Building Information Modeling (BIM)

Development Criteria and Standards
for
Design & Construction Projects

CITY OF SAN ANTONIO

CoSA BIM Standards

January 21, 2011

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for
Design & Construction Projects

CoSA BIM Standards

Developed By:

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San Antonio, Texas

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City of San Antonio
Capital Improvements Management Services (CIMS)

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ARTICLE 1.
INTRODUCTION

1.1 Overview

BIM Standards for the City of San Antonio (CoSA) Building Projects have been developed to define a process and establish requirements, procedures, and protocol for the utilization of BIM in the various stages of CoSA's design and construction building projects. These Standards are based upon the National Building Information Standards (NBIMS) and reference the current technology Standards developed by the General Services Administration (GSA), the U.S. Army Corps of Engineers (USACE), Industry Foundation Class (IFC) by the International Alliance for Interoperability (IAI), OmniClass Construction Classification (OmniClass) as developed by the Construction Specifications Institute (CSI), the Department of Veteran Affairs (VA), and the Pennsylvania State University.

1.2 City of San Antonio - Building Information Modeling (BIM) Life Cycle Vision

The City of San Antonio (CoSA) has determined that Building Information Modeling (BIM) represents both an enhanced technology and a process change for the architecture-engineering-construction-facilities management industry. CoSA is committed to moving both the City and its service providers to BIM as effectively and efficiently as possible, and to integrating BIM process requirements into its design and construction delivery requirements of their buildings.

The goal of CoSA's implementation of BIM is to deliver higher value projects and maximize lifecycle building maintenance and performance. The digitization of building data will improve the design, construction, and facility management of CoSA buildings across their lifecycles—from concept to design to construction to operations to reuse and eventual demolition/replacement. Standardized building data available electronically will help the CoSA implement better ways to design, construct, and manage its facilities in the future.

To achieve this vision, CoSA will require Industry Foundation Classes (IFC)-compliant BIM authoring tools be used as the architectural/engineering software for all major construction and renovation projects (capital projects) appropriated over $3M in construction value. This guidance shall apply to design and construction undertaken by all architects, engineers, other consultants, contractors, and subcontractors for these projects.

1.3 Main Objectives of CoSA Building Information Modeling Standards

The intent of the CoSA BIM Standards is to facilitate the use of BIM technologies and workflow to achieve the following goals:

1. Facilitate a collaborative project environment between all stakeholders from project inception to construction completion through the life cycle facility management of the facility
2. Execute coordinated project A-E design documents using the 3D modeling and parametric features of BIM with building information integrated into the model
3. Improve visualization of the "virtual" building environment
4. Increase the speed of delivery through efficiency – both in design and construction
5. Improved building system coordination and the execution of design intent in the field to streamline the construction processes and minimize change orders
6. Overall reduction in the construction costs and future life cycle maintenance costs
7. Provide CoSA's Facility Management personnel with a "virtually" constructed, information rich, accurate, as-built quality model linked with the building information of all building elements and systems to use as a tool to more efficiently manage, maintain, and renovate the facility for the life cycle of the building

1.4 Ownership Rights of the Data and Model

For all City of San Antonio projects, CoSA has full ownership rights to all data, documents, models, and other deliverables developed and provided by the A/E designers and construction contractors in accordance with the applicable provisions of the City of San Antonio A-E Design and Construction Contracts. All BIM models shall be conveyed and transmitted to various other parties as prescribed and required in this Exhibit. All electronic data related to the project shall be secured as required by this Exhibit.

ARTICLE 2.
BIM PROJECT REQUIREMENTS, STANDARDS, PERFORMANCE CRITERIA, INFORMATION INTEGRATION

2.1 General

The following section establishes the minimum requirements, elements, and information that must be contained in the BIM model. The CoSA BIM Standards will include requirements for development of the 3D BIM model and for the generation of the 2D design and construction document drawing sheets using standardized templates. Mandatory BIM project requirements shall include the modeling, visualization, documentation, building information content, and analytic processes of the building design and shall assist in validating the material quantities and construction cost of the project.

The principal objective of incorporating BIM is to improve the quality of the design solutions and expedite the sequence of construction. The CoSA BIM Standards will result in projects achieving a higher level of consistency, quality, accuracy, and completeness. The required project information shall be kept within a single database file.

CoSA will be using the OmniClass table structure to classify attributes of the model (i.e. Labeling / Identifying Spaces, Work Results and Products, Phases and Disciplines). These categories are identified throughout this standard. For detailed information, use OmniClass link www.**omniclass**.org

2.2 Technology Platform and Software

CoSA only accepts true 3D solid modeling, object oriented software applications that comply with current industry interoperability standards and are able to be used in a collaborative environment. All software platforms used for CoSA projects MUST be compliant with:

1. Most current software version /release
2. Most current version of Industry Foundation Classes (IFC) file format
3. Most current version of collaboration software providing interoperability between the software applications

2.3 Approved BIM Software for CoSA Building Projects (no exceptions and/or alternates):

Authoring – Autodesk Revit Architecture, Autodesk Revit Structure, Autodesk Revit MEP
Authoring – Autodesk Civil 3D
Coordination and Clash Detection – Autodesk Navisworks Manage
Scheduling and Sequencing Reviews – Autodesk Navisworks Manage
Owner Viewing – Autodesk Design Review and Navisworks Freedom

* Traditional 2D documentation shall be prepared with approved IFC Compliant BIM Authoring Software and, as such, the expectation shall be that plans, elevations, sections, schedules, and details are fully coordinated with the concurrent building model. All other documents are to be submitted per the contract requirements.

2.4 Modeling Requirements

1. The BIM shall be used for all site and building systems design, development, and analysis, including but not limited to architectural, structural, mechanical, electrical, plumbing, and fire suppression, etc.
2. Use BIM authoring software element libraries when creating model objects. Model objects shall contain parts and components as opposed to simple 3D Geometry (i.e. walls, doors, windows, railings, stairs, furniture).
3. Model objects shall contain IFC parameters and associated data applicable to building system requirements. These elements shall support the analytic process include size, material, location, mounting heights, and system information where applicable. (As an example, a light fixture may contain several parameters such as energy output requirements, user illumination levels, make, model, manufacturer, bulb life).
4. Sustainable design principles and LEED Credit Documentation shall be included in the BIM.
5. Submittal drawings, calculations and analysis shall be extracted from the Project BIM.

2.5 Drawing Requirements
Drawing requirements pertain to the standards for 2D output from the BIM model such as file naming, linework, font styles, titleblocks, symbols, text styles, template conformance, printing requirements, and other CoSA standard content.

2.6 Types of Model Elements
Model elements shall be derived from the following sources – all model elements shall be accurate and shall include all required information and IFC parameters:

1. Manufacturer's Model Elements - elements created by and acquired from manufacturers. It is the author's responsibility to display the appropriate level of detail for the design element. Embedded performance data shall remain for analysis and specification purposes.
2. Custom Created Model Elements - model elements created by the model author must utilize appropriate BIM Authoring tool templates to create custom elements. Custom models components need to be assigned as a part and part of a family or group.

2.7 Model Based Quantity Take-Off
CoSA will require model development to the degree of accuracy required to allow accurate and reliable model based material quantity take-offs.

2.8 Specifications
CoSA will not require direct model linkage to specifications at this time. CoSA will require the As-Bid Specifications to be linked to the model in the form of interactive Data Sheets and the Contractor Submitted/Reviewed/Approved Product and System Specifications (all building element data incorporated into the construction) to be linked into the model in the form of interactive Data Sheets.

2.9 Data Security
The Project Data and the Model are considered Confidential Information and all parties associated with this Project agree to keep all Project information strictly confidential and not disclose, nor share any of the information with any other party unless specifically requested in writing and approved in writing by the City of San Antonio.

All Project Data associated with this Project shall be securely stored and protected from unauthorized access, distribution, or use. All Project Data shall be backed-up electronically on a regular and consistent basis throughout all Phases of the Project to prevent loss of Data or cause harm to the City of San Antonio in the form of delays to the Project completion dates as required in the design and construction contracts.

2.10 Program Spatial Requirements

1. Spatial data generated and associated with bounding elements (walls, doors, windows, floors, ceilings).
2. Space/area schedules and diagrams must be dynamically updated from the model geometry.
3. Spatial Requirements must be validated using BIM Technology.
4. Each space shall include the following spatial information:
   - Space type – OmniClass (Table 13)
   - Space number – OmniClass (Table 14)
   - Space name
   - Space description
   - Space area

2.11 As-Built BIM
The Building Information Model must be updated continuously throughout the construction phase to an as-built level of development and must include all RFIs, change orders, and as-built/as-constructed conditions. Per the Contract Requirements, the Construction Contractor must submit the as-built BIM to CoSA. The as-built BIM shall include the following:

1. All as-built changes requiring model updating
2. Linking of all building information into the model including; specific materials, products, and systems

3. Close-Out documents including; submittals, warranties, O&M manuals at a minimum unless otherwise required

* Separately, provide any other fabrication models prepared by sub-contractors

2.12 Applications of BIM

BIM output can be utilized in a variety of ways to provide stakeholders with a greater understand of how a building is to be used, designed, and constructed. The various applications in which BIM shall be utilized for all CoSA BIM Standard projects shall be as follows:

2.12.1 Pre-Design and Programming

Programming Requirements which shall define space and adjacency requirements shall be adhered to for individual projects. Where possible, all programming and existing as-built data provided by CoSA will be in a format that is fully translatable to an IFC Compliant BIM Authoring Tool and shall be expected to be incorporated by the Design Teams into their design processes for reference and verification purposes. The Design Teams shall incorporate OmniClass tables 13 (Spaces by Function) and 14 (Spaces by Form) into the As-Built Models as required by each individual project.

2.12.2 Design-Build Projects

As a major component of the RFP competition phase of each project, all competing project teams shall incorporate BIM Authoring Tools incorporating As-Built Information, Programming Requirements, and Sustainable Design Requirements into a conceptual design model or more advanced design model depending on the specific requirements of the RFP. Final D-B Team submittals shall be executed in an IFC Compliant BIM Authoring tool with deliverables as defined by CoSA prior to the D-B Team Selection phase. Examples of these deliverables may include massing studies, design visualization renderings, 3D models, and preliminary building performance and cost analysis.

2.12.3 Site Conditions - Existing Conditions and New Construction

For new construction and renovation projects, the modeling of the project site and the existing structures shall be included in the BIM requirements. Depending upon the project site, a model of the site may be obtained from COSA or commissioned by an external consultant using an approved IFC Compliant, 3D Site and Utility Modeling BIM tool. For all projects, the modeling of existing buildings shall be performed based upon CoSA provided as-built information, with field verification or electronic measurements conducted by Design Team to validate the level of accuracy.

For all existing conditions to be directly impacted, altered, or to be demolished by a proposed renovation, Project Design Team shall model those conditions to the appropriate level of detail that will clearly demonstrate the design intent to building stakeholders, other Project Team Members, and construction trades directly involved with executing this change.

Proposed site conditions shall reference existing benchmarks, and reference existing surveys and GIS mapping systems for accuracy. New site and utility conditions shall be modeled in 3D, and shall coordinate the system and spatial models three dimensionally. Where other systems are directly impacted by landscape features (i.e. vegetation, irrigation), those elements shall be modeled with correct size and clearance requirements in BIM.

2.12.4 Architectural Model - Spatial and Material Design Models

The Architectural spatial model evolves during the design process, and the information modeled in BIM shall be further refined as a project progresses toward construction. In the early phases of design, an Architectural BIM Model may be as simple as a massing model validating program requirements, basic geometries, and building orientation to climate and site conditions. See Article 3: BIM Protocol for specific LOD requirements. As the design progresses, design options shall develop and will need to be clearly documented and delineated in the BIM model. Likewise, as materials and components are selected, generic assemblies shall be assigned material properties, sizes, track LEED values, and other specific component information to clearly define the various building features such as walls, floors, roofs, doors and windows. Program space requirements shall be modeled in the spatial model

and validated using schedules. The Design Teams shall incorporate OmniClass tables 13 (Spaces by Function) and 14 (Spaces by Form) into the Models at the Model Element Level.

2.12.5 System Models - Structural and MEP Design

With current technology, building systems are best organized as separate BIM models linked to a common project origin point or benchmark for efficient and accurate coordination purposes. Similar to the spatial models, the level of detail in these models shall evolve as design progresses such that these systems are accurately modeled, and include sufficient performance, clearance, and LEED requirements as part of the BIM. See Article 3: BIM Protocol for specific LOD requirements.

2.12.6 Scheduling and Sequencing

The construction planning process mandates the sequencing of activities in space and time and accounting for constraints such as procurement lead time/logistics, resources, spatial constraints, and weather among others. Traditional scheduling methods do not address the spatial aspect to the construction activities nor are they directly linked to a design or building model. Traditional bar charts or Critical Path Method Network Diagram can be difficult to understand or interpret. Having the ability to watch the elements of a design come together onscreen gives the design and construction team improved accuracy in construction sequencing. The primary elements COSA requires for construction simulation and sequencing shall be as follows:

- Structural System - All structural framing components including foundations, grade beams, columns, load bearing walls, floor and roof decks and support
- Exterior Building Envelope - Stud walls, Exterior Panels and assemblies, curtain walls, openings, glazing
- Interior Partitions - Main plumbing walls and wall assemblies
- Mechanical System - Main Ductwork and Equipment, (Separated by floors)
- Roof Systems - Roof Assemblies, Major Equipment, Openings
- Plumbing - Main Connection lines from site, main plumbing lines
- Site Work and Ground Plane - Excavation work, footings, foundations, on-grade slab
- Site Logistics Planning (optional) - Site layout, safety access, and coordination

The optimal process in scheduling is to import schedule activity data from a scheduling application such as Primavera P3/P6 into a dedicated scheduling application and “link” the activity data to the associated object in a 3D model at 100% Design Development and 100% Construction Documents submittals. The result is a BIM model which provides a value advantage to the Design and Construction Teams for better visualization and coordination of the construction sequence for the respective trades. Construction Contractor shall link the BIM to the approved construction schedule. Models and their elements must be in concert with the Project Schedule at each Milestone Level. Construction Team is encouraged to incorporate OmniClass tables 31 (Phases) and 33 (Disciplines) into the As-Built Models at the Model Element Level.

2.12.7 Design Visualization

Design Visualization tools refer to animations, fly-throughs, and static 3D renderings exported directly from a BIM Authoring Tool. The Design Team shall participate in providing the quality design visualizations that illustrate building spaces, their use and organization, to assist stakeholders in making decisions throughout the project duration. It should be noted that even though the BIMs contain most of the source information needed for visualization, they may require further refinement in specific animation and visualization software to accomplish intended results.

ARTICLE 3.
BUILDING INFORMATION MODEL PROTOCOL

3.1 General

Using the AIA Document E201-2007 and the AIA Document E202-2008 as the standard, the following section outlines the protocols for managing the use of the Building Information Model (BIM), outlines the requirements for model content at progressive levels of development, authorizes the use of the BIM, and assigns the specific responsibility for development of each model element to a defined Level of Development at each Project phase. In addition, the following section defines the extent to which model users may rely on model content, clarifies model ownership, sets forth BIM standards, file formats, and provides the scope of responsibility for model management from the beginning to the end of the project.

3.2 Definitions

Building Information Model (BIM) – BIM is a digital representation of the physical and functional characteristics of the Project and may be referenced as the BIM or the Model. Building Information Modeling means the process and technology used to create the Model.

Level of Development (LOD) – LOD describes the level of completeness to which the Model Elements are developed.

Linking – Electronic data organized into separate information categories (ie. submittal data, operations and maintenance information, warranties, replacement parts, installation information, etc.) attached to all building components within the Autodesk Revit model from an external database.

Model Elements – Model Elements are a portion of the BIM representing components, systems, or assemblies within the building or site. Model Elements are represented by the Construction Specifications Institute (CSI) UniFormat classification system in the Model Element.

Model Element Author – the Model Element Author is the party responsible for developing the content of a specific Model Element to the LOD required for a particular phase of the Project. The Model Element Author is liable for the completeness, accuracy, and information quality of the Model Elements they generate and are responsible for.

Model User – the Model User refers to any individual or entity authorized to use the Model on the Project, such as for analysis, estimating, or scheduling.

3.3 Transmission of Data and Models

The transmission of the Digital Data and the Model constitutes a warranty by the Transmitting Party to the Receiving Party that the Transmitting Party has reviewed and coordinated the content, and is fully liable for the accuracy, completeness, and usability of the information. All transmission of Data and Models shall be in electronic media using the most current version of the software required in this Exhibit.

The transmission of Data and the Model is considered Confidential Information and both the Transmitting Party and the Receiving Party agree to keep all the transmitted information strictly confidential and not disclose, nor share any of the information with any other party unless specifically requested in writing and approved in writing by the City of San Antonio.

Use, modification, and further transmission of the Data and the Model is specifically limited to the design and construction of this Project and is intended strictly for use on this specific Project. To the fullest extent permitted under law, the Receiving Party shall indemnify and defend the Transmitting Party from and against all claims arising from or related to the Receiving Party's unauthorized modification, or unlicensed use of the Data and Model.

3.4 Defined Levels of Development (LOD)
The Level of Development (LOD) descriptions identify the specific content requirements and associated authorized uses for each Model Element at five progressively detailed level of completeness. Each subsequent LOD builds on the previous level and includes all the characteristics of previous levels.

3.4.1 LOD 150
Schematic Model – content requirements include overall building massing, defining the building envelop, including all window openings and doorways. Model shall be indicative of area, height, volume, orientation, and location. All building areas and spaces shall be indicated with walls, floors, and ceilings. Limited data/information linked to model. Model may be analyzed based on volume, area, orientation by application of general performance criteria. Model may be used to study the organization of the building design, massing effect on the site, and building relationship to surrounding buildings and area.

3.4.2 LOD 200
Generalized System Model – content requirements include model elements modeled as generalized systems and assemblies with approximate quantities, size shape, location, and orientation. Non-geometric information shall be attached to the Model Elements. Model may be used to develop cost estimates based on approximate data and conceptual estimating techniques. Model may be used to show ordered, time-scaled appearance of major systems. Additional authorized uses include; general code review, project phasing, and constructability reviews can be developed from the model.

3.4.3 LOD 300
Assembly Accurate Model – content requirements include model elements modeled as specific assemblies accurate in terms of quantity, size, shape, location, and orientation. Non-geometric information shall be attached to the Model Elements. Model is suitable for the generation of traditional 2D Construction Documents and shop drawings. Model may be used to develop detailed cost estimates based on specific data. Additional authorized uses include; constructability reviews, clash detection testing and reports, and visualization.

3.4.4 LOD 400
Fabrication, Assembly, and Detailing Model – content requirements include model elements modeled as virtual representations of the proposed elements and are suitable for construction. Element data and information shall be attached to the Model Elements. Model may be used to develop actual cost of specific elements at buyout.

3.4.5 LOD 500
As-Built Model – content requirements include model elements modeled as constructed assemblies actual and accurate in terms of size, shape, location, quantity, and orientation. Element data and information shall be attached to the Model Elements. Model may be used to maintain, alter, and add to the existing building/facility. Model may be used for accessing building information in a central building element data repository linked to the model for viewing Project information, close-out documents, operations & maintenance manuals, warranties, etc.

3.5 Authorized Uses of the Model
Model may be used for visualization, building analysis, cost estimating, schedule review, constructability review, clash detection, and other specific uses as identified under each Level of Development (LOD) description. Model Users assume all risk for use of the Model in a manner not prescribed under each LOD.

3.6 Specific Responsibility for Development of Model Elements
Model Element development and the Model Element Author have been identified in the attached Model Element Table. Each Model Element Author is responsible for assuring the accuracy, completeness, and validity of all Model Elements they have been assigned. The Model will be shared with subsequent Model users and Model Element Authors and therefore it is required that each Model Element Author develop the Model with the standard of care commensurate with this sharing and reliance on previously developed effort and data.

3.7 Protocol

3.7.1 Coordination and Conflict Resolution
Where conflicts are found in the Model, regardless of the phase of the Project or LOD, the discovering party shall promptly notify the Model Element Author(s) and upon such notification, the Model Element Author(s) shall act promptly to mitigate the conflict and correct the conflict and all Model Elements affected.

3.7.2 Model Ownership
The City of San Antonio maintains all ownership rights to the Model. In contributing content to the Model, the various Model Element Authors acknowledge and accept this point. Model Users are granted the right to use, modify, and transmit the Model as specifically limited to the design and construction of the Project. Nothing in this Exhibit conveys any right to use the Model for any other purpose.

3.7.3 Model Requirements
The Model shall be developed in accordance with the BIM Standards established by the City of San Antonio as set forth for; 1) naming conventions (file naming, family naming, view naming, workset naming), 2) graphic standards (text, dimensions), 3) common symbology, 4) file formats (Autodesk – most current version), and 5) linking methods.

3.7.4 Electronic Documents Required to be Linked to the Design BIM Model
At a minimum, the following list of the building information shall be linked in electronic format to the BIM by the Design Team:

Construction Document Specifications (as included in Bid Set)
Construction Document Drawings (as included in Bid Set)
Geotechnical Engineering Report & Soil Boring Analysis
Environmental Site Analysis (ESA Phase I, II, or III)
Addendum (as included in Bid Set)
LEED Related Design Credits & Construction Credits

3.7.5 Model Management
During the Design Phase, the Architect or Engineer will be responsible for managing the Model from the inception of the Project up until the point when the Construction Contract has been awarded. At that point, during the Construction Phase, the Construction Contractor will assume responsibility for managing the Model through construction of the Project up until the point when the Model is transmitted to the City of San Antonio. During the Facility Management Phase, the City of San Antonio will be responsible for managing the Model.

As directed by the City of San Antonio, the Independent Information Manager will provide Quality Assurance and Validation services to confirm the Model is being developed and maintained according to the BIM Standards and Best Practices established by the City of San Antonio. During the various phases of the Project, the Independent Information Manager will validate the Model and associated files as to their completeness, accuracy, usability, content, required information, and are in compliance with applicable protocols.

3.7.6 Model Archives and Submission Requirements
The party responsible for Model Management for each Phase of the Project shall produce a Model archive consisting of two sets of files; 1) the first set of files shall be a collective of individual Models as received from the Model Element Author(s), and 2) the second set of files shall consist of the aggregate of those individual Models saved in the most current version/release of Autodesk Revit (.RVT). In addition, provide 3-dimensional Autodesk Design Web Format (.DWF) of the Model and 2-dimensional multi-page Autodesk Design Web Format (.DWF) of all drawing sheets.

3.8 Project BIM Execution Plan
Both the Design Team and the Construction Team shall submit a detailed “BIM Execution Plan” upon Contract Award, and before issuance of Notice to Proceed, which shall contain the following information:

1. Design Team qualifications and experience in BIM, and a list of individuals with relevant experience assigned to the following roles:
    a. Design BIM Manager
    b. Lead BIM Technicians for all major disciplines (i.e. Architect, Civil, MEP, Structural)
    c. Senior Project Designers and Engineers
    d. BIM and IT Managers
2. Construction Team qualifications and experience in BIM, and a list of individuals with relevant experience assigned to the following roles:
    a. Construction BIM Manager
    b. Lead BIM Technicians for all major trades (i.e. Architect, Civil, MEP, Structural)
    c. BIM and IT Managers for all applicable trades
    d. Lead Fabrication Modelers for all trades
3. Project Schedule including the following:
    a. Progress BIMs per Design Document Submission Standards
    b. Proposed BIM Workshops and Training integrated in to project schedule
    c. Documentation of any proposed deviation from BIM Standards for CoSA consideration
    d. Roles and Responsibilities Matrix
4. Strategy for compliance with CoSA BIM Project Requirements
5. Proposed strategy for utilizing BIM during design
6. Proposed computer hardware and BIM Software to be used
7. Strategy for establishing and managing shared file server
8. File exchange protocol
9. File formats to be used for project submittal and file exchange
10. Strategy for updating and coordinating changes during design and construction using
11. Proposed strategy for utilizing BIM during construction
12. BIM Proposed utilization of Scheduling and Sequencing technology
13. Proposed use of digital fabrication to validate constructability of design
14. Updating as-built conditions and integrating of record information in to As-Built (Record) BIM

3.9 BIM Roles and Responsibilities

It is the responsibility of all Design Consultants and Contractors to have or obtain, at their cost, the trained personnel, hardware, and software needed to successfully complete the BIM requirements of the Project. Equipment used by all parties must meet the requirements of the software being implemented so as not to cause delays in modeling and redraw. Individuals assigned to the following project roles shall have the minimum qualifications and responsibilities outlined in this Exhibit.

3.9.1 Design BIM Manager and Construction BIM Manager

As part of the Project requirements, both the Design and Construction Teams shall assign an individual to the role of BIM Manager (DBM & CBM). It is strongly recommended that this individual have previous on-site construction experience as Project Manager, Assistant Project Manager, or Project Engineer. Additionally, the individual shall have at least 2 years of BIM experience and shall have relevant proficiency in proposed BIM Authoring and Coordination Software. This individual and their qualifications shall be approved by CoSA.

Assigned responsibilities shall be as follows:

1. Ensure compliance with BIM Work Plan
2. Coordinate set up of shared file server with CoSA
3. Provide Modeling Quality Control Check of Design or Construction BIMs.
4. Facilitates use of composite models in coordination meetings
5. Ensures that BIMs are used appropriately to test design requirements / criteria
6. Facilitate BIM Technical & Coordination meetings with Lead BIM Technicians
7. Ensure Design Team understands, supports, and meets CoSA's Vision and Main Objectives for BIM
8. Ensure the Project geo-reference points are distributed and used by ALL team members.
9. Interfaces with Independent Information Manager for data and file exchange as needed
10. Coordinate BIM File Exchange and archiving of Milestone Submittals

11. Coordinates software training and establishes protocol for efficient use of software for Construction Team
12. Prior to commencing construction, integrates Sequencing and Scheduling with Fully Coordinated BIMs.
13. Coordinate with Construction BIM Team to ensure changes in the field have been documented and are updated in the As-Built BIM in a timely manner

3.9.2 Lead BIM Technicians

1. Each major design discipline and construction subcontractor shall assign an individual to the role of Lead BIM Technician for the duration of the project. These individuals shall have at least 2 years of relevant BIM experience
2. Maintain and manage integrity of discipline model including:
    a. modeling requirements per BIM Standards
    b. file exchange between other disciplines
    c. upload of models to file exchange server
    d. preparation of model for coordination review
3. Ensure development and documentation of clash resolution
    a. Continuous interface with Design BIM Manager or Construction BIM Manager
    b. Participation in coordination and BIM technology meetings
    c. Coordinate internal project team training as required

3.10 Model Elements

The Model Element Table included in this Exhibit identifies the LOD required for each Model Element at the end of each Project Phase and the Model Element Author responsible for developing the Model Element to the LOD identified. Each Model Element Author's content is intended to be shared with subsequent Model Element Authors and Model Users throughout the course of the Project.

It is understood that subsequent Model Users and Model Element Authors may rely on the accuracy and completeness of a Model Element consistent with the content required for each LOD. Any use of, or reliance on, a Model Element inconsistent with the LOD by subsequent shall be at their sole risk and without liability to the previous Model Element Author.

Abbreviations for each Model Element Author (MEA) to be used in the Model Element Table are as follows:

A	Architect
SE	Structural Engineer
ME	Mechanical Engineer
EE	Electrical Engineer
CE	Civil Engineer
C	Contractor (Construction)

3.11 Model Element and Author Table

Model Elements shall be developed to the LOD identified at the end of each Project Phase by the Model Element Author (MEA) identified as being responsible for developing each identified Model Element. If specific Model Element(s) have not been identified in the attached Model Element Table, development should generally be as follows; LOD 200 for Schematic Design and Design Development Phases, LOD 300 for Construction Documents Phase, LOD 400 during Construction Phase, LOD 500 at completion of Construction Phase for the Record BIM in preparation of transmitting the Model to the City of San Antonio for use during the Life Cycle Facility Management of the building/facility.

Model Element Table - Utilizing CSI UniFormat as follows: (adapted from AIA E202 - 2008)

Abbreviations for each MEA to be used are as follows:

PD	Prime Designer
DC	Design Consultant
PC	Prime Contractor

TC	Trade Contractor
S	Suppliers

Phase Abbreviations:

SD	Schematic Design
DD	Design Development
CD	Construction Documents
CON	Construction

						SD		DD		CD		CON	
						LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA
A	**SUBSTRUCTURE**	A10	Foundations	A1010	Standard Foundations	150	DC	200	DC	300	DC	400	TC
				A1020	Special Foundations	150	DC	200	DC	300	DC	400	TC
				A1030	Slab on Grade	150	DC	200	DC	300	DC	400	TC
		A20	Basement Construction	A2010	Basement Excavation	150	DC	200	DC	300	DC	400	TC
				A2020	Basement Walls	150	DC	200	DC	300	DC	400	TC
B	**SHELL**	B10	Superstructure	B1010	Floor Construction	150	PD	200	DC	300	DC	400	TC
				B1020	Roof Construction	150	PD	200	PD	300	PD	400	TC
		B20	Exterior Enclosure	B2010	Exterior Walls	150	PD	200	PD	300	PD	400	TC
				B2020	Exterior Windows	150	PD	200	PD	300	PD	400	TC
				B2030	Exterior Doors	150	PD	200	PD	300	PD	400	TC
		B30	Roofing	B3010	Roof Coverings	150	PD	200	PD	300	PD	400	TC
				B3020	Roof Openings	150	PD	200	PD	300	PD	400	TC
C	**INTERIORS**	C10	Interior Construction	C1010	Partitions	150	PD	200	PD	300	PD	400	TC
				C1020	Interior Doors	150	PD	200	PD	300	PD	400	TC
				C1030	Fittings	150	PD	200	PD	300	PD	400	TC
		C20	Stairs	C2010	Stair Construction	150	PD	200	PD	300	PD	400	TC
				C2020	Stair Finishes	150	PD	200	PD	300	PD	400	TC
		C30	Interior Finishes	C3010	Wall Finishes	150	PD	200	PD	300	PD	400	TC
				C3020	Floor Finishes	150	PD	200	PD	300	PD	400	TC
				C3030	Ceiling Finishes	150	PD	200	PD	300	PD	400	TC
D	**SERVICES**	D10	Conveying	D1010	Elevators & Lifts	150	PD	200	PD	300	PD	400	TC
				D1020	Escalators & Moving Walks	150	PD	200	PD	300	PD	400	TC
				D1030	Other Conveying Systems	150	PD	200	PD	300	PD	400	TC
		D20	Plumbing	D2010	Plumbing Fixtures	150	PD	200	DC	300	DC	400	TC
				D2020	Domestic Water Distribution	150	DC	200	DC	300	DC	400	TC
				D2030	Sanitary Waste	150	DC	200	DC	300	DC	400	TC
				D2040	Rain Water Drainage	150	DC	200	DC	300	DC	400	TC
				D2090	Other Plumbing Systems	150	DC	200	DC	300	DC	400	TC
		D30	HVAC	D3010	Energy Supply	150	DC	200	DC	300	DC	400	TC
				D3020	Heat Generating Systems	150	DC	200	DC	300	DC	400	TC
				D3030	Cooling Generating Systems	150	DC	200	DC	300	DC	400	TC
				D3040	Distribution Systems	150	DC	200	DC	300	DC	400	TC

				D3050	Terminal & Package Units	150	DC	200	DC	300	DC	400	TC
				D3060	Controls & Instrumentation	150	DC	200	DC	300	DC	400	TC
				D3070	Systems Testing & Balancing	150	DC	200	DC	300	DC	400	TC
				D3090	Other HVAC Systems & Equipment	150	DC	200	DC	300	DC	400	TC
		D40	Fire Protection	D4010	Sprinklers	150	DC	200	DC	300	DC	400	TC
				D4020	Standpipes	150	DC	200	DC	300	DC	400	TC
				D4030	Fire Protection Specialties	150	DC	200	DC	300	DC	400	TC
				D4090	Other Fire Protection Systems	150	DC	200	DC	300	DC	400	TC
		D50	Electrical	D5010	Electrical Service & Distribution	150	DC	200	DC	300	DC	400	TC
				D5020	Lighting and Branch Wiring	150	DC	200	DC	300	DC	400	TC
				D5030	Communications & Security	150	DC	200	DC	300	DC	400	TC
				D5090	Other Electrical Systems	150	DC	200	DC	300	DC	400	TC
E	**EQUIPMENT & FURNISHINGS**	E10	Equipment	E1010	Commercial Equipment	150	DC	200	DC	300	DC	400	TC
				E1020	Institutional Equipment	150	DC	200	DC	300	DC	400	TC
				E1030	Vehicular Equipment	150	DC	200	DC	300	DC	400	TC
				E1090	Other Equipment	150	DC	200	DC	300	DC	400	TC
		E20	Furnishings	E2010	Fixed Furnishings	150	DC	200	DC	300	DC	400	TC
				E2020	Movable Furnishings	150	DC	200	DC	300	DC	400	TC
F	**SPECIAL CONSTRUCTION & DEMO**	F10	Special Construction	F1010	Special Structures	150	DC	200	DC	300	DC	400	TC
				F1020	Integrated Construction	150	DC	200	DC	300	DC	400	TC
				F1030	Special Construction Systems	150	DC	200	DC	300	DC	400	TC
				F1040	Special Facilities	150	DC	200	DC	300	DC	400	TC
				F1050	Special Controls & Instrumentation	150	DC	200	DC	300	DC	400	TC
		F20	Selective Bldg Demo	F2010	Building Elements Demolition	150	DC	200	DC	300	DC	400	TC
				F2020	Hazardous Components Abatement	150	DC	200	DC	300	DC	400	TC
G	**BUILDING SITE WORK**	G10	Site Preparation	G1010	Site Clearing	150	DC	200	DC	300	DC	400	TC
				G1020	Site Demolition & Relocations	150	DC	200	DC	300	DC	400	TC
				G1030	Site Earthwork	150	DC	200	DC	300	DC	400	TC
				G1040	Hazardous Waste Remediation	150	DC	200	DC	300	DC	400	TC
		G20	Site Improvements	G2010	Roadways	150	DC	200	DC	300	DC	400	TC
				G2020	Parking Lots	150	DC	200	DC	300	DC	400	TC
				G2030	Pedestrian Paving	150	DC	200	DC	300	DC	400	TC
				G2040	Site Development	150	DC	200	DC	300	DC	400	TC
				G2050	Landscaping	150	DC	200	DC	300	DC	400	TC

G30	Site Civil/Mechanical Utilities	G3010	Water Supply & Distribution Systems	150	DC	200	DC	300	DC	400	TC
		G3020	Sanitary Sewer Systems	150	DC	200	DC	300	DC	400	TC
		G3030	Storm Sewer System	150	DC	200	DC	300	DC	400	TC
		G3040	Heating Distribution	150	DC	200	DC	300	DC	400	TC
		G3050	Cooling Distribution	150	DC	200	DC	300	DC	400	TC
		G3060	Fuel Distribution	150	DC	200	DC	300	DC	400	TC
		G3090	Other Civil/ Mechanical Utilities	150	DC	200	DC	300	DC	400	TC
G40	Site Electrical Utilities	G4010	Electrical Distribution	150	DC	200	DC	300	DC	400	TC
		G4020	Site Lighting	150	DC	200	DC	300	DC	400	TC
		G4030	Site Communications & Security	150	DC	200	DC	300	DC	400	TC
		G4090	Other Electrical Utilities	150	DC	200	DC	300	DC	400	TC
G50	Other Site Construction	G5010	Service Tunnels	150	DC	200	DC	300	DC	400	TC
		G5090	Other Site Systems & Equipment	150	DC	200	DC	300	DC	400	TC

ARTICLE 4.
INDEPENDENT INFORMATION MANAGER RESPONSIBILITIES

4.1 General

The Information Manager is the CoSA BIM Manager or an independent BIM Commissioning Agent responsible for the Quality Assurance and Validation process during the design and construction phases of the project. This review, oversight, and certification role is necessary to ensure project design and construction teams are adhering to the CoSA BIM Standards and using Best Practices in the development and file exchange of Building Information Models (BIM).

4.2 Quality Assurance and Validation

Quality Assurance, Validation, and Information Management are ongoing processes and will be conducted at established project milestones, as well as at random intervals of the project to ensure each BIM is being developed in conformance with the City of San Antonio's BIM Standards. The BIM must be suitably modeled to meet the contract requirements. The goal is to identify any errors and deficiencies in the models early in the process such that these discrepancies do not result in unresolved issues during construction. The accuracy of the model and all model elements is critical during both the design and construction phases of the project. All building information and product data must be integrated into the model correctly to ensure it is readily extractable and useable. There can be no loss of data upon the transfer of the model from the design phase to the construction phase and from the construction phase to the City at the conclusion of construction. The as-built BIM model and record documents will be required to be validated prior to the file transfer to the City of San Antonio.

4.3 Quality Assurance Checks

Quality Assurance is an ongoing process to be conducted by each member of the Project Design and Construction Team at both project milestones and at periodic intervals during the project. Each member of the Design and Construction team is responsible for checking their specific area of work as well as conducting coordination reviews with all other disciplines their specific area of work connects to, affects, and/or integrates with.

It shall be the responsibility of the Information Manager to validate the information quality, model element accuracy, appropriate level of development, and overall completeness of the models submitted during each project milestone/phase to ensure the BIM has been developed in compliance with Best Practices and the CoSA BIM Standards.

Both the Design and Construction Teams shall develop and maintain a detailed Project BIM Work Plan for CoSA approval prior to issuance of the Notice to Proceed for both design and construction.

Both the Design and Construction Teams shall develop and maintain an Information Delivery Manual for review by the Information Manager at various intervals during the project.

4.4 Review of Electronic Documents Required to be Linked to the BIM Model

Information Manager shall be granted free access to the Design BIM model throughout the design phase and the Construction BIM model throughout the construction phase of the work. All information linked to the model shall be unique and individual electronic documents indexed and organized in a single database.

See the requirements in Article 3 and Article 5 for the list of the building information data that is required to be linked in electronic format from an external database to the BIM by the Design Team and the Construction Team.

ARTICLE 5.
GENERAL CONTRACTOR'S
BIM RESPONSIBILITIES DURING CONSTRUCTION

5.1 General

The General Contractor's BIM Responsibilities During Construction include; Contractor's use of the model for coordination of all subcontractor's work, clash detection testing and reporting of the various elements of the work, development of the as-built BIM model during construction incorporating all as-built revisions into the model, coordination and review of the model on a monthly basis with the Information Manager, attachment of all submittal and product data into the model in the form of linked data sheets, attachment of all Close-Out Documents, O&M Manuals, and warranties to the model, and transmission of the post construction as-built BIM model back to the City of San Antonio.

5.2 Clash Detection Testing and Reporting

1. Both the Design Team and the Construction Team shall be responsible to independently conduct and manage an adequate and thorough Clash Detection process so that all major interferences between building components have been detected and resolved during the design phase and again after bidding and contract award in advance of any construction activity.

2. The Design Team BIM Manager shall assemble a composite model from all of the model parts of each design discipline for the purpose of performing a visual check of the building design for spatial and system coordination. Prior to each scheduled coordination meeting, an updated clash report will be generated by the Design Team BIM Manager.

3. On a multistory project, the models may need to be split on a level-by-level basis for MEP coordination. If a floor is particularly large, it may also need to be split by zones to reduce file size. Typically, 3D clash detection/coordination continues on a single floor until building systems are fully coordinated, and then continues on the next floor up.

4. Coordination software shall be used for assembling the various design models to electronically identify, collectively coordinate resolutions, and track and publish interference reports between all disciplines. The technical disciplines shall be responsible for updating their models to reflect the coordinated resolution.

5. The Design Team shall review the model and the Clash Reports in coordination meetings on a regular as-needed basis throughout the design phases until all spatial and system coordination issues have been resolved.

6. During the construction phase, the accuracy of fabrication models shall be verified. Prior to each fabrication submittal for approval, fabrication contractors shall submit their models to the Construction Contractor's BIM Manager for integration and clash detection/coordination and resolution.

7. Internal Clash Resolution – Design Consultants and Construction Subcontractors who are responsible for multiple scopes of work are expected to coordinate the clashes between those scopes prior to providing those models to the BIM Manager for spatial and system coordination.

8. Spatial Coordination Verification: Verification and tracking of resolved conflicts of all trade coordination issues which could result in change orders or field conflicts shall be provided to COSA with all project required milestone submittals.

5.3 Trade Colors for Clash Detection

For ease of identification during the 3D Clash Detection/Coordination process, it is required that the following trades be represented in these assigned colors:

- Architecture: White
- Structural Steel: Maroon
- Concrete: Gray
- HVAC Equipment: Gold

- HVAC Supply Duct/Diffuser: Blue
- HVAC Return Duct/Diffuser: Magenta
- HVAC Pipe: Gold
- Electrical Equipment: Dark Yellow
- Electrical Conduits: Light Yellow
- Communication Conduit: Light Blue
- Electrical Cable Tray: Dark Orange
- Electrical Lighting: Yellow
- Plumbing Water: Cyan
- Plumbing Sewer: Magenta
- Plumbing Storm Drain: Green
- Fire Protection: Red Pneumatic
- Tube: Dark Green
- Equipment (Medical): Light Green
- Medical Gas: Light Green
- Security Systems: Orange
- Fire Alarm: Fuchsia

5.4 Minimum Requirements for Spatial Coordination and Clash Detection

5.4.1 Architecture + Structural
Below-grade spaces, proposed floor plates with major penetrations, floor-to-floor heights, beam clearances, heavy utilities locations, floor loads, core, and vertical shafts, beam depths and required clearances, patient lift mechanisms, slab thickness, columns, column caps, and seismic bracing. Provide adequate space for construction and maintenance access to structural elements, building equipment, and distribution systems.

5.4.2 Architecture + MEP
Structural and space elements, flow and isolation requirements, proposed functional area configurations, floor-to-floor heights, fire containment, vertical and horizontal transportation. Possible future expansions shall be considered and shall be clash-free.

5.4.3 MEP/HVAC + Architecture, Structure, and Telecommunications
Main distribution and collection systems, configurations and sizes for piping, duct, conduit, power wiring, blowers; diffusers; intakes, large compressors. Clearance reservations for equipment maintenance filter removal, and equipment removal and replacement shall be modeled with the equipment, and sign-off on the adequacy of the space reservations shall be obtained from the CoSA Project Manager.

5.4.4 Architecture + Life Safety Fire Protection
Safe zone and fire suppression pipe location, egress paths and exit distance requirements, equipment, and pipe penetrations.

5.4.5 Medical Equipment (if included in the project) + Architecture, MEP, HVAC, Structural
Medical major equipment positioning and location requirements, medical gases distribution and waste collection, cryogen supply piping for MRI and labs, and cryogen cooling compressors, nurse call systems, public communications, and building controls. This includes major medical equipment adjacencies and shielding barriers, pipes, and venting and air intake locations and other limitations.

5.4.6 Architecture/HVAC + Interiors
Merges shall include ductwork and piping + ceilings and FF&E + HVAC.

5.4.7 Space Validation
There shall be no space gaps. Bounding boxes used to represent room and zone spaces shall match with architectural requirements and data values, and all shall be coordinated.

5.4.8 General Model Quality Checking
All walls shall be properly joined to prevent “space leaks” in areas defined by enclosing walls. Bounding boxes shall not conflict.

5.4.9 Security
Security setbacks + structure + site.

5.4.10 Accessibility Compliance
Wheelchair pathways and clearances + structure.

5.5 Construction Phase Documents Required To Be Linked To Construction BIM Model by Contractor

At a minimum, the following list of the building information shall be linked in electronic format to the BIM by the Construction Team:

Building Permits
Construction Personnel Directory
Subcontractor Directory
Monthly Application for Payment
Construction Progress Meeting Reports
Construction Progress Schedule (updated monthly)
RFI's & ASI’s
Change Orders (CO)
Progress Photographs (updated weekly)
Test & Balance Reports
Commissioning Reports
Facility Key Log
Shop Drawings & Submittals
Training Manuals on Controls, HVAC Equipment, and Systems Operations
Equipment and System Start-Up & Inspections Reports:

- Boiler and Tank
- Elevators and Hoist Systems
- Backflow Preventers on Potable Water, Fire Suppression, HVAC, Misc. Equip.
- Fire Suppression System
- Fire Alarm System
- Security System
- Backup Power Generator
- Cable Test/Certification Reports and Startup Records

Operations & Maintenance Manuals (O&M)
Product Warranties
GC's Workmanship Warranty
Certificate of Occupancy
Certificate of Substantial Completion
Final Release of Liens/Claims
Consent of Surety
Final Application for Payment

5.6 Development of the As-Built BIM Model during Construction

The Building Information Model (BIM) must be updated continuously throughout the Construction Phase to an as constructed and "As-Built" Level of Development (LOD 500) and must include all RFIs, change orders, and as-built/as-constructed changes that occurred during construction. Per the Contract Requirements, the Construction Contractor must submit the As-Built BIM to CoSA as a requirement of the Project Close-Out. The As-Built BIM shall include the following:

1. All "as-built" changes requiring model updating
2. Linking of all building information into the Autodesk Revit model including; submitted and approved materials, specific products, and systems
3. Linking of all Close-Out documents to the model components in the Autodesk Revit model including, but not limited to submittals, warranties, and O&M manual information

Contractor shall provide any other fabrication models prepared by sub-contractors in separate files from the As-Built BIM to the City of San Antonio.