A Dissection of the U.S. Army Corps of Engineers BIM Requirements

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Outline

Introduction
USACE BIM Roadmap
Development of BIM Contract Language (previously Attachment “F”)
Project Execution Plan (PxP) and Checklists
Minimum Model Matrix (M3)
Questions & Answers

"The views expressed in this presentation are those of the author(s) and do not reflect the official policy or position of the United States Army, Department of Defense, or the U.S. Government."
USACE BIM Road Map

Achieve a coordinated move towards BIM while managing technology and business process risks

Transform the USACE BIM implementation to go beyond a labor and time saving device associated with reduced cost of producing coordinated drawings to a set of information upon which to realize business process transformation.
In Fall of 2006 USACE established a dialog with BIM-aggressive AE’s, GC’s, Academia, and Legal firms in conducting discussions and workshops on mutually beneficial BIM issues.

- Mixture of Bentley BIM, Revit and ArchiCAD users

- Collaboration provided a tremendous opportunity to partner in strengthening federal and private sector BIM initiatives.
  - Best practices
  - Contract language
  - Standards
USACE/Industry BIM Advisory Committee

- Mission Statement: Push for innovation within a BIM application-neutral context, yet ensure that the requirements are practical, fair and reasonable within the existing state of the technology and standards.

- Membership
  - Participation is strictly voluntary
  - All costs incurred to participate are the responsibility of the firms
  - Monthly on-site/webmeeting workshops and bi-weekly conference calls
USACE/Industry BIM Advisory Committee

- USACE BIM Contract Requirements
  - BIM Contract Language
  - BIM Project Execution Plan (PxP) Template
  - Minimum Modeling Matrix (M3)
- BIM Submittal Checklist (in development)
USACE/Industry BIM Advisory Committee
USACE BIM Contract Language

- The contract language is a work in progress
  - Fine-tuned to reflect developments in the industry
  - Incorporate lessons learned as projects are awarded and executed.

- In coordination with the BIM COP
  - Continue to develop language in support of other contract requirements
    - MILCON Design Phase
    - MILCON Construction Contracts
    - Civil Works

- Support for other Agencies
  - Adoption or Adaption of USACE Contract Language and tools
USACE BIM Contract Language

- USACE Model RFP Wizard
  - On-line tool for standard development of Requests for Proposals
  - Mandated for the Centers of Standardization (CoS) program

- BIM contract requirements implemented in Wizard in early January 08

- DB contracts with firm fixed price

USACE BIM Contract Language

- CoS Projects
  - Standard Designs for common Army Installation facilities
    - i.e. Barracks, Company Operations, Dining Facility
  - Standard designs developed and maintained by designated CoS Districts
    - Initial development in Bentley Systems BIM with USACE Bentley BIM workspace.
    - Revit templates available now

- USACE in-house design teams and Contractors are provided baseline BIM facility designs for adapt-build projects.
USACE BIM Contract Language

- Covers the following scenarios
  - CoS Projects: Effective 4/7/2011, on a ‘project-specific’ basis, Project Delivery Teams (Installation, Geographic District and CoS District) can specify
    - BIM application-specific format submittals
      - Autodesk Revit or Bentley BIM
    - BIM application-neutral submittals
      - Contractor submits in platform of choice – Revit or Bentley BIM
  - Non-CoS Projects:
    - BIM application-specific submittals
      - Bentley BIM, Revit, ArchiCAD
    - BIM application-neutral submittals
      - Contractor submits in BIM platform format of choice.
Section 1 – General
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7.3. "Model Element": A self-contained element with a unique identification, whose behavior and properties are defined by Facility/Site Data and software processes. Model Elements can represent a physical entity, such as a pump or a concrete wall, and range from the simple to the complex.

7.4. "Facility/Site Data": The non-graphical information attached to objects in the Model that defines various characteristics of the object. Facility/Site Data can include properties such as parametric values that drive physical sizes, material definitions and characteristics (e.g., wood, metal), manufacturer data, industry standards (e.g., AISC steel properties), and project identification numbers. Facility/Site Data can also define supplementary physical entities that are not shown graphically in the Model, such as insulation around a duct, hardware on a door, content of conduit, or transformer properties.

7.5. "Workspace": A collection of content libraries and supporting files that define and embody a BIM standard. A workspace includes BIM libraries such as wall types, standard steel shapes, furniture, HVAC fittings, and sprinkler heads. It also contains sheet libraries such as print/pilot configurations, font and text style libraries, and sheet borders and title blocks. The USBCE has developed Workspaces specific to USBCE BIM standards; these workspaces are dependent on specific versions of the BIM applications they serve. All USBCE BIM Workspaces can be downloaded from the CAD/BIM Technology Center (https://cadbim.usace.army.mil). In some cases, there is a specific Workspace for a given CoS Facility Standard Design.
**USACE BIM Contract Language**

7.2. **“Model”**: A digital representation of physical and functional characteristics of a facility or a part thereof, comprised of “Model Elements” with “Facility/Site Data”.

7.3. **“Model Element”**: A self-contained element with a unique identification, whose behavior and properties are defined by Facility/Site Data and software processes. Model Elements can represent a physical entity, such as a pump or a concrete wall, and range from the simple to the complex.

7.4. **“Facility/Site Data”**: The non-graphical information attached to objects in the Model that defines various characteristics of the object. Facility/Site Data can include properties such as parametric values that drive physical sizes, material definitions and characteristics (e.g. wood, metal), manufacturer data, industry standards (e.g. AISC steel properties), and project identification numbers. Facility/Site Data can also define supplementary physical entities that are not shown graphically in the Model, such as insulation around a duct, hardware on a door, content of conduit, or transformer properties.

**Takeaway** - Understand the definitions for ‘Model’ and ‘Facility/Site Data’

Model Element = 3D Geometry, Facility/Site Data = non-graphical info attached to Model objects, Model = Geometry + Data
Section 1 – General

1.0 Section 1 - General
1.1. Definitions. See Section 7 for definitions of terms used in this document.

1.2. Submittal Format
1.2.1. The Model shall be developed using Building Information Modeling (BIM) supplemented with Computer Aided Design (CAD) content as necessary to produce a complete set of Construction Documents. Submitted drawings shall be eFULL_SIIZE size, suitable for half-size scaled reproduction.
1.2.2. BIM submittals shall conform to the requirements of Sections 3.0 and 4.0 below.
1.2.3. For each Center of Standardization (CoS) facility type included in this Project, all Models and associated Facility/Site Data shall be submitted in either Bentley Systems v8i BIM or Autodesk Revit 2011 format or higher. The submittals shall be fully operable, compatible, and editable within the native BIM tools.
USACE BIM Contract Language

1.2.3. For each Center of Standardization (CoS) facility type included in this Project, all Models and associated Facility/Site Data shall be submitted in the BIM format and version as determined by the Customer, Geographic District BIM Manager, and the CoS District BIM Manager. For this project, the BIM submittal format will be <BENTLEY_BIM>Bentley BIM</BENTLEY_BIM> and InRoads «BENTLEY_VERSION»</BENTLEY_BIM> <AUTODESK_REVIT>Autodesk Revit and Civil 3D «REVIT_VERSION»</AUTODESK_REVIT>. The submittals shall be fully operable, compatible, and editable within the native BIM tools.

Takeaway - USACE expects you to use BIM

You must submit Model in format requested…AND be

“… fully operable, compatible, and editable within the native BIM tools.”

No translations!
Section 1 – General

Section 2 – Design Requirements

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Section 4 – Minimum Modeling and Data Requirements

Section 5 – Ownership Rights in Data

Section 6 – Contractor Electives

Section 7 – Definitions
USACE BIM Contract Language

2.1. **Use of BIM** Contractor shall use BIM application(s) and software(s) to develop Projects consistent with the following requirements.

**Takeaway** - USACE expects you to use BIM
USACE doesn’t want you building a separate BIM off to the side as a parallel effort
USACE doesn’t want you to perform a last-minute effort to fulfill a requirement.
USACE BIM Contract Language

2.1.2. **BIM Program Configuration Standards.** If Contractor selects Bentley Systems BIM as the BIM platform of choice, the latest version of the Bentley TriServices Workspace must be used and can be downloaded from the CAD/BIM Technology Center website, currently [https://cadbim.usace.army.mil](https://cadbim.usace.army.mil). For Revit Versions 2011 or earlier, a USACE Revit Standard will not be provided; Contractor can select which Revit templates and resources to use. For Revit 2012, the USACE Revit 2012 Templates must be used and can be downloaded from the CAD/BIM Technology Center website, currently [https://cadbim.usace.army.mil](https://cadbim.usace.army.mil).

**Takeaway** - Use the USACE BIM Standards

Use the USACE vendor-specific BIM Workspace, Resources, or Templates IF required for the type of project you are working on

Definitely for Center of Standardization projects

As needed or as specified on a project-by-project basis
2.1.5. **BIM Project Execution Plan.**

2.1.5.1. Develop a BIM Project Execution Plan ("Plan" or "PxP") documenting mandatory and Contractor-elected BIM Uses, analysis technologies and workflows.

2.1.5.2. Contractors shall use the USACE BIM PROJECT EXECUTION PLAN (PxP) Template located at [https://cadbim.usace.army.mil](https://cadbim.usace.army.mil) to develop an acceptable Plan.

**Takeaway -** USACE expects you to develop a BIM Execution Plan (PxP)

USACE wants to know how you intend to use BIM, and how you expect to fulfill the Attachment F BIM Requirements

They’ve had many private sector partners say they can do BIM but in the end truly can’t

More about PxP later
2.2. **BIM Content**

2.2.1. **Facility/Site Data.** Develop the Facility/Site Data to include material definitions and attributes that are necessary for the Project facility design and construction as described in Section 4.0. Additional data in support of Section 6.0 Contractor Electives is encouraged to be added to the Model.

2.2.2. **Model Content.** The Model and Facility/Site Data shall include, at a minimum, the requirements of Section 4.0 below.

**Takeaway - Geometry AND Data**

More info on Geometry and Data requirements in Section 4.0
USACE BIM Contract Language

2.3. **Output.** Submitted Drawings (e.g., plans, elevations, sections, schedules, details, etc.) shall be derived (commonly known as extractions, views or sheets) from the Model and Facility/Site Data. Drawings derived from the Model shall remain connected to the Model for the life of the Project and documented in the PxP. Drawings not derived from the Model shall also be documented in the PxP.

**Takeaway -** USACE requires that the drawings submitted as construction documents be a direct output from the model (views/sheets/extractions)

USACE does not want you to produce all your drawings in CAD and build the BIM independently

Don’t try to “fake it” by doing it the “old way” then building a model
The CAD file format specified for drawings shall not dictate which application(s) are used for development and execution of the Model and Facility/Site Data. Application(s) used shall be documented in the PxP.

Takeaway - The CAD submittal can be a different format than the BIM submittal example: USACE can ask for a Revit project with MicroStation drawings

Why?

USACE is the owner’s agent: they are acting on behalf of their ‘client’

USACE is the owner’s voice, who may have specific requirements
USACE BIM Contract Language

2.4. **Quality Control Parameters.** Implement quality control (“QC”) parameters for the Model, including:

2.4.1. **Model Standards Checks.** Provide QC checks demonstrating that the Project Facility/Site Data set has no undefined, incorrectly defined or duplicated elements. Identify and report non-compliant elements and submit a corrective action plan. Provide the Government with detailed justification and request Government acceptance for any non-compliant element that the Contractor proposes to be allowed to remain in the Model.

2.4.2. **CAD Standards Checks.** Provide QC checks demonstrating that the fonts, dimensions, line styles, levels and other construction document formatting issues are followed per requirements in Section 01 33 16. Identify and report non-compliant content and submit a corrective action plan.

**Takeaway** - You must perform good QC of the model

USACE outlines what kinds of things they want you to check

USACE also wants CAD Standards check (AEC x.0 per contract)

You must submit documentation of your checks
USACE BIM Contract Language

2.5. Design and Construction Reviews. The Model and Facility/Site Data will be used to perform reviews at each submittal stage under Section 3.0 to test the Model, including Over-The-Shoulder Progress Reviews:

2.5.1. Visual Checks. Checking to demonstrate the design intent has been followed and that there are no unintended elements in the Model.

2.5.2. Interference Management Checks. Locate conflicting spatial data in the Model where two elements are occupying the same space. Log hard interferences (e.g., mechanical vs. structural, or mechanical vs. mechanical, overlaps in the same location) and soft interferences, (e.g., conflicts regarding equipment clearance, service access, fireproofing, insulation, code space requirements) in a written report and resolve.

2.5.3. Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model, including interference management and design change tracking information.

Takeaway - Perform formal Interference Management ("clash") checks

Tell USACE how you will do this in the PxP

Over the Shoulder Reviews will happen
USACE BIM Contract Language

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2.5.3. Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model, including interference management and design change tracking information.

Takeaway - USACE wants you to USE the Model, not just build it

....not just use it to produce drawings

Get in the model and review the design – with the client
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3.1. **General Submittal Requirements.**

3.1.1. Provide submittals in compliance with the PxP deliverables at stages as described below.

3.1.2. For each Submittal as set forth in Paragraphs 3.3 through 3.5, provide a Contractor-certified written report confirming that consistency checks as identified in Paragraphs 2.4 and 2.5 above have been completed. This report shall be discussed as part of the review process and shall address cross-discipline interferences, if any.

**Takeaway -** Submittals must comply with PxP and delivered at the stages defined in Section 3.

Contractor shall check compliance of sections 2.4 (QA/QC) and 2.5 (Design and Construction Reviews) before submitting and provide written report confirming consistency.
At each Submittal as set forth in Paragraphs 3.3 through 3.5, provide the Government with:

3.1.3.1. The Model, Facility/Site Data, Workspace and CAD Data files in the native BIM/CAD format.

3.1.3.2. A copy of the Model in an interactive review format such as Bentley Navigator, Autodesk Navisworks, Adobe 3D PDF 7.0 (or later), Google Earth KMZ or other format per PxP requirements. The format for reviews can change between submittals.

3.1.3.3. A list of all submitted electronic files including a description, directory, and file name for each file submitted. For all CAD printed sheets, include a list of the sheet titles and sheet numbers. Identify which files have been produced from the Model and Facility/Site Data.

3.1.3.4. **IFC Coordination View.** Provide an IFC Coordination View in IFC Express format for all deliverables. Provide exported property set data for all IFC supported named building elements.

**Takeaway** - Native format (e.g. Revit) and review format (e.g. Navisworks) must be submitted at each interim submittal.

Include all associated files and a directory of where each file is located.

Include IFC Coordination View and property set.
3.1.4. The Government shall confirm acceptability of all submittals identified in Section 3.0 in coordination with the USACE Geographic District BIM Manager.

**Takeaway -** The Geographic District BIM Manager must review for acceptance the BIM submittals.

Approval by the Contracting Officer does not meet requirements.
USACE BIM Contract Language

3.2. Initial Design Conference Submittal.

3.2.1. Submit a digital copy of the PxP and M3 where, in addition to Paragraph 3.1.4, the USACE Geographic District BIM Manager will coordinate with the USACE CoS BIM Manager to confirm acceptability of the Plan or advise as to additional processes or activities necessary to be incorporated into the PxP.

Takeaway - Items in Section 3.2 are one time submittals (unless modified)
PxP must be approved by the Geographic District and CoS District BIM Managers (more on PxP later)
PxP must show intent to meet USACE BIM Contract Language requirements
USACE BIM Contract Language

3.2.2. Within thirty (30) days after the acceptance of the PxP and M3, conduct a demonstration to review the Plan for clarification, and to verify the functionality of planned Model technology workflow and processes. If modifications are required, the Contractor shall complete the modifications and resubmit the PxP performing a subsequent demonstration for Government acceptance. There will be no payment for design or construction until the PxP is completed and accepted by the Government. The Government may also withhold payment if there is design and construction for unacceptable performance in executing the accepted PxP.

Takeaway - Prove you can perform the tasks and procedures outlined in your PxP and M3
Get it right early in the process
Payment can be withheld for non-compliance to PXP and M3
USACE BIM Contract Language

3.3. Interim Design Submittals.

3.3.1. BIM and CAD Data. Submit the Model with Facility/Site Data per the requirements identified in Paragraphs 2.2 and 2.3 as applicable to the Interim Design package(s).

3.4. Final Design Submissions and Design Complete Submittals.

3.4.1. BIM and CAD Data. Submit the Model with Facility/Site Data per the requirements identified in Paragraphs 2.2 and 2.3. Acceptance according to Paragraph 3.1.4 is required before commencement of construction, as described in Paragraph 3.7.6 of Section 01 33 16.

Takeaway - Every submittal needs to meet the requirements of 2.2 (BIM Content) and 2.3 (Output)

Construction cannot start until Final Design Submission is approved
Takeaway - Obviously, the most important submittal.

Manage the interim submittals properly to ensure that the final submittal is accepted and approved.

Don’t forget section 3.2.2 allows for Government to withhold payment.
USACE BIM Contract Language

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4.0 Section 4 – Minimum Modeling and Data Requirements

4.1. Minimum Modeling Matrix (M3)

4.1.1. Develop an M3 documenting elements included in the facility and site. The M3 describes the minimum modeling and data requirements by defining the Level of Development (LOD) and Element Grade.

4.1.2. Contractors shall use the USACE Minimum Modeling Matrix (M3). Template located at https://fedbim.usace.army.mil and submitted as part of the PnP.

4.2. Additional Requirements

4.2.1. Classification. All modeled elements shall include Facility/Site Data referencing one or more classification systems.

4.2.2. Spatial data. The model shall include spatial data containing actual net square footage and net volume, and holding data to develop the room finish schedule including room names and numbers, include program information to verify design space against programmed space, using this information to validate area quantities.

4.2.3. Schedules. Schedules shall be produced from the Facility/Site Data within the Model. Any exceptions should be documented in the PnP and submitted to the USACE for review.

4.2.4. Details and Enlarged Sections. All details and enlarged sections necessary for construction shall be derived from the Model when possible. For views difficult to derive, details and enlarged sections shall be created directly from the Model. Contractor must verify that geometry and data describing the details and enlarged sections are consistent with Model elements. Details with significant drafted content such as ‘standard’ and ‘typical’ details shall not contradict the model and shall utilize the model as an underlay when possible for the purposes of verification and coordination. Three-dimensional, isometric, and section isometric details derived from the model are preferred.

4.2.5. Legends. Model Elements shall be used to produce representations shown in the legends and shall match graphical representations shown in plans, sections, and elevations.

4.2.6. Drawing Indexes. Where BIM authoring platform supports it, drawing indexes should be derived from a model-driven schedule.
## USACE BIM Contract Language

### 4.0 Section 4 – Minimum Modeling and Data Requirements

#### 4.1 Minimum Modeling Matrix (M3)

1. **4.1.1.** Develop an M3 documenting elements included in the facility and site. The M3 describes the minimum modeling and data requirements by defining the Level of Development ("LOD") and Element Grade.

2. **4.1.2.** Contractors shall use the USACE Minimum Modeling Matrix (M3) Template located at [https://cadbim.usace.army.mil](https://cadbim.usace.army.mil) and submitted as part of the PxP.

### Takeaway

- The M3 defines the minimum modeling and data requirements for the project.

- You are required to use the USACE M3.
Takeaway - All elements will reference at least one of the following classifications systems:

- OmniClass
- UniFormat
- MasterFormat
4.2.2. **Spatial Data.** The Model shall include spatial data defining actual net square footage and net volume, and holding data to develop the room finish schedule including room names and numbers. Include program information to verify design space against programmed space, using this information to validate area quantities.

**Takeaway -** Spatial data is the repository for the room Information used for schedules and analysis.

4.2.3. **Schedules.** Schedules shall be produced from the Facility/Site Data within the Model. Any exceptions should be documented in the PxP and submitted to the USACE for review.

**Takeaway -** All schedules shall be derived from the model, unless documented in the PxP that is reviewed and accepted by USACE.
4.2.4. **Details and Enlarged Sections.** All details and enlarged sections necessary for construction shall be derived from the Model when possible. For those details and enlarged sections not derived directly from the Model, Contractor must verify that geometry and data depicting the details and enlarged sections are consistent with Model elements. Details with significant drafted content such as 'standard' and 'typical' details shall not contradict the model and shall utilize the model as an underlay when possible for the purposes of verification and coordination. Three dimensional, isometric, and section isometric details derived from the model are preferred.

**Takeaway -** The model must be fully integrated into your design and drafting process.
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5.0 Section 5 - Ownership and Rights in Data
5.1 Ownership: The Government has ownership of and rights at the date of Closeout Submittal to all CAD files, BIM Model, and Facility/Site Data developed for the Project in accordance with FAR Part 27, clauses incorporated in Section 00 72 00, Contract Clauses and Special Contract Requirement 1.14 GOVERNMENT RE-USE OF DESIGN (Section 00 73 00). The Government may make use of this data following any deliverable.
USACE BIM Contract Language

5.0 Section 5 - Ownership and Rights in Data

5.1. Ownership. The Government has ownership of and rights at the date of Closeout Submittal to all CAD files, BIM Model, and Facility/Site Data developed for the Project in accordance with FAR Part 27, clauses incorporated in Section 00 72 00, Contract Clauses and Special Contract Requirement 1.14 GOVERNMENT RE-USE OF DESIGN (Section 00 73 00). The Government may make use of this data following any deliverable.

Takeaway - USACE owns the Model, all content, the Facility/Site Data, drawings, parts, rules, schedule templates, etc. as submitted in the project.

This does not preclude the submitting company from using the data on other projects.
Section 6 – Contractor Electives

6.0 Section 6 – Contractor Electives

6.1 Applicable Criteria. If the Contractor elected to include one or more of the following features as an elective in its accepted contract proposal for additional credit, as described in the proposal submission requirements and evaluation criteria, the requirements of paragraphs 6.2 through 6.5 are as applicable for those elective feature(s) that will be included in the project.

6.2 COBIE Compliance. The Model and Facility/Site Data for the Project shall fulfill Construction Operations Building Information Exchange (COBIE) requirements on the Whole Building Design Guide website (www.wbdg.org), including all requirements for the indexing and submission of Portable Document Format (PDF) and other appropriate records that would otherwise be printed and submitted in compliance with Project operations and maintenance handover requirements.

6.3 Project Scheduling using the Model. In the PnP and during the Initial Design Conference Submittal Demonstration, provide an overview of the use of BIM in the development and support of the Project construction schedule.

6.3.1 Submittal Requirements. During the Stages identified in Paragraphs 3.3 through 3.4, the Contractor shall deliver the construction schedule linked to the Model.

6.3.1.1 Construction Submittals – Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model for Project scheduling.

6.4 Cost Estimating. In the PnP and during the Initial Design Conference Submittal Demonstration, provide an overview of the use of BIM in the development and support of cost estimating, or other costing applications such as comparative cost analysis for proposed changes and estimate validation.

6.4.1 Submittal Requirements. During the Stages identified in Paragraphs 3.3 through 3.5, the Contractor shall deliver cost estimating information derived from the Model.

6.4.2 Project Completion. At Project completion, the Contractor shall provide an Micro Computer Aided Cost Estimating System Generation II (“MII”) Cost Estimate that follows the USACE Cost Engineering Military Work Breakdown System (“WBS”), a modified Uniformat, to at least the subsystems level and uses quantity information supplied directly from Model output to the maximum extent possible, though other “gap” quantity information will be included by the contractor as necessary for a complete and accurate Cost Estimate. (See Paragraph 6.4.2.2).
USACE BIM Contract Language

6.0 Section 6 – Contractor Electives

6.1. **Applicable Criteria.** If the Contractor elected to include one or more of the following features as an elective in its accepted contract proposal for additional credit, as described in the proposal submission requirements and evaluation criteria, the requirements of paragraphs 6.2 through 6.5 are as applicable for those elective feature(s) that will be included in the project.

6.2. **COBIE Compliance.** The Model and Facility/Site Data for the Project shall fulfill Construction Operations Building Information Exchange (COBIE) requirements on the Whole Building Design Guide website (www.wbdg.org), including all requirements for the indexing and submission of Portable Document Format (PDF) and other appropriate records that would otherwise be printed and submitted in compliance with Project operations and maintenance handover requirements.

**Takeaway:**
Document the electives chosen in the PxP (Any Elective selected in the PxP becomes contractual.)

Electives are previews of requirements to come

Will potentially become factored into future contractor selection criteria
USACE BIM Contract Language

6.3. **Project Scheduling using the Model.** In the PxP and during the Initial Design Conference Submittal Demonstration, provide an overview of the use of BIM in the development and support of the Project construction schedule.

6.4. **Cost Estimating.** In the PxP and during the Initial Design Conference Submittal Demonstration, provide an overview of the use of BIM in the development and support of cost estimating, or other costing applications such as comparative cost analysis for proposed changes and estimate validation.

6.5. **Other Analyses and Reports.** Structural, energy and efficiency, EPACT 2005 & EISA 2007, lighting design, daylighting, electrical power, psychrometric processing, shading, programming, LEED, fire protection, code compliance, Life Cycle Cost, acoustic, plumbing and other analyses that may be generated from the Model or reports summarizing the data compiled from these analyses shall be submitted in the form established by contractor in its accepted PxP.

**Takeaway** - Document the electives chosen in the PxP (Any Elective selected in the PxP becomes contractual.)

Electives are previews of requirements to come

Will potentially become factored into future contractor selection criteria
Project Execution Plan and Checklist
Minimum Modeling Matrix (M3)
SIM
KnowledgeSmart
Submit a Plan

- Establish the organizations’ general Means and Methods of meeting the Scope and Deliverable requirements of USACE BIM Contract Language

- There will be no payment for design or construction until the Plan is acceptable to the Government.

- The Government may also withhold payment for unacceptable performance in executing the Plan
The PROBLEM

- Past Plans format and content varied
  - 1-page “We will do BIM on this project”
  - 50+ pages on the history of BIM, benefits of BIM, why USACE should be using BIM, how the firm invented BIM in 1987…
- Very difficult and time consuming to review
Solution
Project Execution Plan (PxP)

- What are the benefits?
  - Assists organizations in planning their BIM process

- Provides a standard format that streamlines the development of the Plan

- Quality of Plans has improved dramatically

- Review and acceptance process is accelerated
Project Execution Plan (PxP)

Defines BIM Uses for Project

Template available from CAD / BIM Technology Center

Version 2.0

https://caddbim.usace.army.mil/BIM_Contract_Req

Completed by Contractor prior to Start of Project

Must be accepted by Geographic District BIM Manager

Payment can be withheld for failure to perform
## Project Execution Plan (PxP)

### Differences between versions

#### CHANGES to PxP

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<td>SECTION A. PROJECT INFORMATION</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>SECTION B. KEY PROJECT CONTACTS</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>SECTION C. PROJECT GOALS / BIM OBJECTIVES</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>SECTION D. BIM PROCESS DESIGN</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>SECTION F. BIM INFORMATION EXCHANGE WORKSHEET</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>SECTION G. MINIMUM MODELING AND DATA REQUIREMENTS</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>SECTION H. COLLABORATION PROCEDURES</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>SECTION I. QUALITY CONTROL</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>SECTION J. TECHNOLOGICAL INFRASTRUCTURE NEEDS</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>SECTION K. MODEL ORGANIZATION</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>SECTION L. PROJECT DELIVERABLES</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>SECTION M. ATTACHMENTS</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

**DELETE SECTION**
Section C: Project Goals/ BIM Objectives

- Reorganization of BIM Use Chart
- Red & X’s are Required
- COBIE- is potential BIM Use
PxP Version 2.0

Section D: Organizational Roles and Staffing

- **Original Table is now Separated**
- **Design and Construction Roles**
- **REMOVED**-
- **Total Staffing requirements**
- **ADDED**-
- **Separate Table for BIM Use Enhancements**
PnP Version 2.0

Section E: BIM Process Design

- Process map for all Required BIM Uses (marked with X)
- Example Maps can be downloaded from http://www.engr.psu.edu/BIM/PnP
Section G: Minimum Modeling Matrix (M3)

- Download: https://cadbim.usace.army.mil
- Submit as Attachment 4 in PXP
- Contractor shall identify in Column F of M3 what is NOT included in project
- Elective Modeling Enhancements are no longer pre-populated
- Variances Table was Removed
Section H: Collaboration Procedures

- Identification of Participants is added
- Pre-populated “Collaboration Activities” Table to reflect Model RFP, Section 01 33 16, USACE BIM Contract Language Requirements

### SECTION H: COLLABORATION PROCEDURES

1. **COLLABORATION STRATEGY:**
   Describe how the project team will collaborate in development and execution of modeling for the project. Include items such as electronic communication requirements and procedures, document management, transfer, and updating, and record storage, etc.

2. **COLLABORATION ACTIVITIES:**
   The following are examples of activities that should be considered.

<table>
<thead>
<tr>
<th>ACTIVITY TYPE</th>
<th>REQUIRED PER CONTRACT</th>
<th>PROJECT STAGE</th>
<th>FREQUENCY</th>
<th>PARTICIPANTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM REQUIREMENTS KICK-OFF</td>
<td>YES</td>
<td></td>
<td>ONCE</td>
<td>w/ USACE DISTRICT BIM MANAGER</td>
<td>WEB MEETING OR AGREED LOCATION</td>
</tr>
<tr>
<td>BIM EXECUTION PLAN DEMONSTRATION</td>
<td>YES</td>
<td></td>
<td>ONCE</td>
<td>w/ USACE DISTRICT BIM MANAGER</td>
<td>WEB MEETING OR AGREED LOCATION</td>
</tr>
<tr>
<td>DESIGN COORDINATION</td>
<td>YES</td>
<td></td>
<td></td>
<td>w/ USACE DISTRICT BIM MANAGER</td>
<td>WEB MEETING OR AGREED LOCATION</td>
</tr>
<tr>
<td>OVER-THE-SHOULDER PROGRESS REVIEWS</td>
<td>YES</td>
<td></td>
<td></td>
<td>w/ AGENT</td>
<td></td>
</tr>
<tr>
<td>[ANY OTHER BIM ACTIVITY THAT OCCURS WITH MULTIPLE PARTIES]</td>
<td>YES</td>
<td></td>
<td></td>
<td>w/ AGENT</td>
<td></td>
</tr>
</tbody>
</table>
PxP Version 2.0

Section I: Quality Control

- Visual Strategy for model Quality
- Added “Version Updating Check”
- Added “Revision Authority Check”

---

SECTION I: QUALITY CONTROL

1. OVERALL STRATEGY FOR QUALITY CONTROL
   Describe the strategy to control the quality of the model.

2. QUALITY CONTROL CHECKS
   The following checks should be performed to assure quality.

<table>
<thead>
<tr>
<th>CHECKS</th>
<th>DEFINITION</th>
<th>RESPONSIBLE PARTY</th>
<th>SOFTWARE PROGRAM(S)</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISUAL CHECK</td>
<td>Ensure there are no unintended model components and the design intent has been followed.</td>
<td></td>
<td></td>
<td>AT EVERY SUBMITTAL</td>
</tr>
<tr>
<td>INTERFERENCE CHECK</td>
<td>Detect problems in the model where two building components are clashing including soft and hard</td>
<td></td>
<td></td>
<td>AT EVERY SUBMITTAL</td>
</tr>
<tr>
<td>STANDARDS CHECK</td>
<td>Ensure that the BIM and AEC CADD Standard have been followed (style, dimension, line styles, levels/layer, etc.)</td>
<td></td>
<td></td>
<td>AT EVERY SUBMITTAL</td>
</tr>
<tr>
<td>MODEL INTEGRITY CHECKS</td>
<td>Describe the QC validation process used to ensure that the project Facility Data set has no undefined, incorrectly defined or duplicated elements and the reporting process on non-compliant elements and corrective action plans</td>
<td></td>
<td></td>
<td>AT EVERY SUBMITTAL</td>
</tr>
<tr>
<td>VERSION UPDATING CHECK</td>
<td>Ensuring that all users are using the agreed upon version of the software and the method by which changing software version is completed</td>
<td></td>
<td></td>
<td>AT EVERY SUBMITTAL</td>
</tr>
<tr>
<td>REVISION AUTHORITY CHECK</td>
<td>Describe the method by which all users will be given access and extent of revision authority to versions of the model as updated.</td>
<td></td>
<td></td>
<td>AT EVERY SUBMITTAL</td>
</tr>
</tbody>
</table>
Provides consistency in checking

Contract Requirements

USACE BIM Contract

Language Requirements

M3 Requirements

PxP Commitments

Included with each BIM submittal

Review of BIM Requirements only

Is Not Part of the Independent Technical Review (Design Review)
Completed by Contractor

**Step 1** Submittal File Verification
(Is everything included and in the correct format)

Verified by USACE Area Office

**Step 2** Actual Checklist (Checking against Min. Modeling Requirements M3 and PxP)

Verified by Geographic District BIM Manager
PxP and Checklist Conclusions

- Provides Execution Plan Consistency
  - District to District
  - Project to Project
  - Contractor to Contractor
- Applicable for Internal Use
  - USACE, other Federal Agencies
  - Private-sector
- Other Agency Partners Adapted or are Considering Adoption
  - DoD Military Health System
  - United States Air Force (USAF)
  - Federal Aviation Administration (FAA)
Project Execution Plan and Checklist

Minimum Modeling Matrix (M3)

KnowledgeSmart
Minimum Modeling Matrix “M3”

- 01. Instructions
- 02. Modeling Requirements
- 03. Scope- LOD- Grade
01.Instructions

- Basic Functionality/ Features

**GENERAL INSTRUCTIONS**

1. Modify Column F on Tab "03. Scope-LOD-Grade" to indicate the Elements included in the Project scope.
2. Filters are available to sort and limit column data in the table.
3. Discipline and Notes columns available as a convenience and are not a contractual requirement.
4. Bi-directional hyperlinks are available in column headers, Element IDs and Modeling Requirements.
Understanding the Organization

- Classification structure

<table>
<thead>
<tr>
<th>Level</th>
<th>Element ID</th>
<th>OmniClass ID</th>
<th>UniFormat ID</th>
<th>MasterFormat ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td><strong>SUBSTRUCTURE</strong></td>
<td>21-01 00 00</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Level 2</td>
<td>Foundations</td>
<td>21-01 10</td>
<td>A10</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>Standard Foundations</td>
<td>21-01 10</td>
<td>A1010</td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td>Wall Foundations</td>
<td>21-01 10 10</td>
<td>A1010.10</td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td>Column Foundations</td>
<td>21-01 10 10 10</td>
<td>A1010.30</td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td>Standard Foundation Supplementary Components</td>
<td>21-01 10 10 30</td>
<td>A1010.90</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>Special Foundations</td>
<td>21-01 10 20</td>
<td>A1020</td>
<td>31 60 00</td>
</tr>
<tr>
<td>Level 4</td>
<td>Driven Piles</td>
<td>21-01 10 20 10</td>
<td>A1020.10</td>
<td>31 62 00</td>
</tr>
<tr>
<td>Level 4</td>
<td>Bored Piles</td>
<td>21-01 10 20 15</td>
<td>A1020.15</td>
<td>31 63 00</td>
</tr>
<tr>
<td>Level 4</td>
<td>Caissons</td>
<td>21-01 10 20 20</td>
<td>A1020.20</td>
<td>31 64 00</td>
</tr>
<tr>
<td>Level 4</td>
<td>Special Foundation Walls</td>
<td>21-01 10 20 30</td>
<td>A1020.30</td>
<td>31 66 16</td>
</tr>
<tr>
<td>Level 4</td>
<td>Foundation Anchors</td>
<td>21-01 10 20 40</td>
<td>A1020.40</td>
<td>31 68 00</td>
</tr>
</tbody>
</table>
Definitions: Level of Development

- Unique to the USACE requirements
- To what degree of accuracy is the information being provided?

### LEVEL OF DEVELOPMENT DEFINITIONS (ACCURACY)

The following LOD descriptions identify the specific element requirements for each Model Element.

<table>
<thead>
<tr>
<th>LOD</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Refer to the specific child element for appropriate LOD. (Used for categories that have multiple sub-elements for which varying LOD apply.)</td>
</tr>
<tr>
<td>100</td>
<td>Model Elements indicative of area, height, volume, location, and orientation may be modeled in three dimensions or represented by other data. (i.e., a pump would be a cube)</td>
</tr>
<tr>
<td>200</td>
<td>Model Elements are modeled as generalized systems or assemblies with approximate quantities, size, shape, location, and orientation. Non-geometric information may also be attached to Model Elements. (i.e., a pump would be a generic pump of approximate size.)</td>
</tr>
<tr>
<td>300</td>
<td>Model Elements are modeled as specific assemblies accurate in terms of quantity, size, shape, location, and orientation. Non-geometric information may also be attached to Model Elements. Accurate to the degree dimensioned or indicated on contract documents. (i.e., a pump would be a generic pump of accurate size complete with connections and clearances for a complete system.)</td>
</tr>
</tbody>
</table>
Definitions: Element Grade

- What format is the content supposed to be delivered in?

**ELEMENT GRADE DEFINITIONS (FORMAT)**

Within each Level of Development, there is the potential to represent information in various formats. In practice, it has been proven that there are certain elements for which there is a greater benefit in providing 3-dimensional representation, while in others drafting or representation in the form of narratives is sufficient for a particular deliverable.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3D + Facility Data</td>
</tr>
<tr>
<td>B</td>
<td>2D + Facility Data</td>
</tr>
<tr>
<td>C</td>
<td>2D Only (Drafting, linework, text, and or part of an assembly)</td>
</tr>
<tr>
<td>+</td>
<td>Original Grade (A, B, or C) adjusted for contract changes and field conditions.</td>
</tr>
<tr>
<td>-</td>
<td>Not included in or tied to the model (however is still required in the deliverable)</td>
</tr>
<tr>
<td>⚪</td>
<td>Refer to the specific child element for appropriate Grade. (Used for categories that have multiple sub-elements for which varying Grades apply.)</td>
</tr>
</tbody>
</table>
02. Modeling Requirements

- Covers elements at Levels 01 and 02 of classification
  - A-Substructure
  - B-Shell
  - C-Interiors
  - D-Services
  - E-Equipment & Furnishings
  - F-Special Construction & Demolition
  - G-Sitework
- These work IN TANDEM with the LODs prescribed in tab 03.
<table>
<thead>
<tr>
<th>Level</th>
<th>Element ID</th>
<th>OmniClass</th>
<th>UniFormat</th>
<th>MasterFormat</th>
<th>GRADE (CD)</th>
<th>GRADE (AB)</th>
<th>Primary Discipline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Substructure</td>
<td>21-01:00:00</td>
<td>A</td>
<td></td>
<td>Yes</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Level 2</td>
<td>Foundations</td>
<td>21-01:10</td>
<td>A10</td>
<td></td>
<td>Yes</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Level 2</td>
<td>Standard Foundations</td>
<td>21-01:10</td>
<td>A1010</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 2</td>
<td>Wall Foundations</td>
<td>21-01:10</td>
<td>A1010:10</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 2</td>
<td>Column Foundations</td>
<td>21-01:10</td>
<td>A1010:30</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 2</td>
<td>Standard Foundation Supplementary Components</td>
<td>21-01:10</td>
<td>A1010:60</td>
<td></td>
<td></td>
<td>200</td>
<td>C</td>
</tr>
<tr>
<td>Level 3</td>
<td>Special Foundations</td>
<td>21-01:10</td>
<td>A2020</td>
<td></td>
<td>Yes</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Level 3</td>
<td>Driven Piles</td>
<td>21-01:10:20:10</td>
<td>A1020:10</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 3</td>
<td>Bored Piles</td>
<td>21-01:10:20:15</td>
<td>A1020:15</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 3</td>
<td>Caissons</td>
<td>21-01:10</td>
<td>A2020:20</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 4</td>
<td>Special Foundation Walls</td>
<td>21-01:10</td>
<td>A2020:30</td>
<td></td>
<td>Yes</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Level 4</td>
<td>Foundation Anchors</td>
<td>21-01:10</td>
<td>A2020:60</td>
<td></td>
<td>Yes</td>
<td>300</td>
<td>A</td>
</tr>
<tr>
<td>Level 4</td>
<td>Underpinning</td>
<td>21-01:10</td>
<td>A2020:50</td>
<td></td>
<td>Yes</td>
<td>300</td>
<td>C</td>
</tr>
<tr>
<td>Level 4</td>
<td>Raft Foundations</td>
<td>21-01:10</td>
<td>A2020:60</td>
<td></td>
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<td>300</td>
<td>A</td>
</tr>
<tr>
<td>Level 4</td>
<td>Pile Caps</td>
<td>21-01:10</td>
<td>A2020:70</td>
<td></td>
<td>Yes</td>
<td>300</td>
<td>A</td>
</tr>
<tr>
<td>Level 4</td>
<td>Grade Beams</td>
<td>21-01:10</td>
<td>A2020:80</td>
<td></td>
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<td>300</td>
<td>A</td>
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<tr>
<td>Level 2</td>
<td>Subgrade Enclosures</td>
<td>21-01:20</td>
<td>A20</td>
<td></td>
<td>Yes</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Level 4</td>
<td>Subgrade Enclosure Wall Construction</td>
<td>21-01:20:10</td>
<td>A2010:10</td>
<td></td>
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<td>300</td>
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</table>
Breaking Down the M3

<table>
<thead>
<tr>
<th>REQUIRED LEVEL OF DEVELOPMENT</th>
<th>COUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>62</td>
</tr>
<tr>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>13</td>
</tr>
<tr>
<td>B</td>
<td>17</td>
</tr>
<tr>
<td>C</td>
<td>31</td>
</tr>
<tr>
<td>200</td>
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</tr>
<tr>
<td>A</td>
<td>89</td>
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<tr>
<td>B</td>
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<tr>
<td>C</td>
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<td>245</td>
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<tr>
<td>A</td>
<td>226</td>
</tr>
<tr>
<td>B</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td>Grand Total</td>
<td>502</td>
</tr>
</tbody>
</table>
Site Information Modeling (SIM) Initiative

- Site/Infrastructure Design
- Survey/Mapping/LIDAR/DTM
- Landscape Architecture
- Surface and Subsurface Utilities

Also known as
- ‘BIM’ for Civil Works
- Civil Works Information Modeling
- Infrastructure Information Modeling
KnowledgeSmart Initiative

- ‘USACE BIM Contract Requirements’ Module
- Assessment comprised of questions relating to Contract Language, the PxP and the M3.
- What USACE wants the industry to know
- Potential use as a differentiator on an RFP response
Where to get great information

Where to get great information

BIM LINKS

- Tri-Service Workspace
- REVIT Templates
- USACE BIM Roadmap
- BIM Contract Requirements
- BIM Primer

2012 USACE BIM Revit Templates Version 1.1 June 2012
- USACE Revit 2012 Template - All Disciplines v1.1
- USACE Revit 2012 Template - Architectural v1.1
- USACE Revit 2012 Template - Electrical v1.1
- USACE Revit 2012 Template - Mechanical v1.1
- USACE Revit 2012 Template - Structural v1.1

User Guides for Version 1.1 June 2012
- USACE Revit 2012 Template README
- Guide - USACE Revit 2012 - Architectural
- Guide - USACE Revit 2012 - Electrical
- Guide - USACE Revit 2012 - Mechanical
- Guide - USACE Revit 2012 - Structural

US Army Corps of Engineers

US Army Corps of Engineers Building Information Modeling Template for Revit
Template based on the 2012 Autodesk Revit Software

Architectural Template v1.1
- June 2012

Structural Template v1.1
- June 2012

Electrical Template v1.1
- June 2012

Mechanical Template v1.1
- June 2012
For more information on the USACE BIM Contract Language, the PxP, or the M3, please contact Steve Hutsell or Van Woods.

Steve.Hutsell@usace.army.mil
Van.Woods@usace.army.mil
Questions & Answers

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Black & Veatch
fosters@bv.com
@kcflatlander (Twitter)