CO4981 - Mortenson Construction Concrete Pour Sequence Tool for Revit Developed by CTC

“Eliminating Waste in Concrete Process”

Mortenson Construction and Cad Technology Center

Introductions

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Class summary

At Mortenson Construction we self perform concrete work, as well as other construction activities, which enables our project teams to control a critical component of our construction schedule that we call The Critical Path. Our objective is to improve our virtual design and construction (VDC) integration by increasing the efficiency of our construction system design VDC and integrated work planning (IWP) processes to drive higher value to our concrete planning and execution process. In partnership with Mortenson, CAD Technology Center has developed a plug-in to Revit software that will yield higher efficiency to our issued-for-construction sheet drawings by eliminating waste in our tedious, manual, sheet-generation tasks. The new concrete pour sequence tool will automate the process and reduce the time and effort needed to deliver high-quality drawings to our field crew (which relies on our output to put work in place). We want to spend less time with non-valuable activities and more time integrating with our concrete crews to drive value and revenue to our projects.

Learning Objectives

Process

See how Value Stream Mapping can be used to document, plan and improve your process

People

How Process Improvement saves valuable time of our people so we can focus on value add activities

Platform

Leverage Revit and CTC Fab Sheets to automate tedious drafting steps to drive continuous improvement

Performance

How we measured process improvement and the value added outcomes that resulted from the CTC Plug-in

Agenda

What Problem were we trying to Solve?
PROCESS: CONSTRUCTION SYSTEM DESIGN

Problem Approach and Solution
CTC POUR SEQUENCE TOOL

Measured Outcomes
VALUE ADD

Improving Customer Experience *and the facilities we build through* Measured VDC Outcomes

VDC in our DNA

For nearly 20 years, our team has helped pioneer the use of Building Information Modeling (BIM) and Virtual Design and Construction (VDC) in all phases, from preconstruction through operations and maintenance. As measured by McGraw Hill, the longer a firm has invested in the use of BIM, the greater the impact to its partners and customers. Our innovation-based culture has led us to develop an experience level that is simply unparalleled in the industry.

www.mortenson.com/vdc-journey

BUILDING WHAT'S NEXT.℠

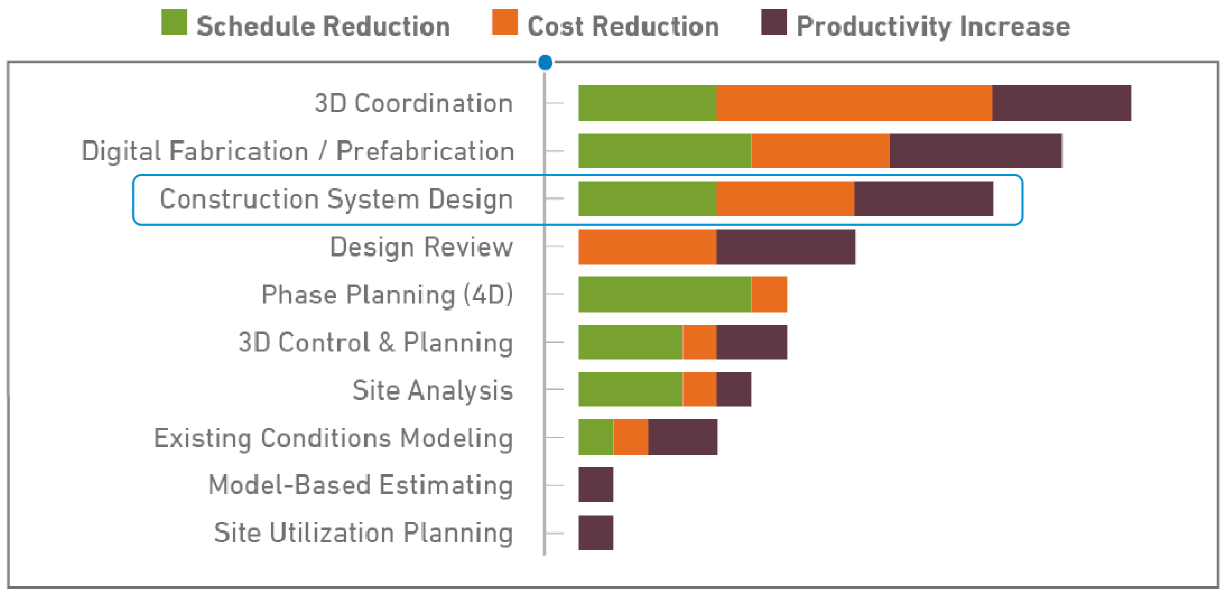
Mortenson®

VIRTUAL DESIGN & CONSTRUCTION

CONSTRUCTION SYSTEM DESIGN SELF PERFORM CONCRETE

IMPROVING **CONSTRUCTION** QUALITY | DELIVERING AN **EXCEPTIONAL** EXPERIENCE

PROCESSES* WITH **SIGNIFICANT OVERALL IMPACT**



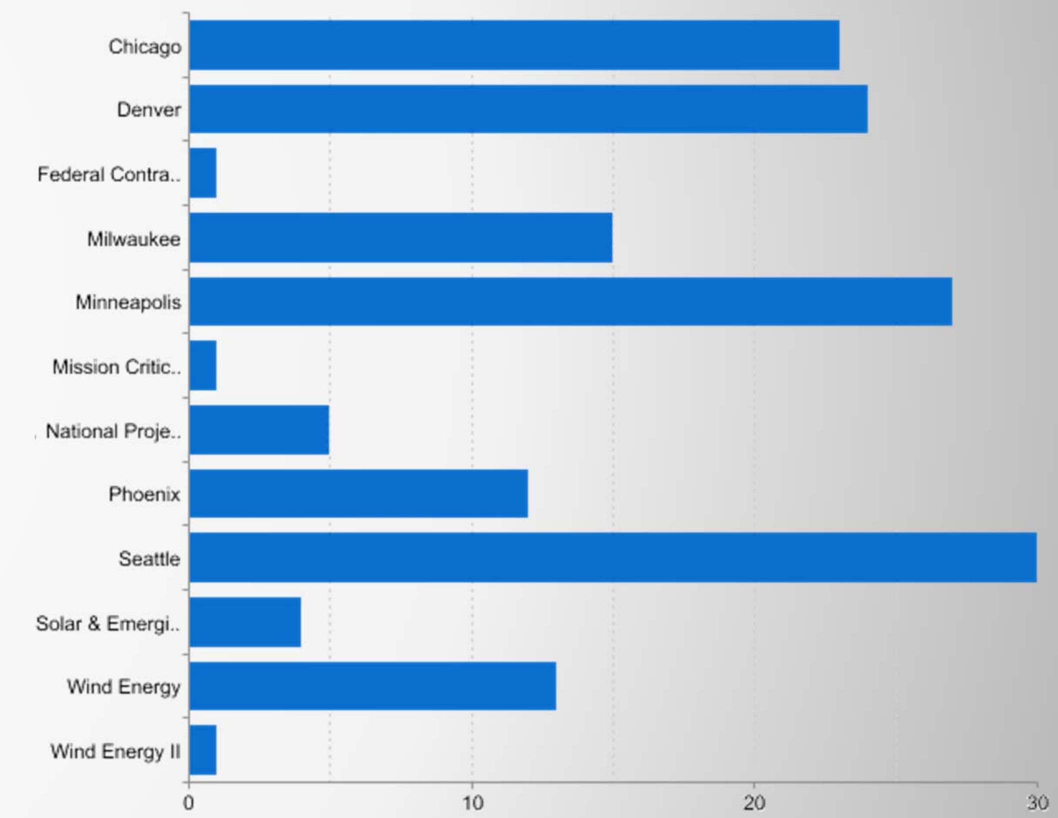
CONSTRUCTION SYSTEM DESIGN @ MORTENSON

160

PROJECTS

$9B

CONSTRUCTION VALUE



BUILDING WHAT'S NEXT. SM

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Chapter 1

What Problem were we trying to Solve?

PROCESS: CONSTRUCTION SYSTEM DESIGN

What Problem were we trying to Solve?

Purpose

Leverage VDC to support Integrated Work Planning to drive first time quality, Improve productivity and eliminate waste from our process.

VDC Output: a single work plan with all of the required information to build it right the first time.

People

- Team members spend too much time on manual non-value added, but necessary activities
- Team implementing multiple VDC process in parallel
- Work / life balance is poor due to inefficiencies

Process

- Labor intensive due to many redundant, time consuming manual steps
- Spend too much time drafting sheets, less time collaborating with team on solutions

Platform

- Revit has become our standard platform for construction system design (concrete/masonry)
- Revit is a robust application and has high learning curve for concrete crew
- Lack of features in Revit Platform to automate key steps in drafting process

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VDC Model Use

CONSTRUCTION SYSTEM DESIGN

Plan	Design	Build	Operate

- Existing Conditions Modeling
- Cost Estimation (5D)
- Phase Planning (Macro 4D)
- Programming
- Site Analysis
- Design Reviews
- 3D Visualization
- Design Authoring
- Engineering Analysis
- Code Validation
- 3D Coordination
- Site Utilization Planning
- **Construction System Design**
- Digital Fabrication
- 3D Control And Planning
- Record Model
- Maintenance Scheduling
- Building Systems Analysis
- Asset Management
- Space Management
- Building Maintenance
- Disaster Planning

Mortenson Primary Model Uses

Secondary Model Uses – Usually Performed By Others

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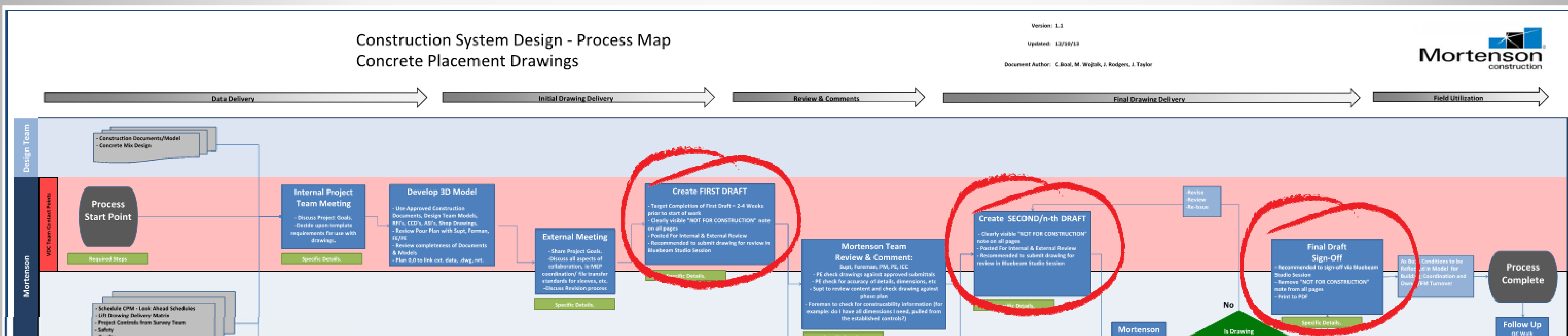
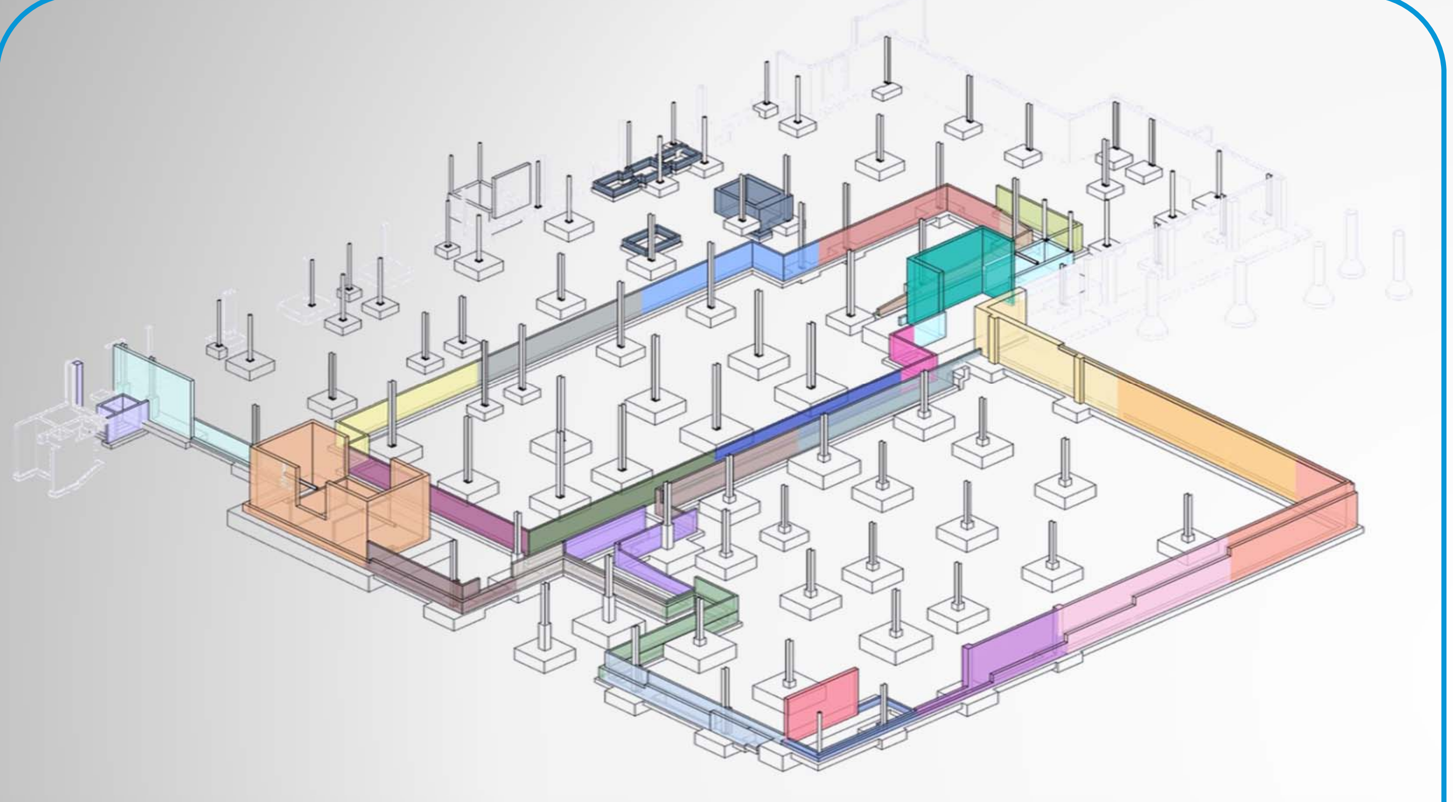
Value Stream Mapping



3 Non Value Added but **Necessary** steps

DRAFTING SEPARATE LIFT DRAWINGS SHEETS

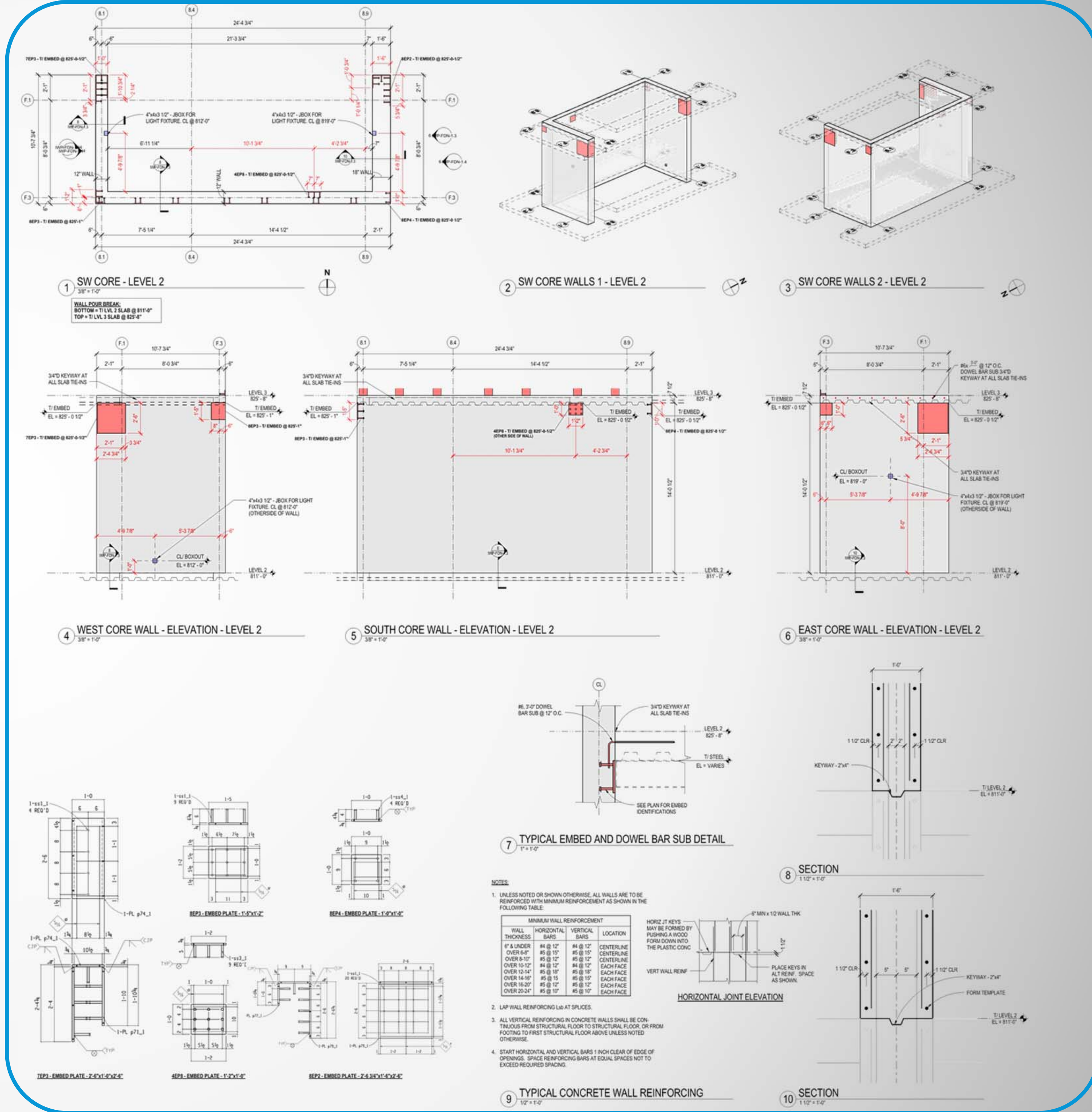
Integrated Work Plan Lift Drawing



- FDN-1 - CORE WALLS - SW CORE WALLS
- FDN-2 - CORE WALLS - SE CORE WALLS
- FDN-3 - CORE WALLS - NE SHEAR WALL
- FDN-4 - EXT. FDN - WEST WALLS - W1
- FDN-5 - EXT. FDN - WEST WALLS - W2
- FDN-6 - EXT. FDN - WEST WALLS - W3
- FDN-7 - EXT. FDN - NORTH WALLS - N1
- FDN-8 - EXT. FDN - NORTH WALLS - N2
- FDN-9 - EXT. FDN - NORTH WALLS - N3
- FDN-10 - EXT. FDN - EAST WALLS - E1
- FDN-11 - EXT. FDN - EAST WALLS - E2
- FDN-12 - EXT. FDN - EAST WALLS - E3
- FDN-13 - EXT. FDN - EAST WALLS - E4
- FDN-14 - EXT. FDN - EAST WALLS - E5
- FDN-15 - EXT. FDN - EAST WALLS - E6
- FDN-16 - INT. FOUNDATION WALLS - 1
- FDN-17 - INT. FOUNDATION WALLS - 2
- FDN-18 - INT. FOUNDATION WALLS - 3
- FDN-19 - INT. FOUNDATION WALLS - 4
- FDN-20 - INT. FOUNDATION WALLS - 5
- FDN-21 - INT. FOUNDATION WALLS - 6
- FDN-22 - INT. FOUNDATION WALLS - 7
- FDN-23 - INT. FOUNDATION WALLS - 8
- FDN-24 - INT. FOUNDATION WALLS - 9
- FDN-25 - INT. FOUNDATION WALLS - 10
- FDN-26 - INT. FOUNDATION WALLS - 11
- FDN-27 - INT. FOUNDATION WALLS - 12
- FDN-28 - INT. FOUNDATION WALLS - 13
- FDN-29 - INT. FOUNDATION WALLS - 14
- FDN-30 - INT. FOUNDATION WALLS - 15

NOTES:

1. CUBIC YARD CALCULATIONS ARE BASED ON DESIGNED DIMENSIONS, ADDITIONAL FACTORS NEED TO BE ACCOUNTED FOR SUCH AS BANK POURING PAD FOOTINGS AN EXTRA GROUT IN THE PUMP PER DAY'S POUR.
2. PAD FOOTING SETS WERE BROKEN UP PER AREA.
3. WALL FOOTING POUR BREAKS ARE APPROXIMATELY 100'-0" IN LINEAR LENGTH
4. WALL POUR BREAKS ARE APPROXIMATELY 60'-0" IN LINEAR LENGTH, WITH EXCEPTION TO THE CORES AND SHEAR WALLS.



Study Metrics

BEFORE CTC PLUG-IN

Existing Process Tact Time

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29 Hours

17 Steps

10 Areas For Improvements

PROCESS IMPROVEMENT TARGETS

50% TIME REDUCTION

ELIMINATE 10 WASTED STEPS

Concrete Coordination Process Steps

	12 Footing Pours, 12 Wall Pours; 2 CPP (24 pours)	Minutes
1	Transfer Project Standards from Project Template	5
2	Create 3D and Plan "Coordination Views"	15
3	Create/Edit/Assign Work-sets	15
4	Create Text Shared Parameter per Pour Sequence	15
5	Split and Assign Pour Sequence Parameter	60
6	Create Color Filters	30
7	Create/Edit Title-blocks	10
8	Create Overall Pour Sequence IWP	120
9	Create View Templates	15
	Subtotal (hours)	**5**

Drafting IWP Process Steps

	Drafting Tasks/Regardless of Scope and Project	Minutes
1	Create Plan View	10
2	Create Elevation View(s)	10
3	Create 3D View(s)	5
4	Create Sheet	5
5	Copy/Paste Relevant Information from Previous Sheets	5
6	Add All Required Views to Sheet	15
7	Add All Required Drafting/Detail Views to Sheet	5
8	Adjust and Renumber View Titles	5
	Tact Time for 1 IWP (hours)	1.00
	Total Tact Time Hours for 24 IWP's (hours)	24
	Concrete Coordination + IWP Drafting = Total Process Hours	**29**
	Number of Process Steps	**17**

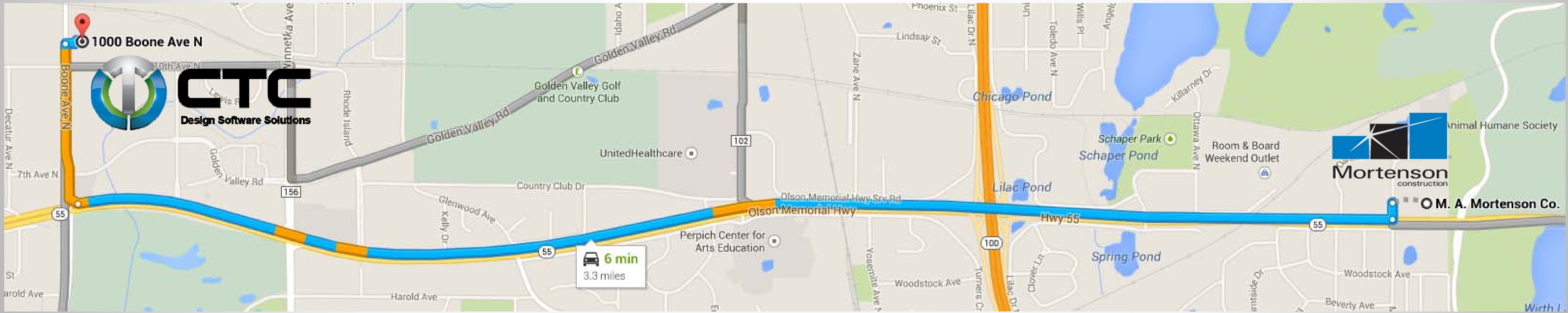
Chapter 2

Problem Approach and Solution

CTC POUR SEQUENCE TOOL

Our Approach to the Problem

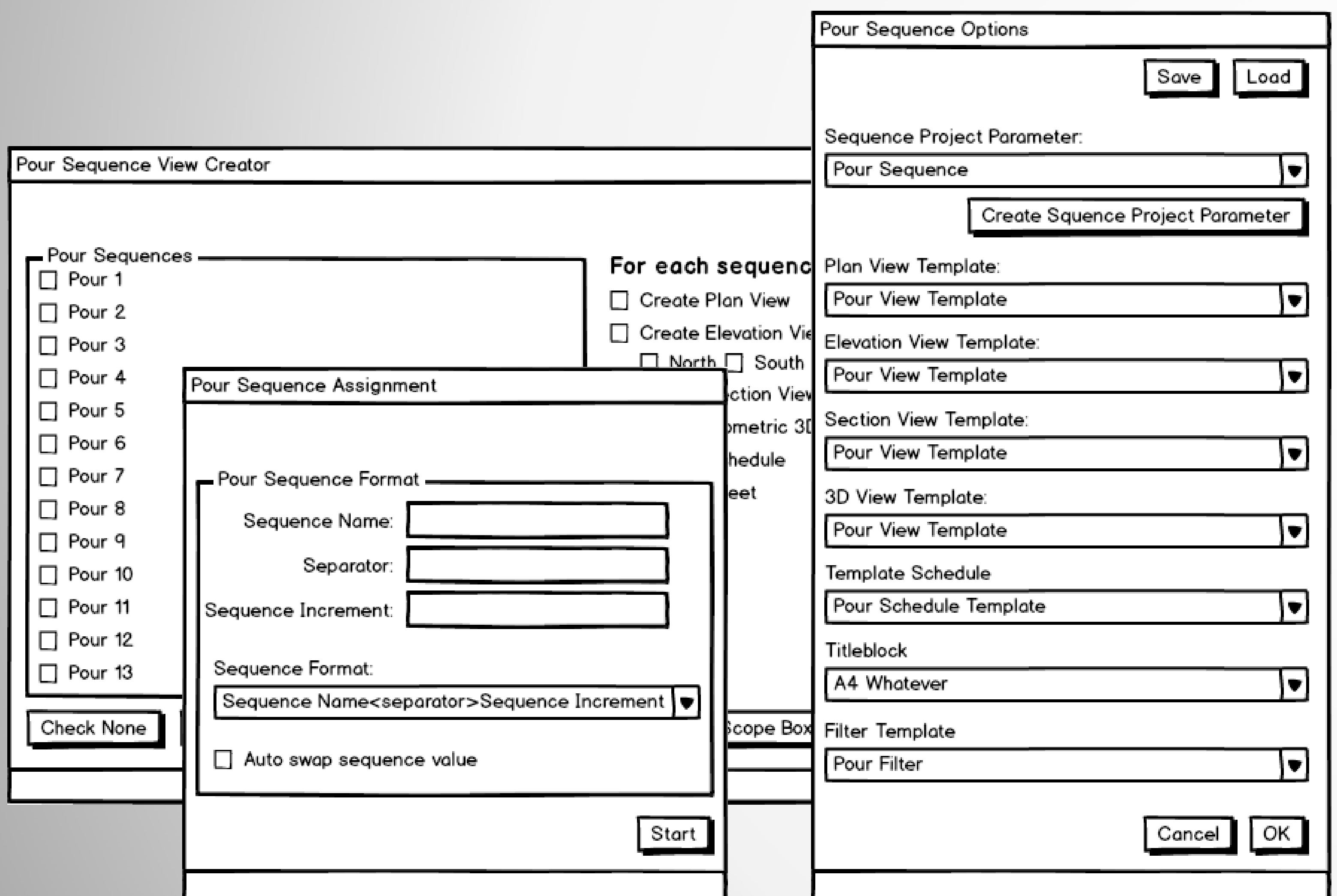
- Understand the Issue
- Understand the Culture
- Reverse Engineer Existing Model and Process
- Develop User Interface and Functional Specification

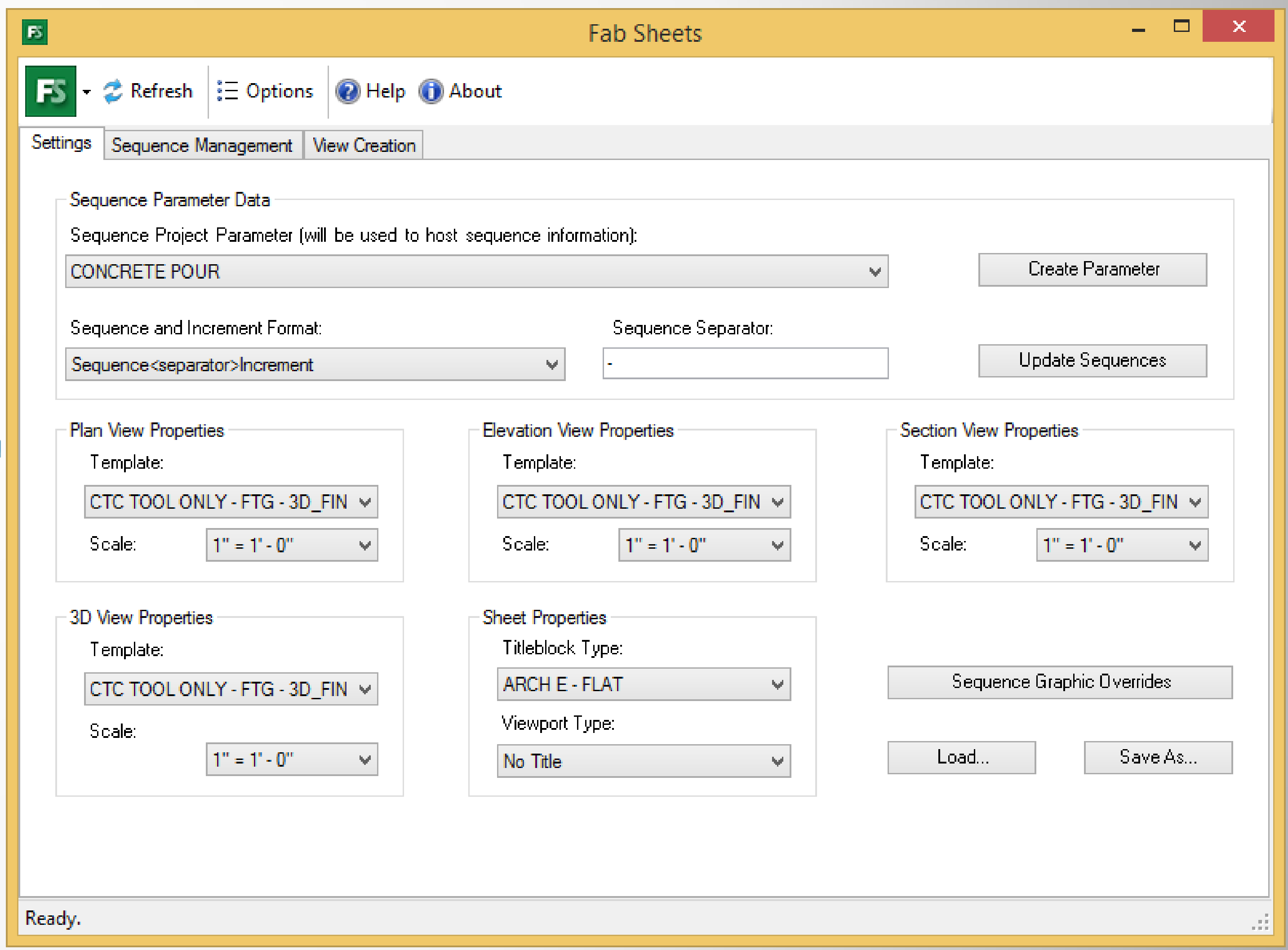


Our Approach to Problem

Beta Testing & Refinement

Pour Sequence Tool to Fab Sheets

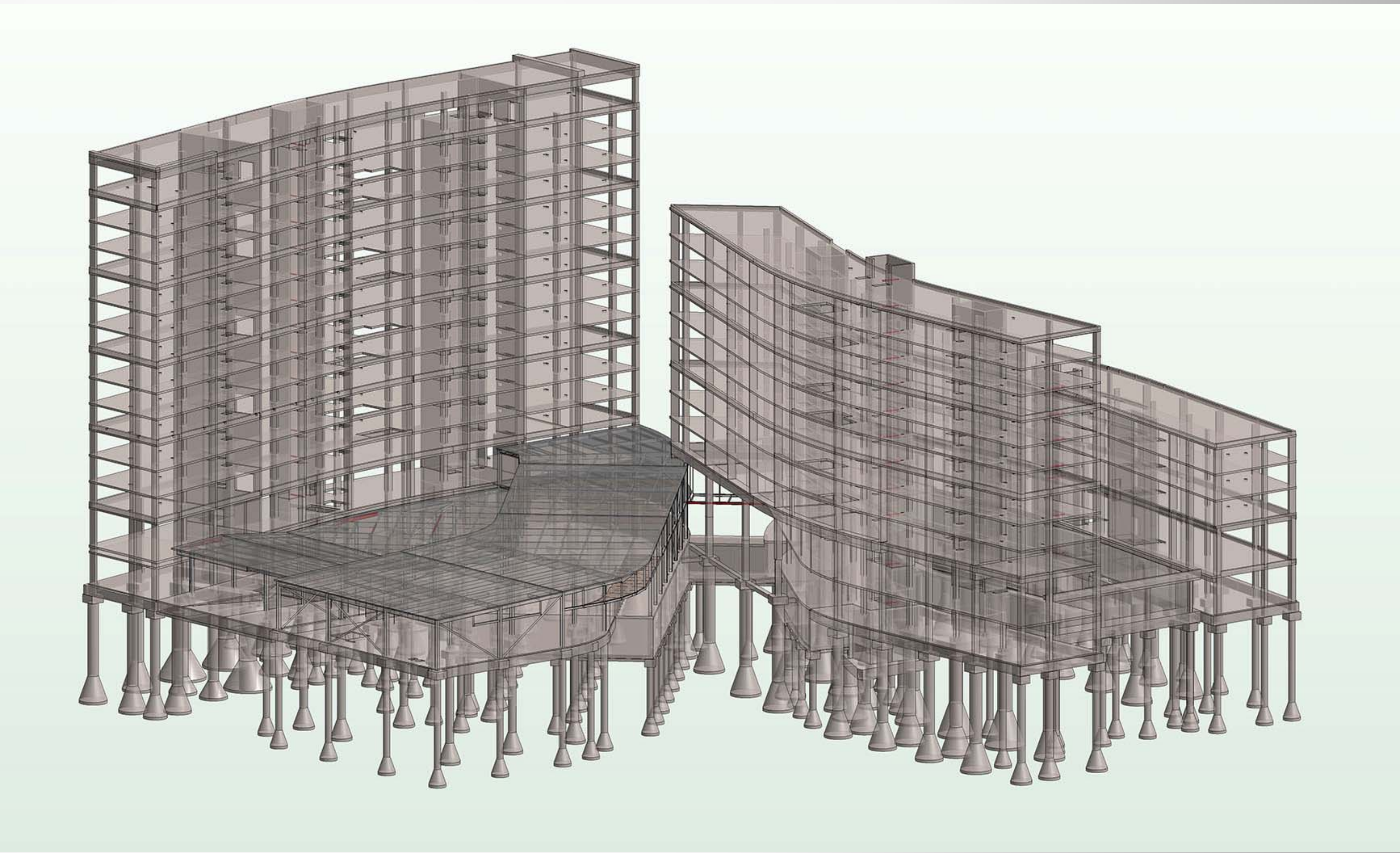




Our Approach to Problem

Fab Sheets Demo

REVIT EXPRESS TOOLS



Chapter 3

Measured Outcomes

VALUE ADD

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Study Metrics **WITH CTC PLUG-IN**

Process Improvement Time

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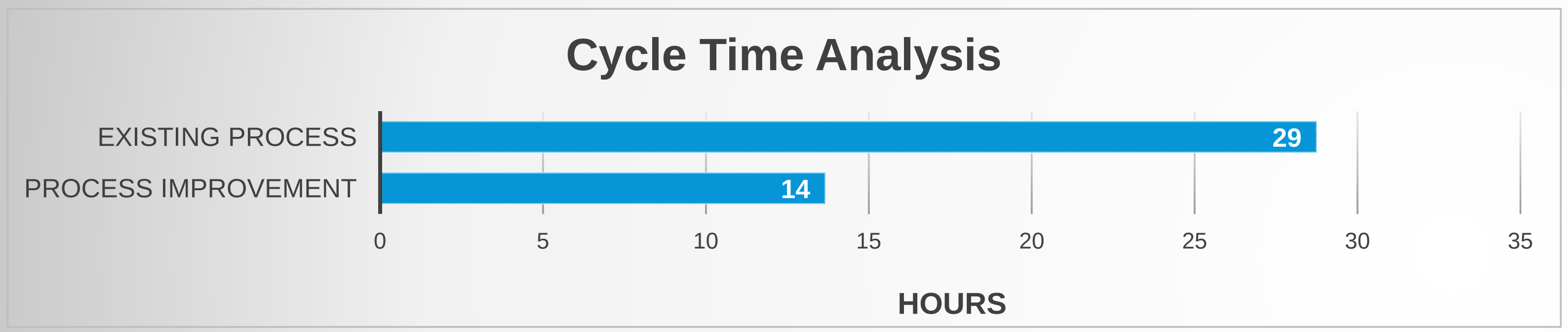
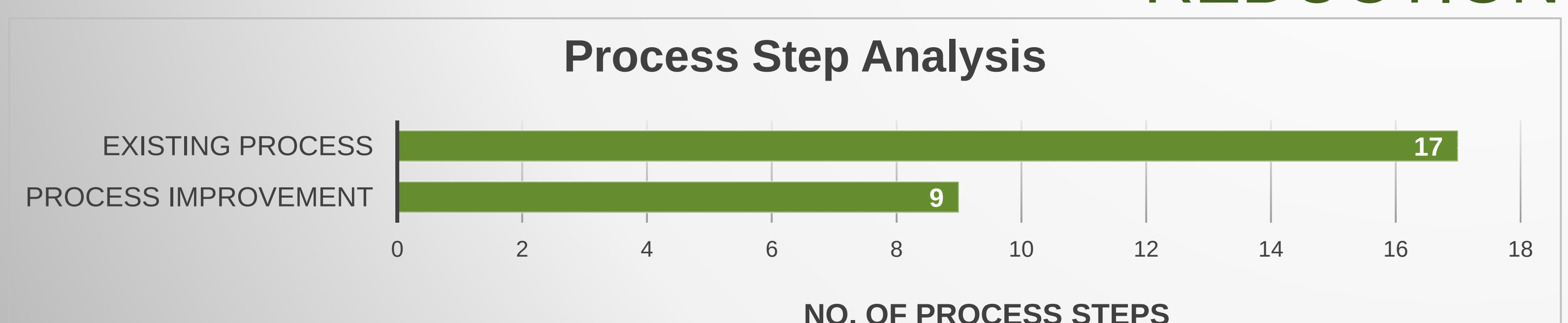
14 Hours

48% TIME REDUCTION



9 Steps

8 STEP REDUCTION



Concrete Coordination Process Steps

12 Footing Pours, 12 Wall Pours; 2 CPP (24 pours)		Minutes
1	Transfer Project Standards from Project Template	5
2	Create 3D and Plan "Coordination Views"	10
3	Create/Edit/Assign Work-sets	15
~~4~~	~~Create Text Shared Parameter per Pour Sequence~~	0
5	Split and Assign Pour Sequence Parameter	60
~~6~~	~~Create Color Filters~~	0
~~7~~	~~Create/Edit Title-blocks~~	0
7	**Setup / Run Concrete Pour Sequence Tool**	**15**
8	Create Overall Pour Sequence IWP	120
~~9~~	~~Create View Templates~~	0
	Subtotal (hours)	4

Drafting IWP Process Steps

~~1~~	~~Create Plan View~~	0
~~2~~	~~Create Elevation View(s)~~	0
~~3~~	~~Create 3D View(s)~~	0
~~4~~	~~Create Sheet~~	0
5	Copy/Paste Relevant Information from Previous Sheets	5
~~6~~	~~Add All Required Views to Sheet~~	0
7	**Organize Views on Sheet**	**15**
8	Add All Required Drafting/Detail Views to Sheet	5
~~8~~	~~Adjust and Renumber View Titles~~	0
	Tact Time for 1 IWP (hours)	0.4
	Total Tact Time Hours for 24 IWP's (hours)	10
	Concrete Coordination + IWP Drafting = Total Process Hours	**14**
	Number of Process Steps	**9**

Study Metrics **OUTCOMES**

48% Time reduction eliminated non-value added activities

Spend more time on value add:

- Coordination and management of trades
- Improve review time and problem solving with team
- Improve planning time for quality and safety

Implementation – University Residence Hall Case Study

Approach: Design Build
Size: 400,000 SF
Structure: Concrete >95% = Self Perform

1 ICC – Estimated @ 1,440 Hours
Estimate Uses 8Hrs/IWP as Baseline
180 Concrete Lift Drawings Expected

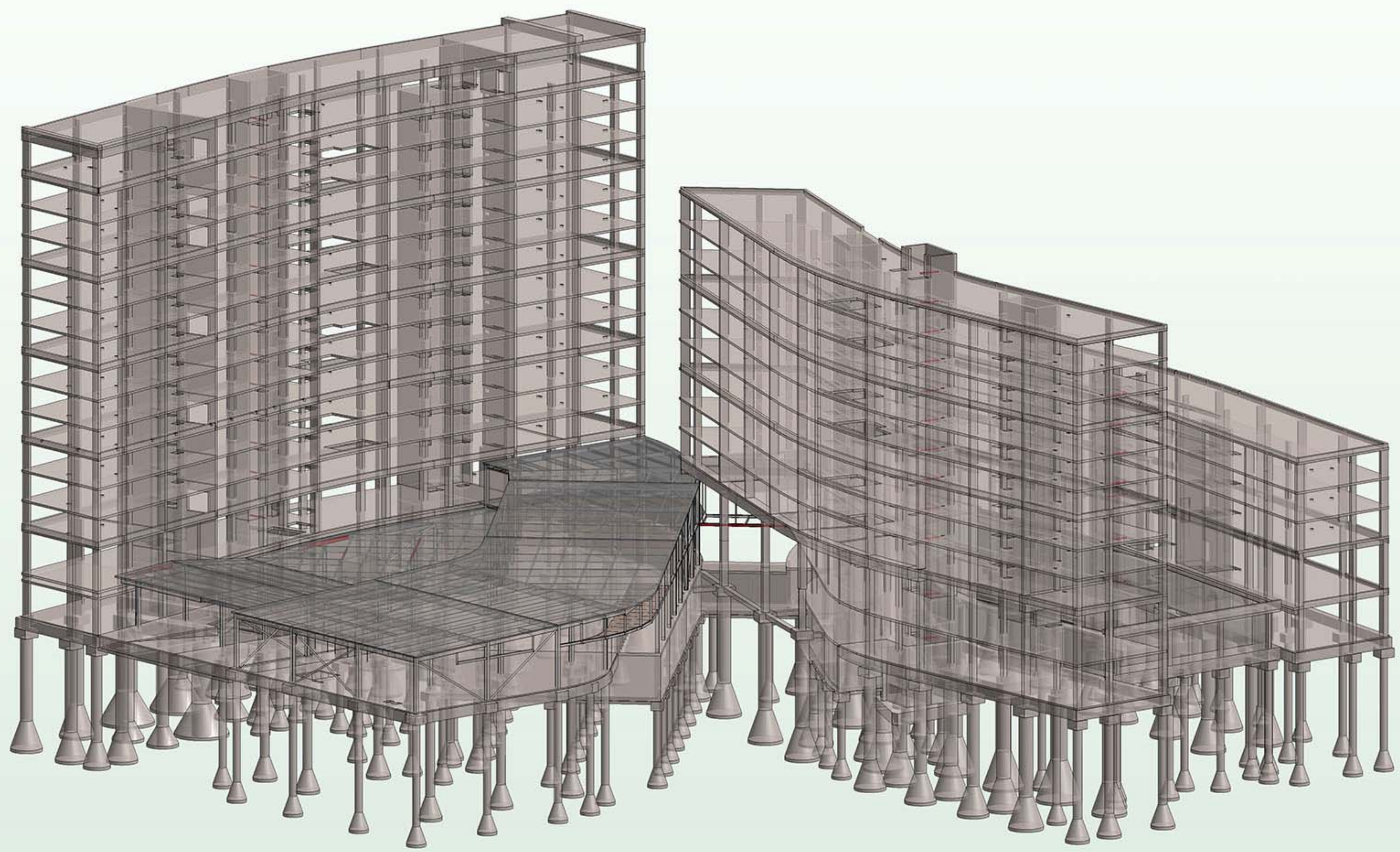
Concrete Individual Pour IWPs - 177
- Pilasters
- Foundations (Walls and Footings)
- Core/Shear Walls (Each Level)

***Concrete Composite Plans - "IWP-Light" – 82**
- Slab on Grade and Elevated Decks – 41
- Caisson Capitals/Interior Columns -39
- Waterproofing - 2

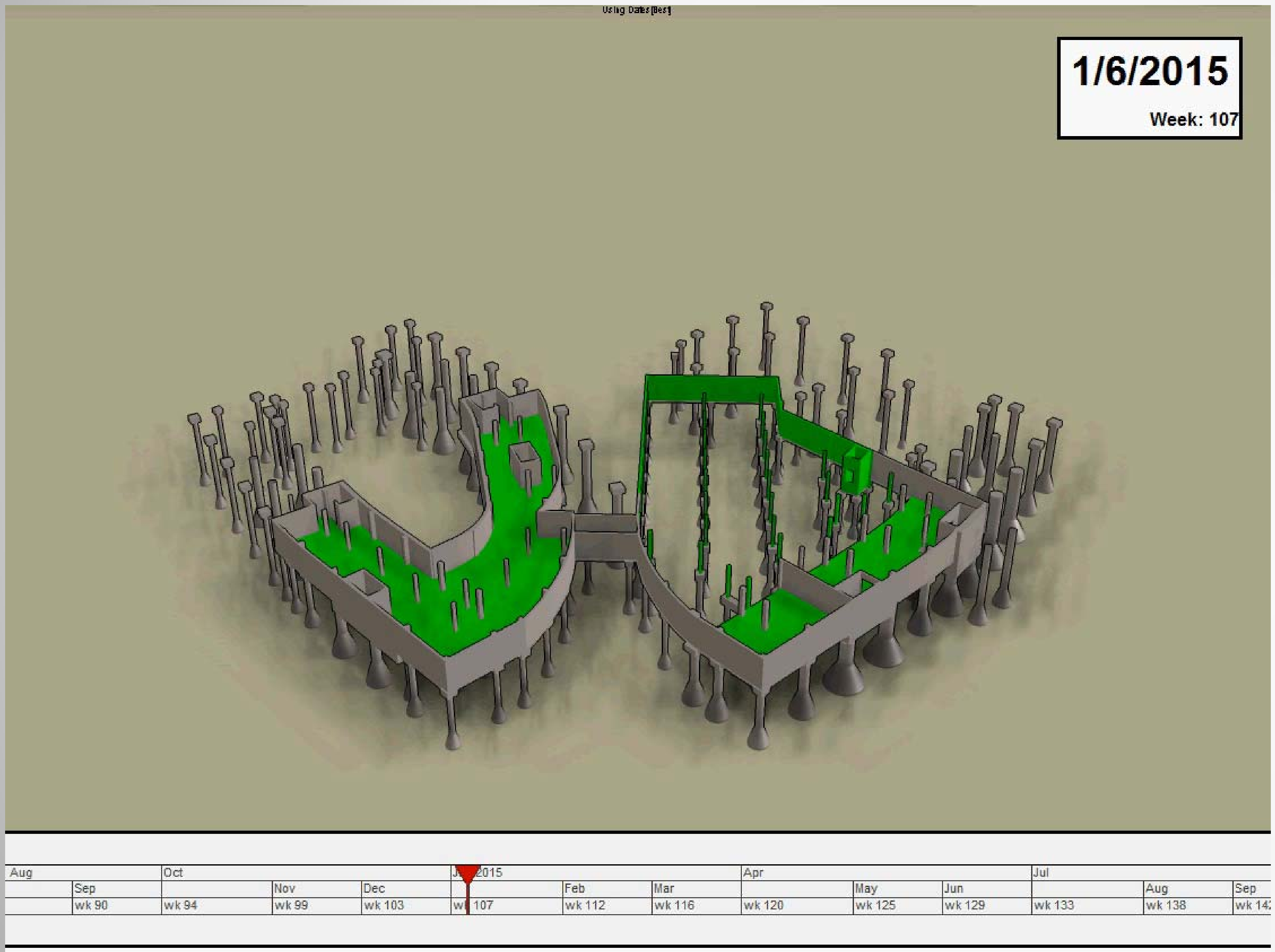
***"IWP-Light" – Not Figured into 177 IWPs**

Existing Process drafting time:
1h x 177 = ±177 hours

New Process drafting time:
.4h x 177 = ±71 hours



OUTCOMES

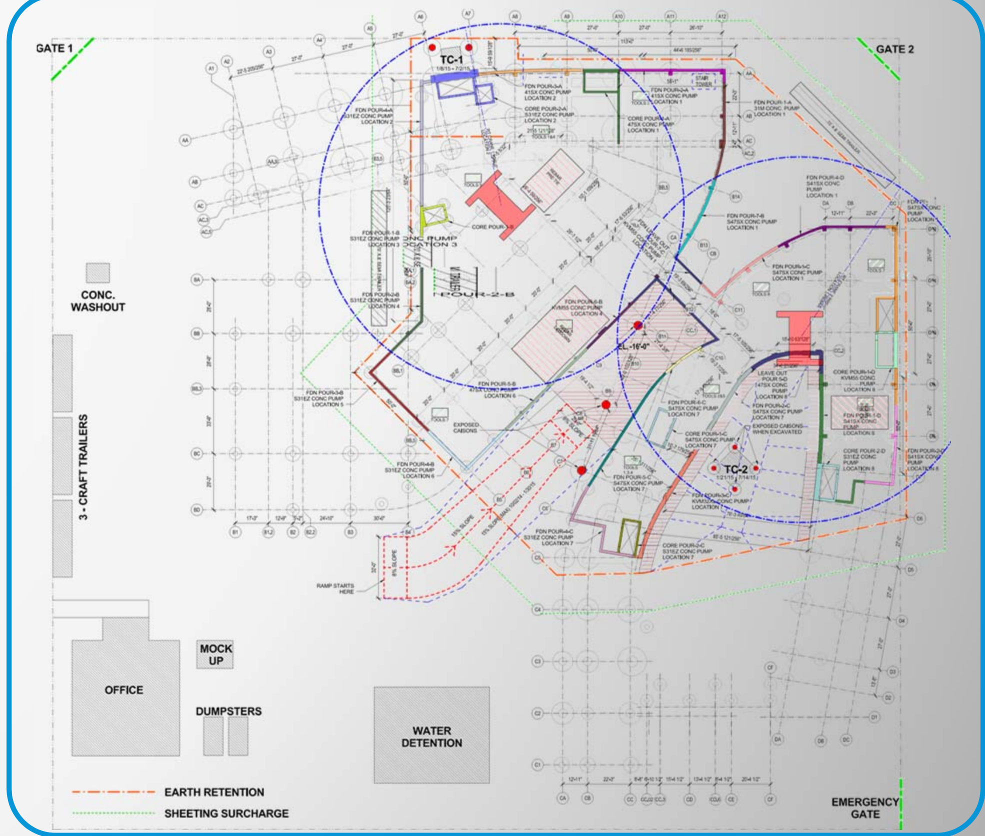


FDN-26-0-CD - WALLS

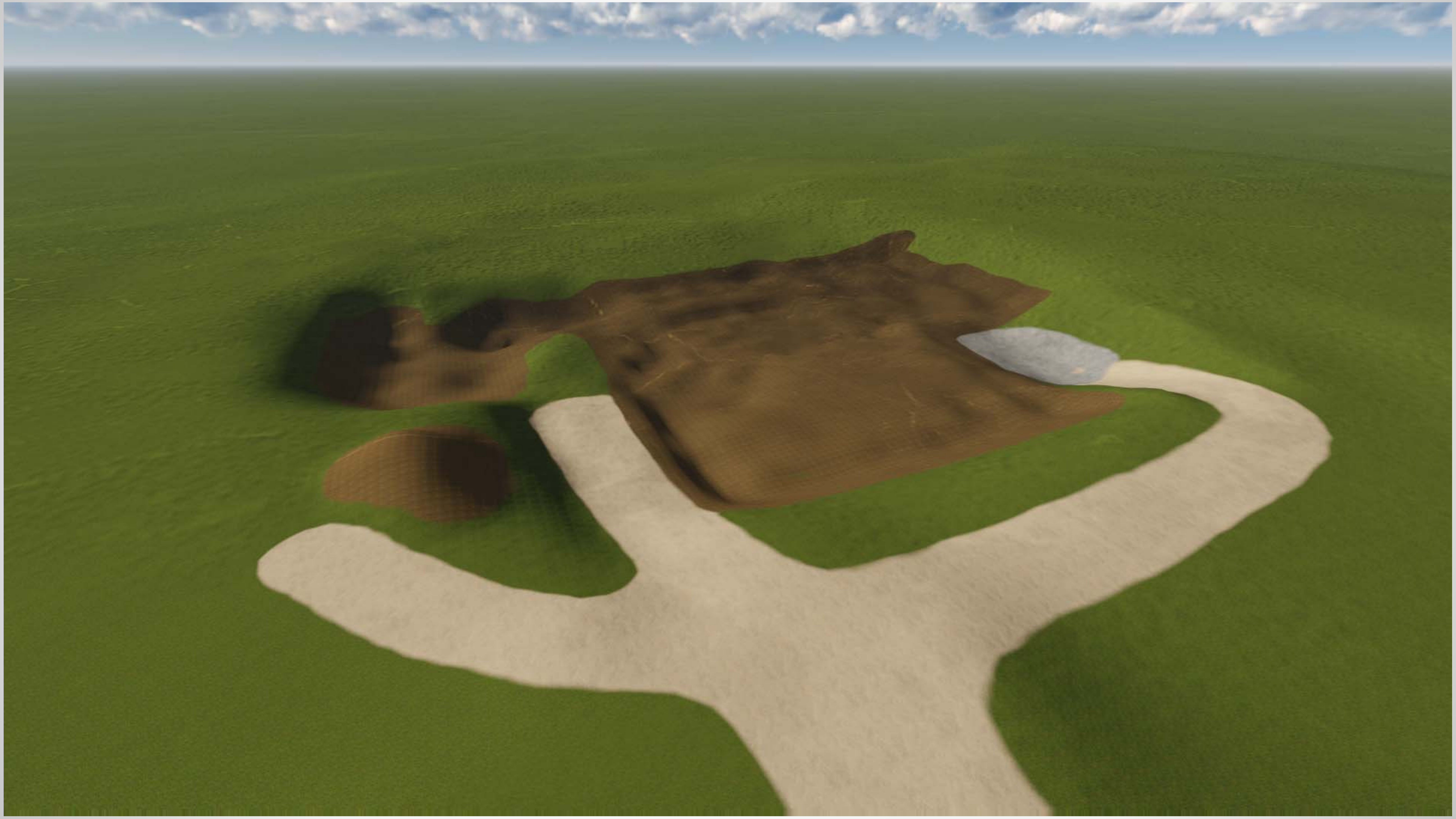
WALL TYPE	LENGTH	SURFACE AREA (BOTH SIDES)	VOLUME
Concrete - 12"	9'-9 1/2"	62.11 SF	1.15 CY
Concrete - 12"	18'-0"	129.00 SF	2.39 CY
Concrete - 15"	1'-3 3/8"	46.46 SF	1.08 CY
Concrete - 15"	5'-6"	185.79 SF	4.30 CY
Concrete - 15"	8'-3 3/4"	252.19 SF	5.84 CY
Concrete - 15"	11'-0"	399.67 SF	9.25 CY
Concrete - 15"	19'-2 5/8"	680.21 SF	15.75 CY
Concrete - 15"	34'-5 1/2"	1026.28 SF	23.76 CY
Grand total	107'-6 3/4"	2781.71 SF	63.51 CY

FDN-26-0-CD - COLUMNS

COLUMN TYPE	HEIGHT	SURFACE AREA (ALL SIDES)	VOLUME
CD-5 - 24" x 24"	16'-0"	128.00 SF	1.23 CY
CD-3 - 18" x 24"	16'-0"	112.00 SF	1.64 CY
CD-3 - 18" x 24"	19'-0"	133.00 SF	2.11 CY
Grand total		373.00 SF	4.98 CY



OUTCOMES



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