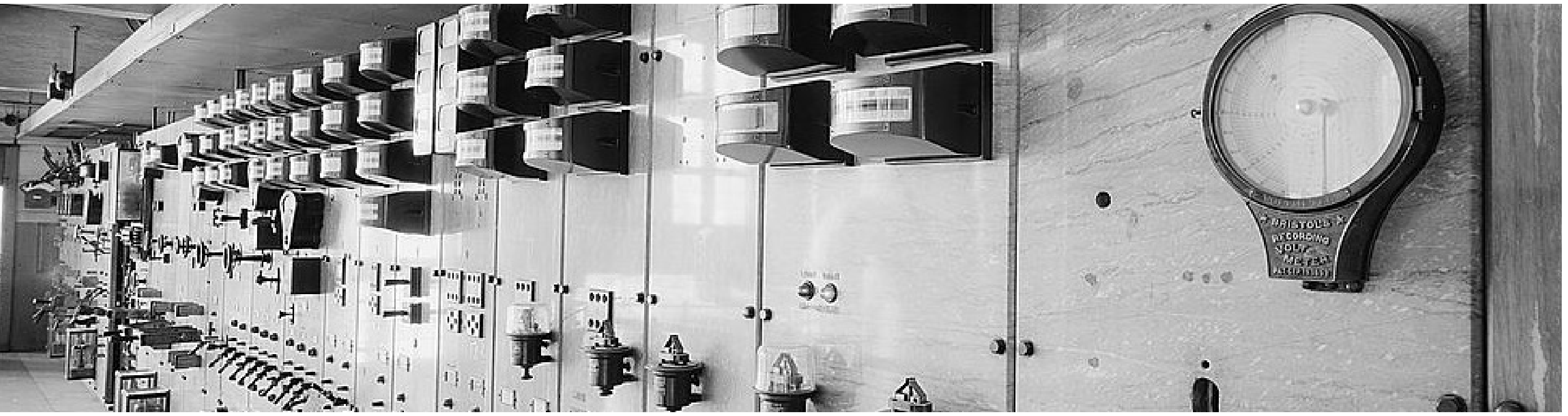
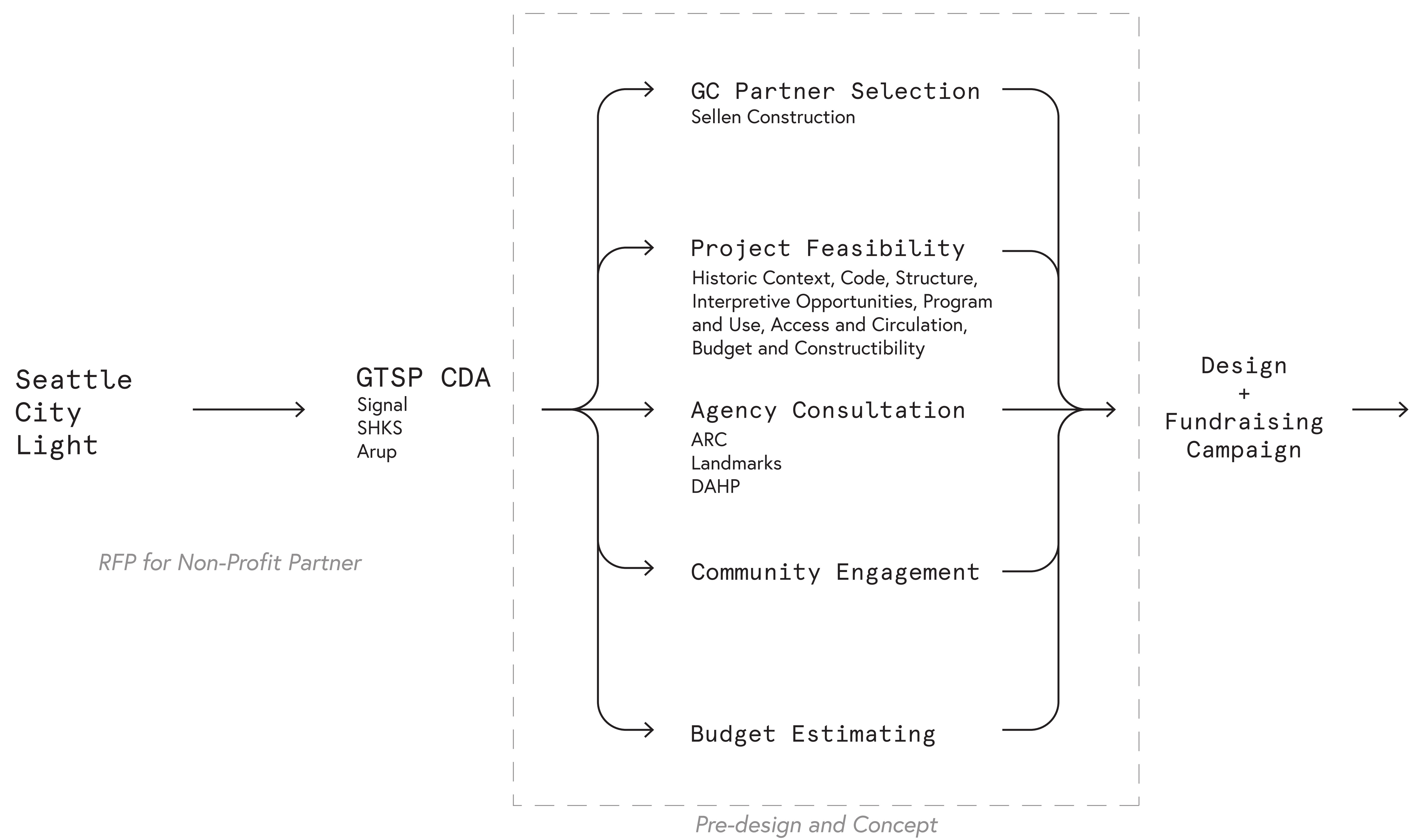


# Project Briefing #2: March 2, 2022

Georgetown Steam Plant

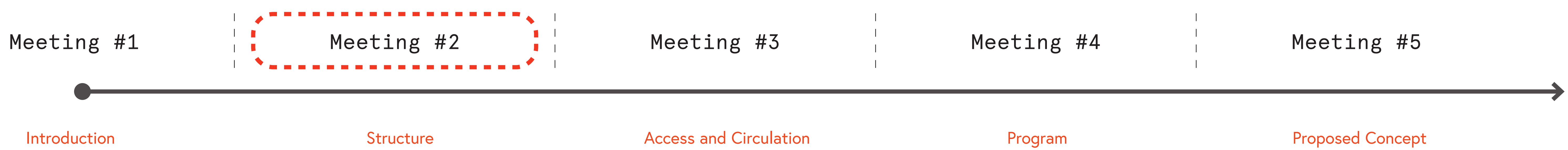
# Who are we and Why are we here?



## What are the goals of the project?

Tell the stories of the Georgetown Steam Plant
Activate through reprogramming, life safety, and seismic improvements
Provide universal access to all spaces

# Planning for Subsequent Meetings

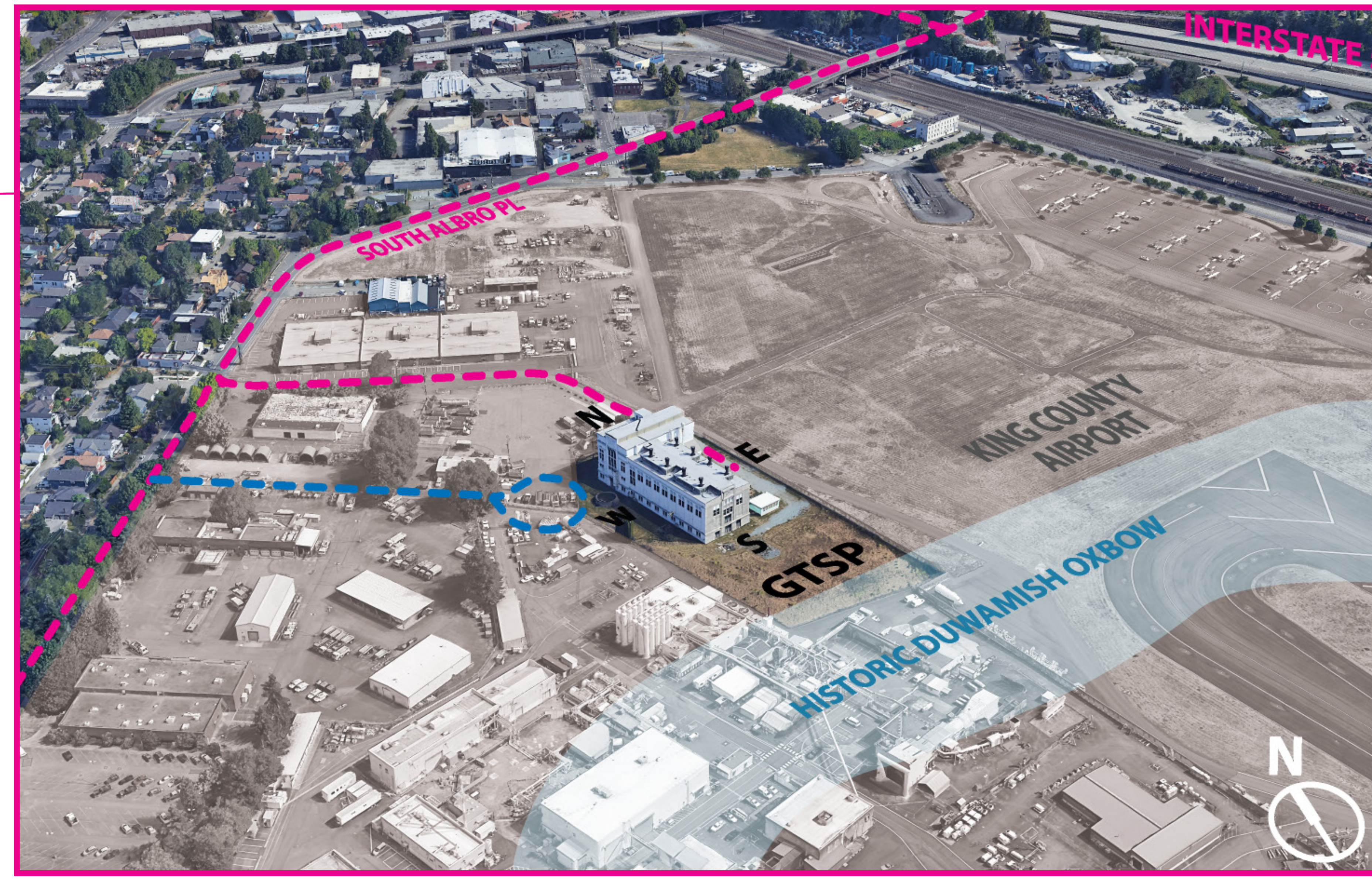


## What is the purpose of Today's meeting?

Communicate the project's seismic challenges
Share the team's preferred seismic approach
Gather feedback and support

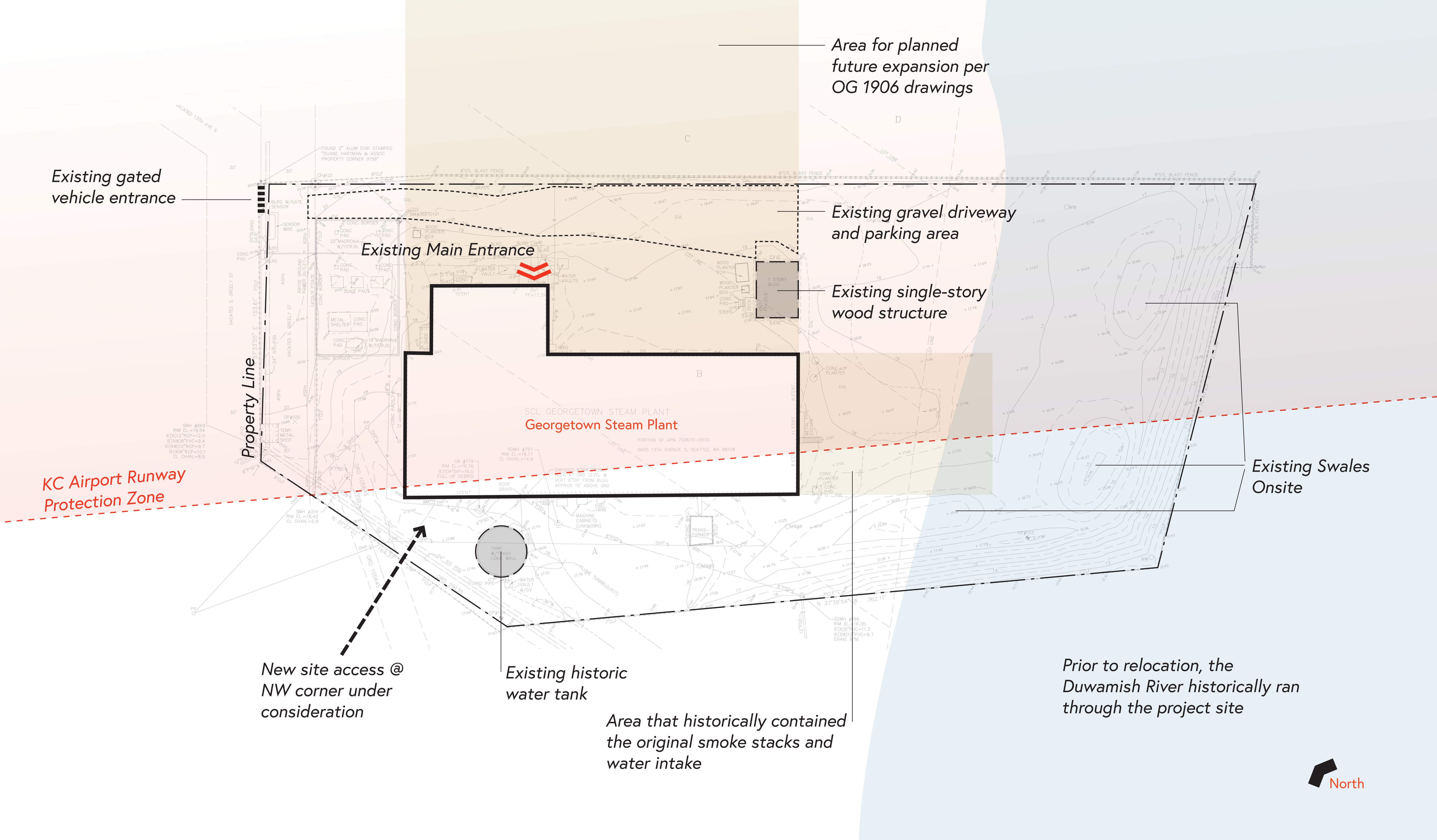
# Where is the Georgetown Steam Plant?


Birdseye of Georgetown and Adjacent Neighborhoods

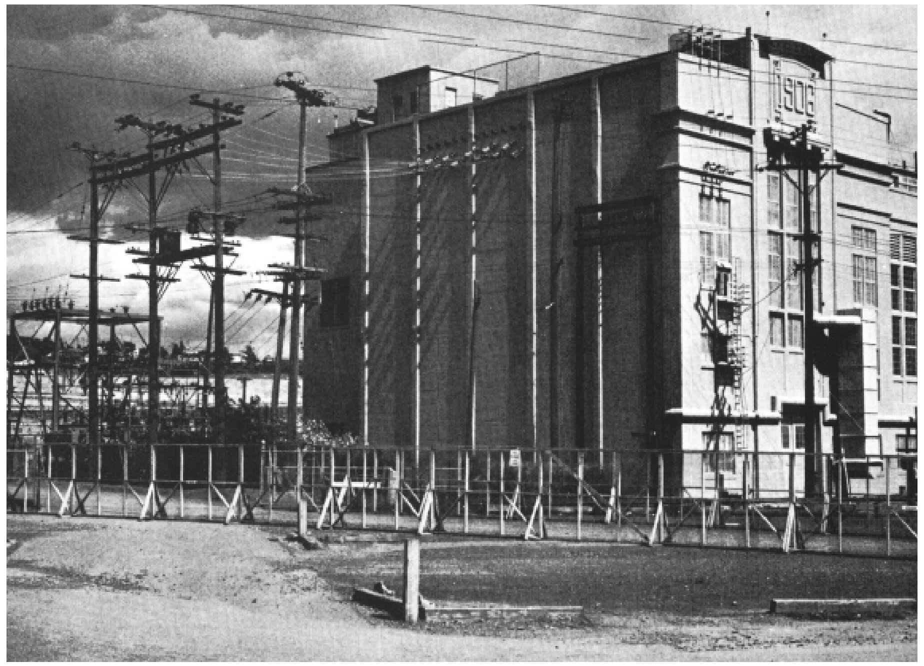



Zoom-in: GTSP Site and Surroundings

# The Georgetown Steam Plant Site



# What is the Georgetown Steam Plant?

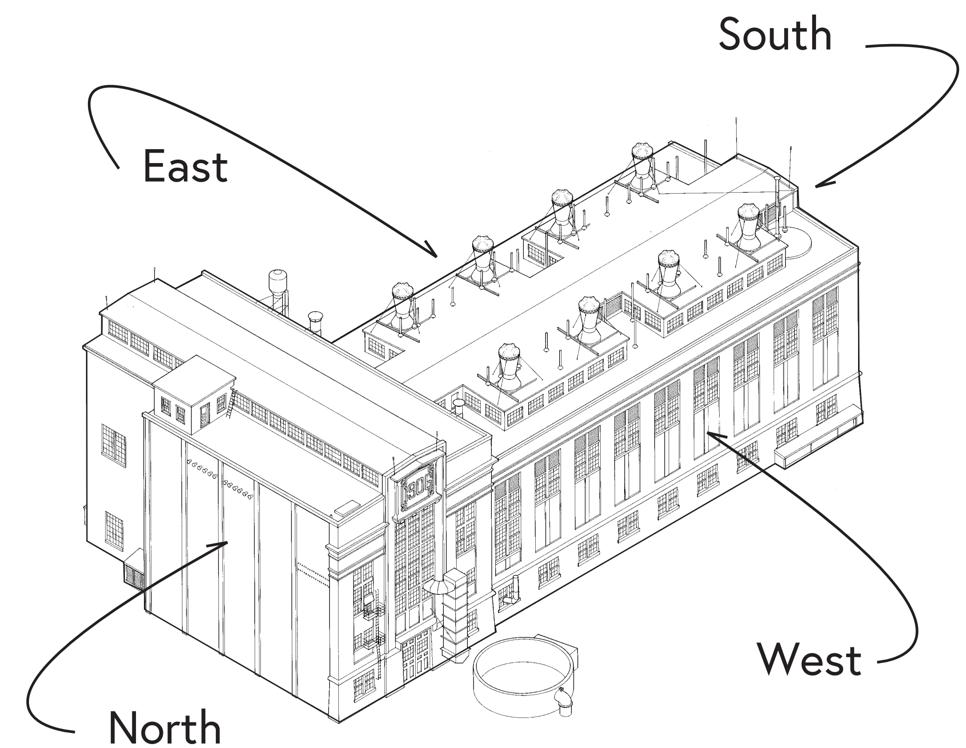


North Elevation

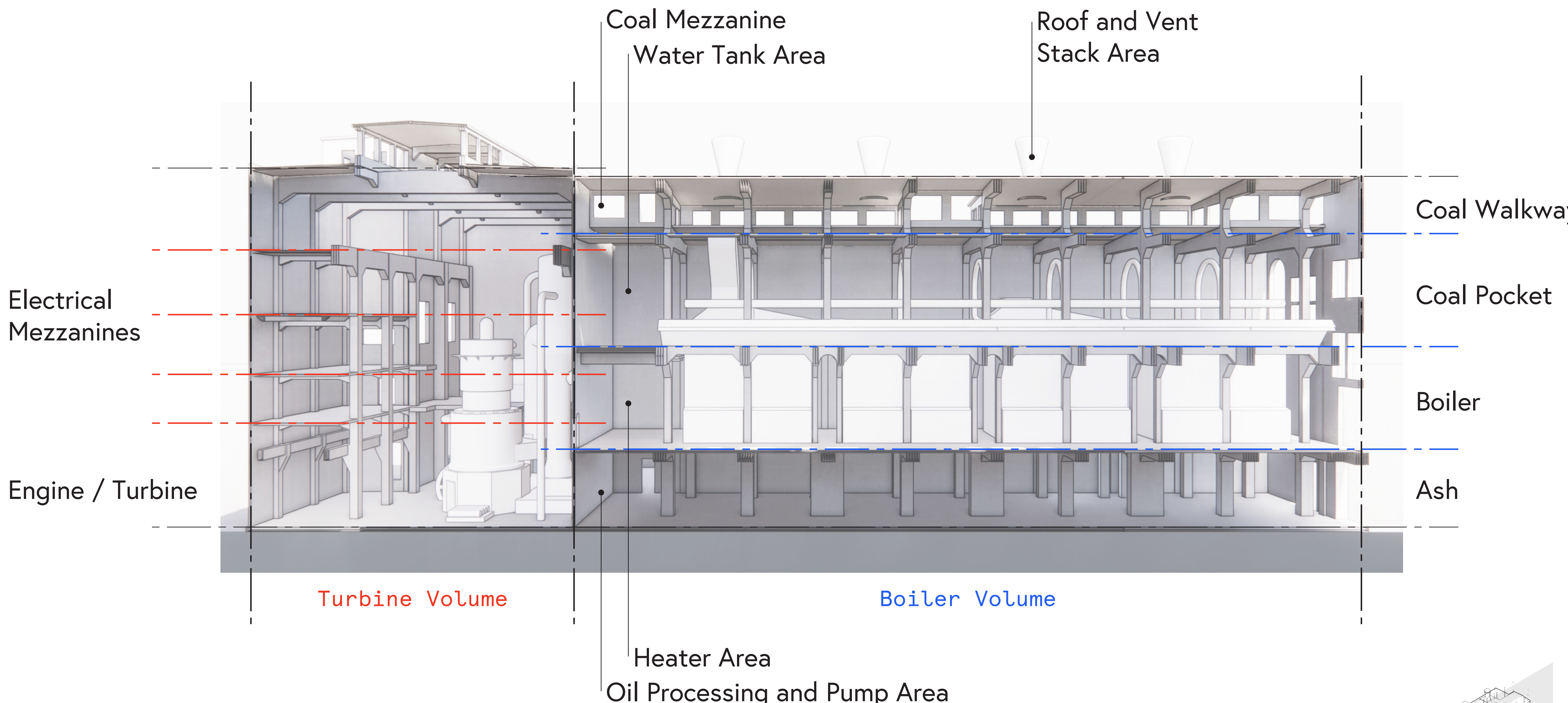
East Elevation

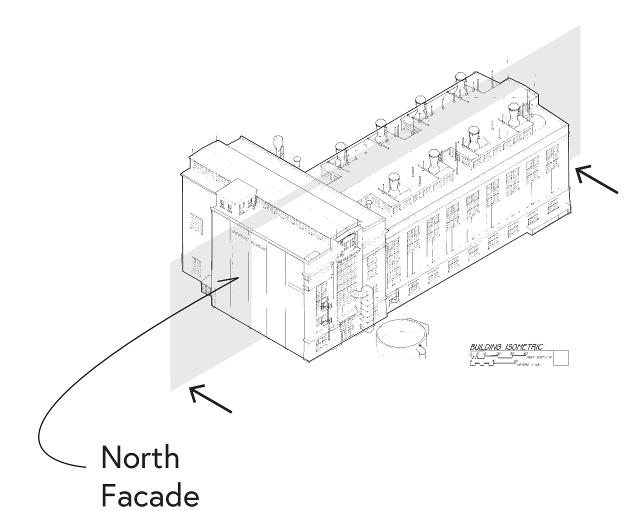
South Elevation


West Elevations

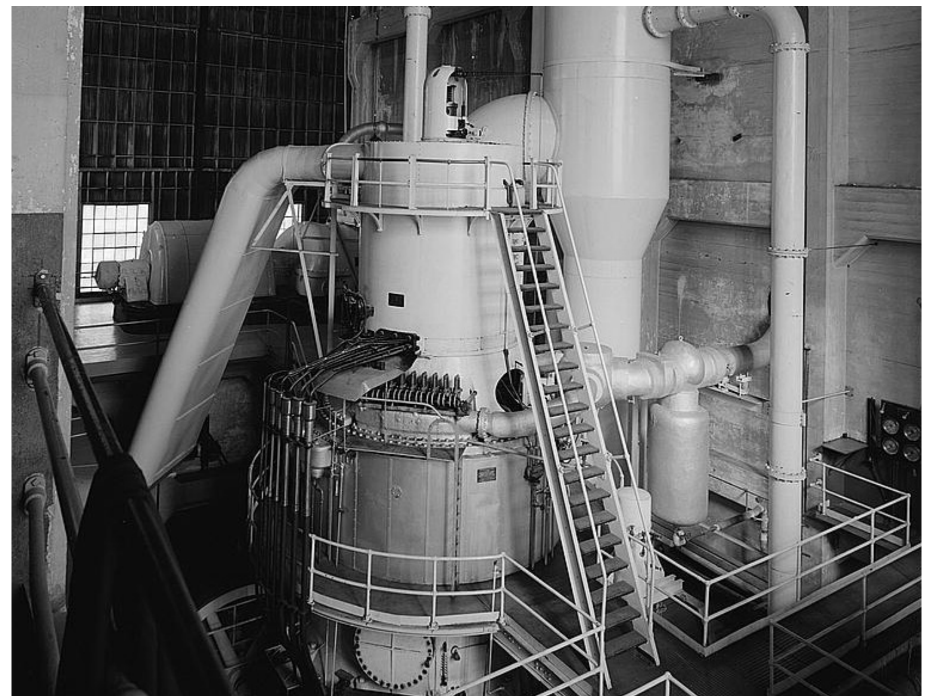


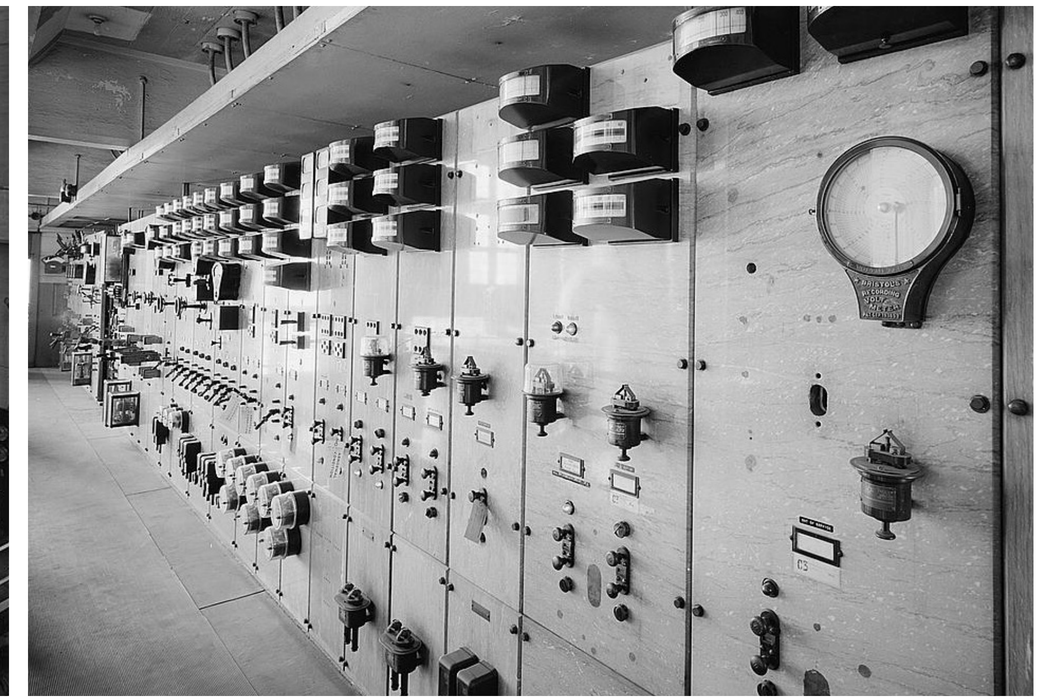
# What is inside the Georgetown Steam Plant?

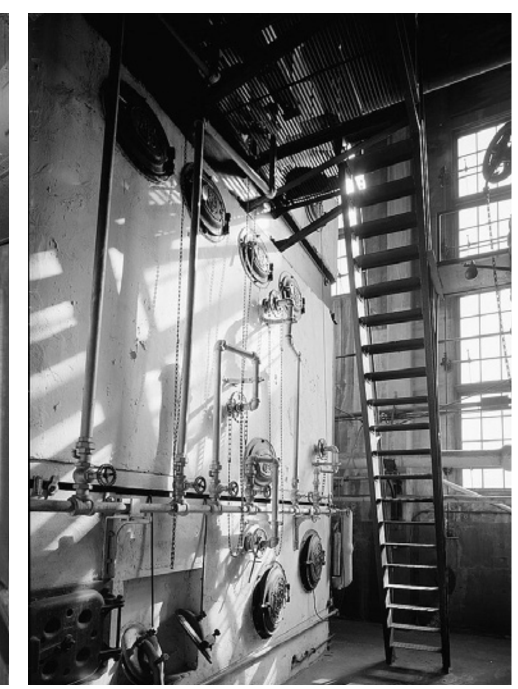


# What is inside the Georgetown Steam Plant?

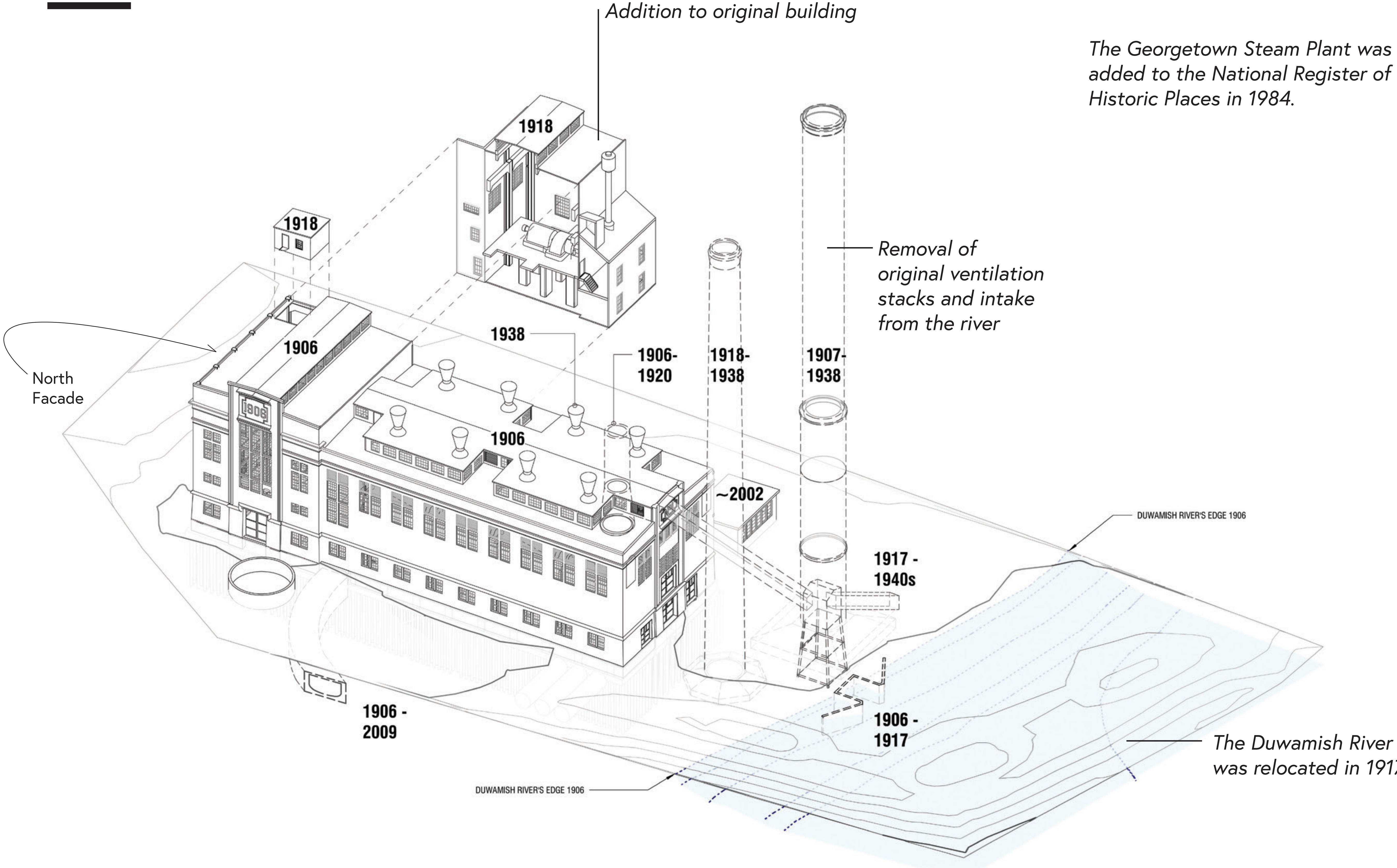






# How has it changed?

*The Georgetown Steam Plant was added to the National Register of Historic Places in 1984.*



**Are there any clarifying questions?**

# Secretary of the Interior's Standards for Rehabilitation

1 A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2 The historic character of a property shall be retained and preserved . The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

3 Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4 Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

5 Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

6 Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7 Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8 Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9 New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property . The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10 New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

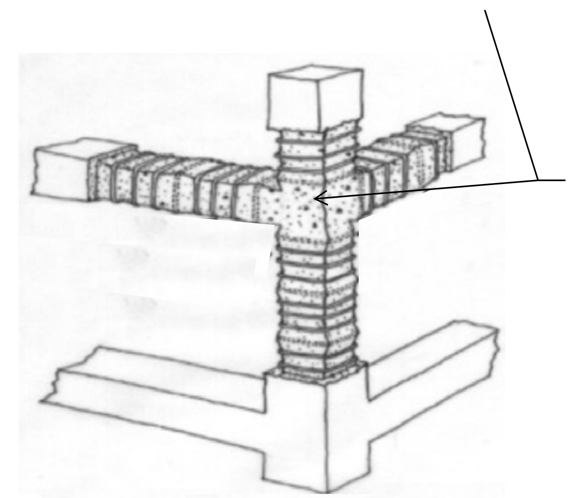
# Structural Risks

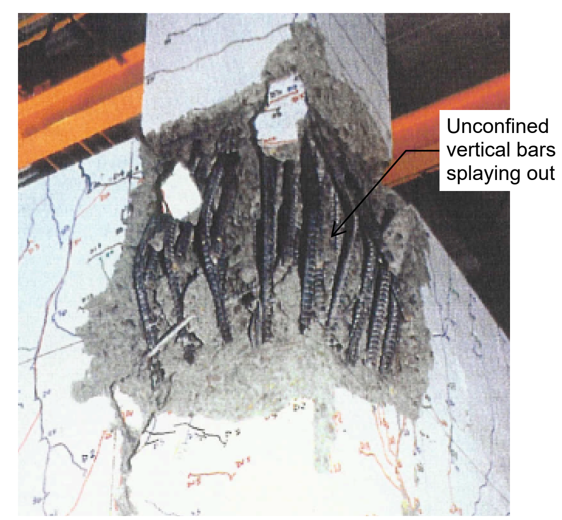
## Joint Failure

The structural engineering industry has largely evolved in its understanding of seismic design since this building was constructed in the early 1900s. The magnitude of seismic loads accounted for in the historic design would be much lower than modern requirements. Further, rebar detailing at the time did not account for cyclic loading and are prone to joint or hinging failures. Modern reinforced concrete seismic detailing provides significantly more confinement with rebar hoops & ties, particularly around beam-column joints to account for this.

Providing a lateral system yields the following benefits:

- The new lateral system can be designed to carry the full seismic load, lowering the forces carried by the existing elements.
- Existing gravity elements must be checked for deformation compatibility, meaning the existing elements must be able to carry gravity loads even while the building is swaying. The new lateral system must be stiffer than the existing walls so that loads will be directed to the new system.






# Structural Risks

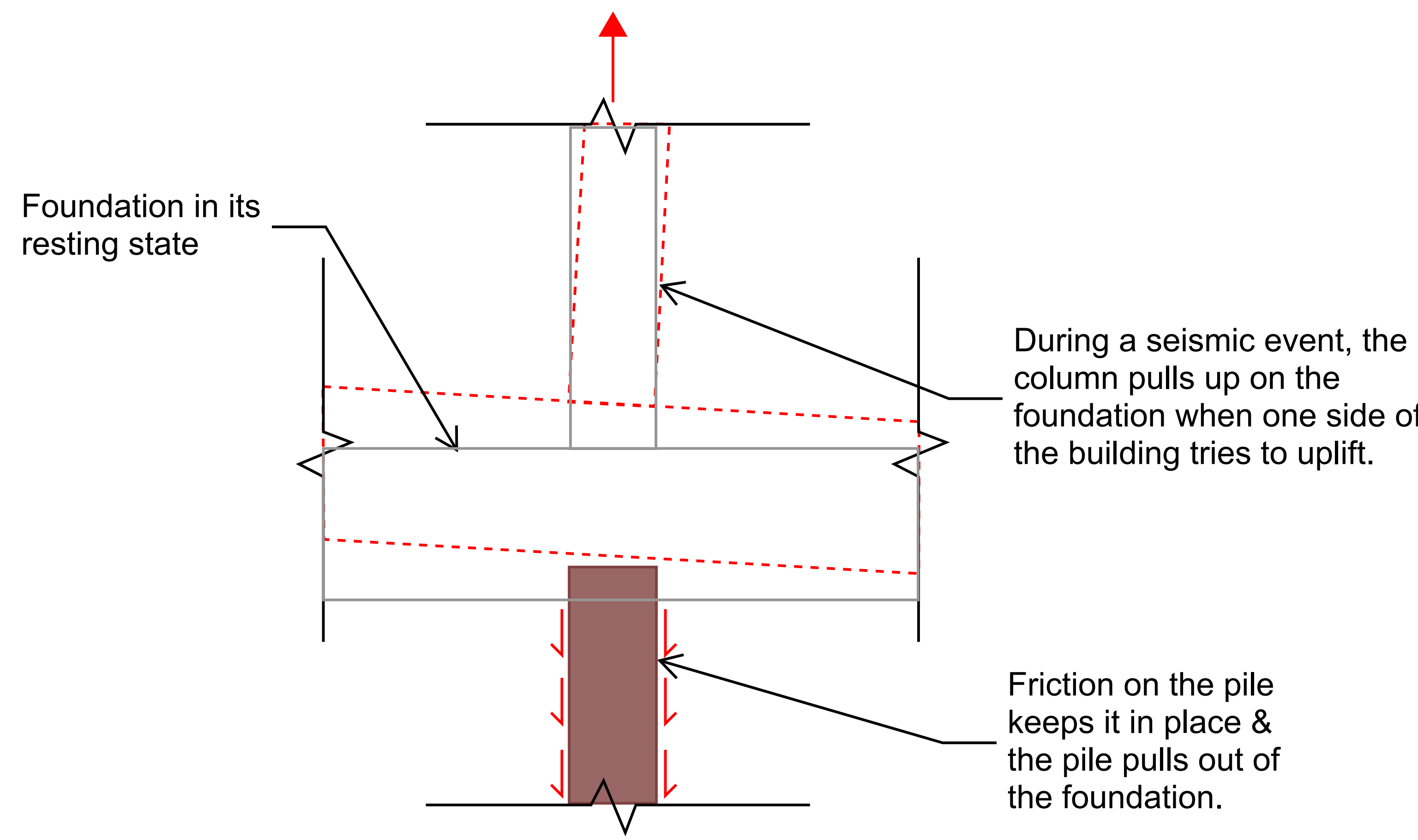
## Pile Failure

### Piles in Compression

A significant number of timber piles under a concrete pile caps were provided to withstand the large historic gravity loads throughout the building. The piles are likely fully submerged due to the site proximity to the Duwamish River, meaning that timber is likely well-preserved. The structure does not exhibit signs of settlement or foundation failure. Even with some possible degradation over time, the compression capacity of the existing piles are likely much higher than that which will be required for the new building usage.

### Piles in Tension

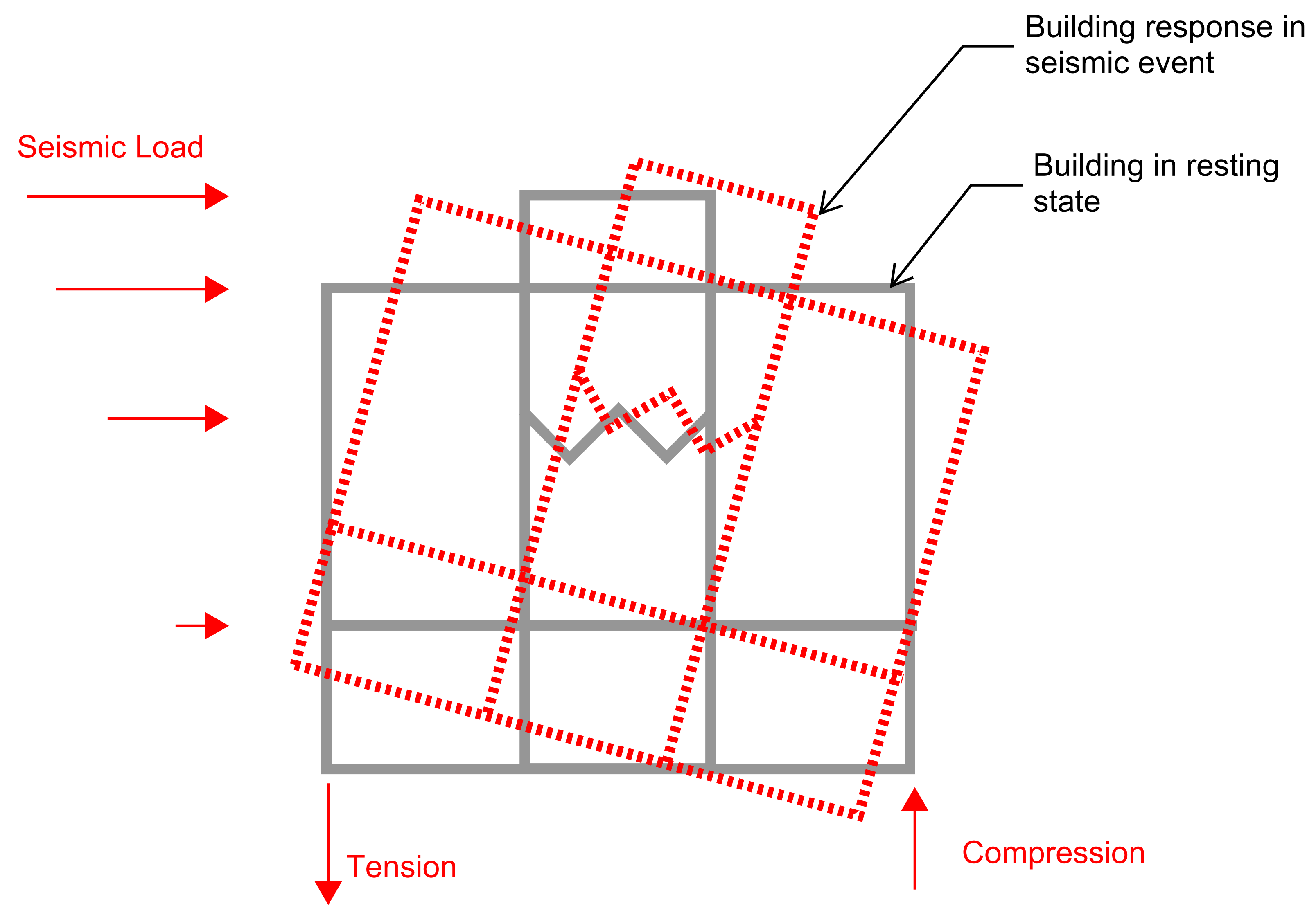
Pile length, diameter, and detailing of pile anchorage into the concrete pile caps are not available. Because of unreliable anchorage between the piles and pile caps, the original piles likely have minimal tensile capacity and even less over time with minor timber degradation. Without sufficient anchorage, the piles are susceptible to a pull-out failure during a seismic event. To remedy this, rock anchors, additional interior micro-piles, or external larger piles with modern anchorage detailing can be provided to provide uplift resistance.



# Structural Risks

### Overturning

During a seismic event, the building tries to overturn, putting one side of the building in tension. In modern construction, piles are detailed with sufficient anchorage into the mat and pull the building back down.



# 'Global' Structural Lateral Studies

Several lateral system conceptual diagrams were evaluated with the following structural considerations:

Floor Interaction + Diaphragms: Floor plates

Foundations

Constructibility

Impact to Existing

Critical Flaw

---

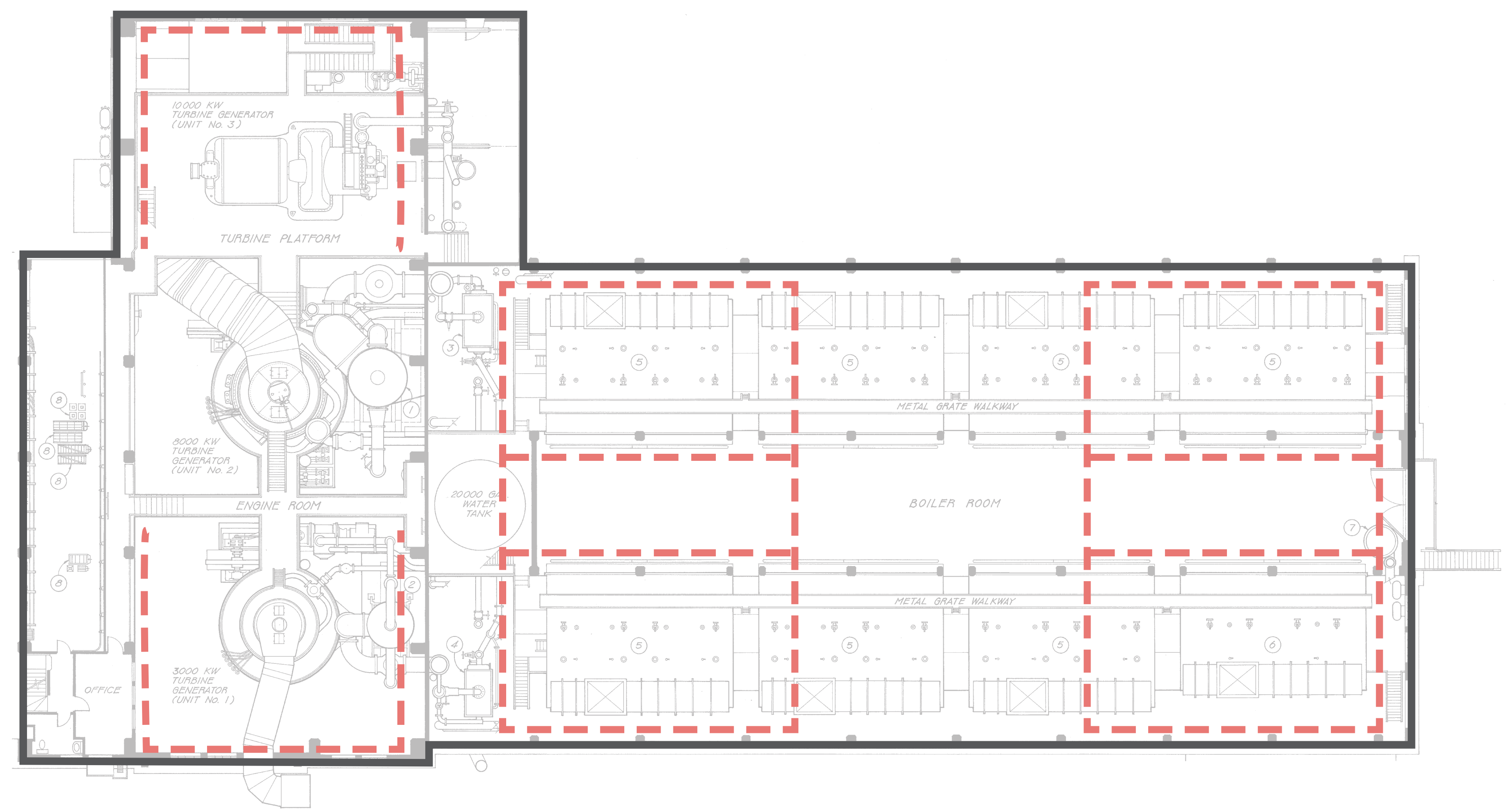
1. *Small Distributed Braced Frames*
2. *Large Cores of Braced Frames*
3. *Moment Frames*
4. *Exoskeleton*
5. *Shotcrete*

6.1 *Hybrid Braced Frames*

6.2 *Boiler Stack Brace*

7 *Hybrid Braced Frames*

# Study 1: Small Distributed Braces




### Floor Interaction + Diaphragms

Interior braced frames are placed at ends of major floor plates. All floors plates have direct points of contact with the lateral system except the high roofs in the engine hall. More frequent lateral supports reduce the amount of steel framing needed to stiffen the diaphragms and tie them to the lateral system.

### Foundations

With a small, distributed braced frame approach, some of the seismic uplift demand is offset by the building's weight. Smaller foundations (ex. micro-piles, prestressed soil anchors) can be used to carry the remaining uplift.

### Constructibility

This scheme contains a large number of smaller lateral system elements and minimizes steel required for diaphragm connections to the lateral system. Interior braces create constructibility challenges around landmarked equipment. Braced frames conflicting with boilers would require partial demolition of the boiler.

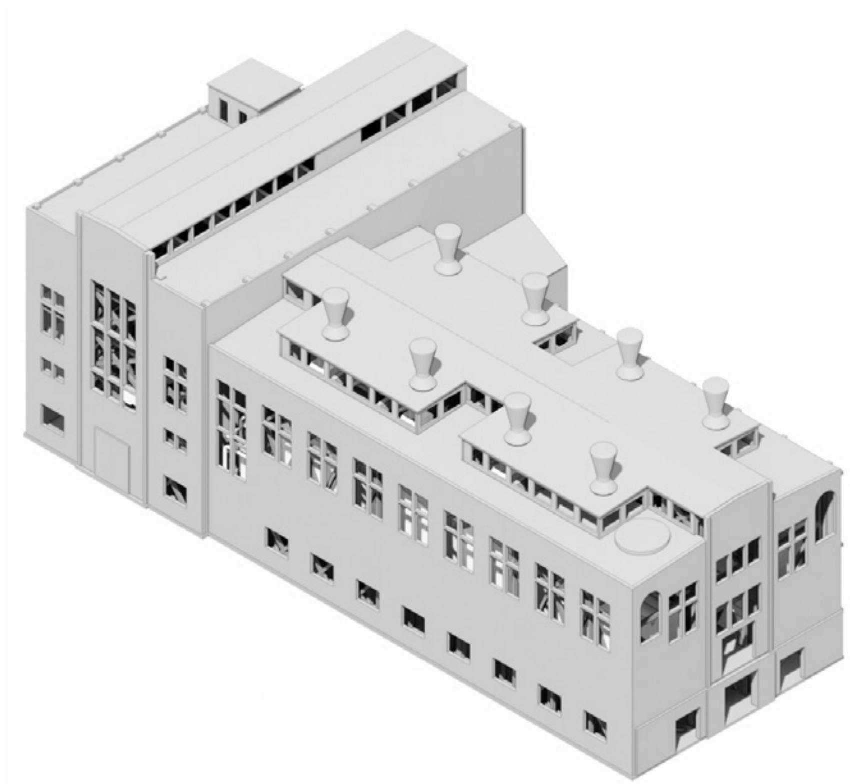
### Impact to Existing

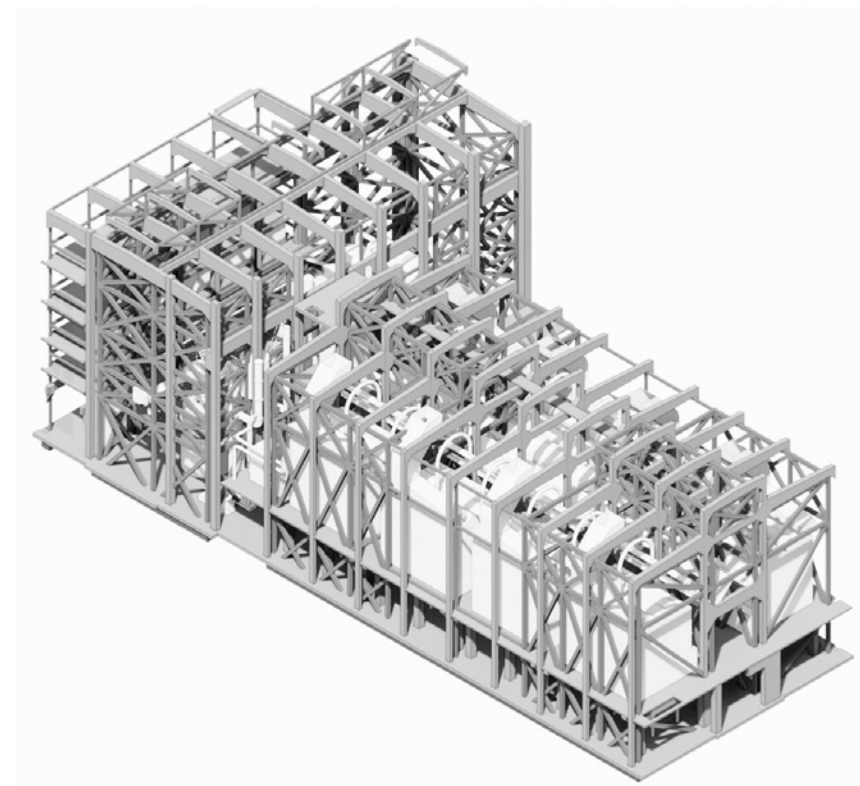
Views of the boilers are obstructed and structure is largely visibly in the Engine Room. No impact to exterior views.

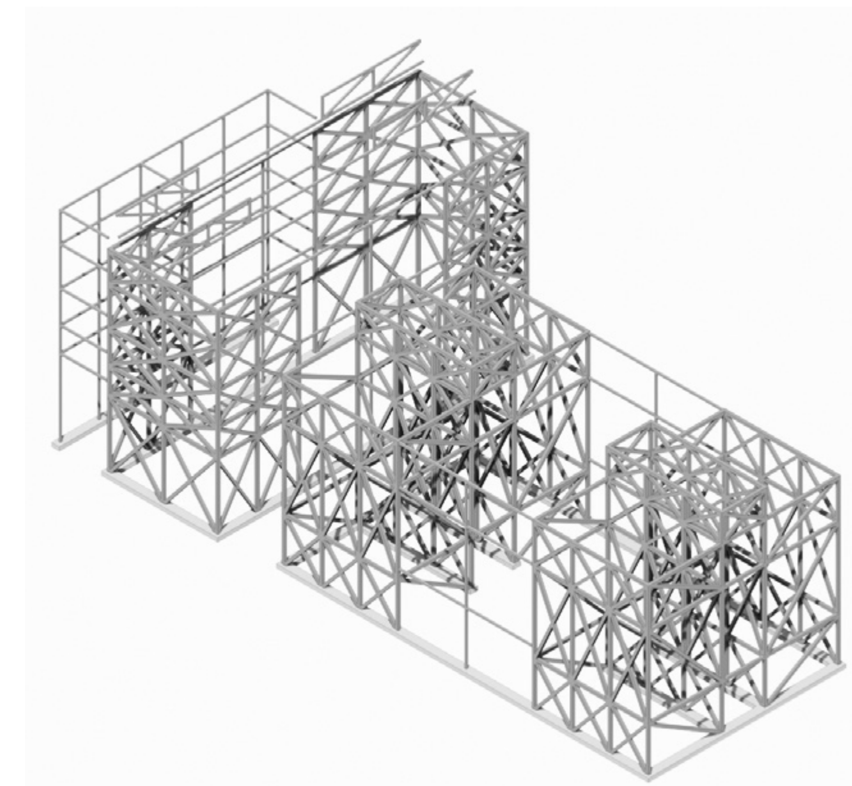
### Critical flaw

Key interior experiences are visually affected with the new structure. Two lines of braced frames would go through boilers.

## Study 1: Small Distributed Braces





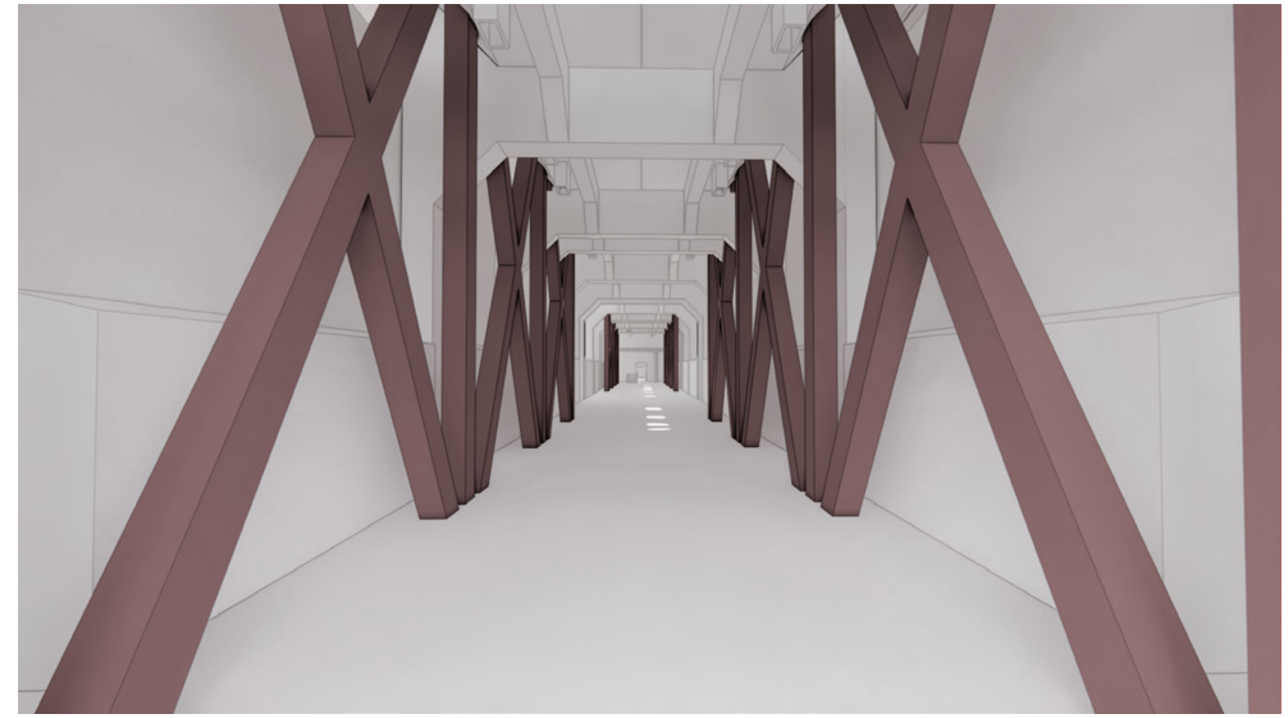


Primary Structure

Secondary Structure

# Study 1: Small Distributed Braces

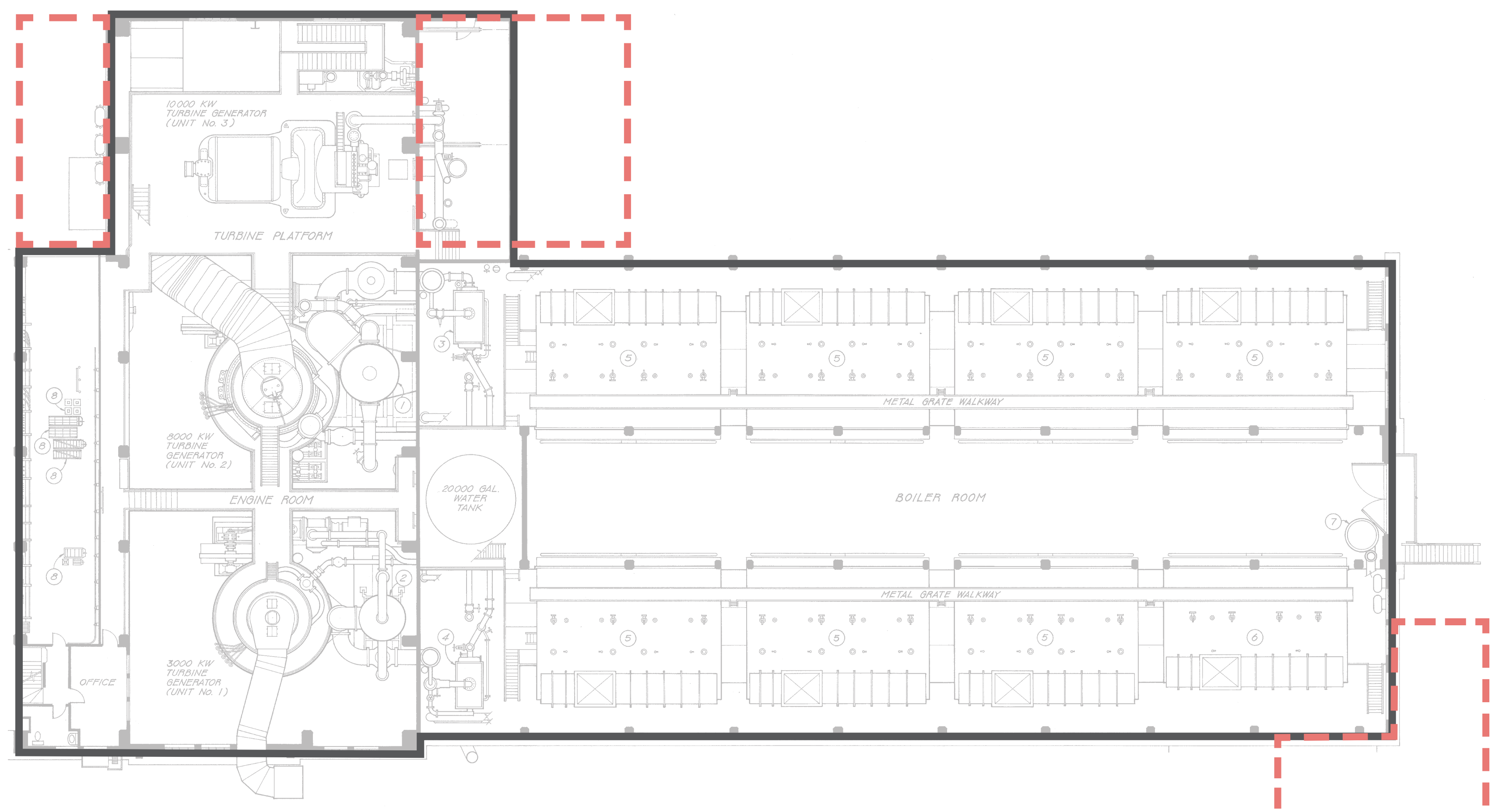
*Engine Room*



*Boiler Room*

*Ash Room*

# Study 2: Large Braced Cores




**Floor Interaction + Diaphragms**

Large, concentrated cores of braced frames are placed at the building's exterior. Several floors (coal bin, high roofs) do not have direct points of contact with the lateral system. Less frequent lateral supports require significant steel framing to stiffen the diaphragms and tie them to the lateral system.

**Foundations**

Seismic loads will concentrate at the fewer core locations and require large new foundations. Placing the cores outside the building reduces the complexity of pile construction.

**Constructibility**

This scheme contains a small number of large lateral system elements but the extent of interior steel connecting diaphragms to lateral system will create constructibility challenges. Exterior braces avoid landmarked equipment

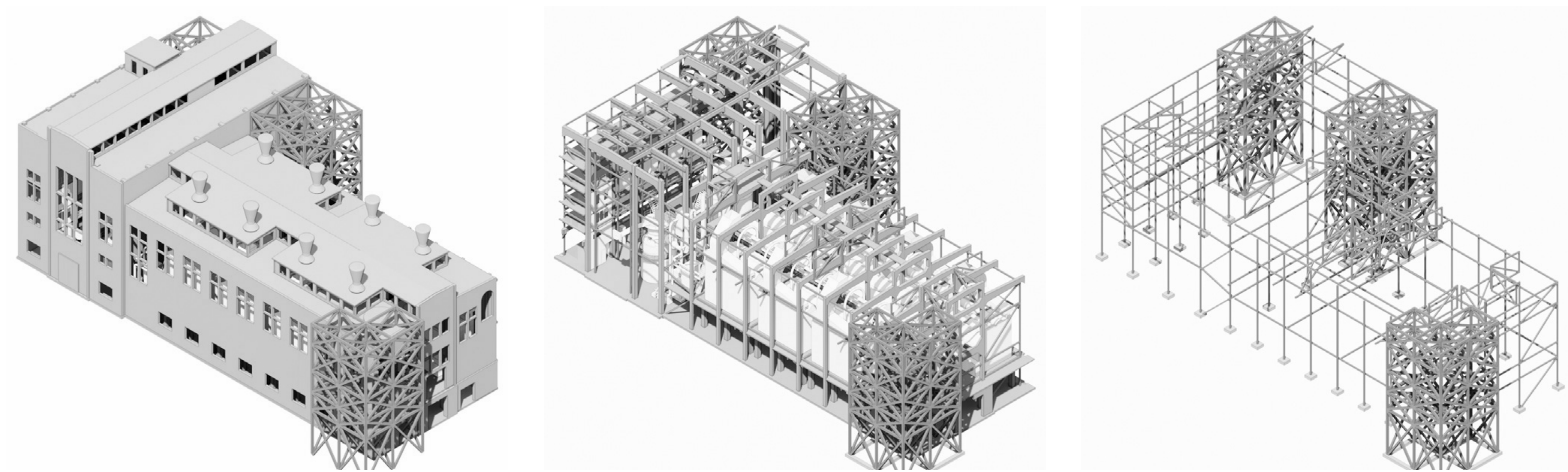
**Impact to Existing**

Exterior facades are impacted by the new structure.

**Critical flaw**

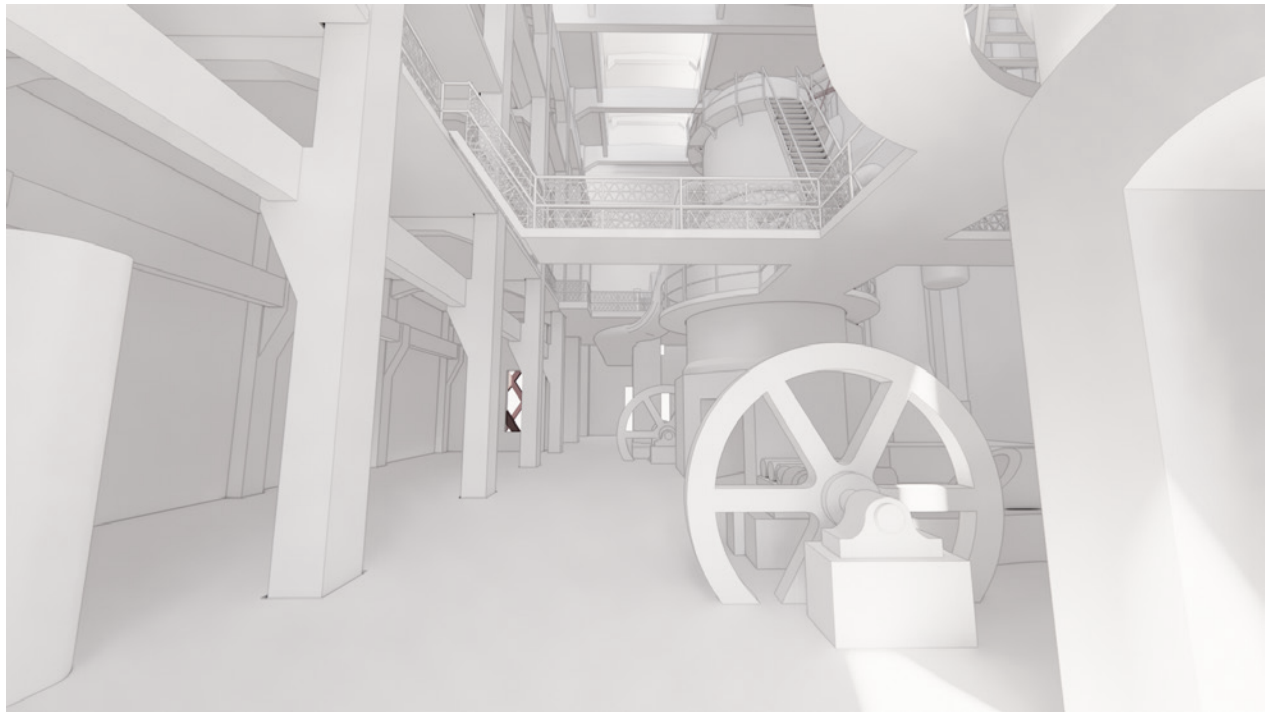
The extent of steel needed to stiffen the floor plates and to tie them to lateral system would be much more significant than other schemes. Further, the south facade has significant visual impacts with new structure.

## Study 2: Large Braced Cores

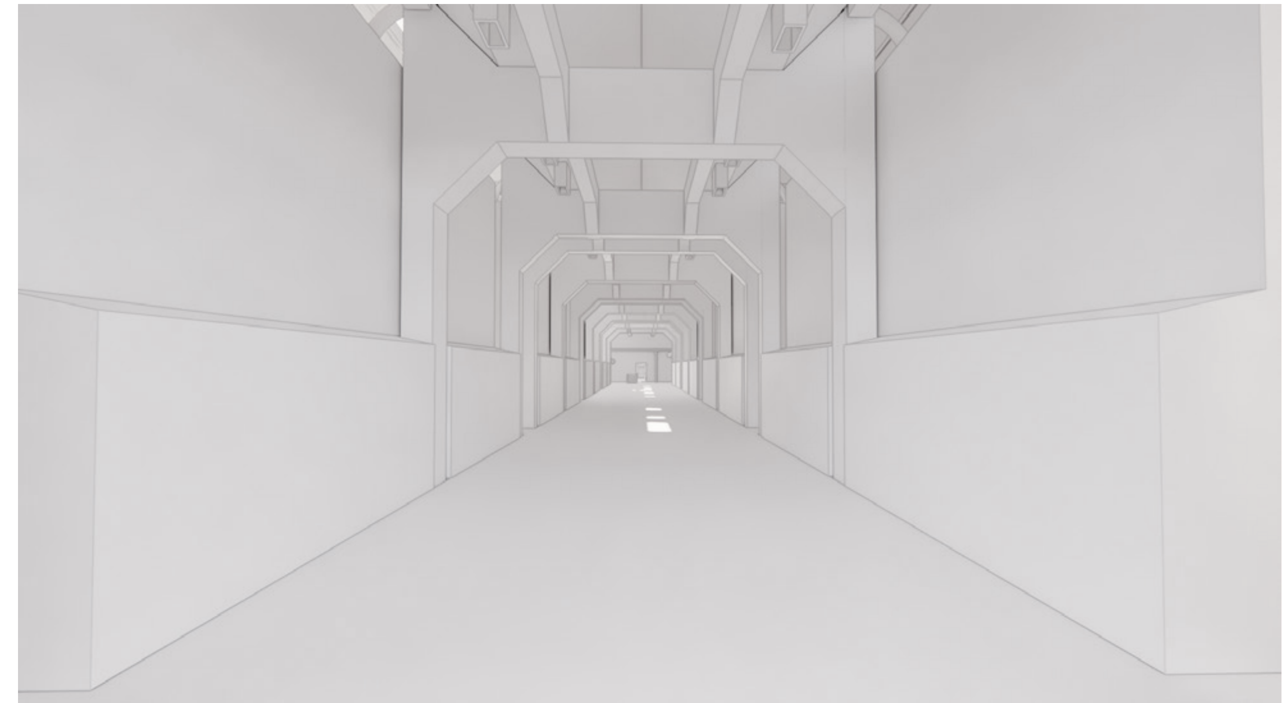


Primary Structure
Secondary Structure

# Study 2: Large Braced Cores



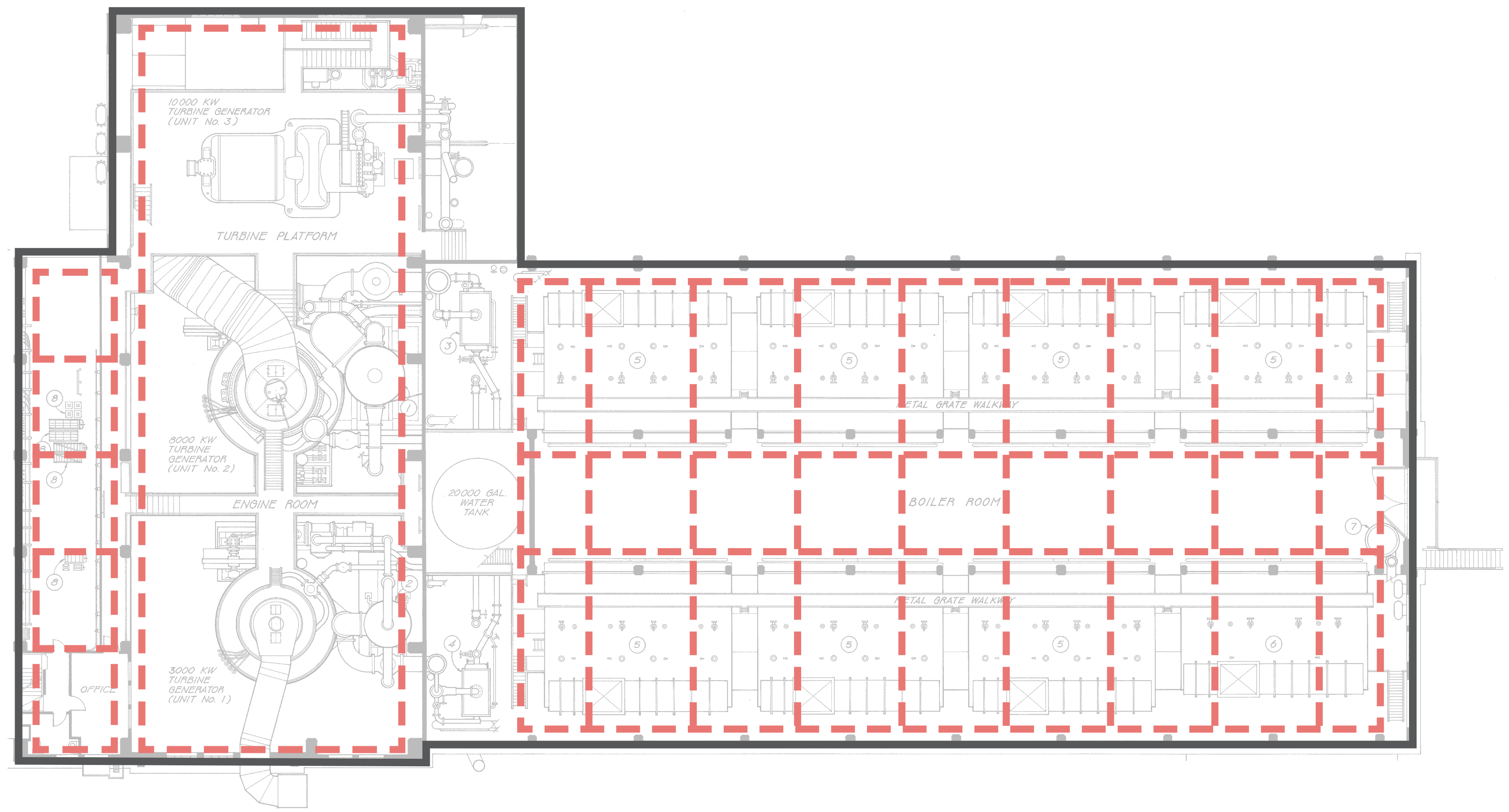
*Engine Room*



*Boiler Room*

*Ash Room*

# Study 3: Moment Frames




### Floor Interaction + Diaphragms

Interior moment frames are regularly distributed across the building. All floors plates have direct points of contact with the lateral system except high roofs in the engine hall. More frequent lateral supports reduce the amount of steel framing needed to stiffen the diaphragms and tie them to the lateral system.

### Foundations

With a small, distributed moment frame approach, some of the seismic uplift demand is offset by the building's weight. Smaller foundations (ex. micro-piles, prestressed soil anchors) can be used to carry the remaining uplift.

### Constructibility

This scheme contains a substantial number of lateral system elements. Interior moment frames create constructibility challenges around landmarked equipment.

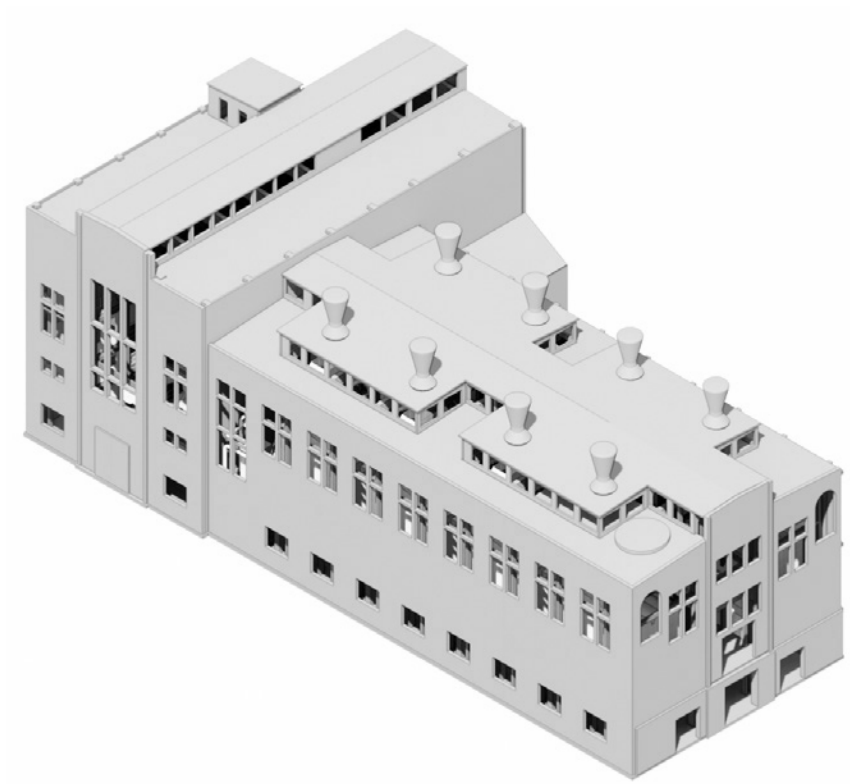
### Impact to Existing

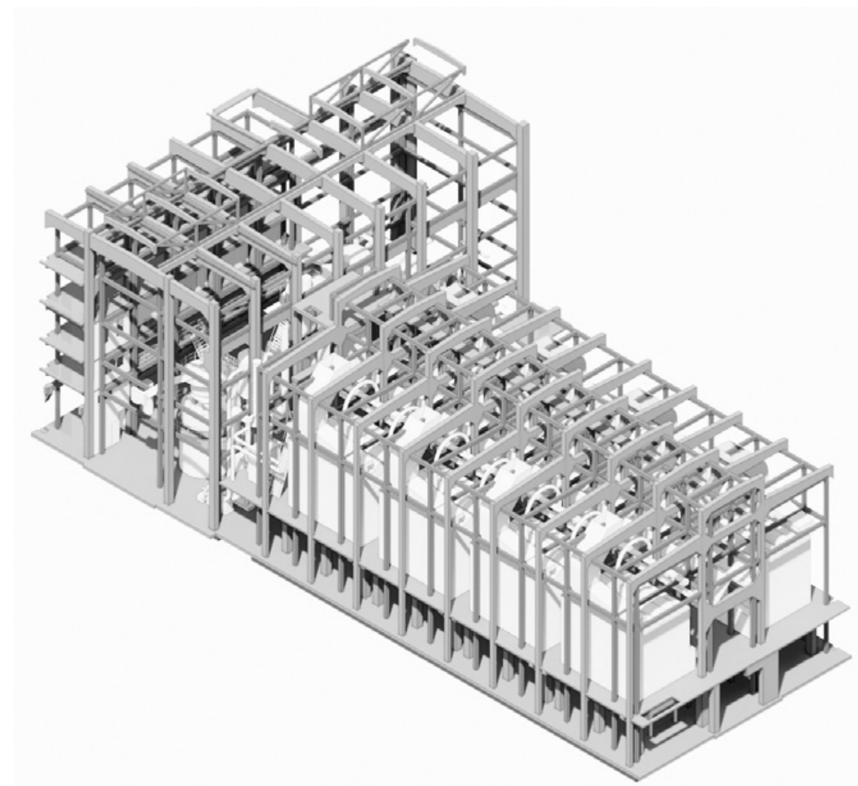
Views of the boilers are obstructed and structure is largely visibly in the Engine Room. No impact to exterior views.

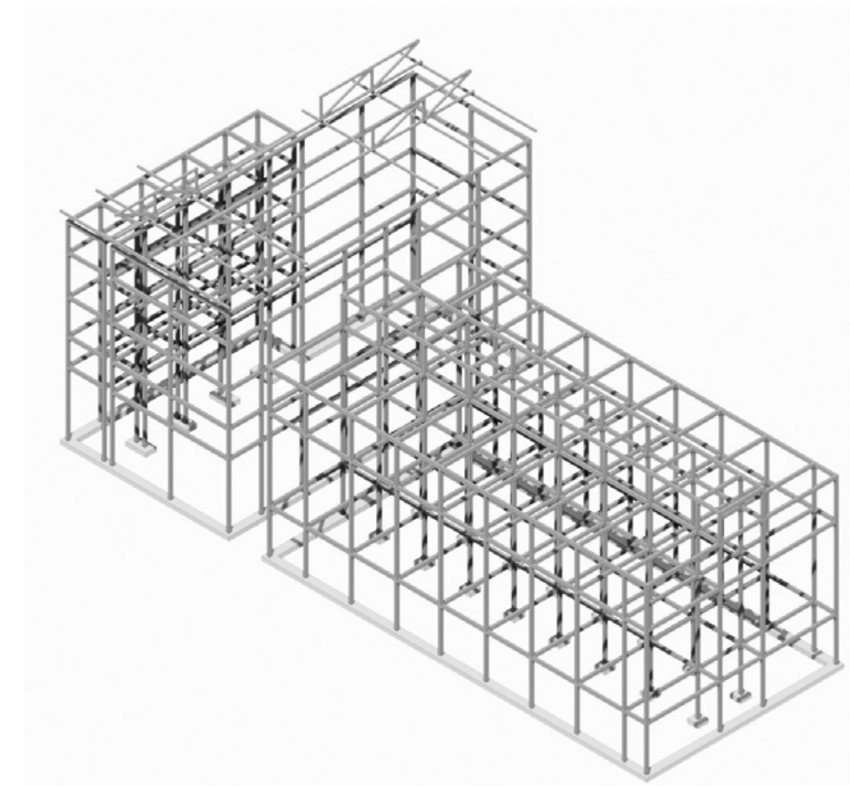
### Critical flaw

Moment frames are typically not used to retrofit reinforced concrete buildings because the existing building as a collection of structural and non-structural elements is much stiffer, therefore attracting seismic loads before the moment frames are activated. The extent of the necessary moment frame insertions would be much higher than other schemes.

# Study 3: Moment Frames

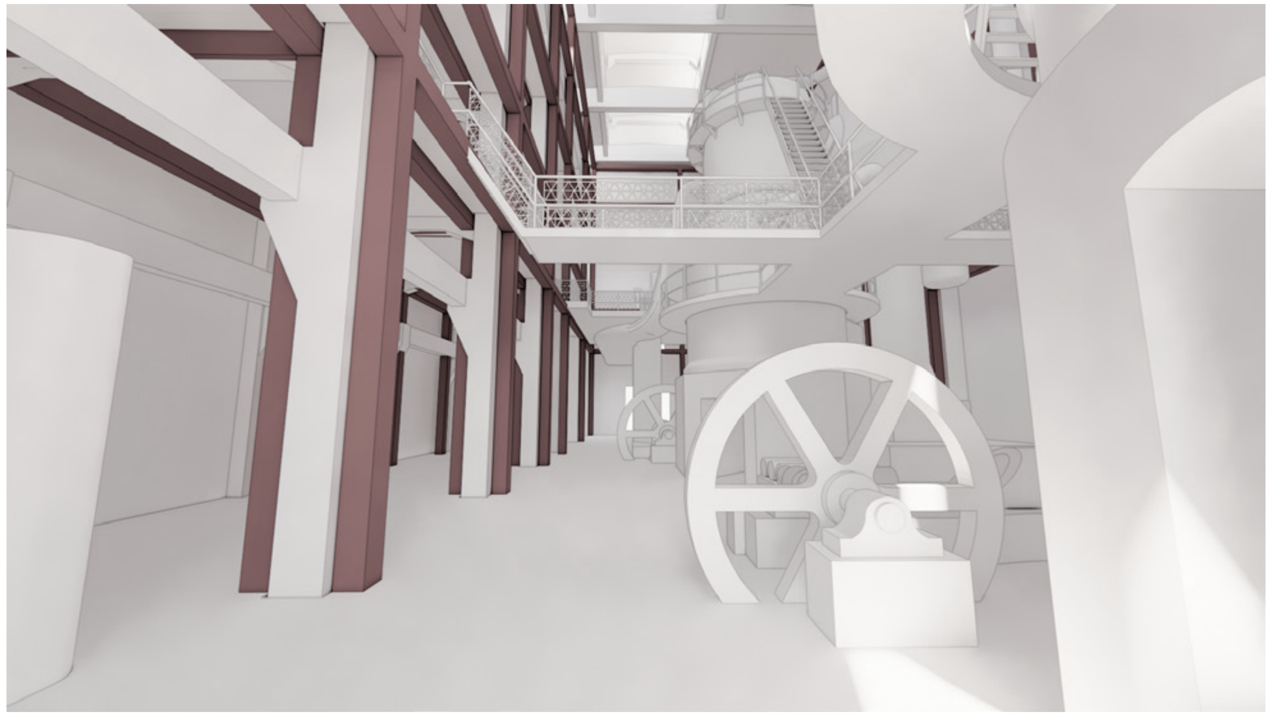






Primary Structure
Secondary Structure

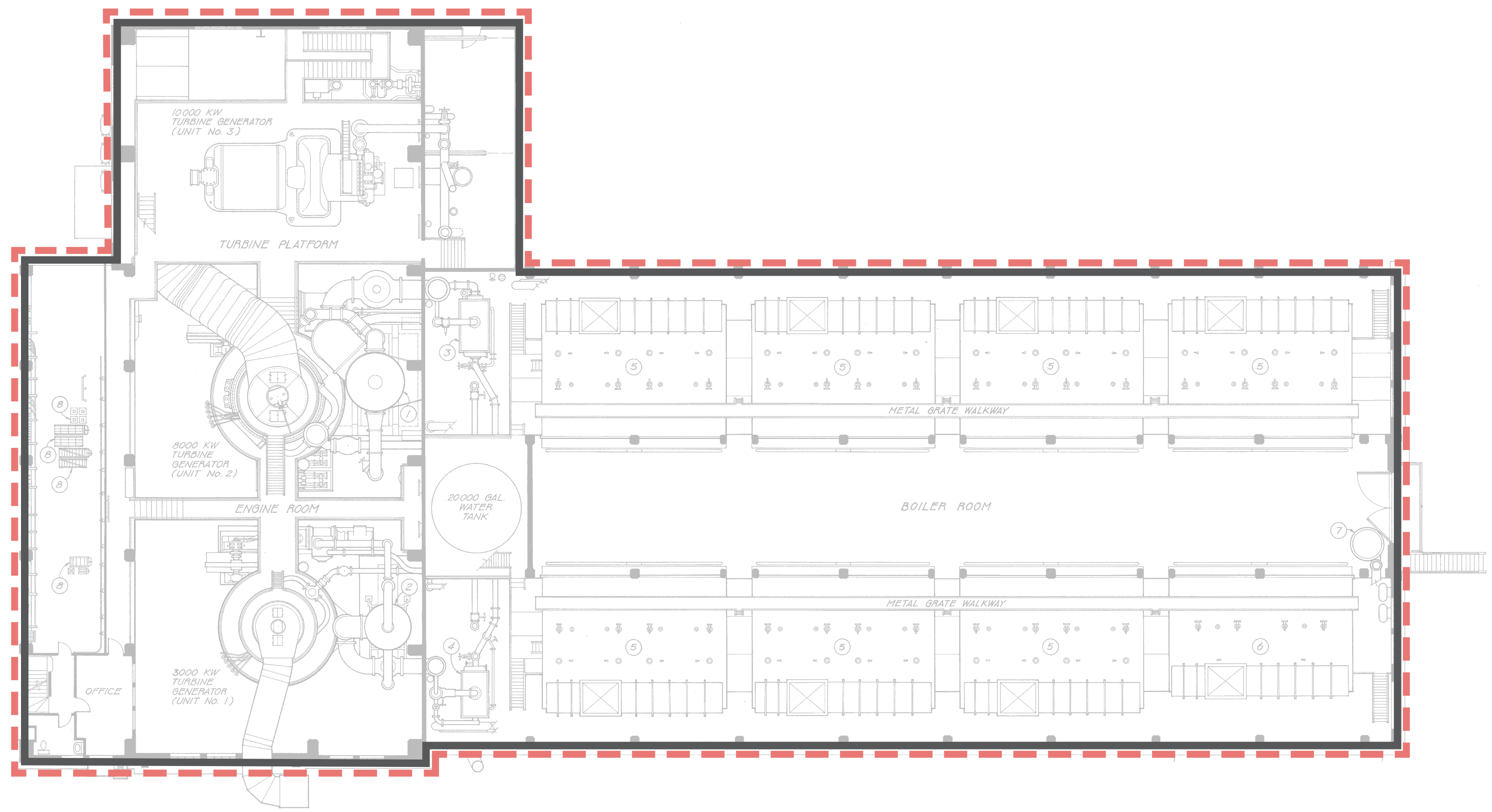
# Study 3: Moment Frames


*Engine Room*


*Boiler Room*


*Ash Room*

# Study 4: Exoskeleton




### Floor Interaction + Diaphragms

An exoskeleton of braced frames is placed at the building's exterior. Several floors that don't reach the building perimeter (coal bin, high roofs) do not have direct points of contact with the lateral system and require steel framing to stiffen the diaphragms and tie them to the lateral system.

### Foundations

With a small, distributed braced frame approach, some of the seismic uplift demand is offset by the building's weight. Smaller foundations (ex. micro-piles, prestressed soil anchors) can be used to carry the remaining uplift. As needed, new piles can be placed outside the building.

### Constructibility

This scheme contains a large number of smaller lateral system elements around the perimeter. Some steel is required for diaphragm connections to the lateral system.

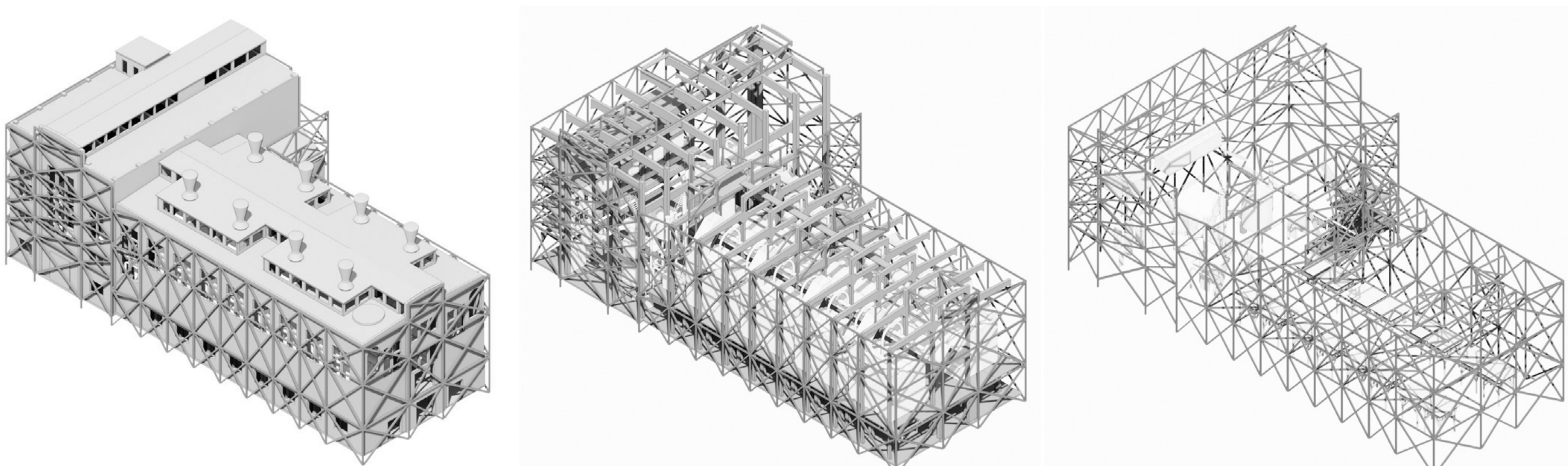
### Impact to Existing

Exterior facades are significantly impacted by the new structure, although uniform on all faces.

### Critical flaw

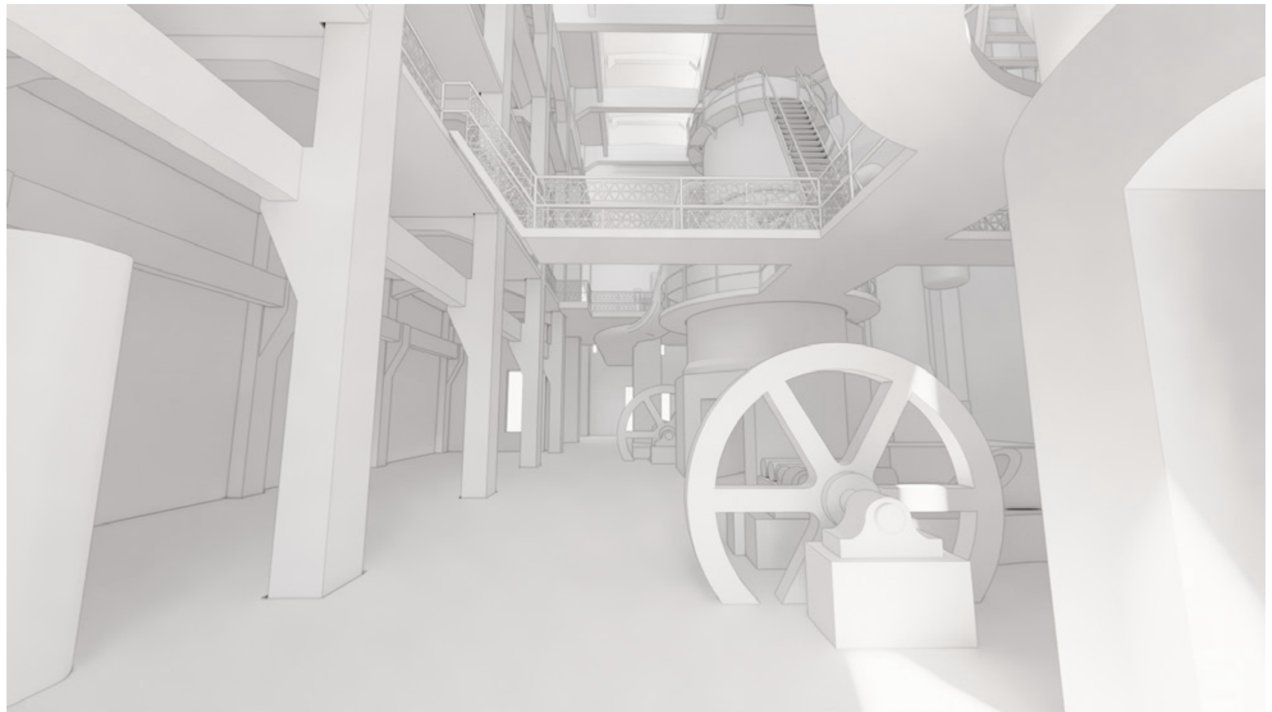
Exterior character-defining facades are significantly impacted by the new structure.

# Study 4: Exoskeleton

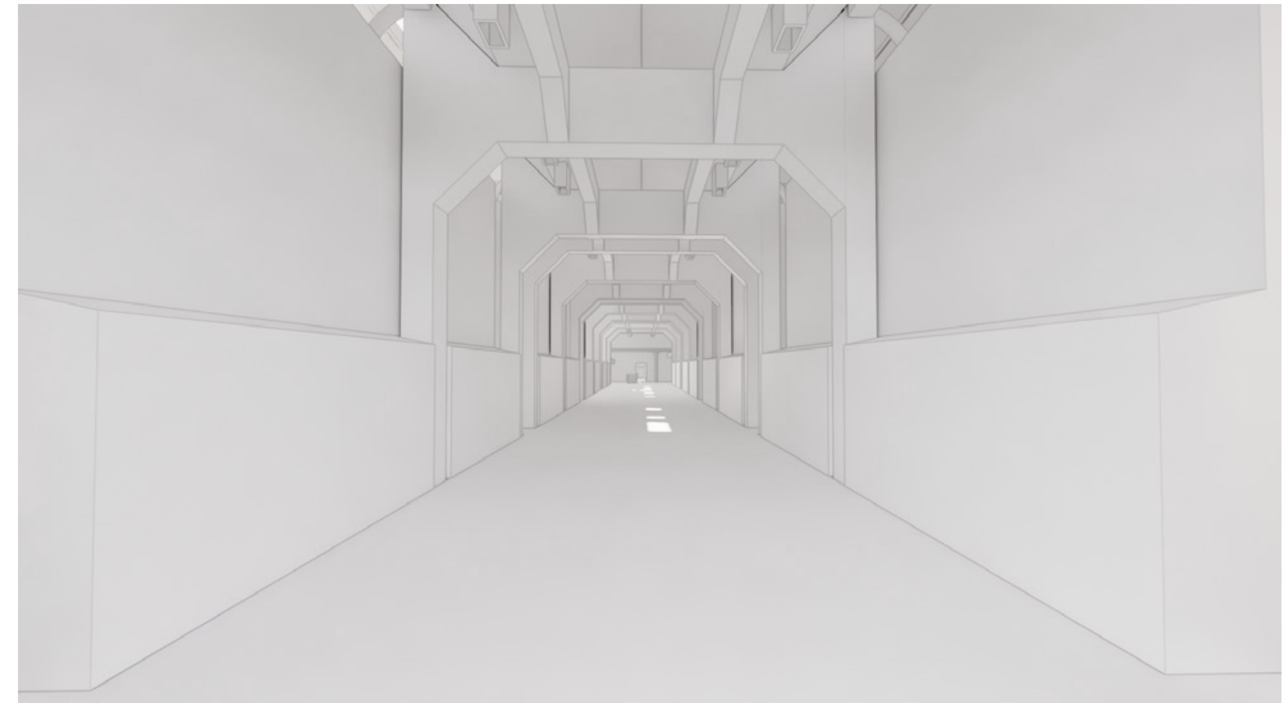


Primary Structure
Secondary Structure

# Study 4: Exoskeleton



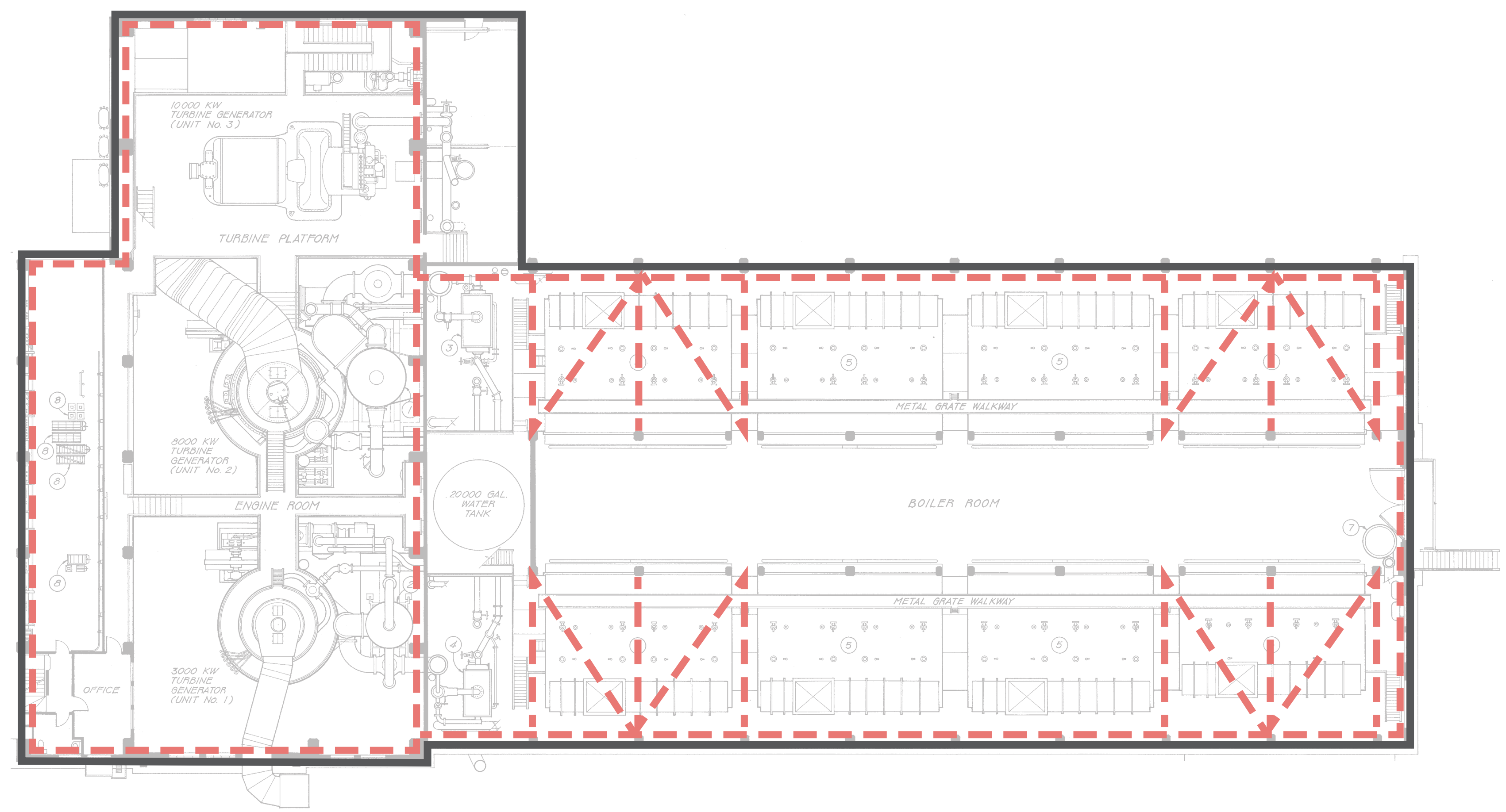
*Engine Room*



*Boiler Room*

*Ash Room*

# Study 5: Shotcrete




**Floor Interaction + Diaphragms**

Reinforced concrete can be applied to either the interior or exterior face of the building. Several floors that don't reach the building perimeter (coal bin, high roofs) do not have direct points of contact with the lateral system and require steel framing to stiffen the diaphragms and tie them to the lateral system.

**Foundations**

With a small, distributed approach, some of the seismic uplift demand is offset by the building's weight. Smaller foundations (ex. micro-piles, prestressed soil anchors) can be used to carry the remaining uplift. As needed, new piles can be placed outside the building.

**Constructibility**

This scheme contains a large volume of concrete around the perimeter to form the lateral system. Some steel is required for diaphragm connections to the lateral system.

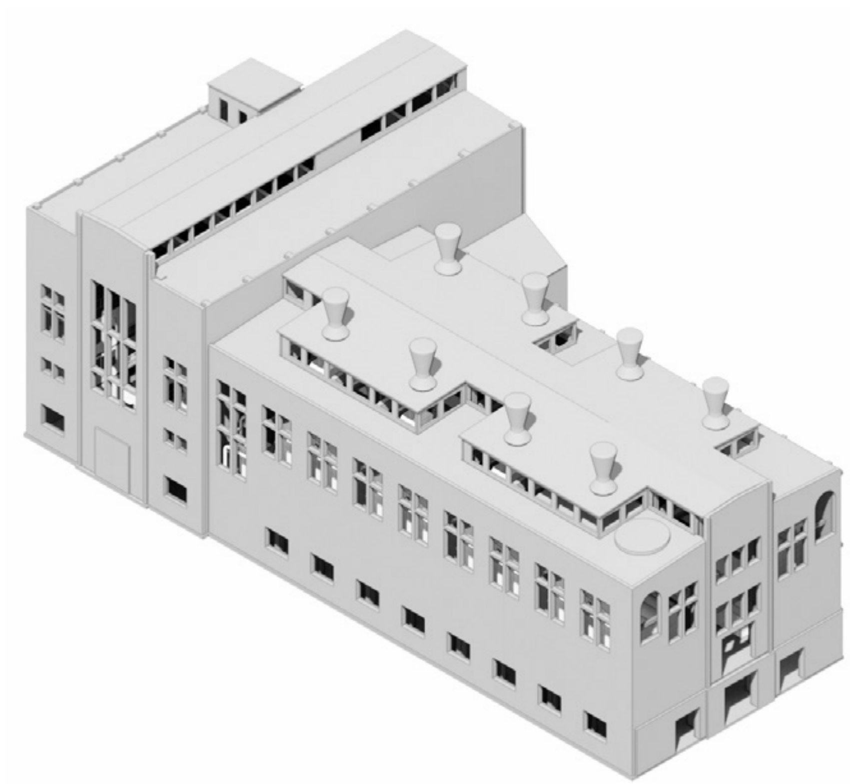
**Impact to Existing**

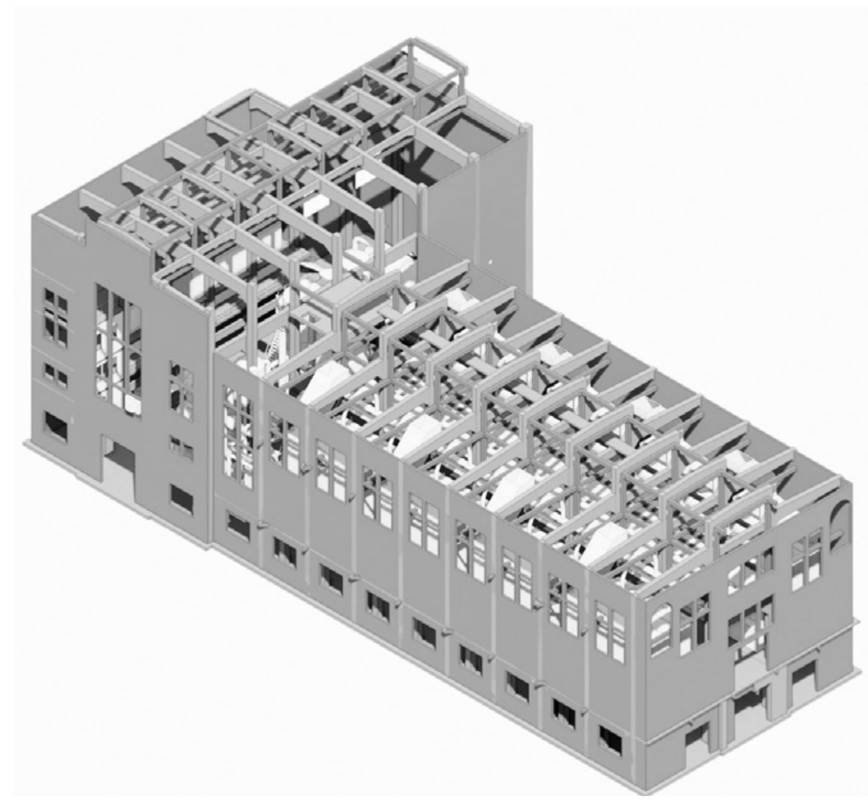
No visual delineation between historic and new structure. Either the interior or exterior facades are significantly impacted by the new structure, although uniform on all faces.

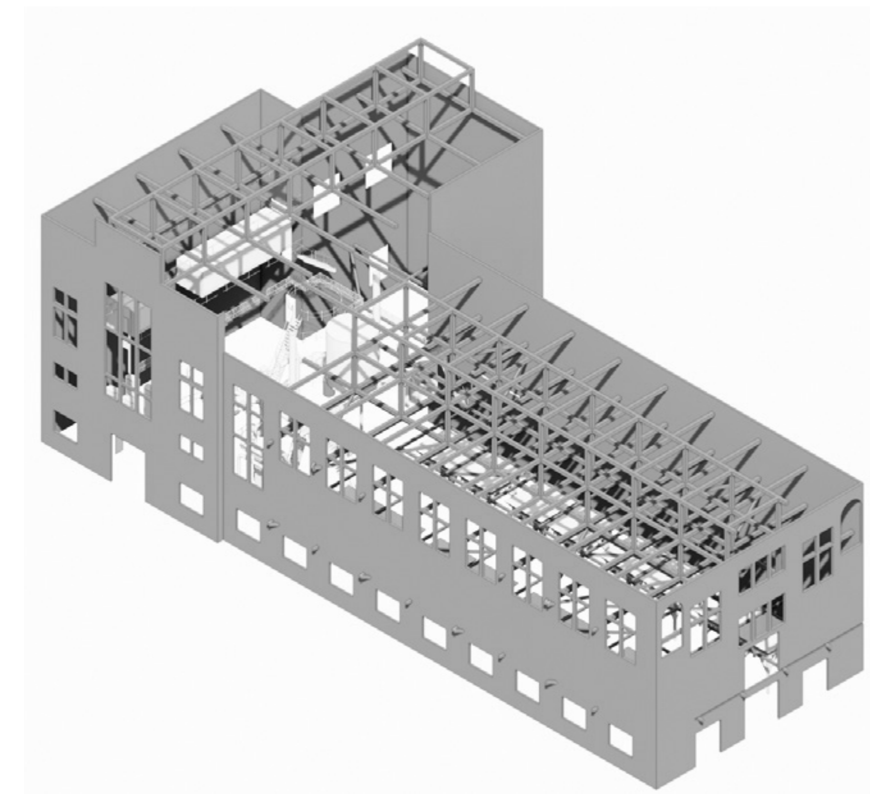
**Critical flaw**

There is no visual delineation between historic and new structure, and the approach is not reversible. Exterior character-defining facades are significantly impacted by the new structure.

# Study 5: Shotcrete



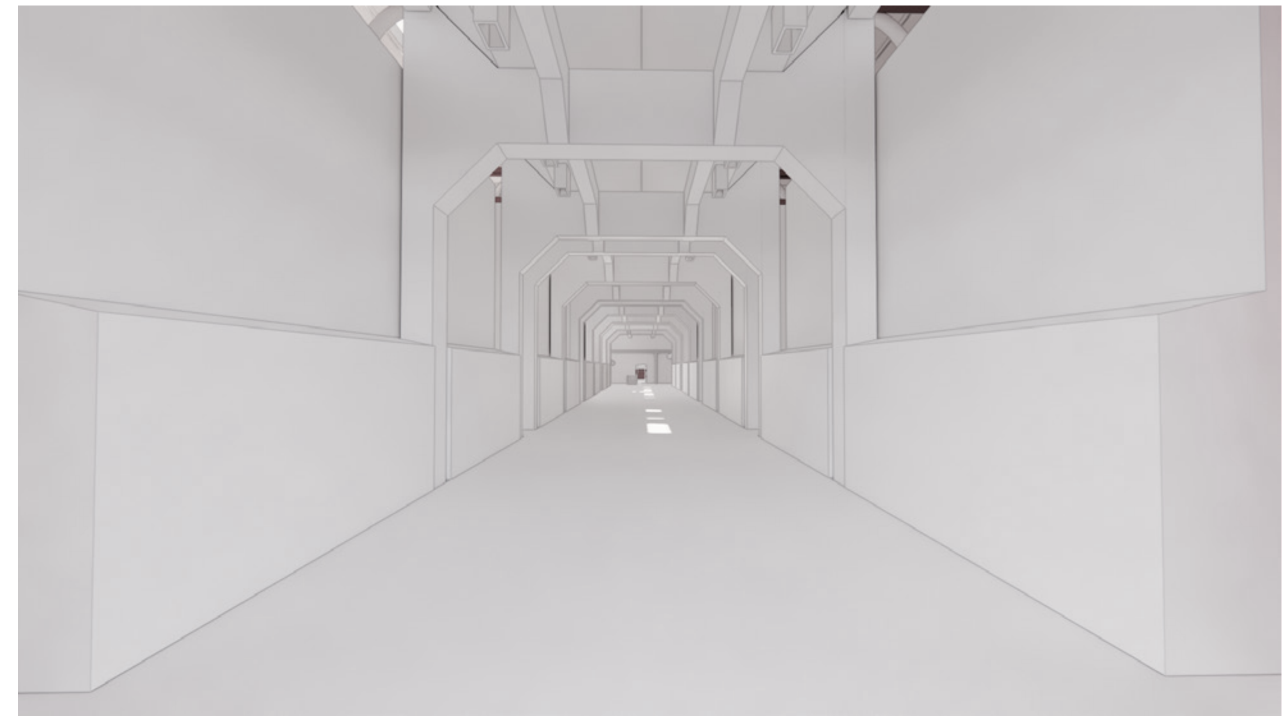




Primary Structure
Secondary Structure

# Study 5: Shotcrete

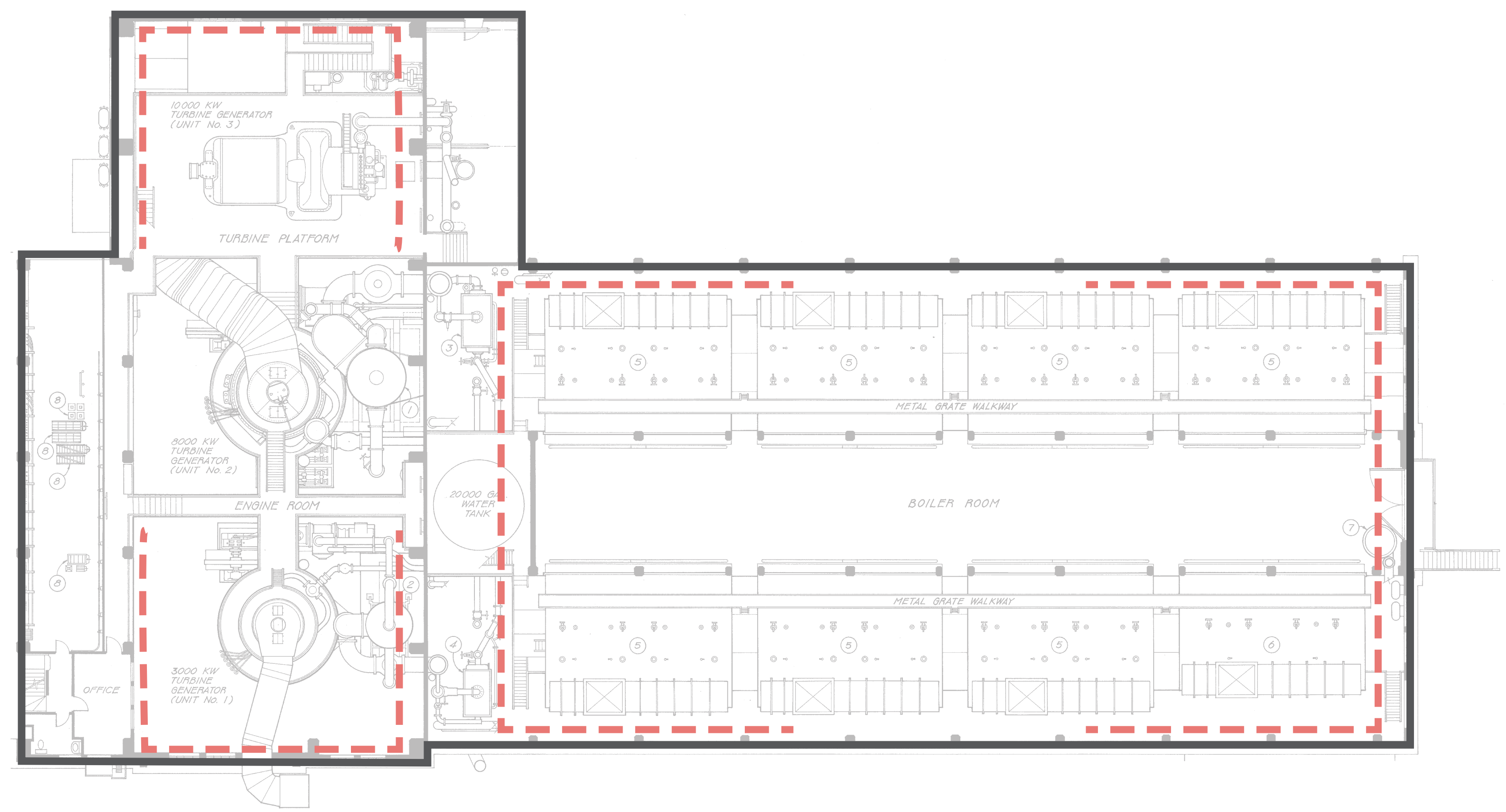
*Engine Room*



*Boiler Room*

*Ash Room*

# Study 6.1: Hybrid 1.0




### Floor Interaction + Diaphragms

Interior braced frames are placed at ends of major floor plates. Several floors (coal bin, high roofs) do not have direct points of contact with the lateral system. Somewhat frequent lateral supports require steel framing to stiffen the diaphragms and tie them to the lateral system.

### Foundations

With a small, distributed braced frame approach, some of the seismic uplift demand is offset by the building's weight. Smaller foundations (ex. micro-piles, prestressed soil anchors) can be used to carry the remaining uplift.

### Constructibility

This scheme contains a large number of smaller lateral system elements and minimizes steel required for diaphragm connections to the lateral system. Interior braces create constructibility challenges around landmarked equipment but avoid any boiler demolition.

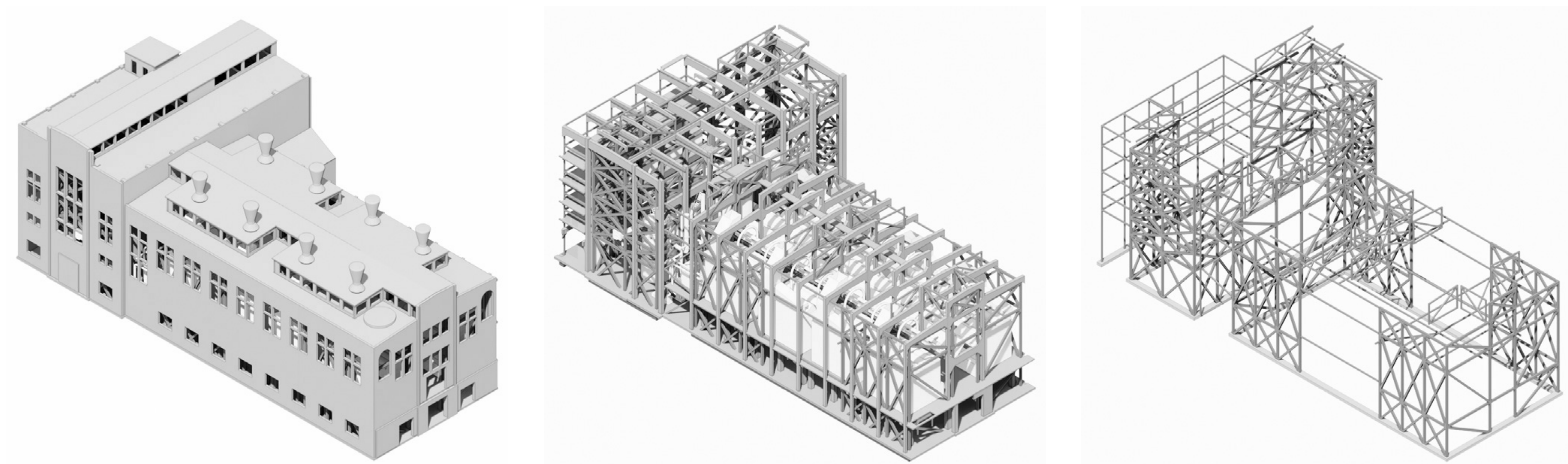
### Impact to Existing

Structure is largely visibly in the Engine Room. No impact to exterior views. The lateral system is hidden behind boilers and preserves the Boiler Room experience. No impact to exterior views.

### Critical flaw

Key interior experiences in the Engine Room are visually affected with the new structure.

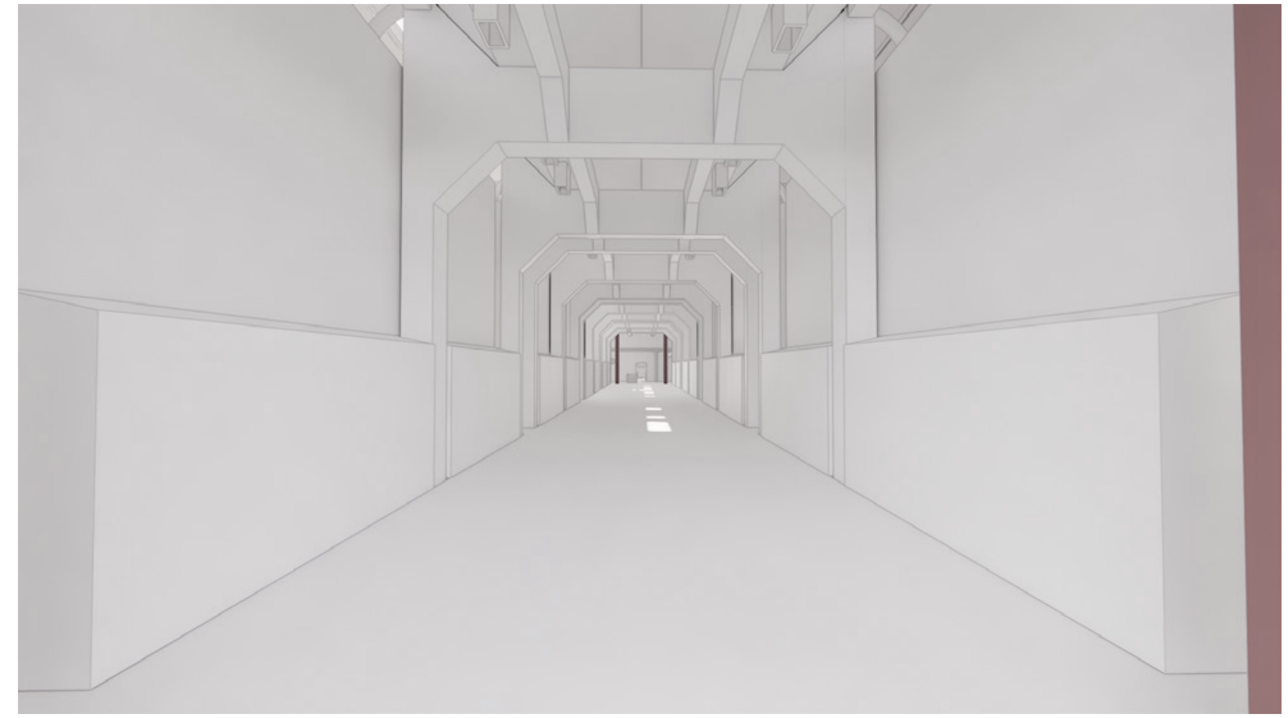
# Study 6.1: Hybrid 1.0



Primary Structure
Secondary Structure

# Study 6.1: Hybrid 1.0

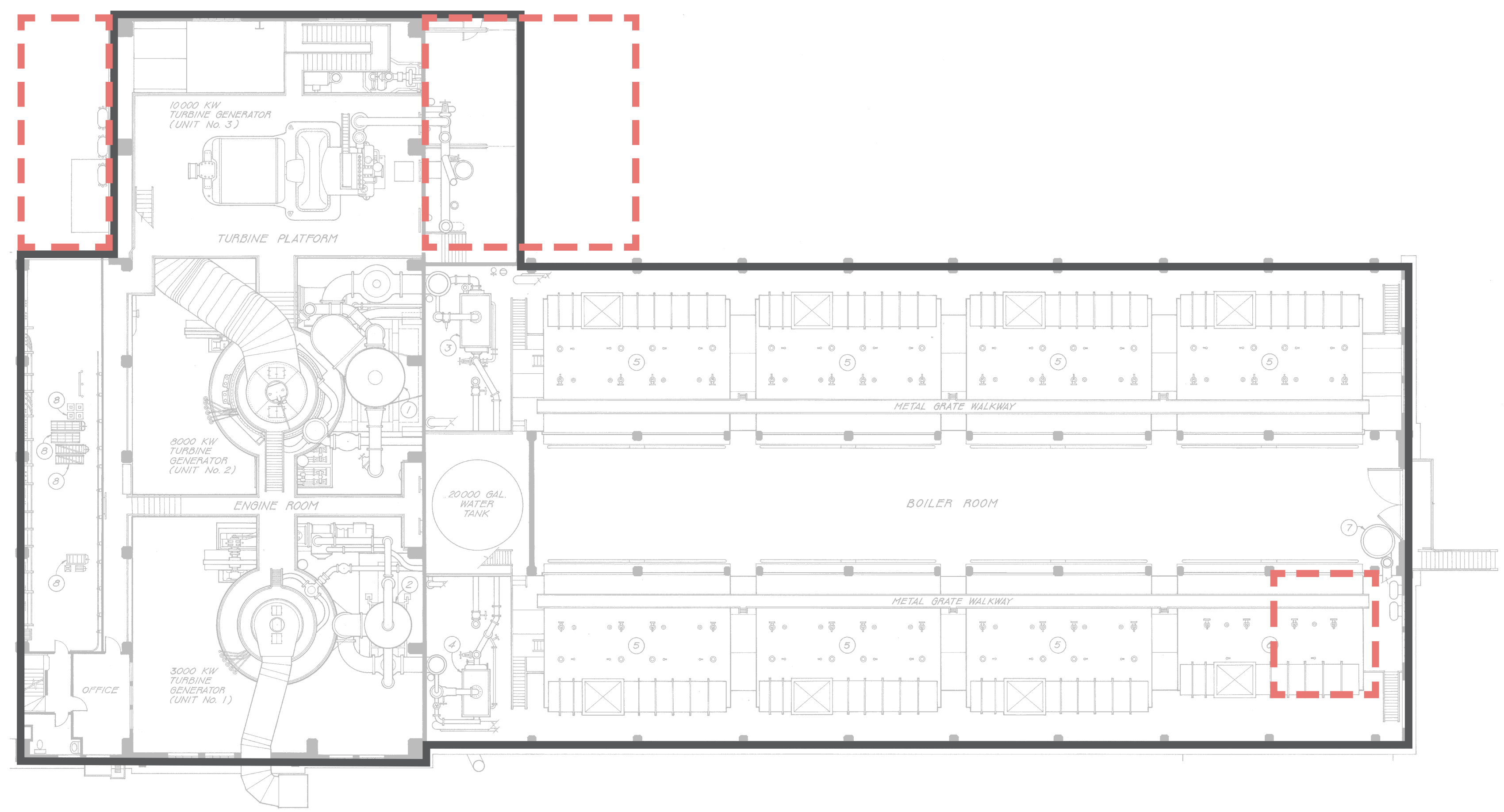
*Engine Room*



*Boiler Room*

*Ash Room*

# Study 6.2: Boiler Stack Brace




### Floor Interaction + Diaphragms

Similar to Scheme 2, large, concentrated cores of braced frames are placed at the building's exterior in the Engine Room. The Boiler room core is moved inside the building. Several floors (coal bin, high roofs) do not have direct points of contact with the lateral system. Less frequent lateral supports require significant steel framing to stiffen the diaphragms and tie them to the lateral system.

### Foundations

Similar to Scheme 2, however, further challenges occur for constructing large foundations inside the building, particularly with the limited head height in the Boiler Room.

### Constructibility

This scheme contains a small number of large lateral system elements but the extent of interior steel connecting diaphragms to lateral system will create constructibility challenges. The interior core would require demolition of one of the boilers.

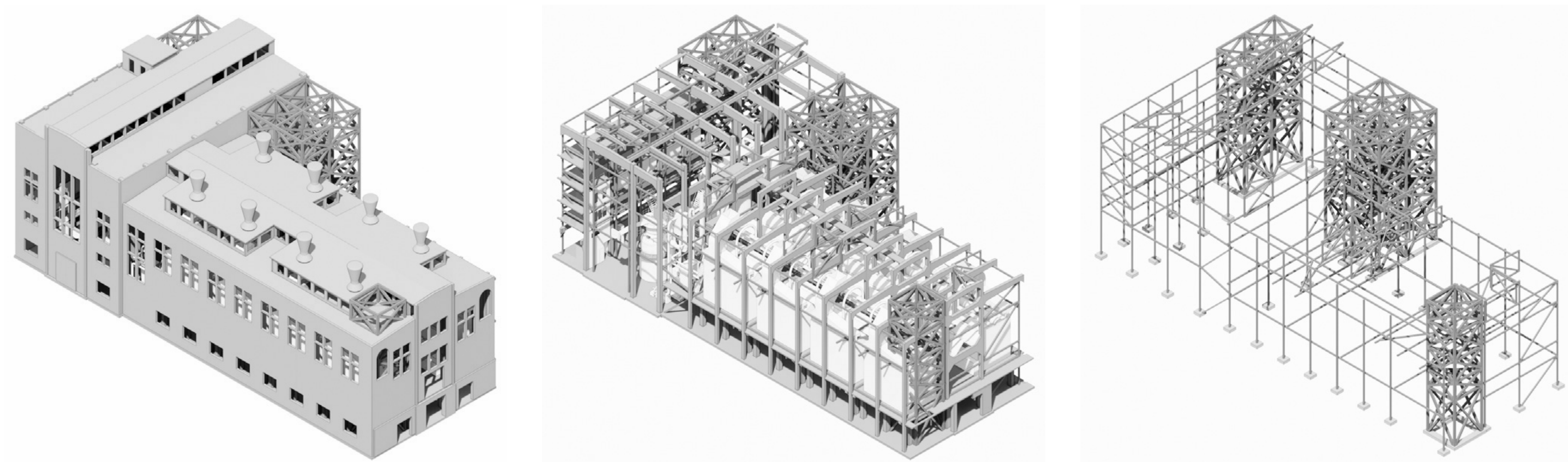
### Impact to Existing

Exterior facades are impacted by the new structure in the Engine Room. A boiler would be removed at the internal core.

### Critical flaw

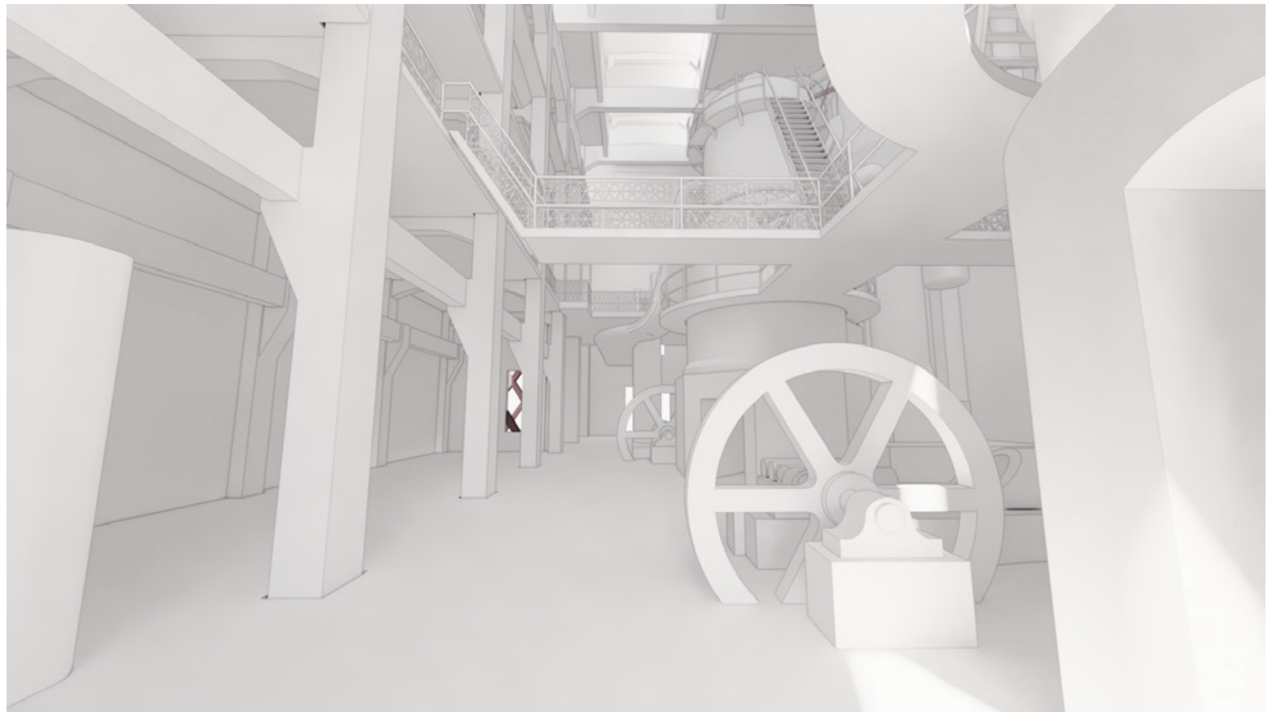
The size of foundation required would be difficult to construct with limited head height in the Boiler Room. Further, the extent of steel needed to stiffen the floor plates and to tie them to lateral system would be much more significant than other schemes.

# Study 6.2: Boiler Stack Brace

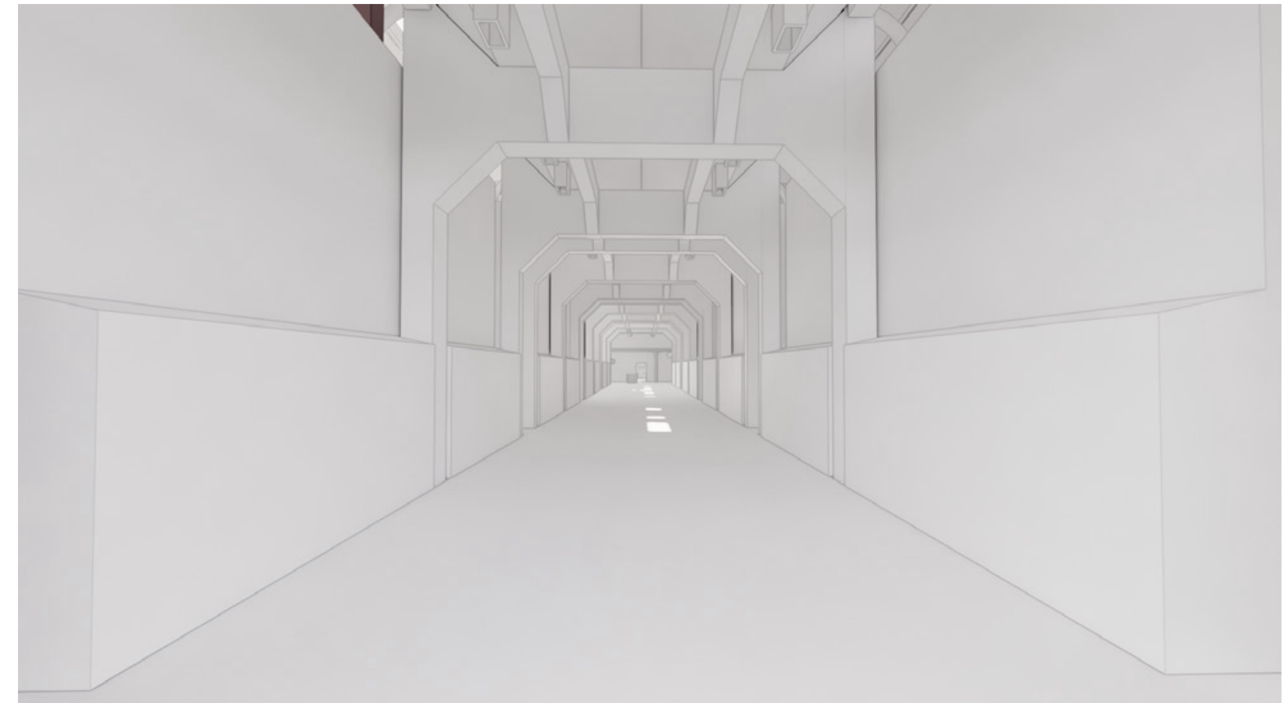


Primary Structure
Secondary Structure

## Study 6.2: Boiler Stack Brace



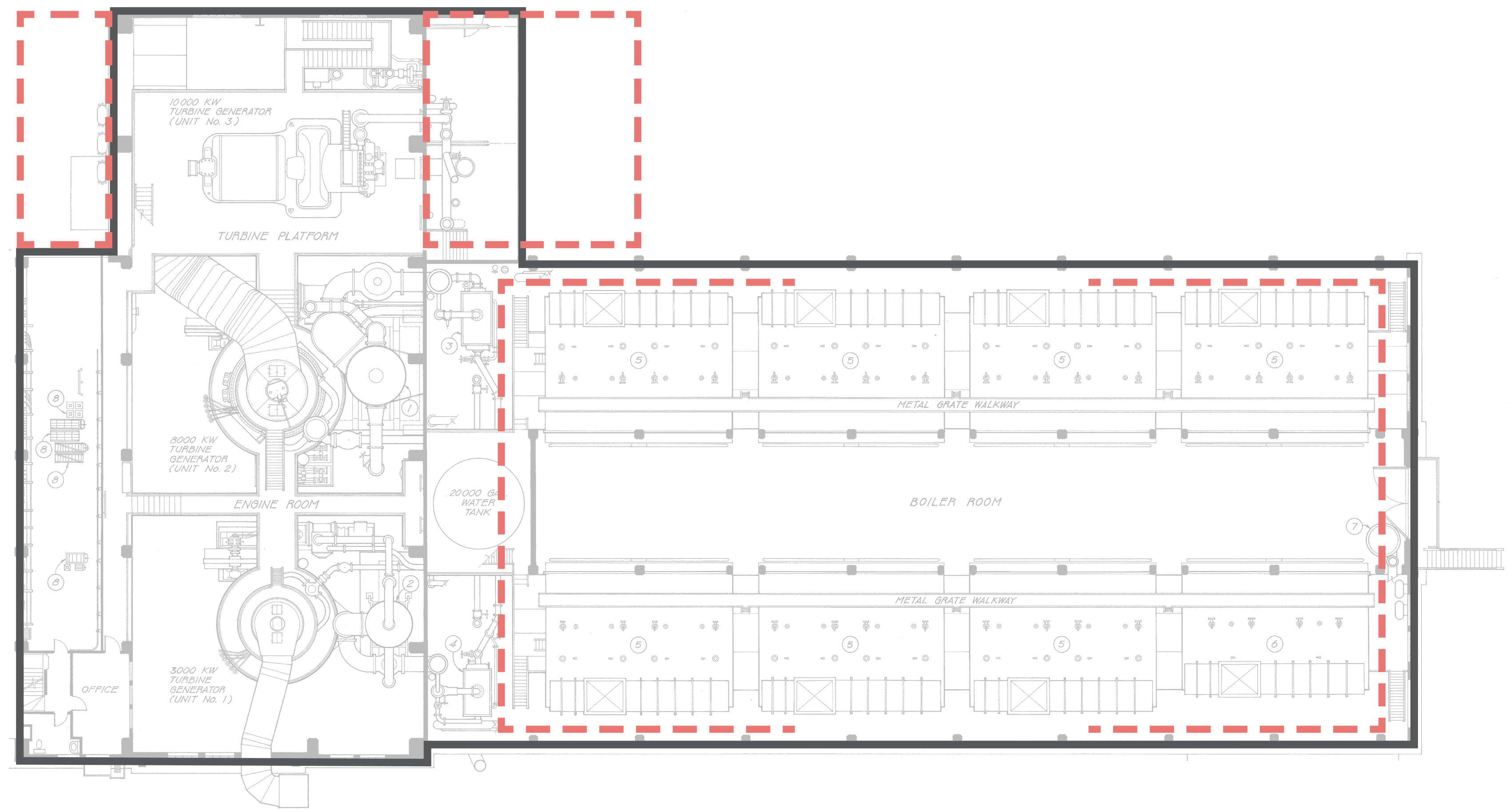
*Engine Room*



*Boiler Room*

*Ash Room*

# Study 7: Hybrid 2.0 Braced Frames




### Floor Interaction + Diaphragms

A hybrid of a small, distributed braced frames (Scheme 6) in the Boiler Room and large, concentrated braced frames approach (Scheme 2) in the Engine Room are used to preserve the capture the best aspects of each.

### Foundations

Smaller foundations (ex. micro-piles, prestressed soil anchors) can be used in the Boiler Room and larger external foundations can be used in the Engine Room.

### Constructibility

This scheme contains a large number of smaller lateral system elements in the Boiler Room and a small number of large lateral system elements in the Engine Room. Some steel is required for diaphragm connections to the lateral system, particularly in the Engine Room. Interior braces create constructibility challenges around landmarked equipment but avoid any boiler demolition.

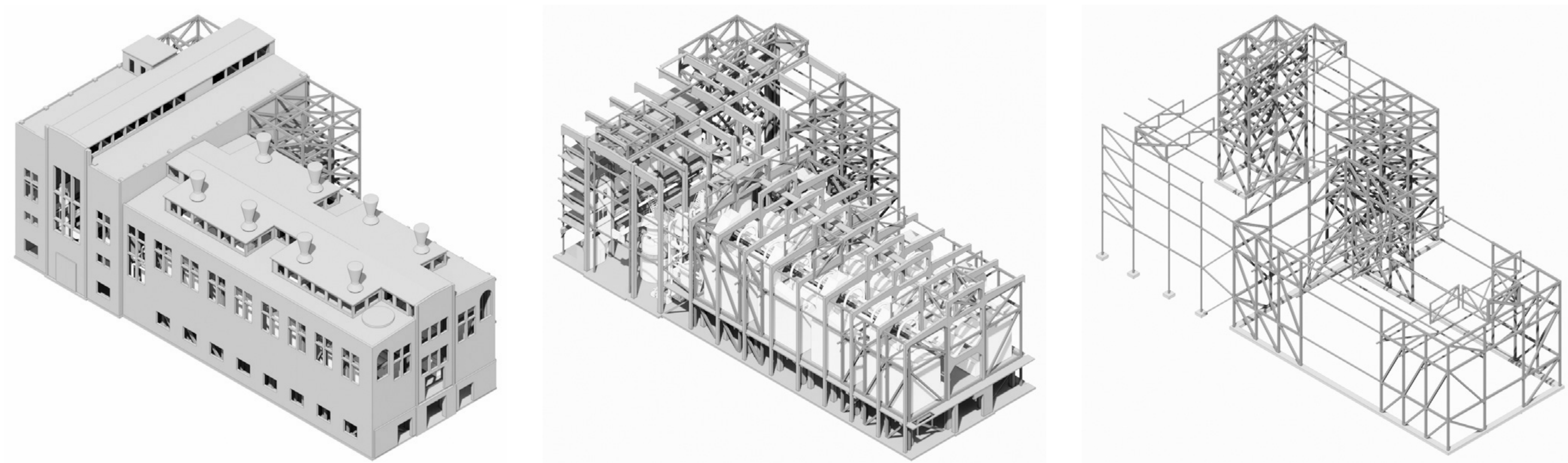
### Impact to Existing

Exterior facades are impacted by the new structure in the Engine Room. The interior Engine Room views are preserved. The lateral system is hidden behind boilers and preserves the Boiler Room experience. No impact to exterior views.

### Critical flaw

N/A

# Study 7: Hybrid 2.0 Braced Frames



Primary Structure
Secondary Structure

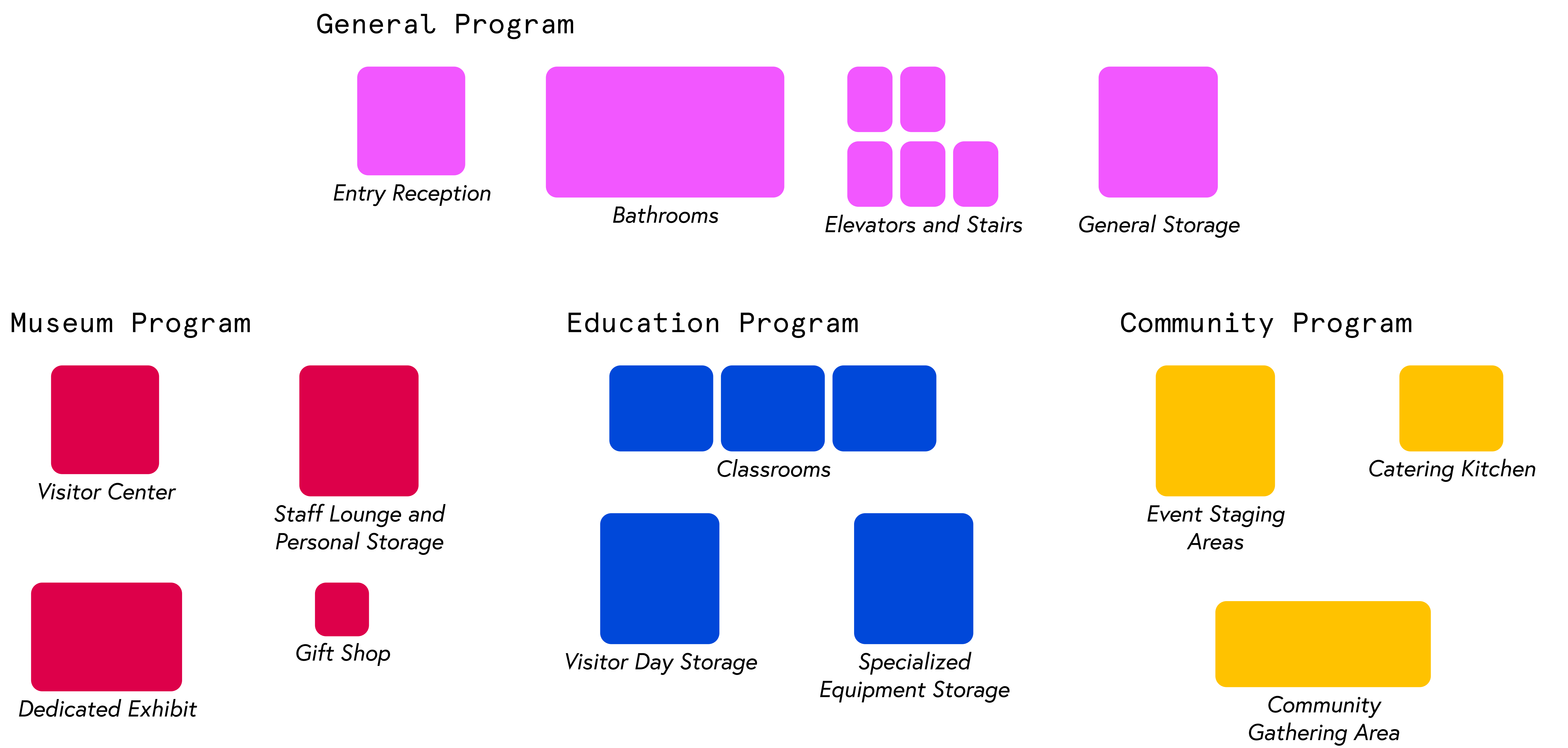
# Study 7: Hybrid 2.0 Braced Frames

*Engine Room*

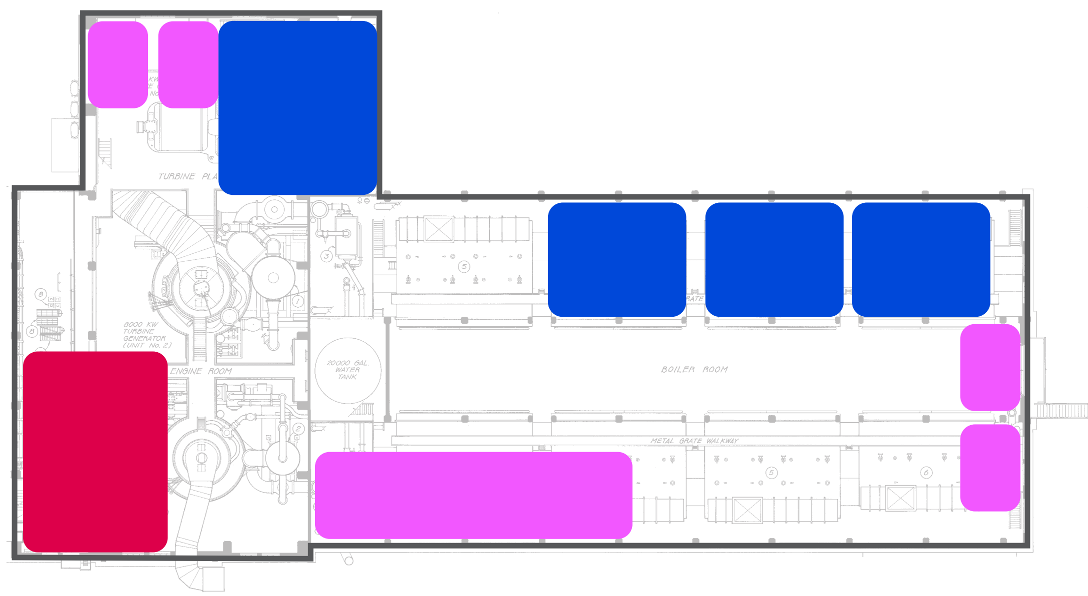
*Boiler Room*

*Ash Room*

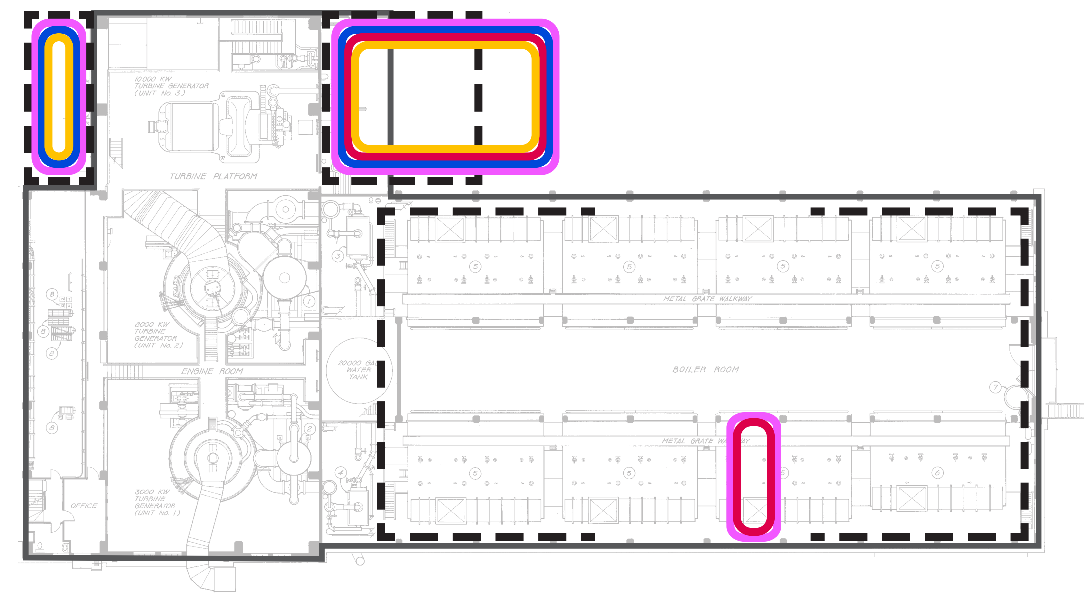
# Program Challenges



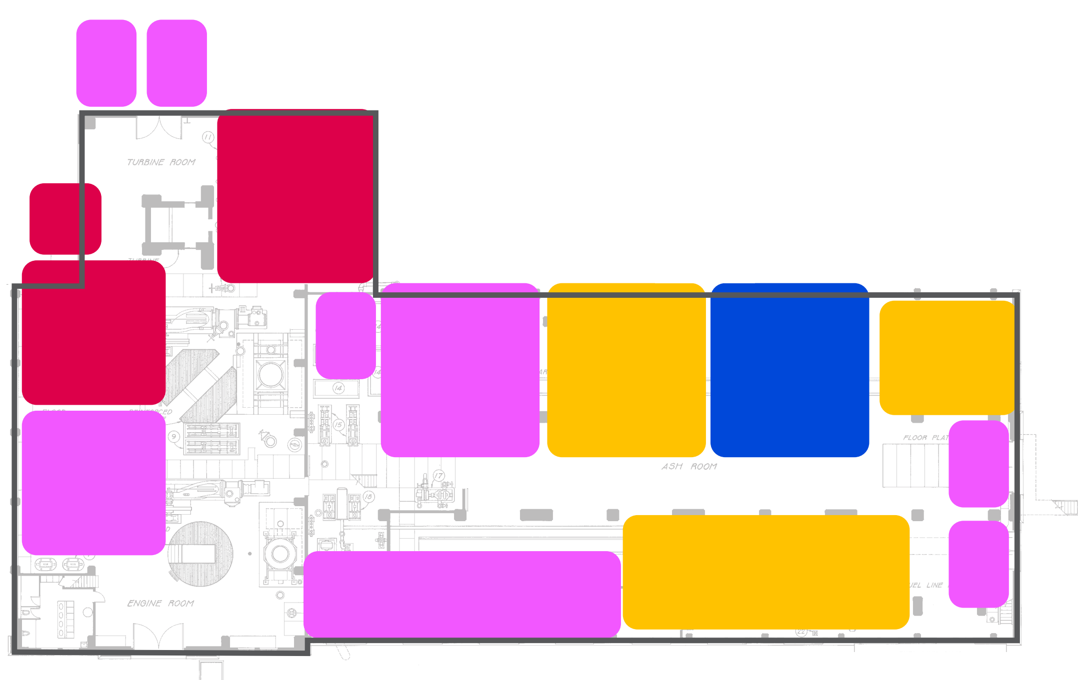
# Program Challenges and Opportunities



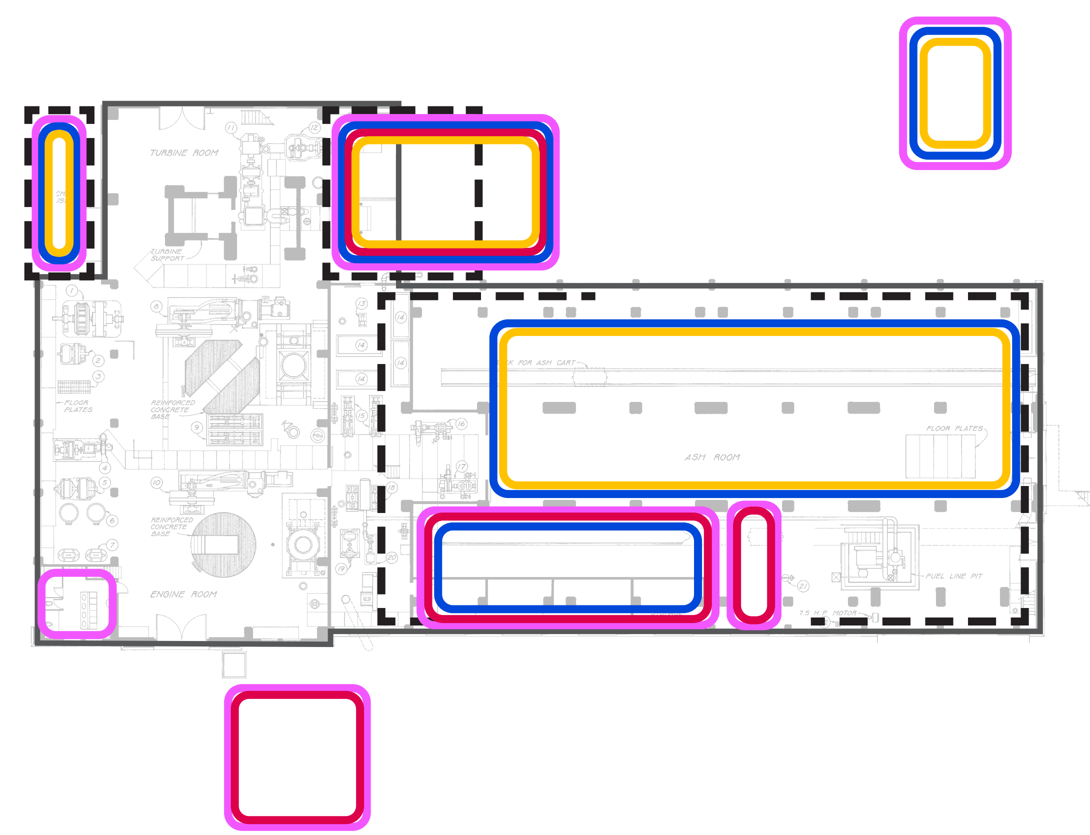
Level 2



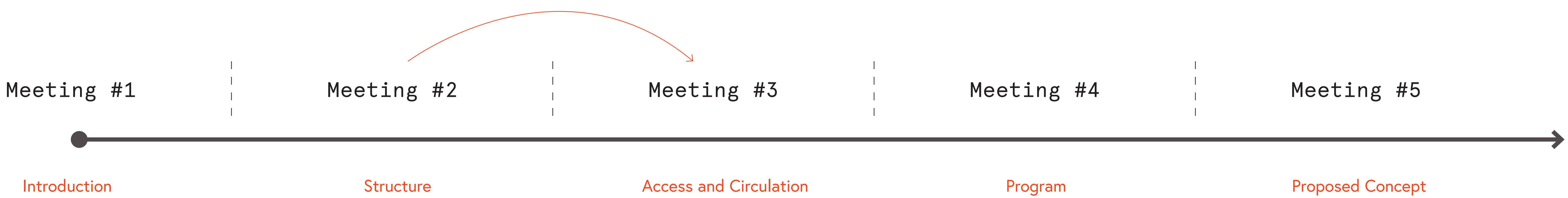
General Program
Museum Program
Education Program
Community Program



Level 1



# Next Steps


Meeting #1
Meeting #2
Meeting #3
Meeting #4
Meeting #5
Introduction
Structure
Access and Circulation
Program
Proposed Concept