approach to Data Flow

Enable a dynamic workflow

ISO conforming non-proprietary format

The software agnostic approach removes barriers of proprietary formats

Confidence in *your* data

Connectors ensure no loss of data fidelity, for importing or exporting of critical data in near real-time. Objects in CDE database are linked dynamically through tasks

Retain existing knowledge & experience

By allowing users to continue to use their software of choice and retain their experience & knowledge



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Optimize your Digital As-Built workflow

Quadri facilitates core integrations to make your construction workflows quicker and smarter

Optimize the design process

All team members can share model data across all disciplines, where changes are shared continuously in a transparent and agile process

Deliver construction-ready design

Minimize idle time, downtime and theft, and extend the life of your equipment

Collaborate throughout the project

Track design changes through real-time collaboration in one central model

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Trimble Business Center Survey & Contractors Data Application

Improving surveyors and contractor workflows to bring data to the field systems and capture data as built

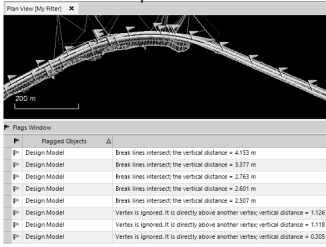


Import Data

Use the Quadri Connector to import design data from Quadri

Alternatively import design data from other authoring tools

Convert PDF or 2D CAD data into a clean 3D model

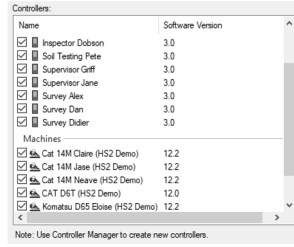


Data Validation

Ensure that design intent is constructible and free from error in the office rather than in the field

Utilize simple tools to determine errors in a model

Maintain consistency with templates



Field Device Management

Send 3D models to defined crews for set-out by survey or construction by machine systems

Ensure the right data goes to the right person all day every day

Exports to WorksManager

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WorksManager

Tools that facilitate creation of the *intelligent* digital as-built

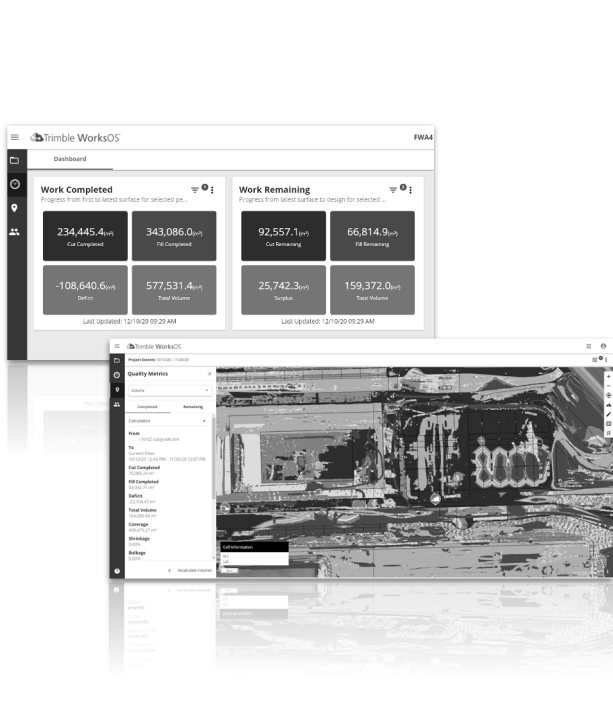
Confirm asset location

Ensure awareness of survey teams or machines that can execute tasks

Maintain construction integrity

Ensure the correct models are being used in the field

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WorksOS

Jobsite productivity delivering field to office connectivity

Cloud-based Software as a Service (SaaS) solution that provides real-time productivity and jobsite monitoring to site supervisors, jobsite coordinators and project managers.

Comparative Analysis

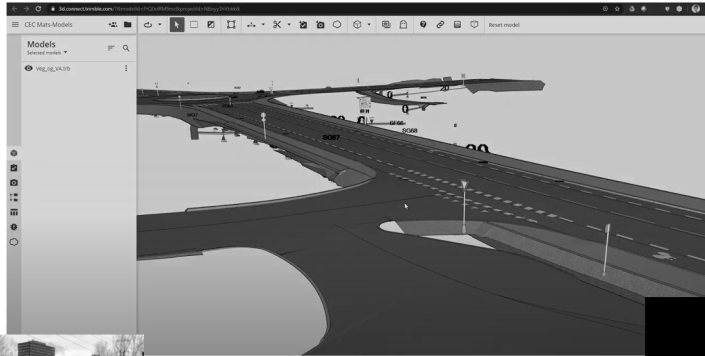
Run Quantity Calculations and Compare to Project Surfaces (Survey/Design)

Monitor meeting your standards

Meet and prove your Pass Count and Compaction Standards

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Integration of 3D Datasets for the As-Built

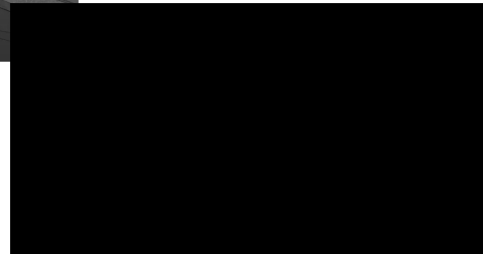


3D Data is now shown within Trimble connect

SiteVision downloads model from Connect for in-field visualization



Allows for visualization and inspection of complex 3D Datasets in the field



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Quadri Drives Construction

Quadri 3D BIM Model

Review field datasets and make data driven decisions with **Trimble Business Center**

Capture progress updates and intelligence from the field via **WorksOS and WorksManager**

Bring the *Design Model* into Quadri and send seamlessly into **Trimble Business Center** to create the *Constructible Model*

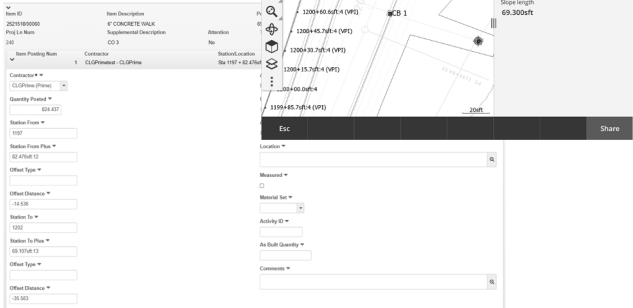
Share the model to the field using **Trimble WorksManager** and ensure equipment and machines are using the correct designs

Bring the model to the machine with API feeds into **Siteworks, EarthWorks and Roadworks**



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Infotech Partnering

Partnering with industry to develop superior solutions to aid customers

The Mobile Inspector Measure Service allows Trimble users to share precise measurements between Trimble's Access and Infotech's Mobile Inspector Application

Field Data Capture

Eliminates manual or duplicate data entry
Speeds up the field process resulting in efficiency
Smooth handling of disputes & estimate processing

Everything vital to daily work is Connected

The Trimble/Infotech solution allows information to be captured in the field by inspectors to seamlessly sync back to preferred construction management system

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Empowering Adoption

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Digital Project Delivery with Trimble

Risk reduction, improved profits and shared savings

In August 2020, this Norway PPP project opened national road 3/25 Løten-Elverum after 26 months of construction.

Total project cost was \$657M, including operation and maintenance (incl. VAT), and was **cheaper and faster** than originally planned.

Source: <http://www.bygg.no/article/1440407>



The road opened three months ahead of schedule, including **\$167M USD in shared savings** and in just over two years of construction.

"It is a record," said Kjell Inge Davik, development director, Norwegian Public Roads Administration.



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Digital Delivery & As-Built Experience



- 1 Bridges Designed in Tekla
- 2 Road Corridors Designed with Civil 3D
- 3 Point Cloud data incorporated from Stratus
- 4 Ortho Imagery overlaid on final surfaces
- 5 Metadata added to structures as part of the as-built



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Digital Delivery & As-Built Experience

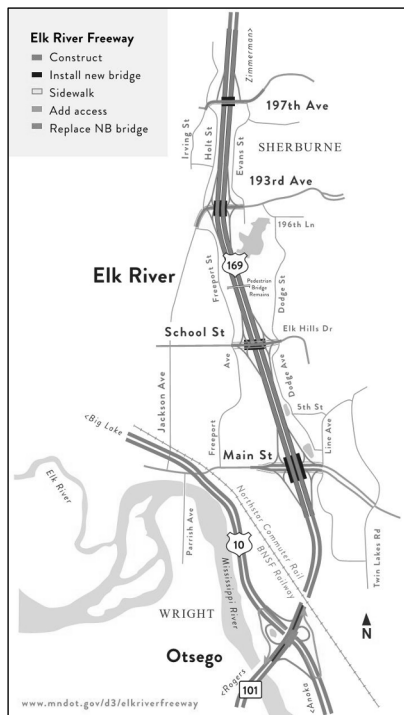
New Mexico Department of Transportation (NMDOT) implemented a pilot project built as part of the Federal Highway Administration's (FHWA) Every Day Counts (EDC) e-construction initiative.

Trimble is assisting NMDOT with the state's first e-construction project leveraging core technologies such as Quadri helping facilitate a collaborative environment with the end goal being a digital as-built for the project.

Trimble partnered with NMDOT and FNF Construction for a digital design review of the I-40 project dataset with a focus on suitability for construction model purposes against the typical needs of a contractor for earthmoving, grading, and paving purposes.



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Project Overview for the TH 169 Elk River Redefine

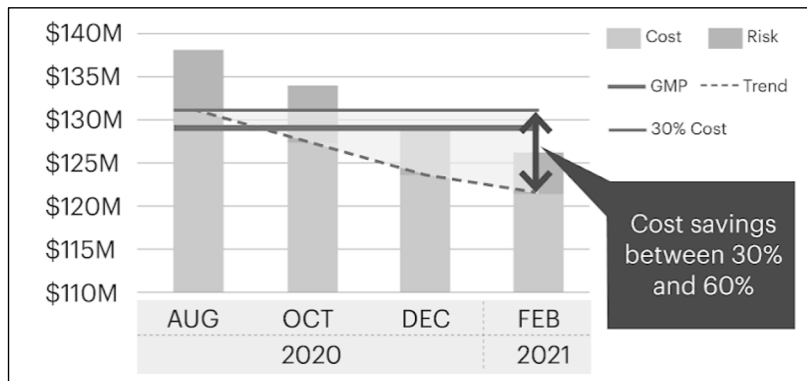
- \$130 Million Construction Cost
- 3 miles of reconstruction
- Five Proposed Interchanges
- Construction Manager/General Contractor (CMGC) Delivery Method
- Continuous iterative design instead of traditional design/review cycles



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TH 169 Elk River Redefine

Current Cost Status



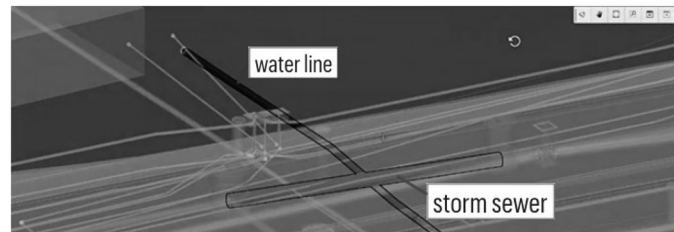
- Final Design Firm with Digital Delivery started at 30% OPCC
- Documented savings of over \$10 Million
- MnDOT set a Guaranteed Maximum Price (GMP) of \$129 Million



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TH 169 Redefine Elk River

Schedule Benefits - Utilities



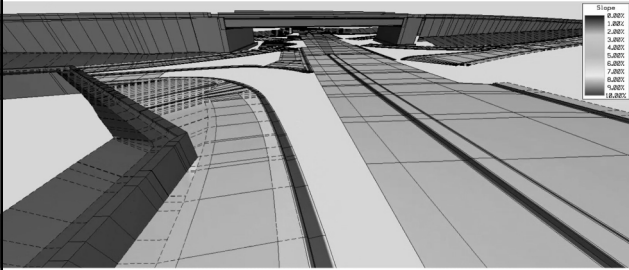
- Over 310,000 linear feet (58.7 miles) of Underground Utilities had to be relocated
- Notice and Orders are normally delivered at 90% plans which would be June 2021 for this project
- Utilizing Digital Delivery Clash Detection, Notice and Orders were submitted at 30% which was September 2020
- As of May 2021, most utility relocation plans have been submitted to MnDOT allowing relocation to occur this summer
- The Contractor to start earlier in 2022, eliminating any winter work during the 2022 season and saving MnDOT money



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TH 169 Redefine Elk River

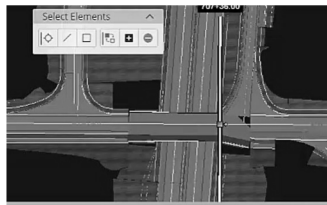
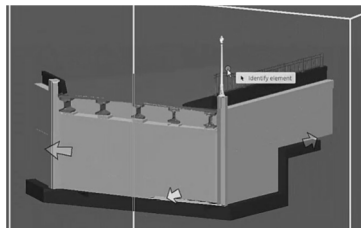
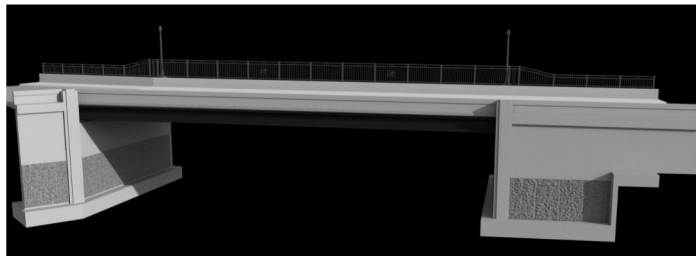
Schedule Benefits - Continued



- Construction Limits were set in August 2020 for R/W acquisition purposes
- ADA compliance was confirmed at 30% using ADA Heat Maps to for slopes of sidewalks and trails
- R/W acquisition process was enhanced by 3D models to visualize final configuration for the property owners
- MnDOT Maintenance accessed these designs for concurrence on maintenance access for modified noise wall designs



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TH 169 Redefine Elk River

Benefits to MnDOT

- Design Team created MnDOT Standards and the workspaces in 3D for roadway, bridge, traffic and water resources
- Designed the standards with the attributes for asset management and machine control being incorporated into the design
- Designed over 40 versions instead of the standard three versions (30,60, and 90%)
- Imported the P6 schedule from the CMGC Contractor to create a 4D Model
- Imported cost to create a 5D Model



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Elk River Asset Management Approach

MN DOT and WSB Elk River Strategic Plan and Asset Matrix

Plan Includes:

- Asset Matrix for Tier Prioritization (Costs, Spend %, # of Assets, **UNIQUE RANKING ITEM** - number of data consumers for that asset)
- Baseline Inventory of Assets
 - Starting with 74 Identified Elk River Assets Ranked by Tier
 - Costs for Repeatable Lidar Data Capture
- Inspection Plan (Cyclical Maintenance, Reactive, Frequency of Data Capture, etc)
- Implementation Tasks (Steps to Create a Repeatable Process for Project Assets and Inspections)
- Pilot Project: Capturing Work Order Data for Assets with Ames the Contractor Using Trimble SiteWorks and Trimble Business Center



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Elk River Asset Management Approach

- MN DOT and WSB Asset Management Plan on Elk Assists Vendors Like Trimble In Identifying Data Being Captured Today by Contractors and Their Technology
- This Creates Asset Data Integration Opportunities with the DOT and AASHTO

1	Composite Asset key (Desc., Contact)			Tier and AM Maint. Approach				TAMP (b)		
As set ID	Asset Group	Asset Class	Tier	Desired Asset Mgmt Approach	AM Maturity Step Gap	TAMP 19	Asset Value (High >\$1B, Med \$1B-\$0.5B, Low <\$500M)	No. of Assets (High > 3000, Med, <500 Low)	TAMP App	
2										
3	All	All	All	All	All	All				
4	10	Bike and Ped	Accessible On-street ADA Parking	2	Condition	4	No	LOW	LOW	
5	12	Bike and Ped	Bike Lane (not sep) and shared roadways	2	Condition	4	No	MED	HIGH	Rem
6	11	Bike and Ped	Pedestrian curb ramps, signals, and sidewalks	2	Condition	4	Yes	MED	HIGH	
7	46	Bike and Ped	Shared use paths, side paths, sep bike lanes	3	Cycle	2	No	MED	HIGH	
8	1	Bridges	Vehicle Bridges >10' and Tunnels	1	Condition+	0	Yes	HIGH	HIGH	MED
9	9	Bridges	Bridge Pedestrian/Bicycle/Utility	2	Condition	0	No	MED	LOW	Federa
10	75	Bridges	Bridge Clearance	5	None	0	<null>	<null>	<null>	
11	4	Facilities	Class 1 Rest Areas, Class 1 Truck Stations, Office	1	Condition+	0	Yes	LOW	LOW	



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Trimble's digital delivery workflow contributes to sustainability throughout the project lifecycle from design through O&M.

Elk River Project Sustainable Contributions

- The **3D design hub** provides existing, design, and process data, **preventing costly surprises** - environmentally and otherwise - and allowing for **evaluation of potential risks and events** through each phase of construction from the beginning
- **Rework is minimized** through the **collaborative design** environment, containing *all* design information
- **Machine control optimizes run-time and material use**, while ensuring **minimal disturbance of surrounding communities and habitats** and avoiding any **dangerous areas**
- **Digestible plans** and progress information allow for smooth **stakeholder interaction**
- **Communication** between the field and office empowers **safe and efficient** response
- A complete, accurate, and accessible **as-built** model encapsulates detailed information for repair history, preventing unnecessary work and exploration to **evaluate and solve** issues **quickly and accurately**



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Thank You

Questions & Next Steps

For Questions or Feedback please contact:

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감사합니다

GRAZIE VINAKA ERIMA KASIH

THANK YOU TAKK

merci

謝謝 ありがとう

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