



Structural Condition Assessment Report

of the

Storey County Courthouse Virginia City, Nevada

Prepared for

Storey County Virginia City, Nevada

Submitted by

Melvyn Green and Associates Structural Engineers

and

Tobey-Wade Consultants

October, 2014



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Executive Summary

The Storey County Courthouse was constructed in 1876 after the great fire of 1875 that destroyed most of Virginia City. Today the Courthouse stands as a center of county government, a well preserved and maintained symbol of Virginia City's mining tradition and an important tourist attraction.

Built in 1876, the Storey County Courthouse is High Victorian Italianate in style. It is a two story brick building, extremely plain on all sides except for its highly ornamented front facade. The building is rectangular in plan, approximately 75 feet wide and 117 feet long. The front facade rises above the roof in a bracketed parapet. The building is an unreinforced masonry bearing wall structure with wood frame floors and roof.

Throughout the building's life, cracks have been observed in the walls of the south and north stairways in the Courthouse. These cracks appear to have become very active in the past several years. In order to determine whether these cracks are due to a structural problem, site movement or other cause, the Storey County directed that a structural inspection and investigation of the County Courthouse be undertaken. The County also directed that the seismic safety of the building be evaluated again based on current building code provisions.

The findings are:

The cracks in the north and south stairway have increased in width. It may be that the walls are moving outward at the top or foundation settlement. Regardless the repair and strengthening of the masonry stair walls should be considered an urgent need.

The building is an unreinforced masonry (URM) structure. Such structures have been a source of injuries and deaths in past earthquakes in the Western states. The report presents recommendations for a phased approach to seismic strengthening. The first phase is the east facade of the building. This should be followed by bracing the gable end walls, anchoring the roof and floor to the walls, bracing of tall brick walls such as those in the Courtroom, and other shearwall upgrades. Any of these activities may be combined.

Seismic strengthening may be done with ordinary materials and tools and is very feasible. The work may also be done without damage to the historic character of the building.

Exterior brickwork is in need of repointing.

Scope and Intent

The Storey County Courthouse was constructed in 1876 after the great fire of 1875 that destroyed most of Virginia City. Today the Courthouse stands as a center of county government, a well preserved and maintained symbol of Virginia City's mining tradition and an important tourist attraction.

Previously a study was conducted by Melvyn Green and Associates, Structural Engineers. At that time it was noted that the building was an unreinforced masonry structure and that there was a crack pattern in the lightwells.

The County determined that an update to the report would be helpful as the lightwell cracks appear to have become more active. The County selected the team of Melvyn Green & Associates, in association with Tobey-Wade Consulting to conduct the study. The purpose of this study is to observe the areas of distress, identify any new conditions, and to update the previous study.

Limitations

The services under this study are limited to findings that could be determined by a visual inspection without removal of finishes or flooring. Data from the previous investigation was used for portions of this report. Preliminary calculations relative to seismic safety are to be prepared but no construction documents are to be developed under this contract.

The product of the project is a report with recommendations. The report could be used as a basis for future grant requests, budgeting, and selection of specific construction projects.

Methodology

The initial activity was to conduct a detailed inspection of the building by structural engineers from the design team. This included the exterior, building interior areas, the jail, and the attic and roof. In the previous project underfloor areas were inspected.

A preliminary seismic analysis was conducted to determine building elements that may require retrofit.

Structural Description

A set of the original construction drawings as prepared by Kenitzer & Raun Architects of San Francisco, California and dated June 1876 is available for our use. These drawings show the floor plans as well as a general depiction of the building's construction. The drawings show that the building is a masonry wall structure with wood frame floors and roof. This construction was verified during our inspection.

The details of the building are described below.

The first floor of the two story building contains county offices and the jail which is no longer in use. The second floor contains the courtroom, judge's chambers, county offices and records storage. The second floor is accessed from the main entry hall by two identical sets of stairs. Recently, an elevator was installed to provide additional access to the courtroom. The original drawings also show light wells with skylights situated west of the main stairs on the north and south sides of the building. These skylights have been replaced with a timber roof system that extends slightly above the adjacent roof.

The building's area is approximately 16,000 square feet. See Figures 1 and 2 for schematic floor plans. See Figure 3 for a building section.

Foundations are continuous walls made of rough cut stone. For the exterior walls they extend to grade and serve as the base for the brick walls. There are also stone interior foundations. These support the first floor and some interior walls. The interior foundations extend up to the underside of the first floor joists.

With the exception of the lower portion of the rear wall along Line D and parts of Lines 2 and 3 which is constructed of stone, the building's load bearing walls consist of unreinforced brick masonry. The term unreinforced masonry indicates that the construction utilizes fired clay bricks mortared together to form a structural wall element. Reinforcing steel is not used to provide flexural strength and continuity within the brick walls. Lateral loads are transferred to the foundations through compressive and shear action of the brick masonry. Since these walls lack reinforcing steel, the tensile component of the lateral force is resisted by the weight of the building. The bricks are laid in a running bond type assembly and header courses are visible every two feet.

The masonry wall thickness varies depending on the location within the building and on their height. Typically, the walls reduce in thickness at the second floor line and at the base of the gabled ends. Wall thicknesses are shown in Tables 1 and 2.

The front wall, gridline A, appears to be a veneer brick over conventional running bond brick coursing.

The interior walls that form the north and south stairway enclosures are of brick construction. These walls are part of the jail.

The rear wall of the building, grid line D, is partially constructed of stone. At the northwest corner of the building is a one story addition of stone construction.

Wall heights vary because of the roof slope. The interior story to story height in the jail is 19 feet. Above the jail is the Courtroom which has a height of about 19 feet. The walls at the front of the building on the first floor are the same height as the jail. The walls on the second floor vary in height in the different spaces from 12 feet to 19 feet.

Brick walls typically support an intermediate floor in addition to the roof. In the north and south lightwell enclosure the exterior walls are full height from the first floor to the roof, an unsupported height of about 37 feet. There are intermediate steel tie rods between the exterior wall and the wall of the jail.

Interior walls are conventional wood stud construction with plaster finish. Wall thickness varies as required by the architectural design needs. It was not determined whether the thick walls were constructed with a single width of stud or are of double stud construction.

The construction of the interior wall between the courtroom and the main stairway is an unknown. In the attic space a single wythe of brick is placed between the 6 inch studs of this wall. However at the first and second floor the wall is thicker because of furring and pocket doors. Without removal of finishes, it could not be determined whether this wall is brick.

The roof framing consists of heavy timber wood trusses. Iron rods form the tension elements of the trusses, timber the compression members.

The trusses from grid line B westward span from north to south approximately 45 feet and are spaced at 10 feet on center. These trusses span over the high ceiling of the courtroom and to the walls that form the jail walls. Spanning between trusses and located at the truss panel points are 4 x 12 purlins. These are located about 10 feet on center. 2 x 6 roof rafters at about 26 inches on center span between the purlins.

The roof sheathing is 1 x 12 straight boards. The building originally had a wood shingle roof covering; it currently has a metal roof.

At the front of the building, from grid line A to B, the trusses are turned and span east to west. The bottom of these trusses is at the lower ceiling height of the office portion of the building. The trusses span approximately 45 feet and are spaced about 15 feet on center.

However in this area of the attic the trusses do not directly support the roof. Instead, one or more vertical posts support a ridge beam. These vertical posts do not line up with the panel points of the trusses.

Diagonal (hip) beams span from the corners of the building to the ridge beam creating a hip roof at the front of the building. The hip is not visible from the front of the building because of the facade and parapet. The ridge beam is at the same elevation as the peak of the trusses over the west half of the building. Thus from the exterior there is a single and continuous ridge line on the building. The front wall of the building has a high parapet. This returns around the corner on the north and south walls. The parapet thickness varies with a minimum thickness of 9 inches near the lower end at the building corner. While

the parapet looks as if it may be constructed of sheet metal, its backing and structure are brick.

The building appears to have had minimal structural alterations over its lifetime. An elevator has been installed to access the courtroom and metal roofing is present. The original skylights over the light wells have been replaced by a timber roof system containing smaller skylights.

Architectural Description

The Storey County Courthouse is a two story brick building, extremely plain on all sides except for its highly ornamented front facade.

Built in 1876, it is High Victorian Italianate in style. The building is rectangular in plan, approximately 75 feet wide and 117 feet long. The roof is gabled, but the roof immediately behind the parapet is a hip. The front facade rises above the roof in a bracketed parapet. This ad hoc construction may have been necessary to keep the peak of the roof below the level of the front facade, which is largely constructed of prefabricated cast iron pieces.

The front facade is a bilaterally symmetrical arrangement of five bays, with the center bay projecting slightly. The building's corners are defined by pilasters at each level. Each of the flanking bays has a pair of windows under a single pediment at each of the two levels.

First floor windows are arched; their pediments are segmental. Each of the segmental pediments has an ornate face with a central cartouche.

Second floor windows are trabeated; their pediments are triangular. Pairs of windows are separated by slender columns. Windows are 1/1, double hung. First floor window pairs are aligned with those on the second floor. Both first and second floor window pairs are defined by pilasters. First floor window pairs have projecting bracketed sills. The center bay is set off with quoining at the lower level, with pilasters at the upper. Centered in this bay is an arched entry flanked by pilasters.

Above this entry is a bracketed overhang surmounted by a railing. At the second level, the center bay consists of two windows flanking a niche, all surmounted by a segmental pediment. In the niche is a statue of Justice, sans blindfold.

Above the upper story windows is a bracketed cornice with a broken pediment above the central bay. Rising through the pediment is a plaque with the building's date of construction.

The front wall is brick; the ornamentation cast iron.

Findings and Recommendations

Our investigation has determined that the courthouse has several structural conditions that require attention.

Cracks in North and South Lightwells

The severe cracking of portions of the building's lightwell walls is a sign of ongoing movement. The width of cracks has increased significantly since our previous inspection. Unless structural repair is undertaken, the cracking will probably continue until the walls become unstable. In our opinion, this is an urgent item for installing additional bracing and repairs.

The potential causes of cracks in building walls are numerous. However, wall cracks which occur soon after completion of construction are usually related to differential movements of the building foundations. This did occur; early cracking was noted in the *Daily Territorial Enterprise* for April 25, 1877. Such cracking, however, only remains active for a few years. Moreover, if foundation settlement were the entire cause, we would expect to see some cracking throughout the building. In fact, significant cracking is located only in the stairwells probably indicating some localized foundation issue.

Strengthening will involve the installation of horizontal braces from the exterior wall to the walls that are perpendicular to them. In addition some strengthening will be required at the interior wall cracks to tie the walls across the cracks.

Seismic Retrofit

More significantly, the building is potentially hazardous in an earthquake due to its URM construction.

Unreinforced masonry (URM) buildings typically do not have adequate physical connection between the roof and the walls. In a similar manner the same condition occurs between the second floor and the masonry walls. This connection keeps the wall from falling outward in an earthquake, a significant deficiency. All walls will have to be anchored to the roof and second floor.

In a similar manner, the east parapet will tend to rock and fall outward in an earthquake. Parapet collapse is usually the first thing that happens to this type of building in an earthquake and should be considered a priority strengthening task. The portion of the wall between the roof and the ceiling of the second floor is a gable. It too tends to act as a parapet and fall outward. Gables occur at both the east and west elevations of the building.

Walls that are attached at the roof and intermediate floors are stable if they are within a certain height to thickness (h/t) ratio. As shown in Tables 1 and 2, several walls, including the tall walls of the Courtroom and the lightwell exceed the acceptable h/t ratio.

Additional elements of the strengthening will include some interior wall strengthening and connections.

Not all the strengthening needs to be completed at once. It may be phased to fit budget and schedule demands. The suggested phasing for the Courthouse is:

Phase I

- East Elevation – Brace the parapet and the gable wall. This will involve bracing on the back side of the parapet with diagonal braces extending to the roof system. The gable will be braced on the interior side of the brick with steel shapes anchored to the wall and to the roof and ceiling framing (the ceiling framing may need some strengthening in the attic).
- West Elevation – This will require bracing within the attic similar to that described for the east elevation.

Phase II

- Roof Line – The roof needs to be fastened to the walls. Since there is a new roof covering installed, plywood may be installed in the attic on the underside of the roof. Alternatively, plywood could be applied on top of the roof at the time of the next roof replacement project.
- Second Floor Line – Anchoring the walls at the second floor is necessary. It may be a separate project or could be integrated with other alterations and improvements.

Phase III

- Interior Shearwalls – Additional wall strengthening will be necessary as part of the total seismic retrofit. This may be integrated with other alterations or system upgrades. Plaster removal to add plywood is dusty so it should be carefully scheduled around other alterations and building occupancy.

Brick Maintenance and Pointing

Repointing of masonry walls is an important maintenance task to preserve brick buildings. The need for this is getting urgent on areas of both the north and south walls in selected areas. Planning for repointing all the walls should be considered. All new mortar should match the existing in material properties.

Summary

While these deficiencies are considerable, rehabilitation is feasible and may be readily accomplished with conventional supplies and tools. Due to the historic nature of the courthouse, preservation must be addressed as well as safety. Both preservation and safety can be accomplished. Strengthening of the URM parapets is recommended to oc-

cur concurrently with the stairway enclosure stabilization since the work on the parapet would involve the same type of subcontractor.

There should be no significant visible exterior effect from the work proposed in this report. Any seismic bracing will be visible in the north and south stairways; it can be designed to be relatively unobtrusive.

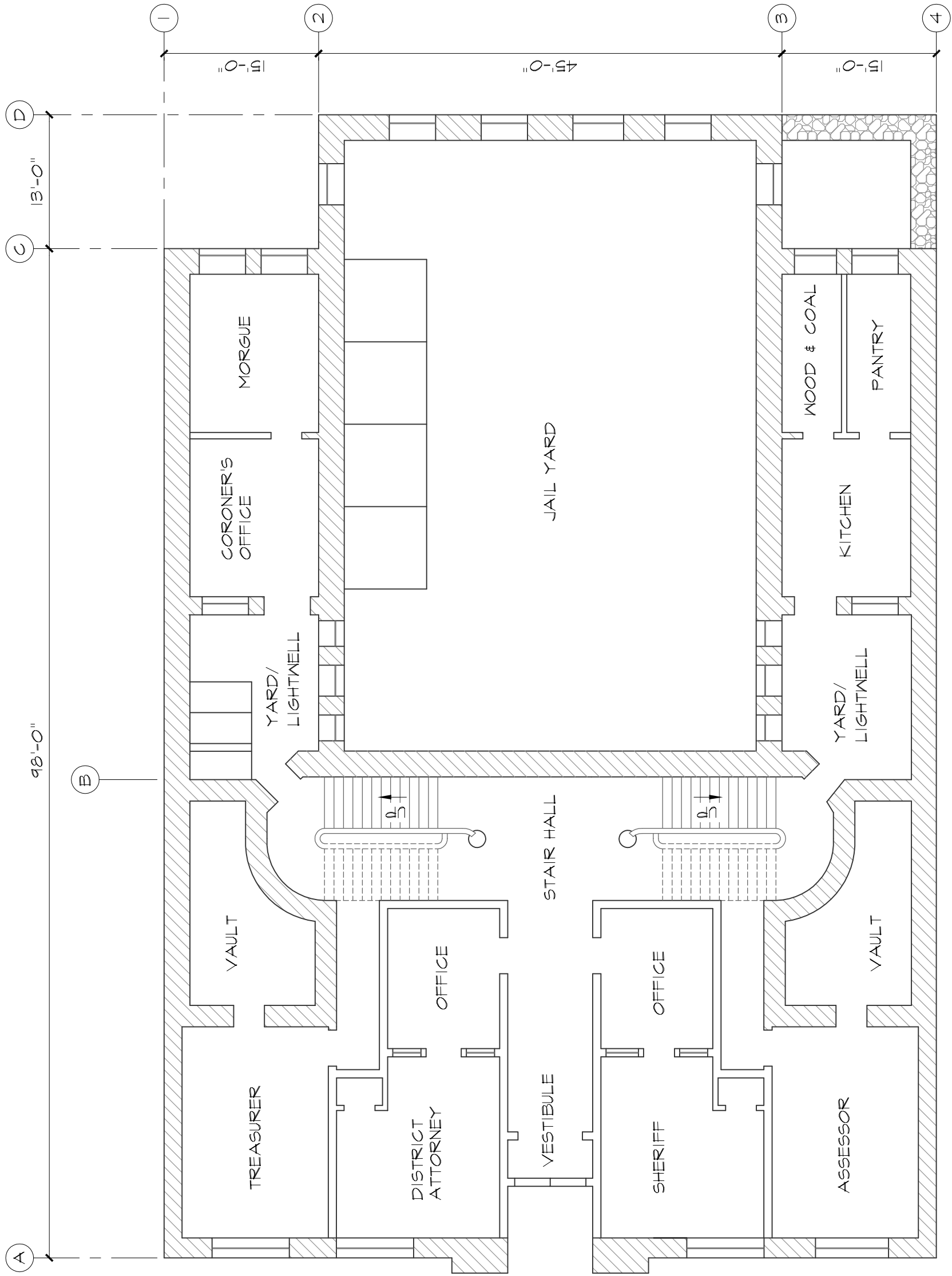


FIGURE I
FIRST FLOOR PLAN
N.T.S.

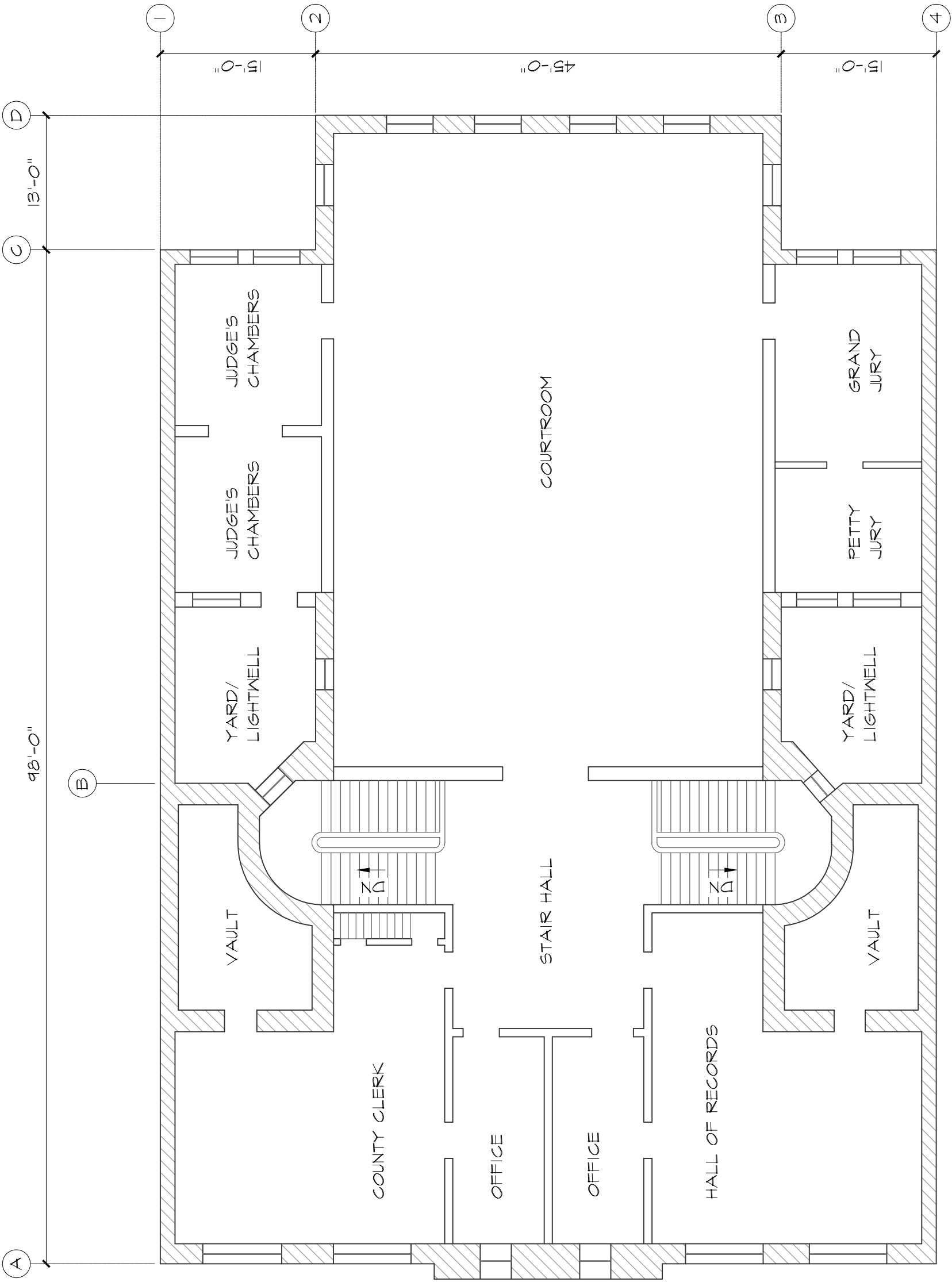


FIGURE 2
SECOND FLOOR PLAN

N.T.S.

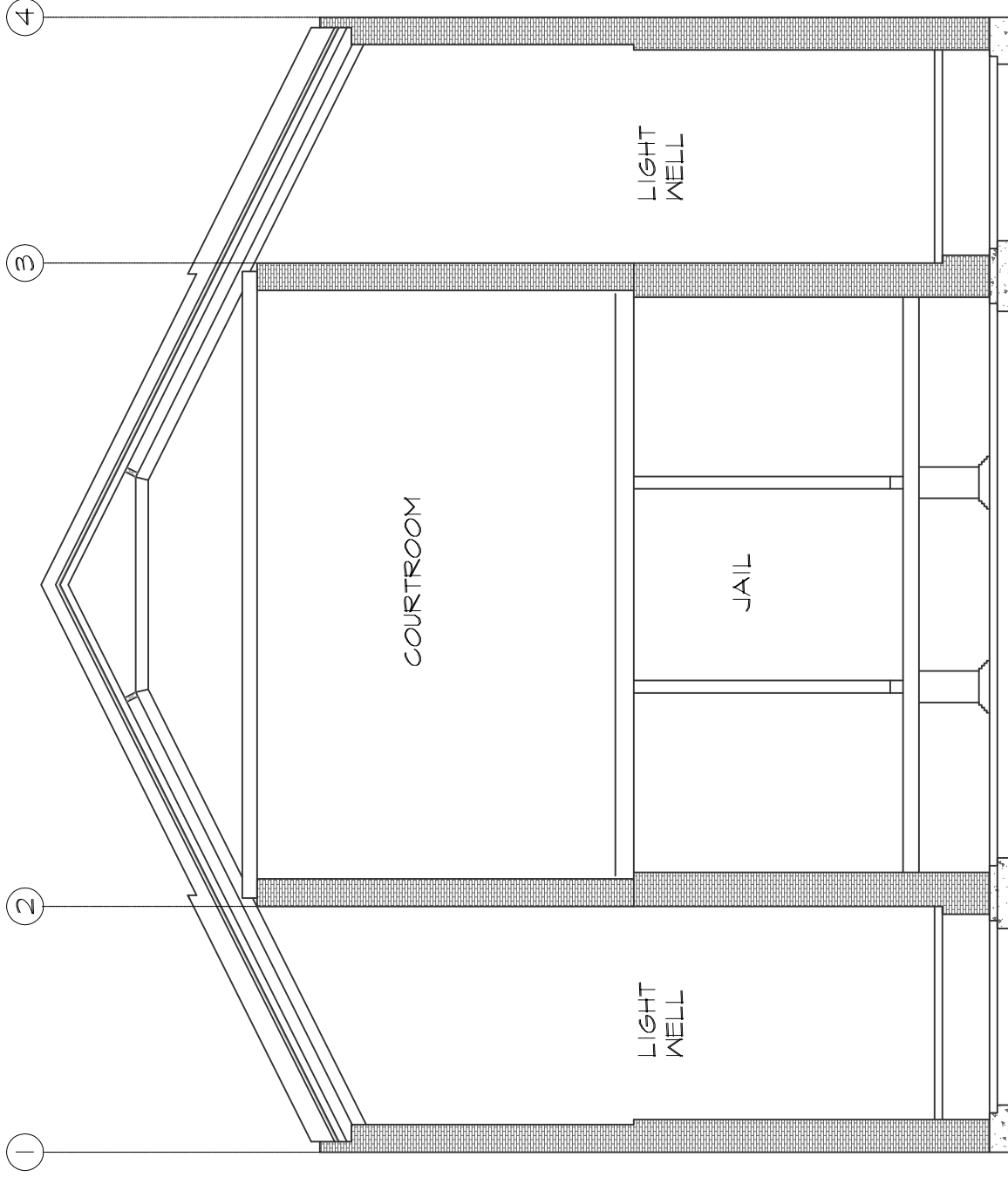


FIGURE 3
SECTION THRU LIGHT WELL

N.T.S.

MASONRY WALL HEIGHT TO THICKNESS RATIOS						
FIRST STORY						
WALL IDENTIFICATION	GRIDS	WALL HEIGHT (FT)	WALL THICKNESS (IN)	H/T	ALLOWABLE H/T	COMPLY (YES/NO)
KITCHEN, PANTRY, WOOD AND COAL ROOM, MORGUE, CORONERS OFFICE	1, 2, 3, 4	18'-8"	30"	7.5	15	YES
YARD/LIGHTWELL EXTERIOR WALL STONE FLOOR TO 19'-4" LEVEL	1, 4	19'-4"	25"	9.3	9	NO
JAIL YARD BELOW COURT ROOM, KITCHEN FLOOR TO CEILING	2, 3, B, D	18'-8"	30"	7.5	15	YES
ASSESSORS OFFICE, DISTRICT ATTORNEY, TREASURY, SHERIFF	1, 4	19'-5" (assumed height)	21"	11.1	15	YES
VAULT WALLS	1, 2, 3, 4, A.5, B	19'-5" (assumed height)	25"	9.3	15	YES
FRONT WALL FIRST FLOOR TO SECOND FLOOR	A	19'-5" (assumed height)	25"	10.2	15	YES

TABLE 1. FIRST STORY H/T RATIOS

MASONRY WALL HEIGHT TO THICKNESS RATIOS						
SECOND STORY						
WALL IDENTIFICATION	GRIDS	WALL HEIGHT (FT)	WALL THICKNESS (IN)	H/T	ALLOWABLE H/T	COMPLY (YES/NO)
YARD/LIGHTWELL EXTERIOR WALL 19'-4" TO 37'-7" (+/-)	1, 4	18'-6"	21"	10.6	9	NO
JUDGES CHAMBERS, PETTY JURY, GRAND JURY	1, 4	18'-6"	17"	13.1	14 *	YES
JUDGES CHAMBERS, GRAND JURY GABLE END WALL	C	22'-6" (assumed height)	17"	15.9	14 *	NO
COURT ROOM FLOOR TO CEILING	D	25'-0"	21"	14.3	9	NO
HALL OF RECORDS, COUNTY CLERK	1, 4	22'-0" (assumed height)	17"	15.5	14 *	NO
FRONT WALL	A	22'-0" (assumed height)	23"	11.5	14 *	YES
VAULT WALLS	1, 2, 3, 4, A.5, B	19'-5" (assumed height)	25"	9.3	14 *	YES

* BASED ON THE USE OF EXISTING CROSSWALL. THE CROSSWALLS MAY REQUIRE MODIFICATION.

TABLE 2.SECOND STORY H/T RATIOS



Photo 1. Back of tall parapet on the east side of the building. This requires bracing.



Photo 2. View west. Chimneys require additional bracing.



Photo 3. Interior view of the building facade from within the attic. Gables tend to fall outward and require bracing. This would be from within the attic.



Photo 4. South wall. Brick deterioration at the base and at the top of the applied cement plaster. Repointing of brick joints and some brick replacement is needed.