STRUCTURAL EVALUATION OF

PINOLE MIDDLE SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
1300 Potrero Avenue
Richmond, CA 94804

By

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DASSE Design Project No. 01B300x2

TABLE OF CONTENTS

Appendix A: Figures

Appendix B: Drawings

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Pinole Middle School in Pinole, CA. The structural assessment includes a site walk through and a limited study of available architectural and structural drawings. The purpose of the structural assessment is to identify decay or weakening of existing structural materials (when visible), to identify seismic deficiencies based on our experience with school buildings, and to identify eminent structural life-safety hazards.

The school campus has had a walk-through site evaluation and a limited study of available architectural and structural drawings. The general structural condition of the buildings and any seismic deficiencies that are apparent during our site visit and review of existing drawings are documented in this report. This report includes a qualitative and quantitative evaluation of the buildings. A limited lateral (seismic) numerical analysis was performed to identify deficient lateral elements, which could pose life safety hazards.

The site visits did not include any removal of finishes. Therefore, identification of structural conditions hidden by architectural finishes or existing grade was not performed.

10.2 Description of School

This school was built in 1966. The original buildings are a one-story wood- and steel-framed structure with stucco finish on the exterior (see figure 2). The main building consists of a Library Building, an Administrative Building and a Multi-Purpose Building. Library Building is circular (see figure 3) and is connected to the main classroom buildings through connecting corridors. There are four portable buildings (see figure 1). There are two 1966 portables, one 1965 portable attached to 1966 portable, one 1971 portable attached to 1990 portable and one 1990 portable. The total square footage of the permanent structures is about 46829 square feet.

10.3 Site Seismicity

The site is a soil classification S_C in accordance with the 2001 California Building Code (CBC) and as per the consultants, Jensen Van Lieden Associates, Inc.

The main building and classroom building have an educational occupancy (Group E, Division 1 and 2 buildings) and the multi-purpose building has an assembly occupancy (Group A, Division 3), both of which have an importance factor in the 2001 CBC of 1.15. The campus is located at a distance of about 5 kilometers from the Hayward fault. The main building is a one story wood framed building with plywood sheathing for walls and roof. The response modification factor R = 4.5. The 2001 CBC utilizes a code level earthquake, which approximates an earthquake with a 10% chance of exceedance in a 50-year period or an earthquake having a 475-year recurrence period.

The seismic design coefficient in the 2001 CBC is:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.40\,x1.20\,x1.15)W}{5.5} = 0.251W$$

The site seismicity is used to provide a benchmark basis for the visual identification of deficient elements in the lateral force resisting systems of campus buildings. The calculated base shear was used to perform a limited lateral analysis of the school buildings as described in section 10.7.

10.4 List of Documents

1. 7th and 8th Grade School, Pinole and Hercules Union School District, Jack Buchter Architect, Lafayette, CA – Architectural Drawings 1 to 10 dated Sept. 1964 (Sht. 1) and May 1965 (Sheets 2 to 10)
2. 7th and 8th Grade School, Pinole and Hercules Union School District, Eric Moorehead, Structural Engineer – Structural Drawings Sheets S-1 to S-14 dated May 1965

10.5 Site Visit

DASSE visited the site on August 14th 2002. The main purpose of the site visits was to evaluate the physical condition of the structure and in particular focus on the lateral force resisting elements of the building. Following items were evaluated during the site visit:

1. Type and Material of Construction
2. Type of Sheathing at Roof, Floor and Walls
3. Type of Finishes
4. Type of Roof
5. Covered Walkways
6. Presence of Clerestory Windows
7. Presence of Window Walls or High Windows in exterior and interior walls
8. Visible cracks in superstructure, slab on grade and foundation

The main building is a one story wood structure (see figures 2). The building exterior typically has a stucco finish. The covered walkways have a plaster finish at ceilings and are connected at their ends to the main buildings. The west face of the administration building has multiple large window openings. The exterior longitudinal walls of classroom buildings (room numbers 1, 2, 3, 5, 7, 9, 11 to 20) have number of window openings (see figure 4).

The circular library building has continuous window openings just below the roof diaphragm and is connected to the classroom buildings on east and west sides by covered walkways.

The Multi-Purpose Building has tapered glu-lam beams and wood posts. The east wall of the multi-purpose building has many window openings.

A covered walkway connects the administration building and the multi-purpose building. All the covered walkways have electrical conduits suspended below the ceilings. Since the covered walkways are connected at either ends to different buildings, electrical conduits will be subjected to differential movement between buildings and therefore could be pulled apart, which could pose an electrical line hazard. Therefore, the conduits could pose a life safety hazard.

10.6 Review of Existing Drawings

The main building is a one story, wood framed, "U" shaped structure, which is connected by covered walkways. Exterior walls are typically 2x6 studs at 16" centers with 3/8" plywood sheathing on the exteriors.

Class room roof framing consists of 2x10 joists at 24" centers framing into 16WF36 steel beams spanning in north-south direction (35' span), which is in turn supported by transverse wood shear walls or TS 5x5x3/16 posts at the interior. The 35' span WF beams have non-moment shear splices at one end. The WF beam supporting above beam cantilevers 6' with a back span of 8'. Exterior corners typically have 6x6 wood posts. The interior corridor wall has 3/8" plywood sheathing on one side. There are eight skylights in corridors at east and west classroom wings of the main building, which are approximately 6'x4'. Existing drawings show additional framing around the skylight openings. The transverse walls of the classrooms are 2x6 stud walls at 16" centers with 3/8" plywood on one side of walls. Roof sheathing consists of ½" plywood with built-up roofing over the sheathing. There is a 3' overhang of the roof. Ceiling joists are 2x6 at 16" centers and are located 1-6" below the 2x10 roof joists. The hangers supporting the ceiling joists are 2x4 at 16" centers.

The lateral system of the classroom wing consists of ½" plywood roof sheathing, which acts as a horizontal diaphragm to transfer the seismic loads to 2x6 stud walls acting as shear walls. In the longitudinal direction, the exterior walls have numerous window openings and hence are not adequate shear walls to resist prescribed seismic loads, which poses a life safety hazard. The interior longitudinal corridor walls, with 3/8" plywood sheathing, act as shear walls resisting the lateral forces in the longitudinal (north-south) direction. In the transverse direction, the seismic forces are resisted by transverse shear walls, which have 3/8' plywood sheathing on them. Collector elements to drag the seismic forces to the transverse shear walls are missing and should be provided.

The foundation system consists of continuous spread footings, typically 14" wide x 24" deep with 2#7 bars top and bottom and with #4 ties at 4" on center. Isolated spread footings have been provided under columns. The slab-on-grade is typically 5" thick with #3 bars at 16" centers each way.

The Multi-Purpose Room (MPR) has high roof. On the west side of MPR are the Music, Faculty and Shop Buildings with a lower roof. Framing consists of 27-5/8" deep glu-lam beams spanning about 50' and spaced at 14' centers. Joists are 2x10's at 24" centers, which frame into the glu-lam beams. 2x10 blocking is located at mid span of the roof joists. The glu-lam beams frame into 7"x71/2" glu-lam posts. The roof of multi-purpose room has ½" plywood sheathing, with built-up roofing. The east wall (north-south direction) of the above building has five big window openings (approx. 14'wide x 7.5' long) in the middle portion of the wall and has ½" plywood sheathing on the exterior. The common longitudinal shear wall (with a 3/8" plywood sheathing) between the multi-purpose room and the music/shop rooms has few door and window openings and has ½" plywood sheathing on one side. Holdowns have been provided at some door openings. The south wall and the east wall of the multi-purpose room consist of 2x8 stud walls at 16" centers with a 3/8" plywood sheathing. These walls have excessive door openings and do not have adequate length of shear wall to resist seismic loads.

The music room adjacent to the multi-purpose room has a partial mezzanine floor, located towards to the north. This mezzanine floor cantilevers 3'-4" from the north exterior wall. From the mezzanine to roof level the north exterior wall has a 3/8" plywood sheathing on the exterior. This wall is not continuous to ground level and thus is a discontinuous shear wall. It could pose a life safety hazard. Also, there are excessive window openings on the north face of music room. There is a 3'-4" horizontal offset between the exterior face of wall above and below the mezzanine floor. The wall below the mezzanine is a 10" thick concrete shear wall, about 24" in height. This stem wall occurs at the north and west face of mezzanine and partially at east face of mezzanine. Mezzanine floor consists of 2x12 joists at 16"centers with a 5/8" plywood sub-floor. The north face of music room has excessive window openings resulting in an inadequate length of shear wall to resist lateral loads. The west face of music room has a big window and door openings at the south side. Holdowns are called out at either end of the walls. The remaining portion of the west wall (shop and faculty room) has numerous openings with some holdowns called out on the drawings at the ends of openings. This wall also does not have an adequate length of shear wall to resist prescribed seismic loads. The south interior transverse (east-west) shear wall and the north transverse shear wall of the Shop building do not have adequate length of shear wall to resist prescribed seismic forces. Also, the collector connections at these walls should be strengthened to effectively transfer seismic loads into the shear walls.

The Circular Library Building has 2x6 stud walls framed with a 3/8" plywood sheathing between 5" diameter extra strong pipe columns located on a circle for a total of 12 equal spaced columns. At the roof level, 8WF24 sloped steel beams span radially from the center of the circle towards the perimeter and frame into the 5" diameter pipe columns. At the perimeter of the building, there are 8WF17 steel beams spanning between the pipe columns. Covered walkways frame into the Library building on the east and west sides and there is an expansion joint between the covered walkways and the Library building. The presence of continuous windows along the circumference of the building results in an inadequacy of the building to transfer seismic forces from roof diaphragm to the perimeter shear walls. Some of the windows need to be in-filled to provide a continuous load path to transfer seismic forces into the perimeter shear walls.

Covered walkway framing consists of 2x14 joists at 24" centers framing into 12WF40 steel beams spanning between the columns. The columns are 1'-0" x 1'-6" reinforced concrete columns with 4-# 9 vertical reinforcement and #3 ties at 9" centers. Columns are spaced at 31' centers. The roof has a ½" plywood sheathing. The covered walkway connecting the administration building and the multi-purpose room has a 2" seismic joint at mid-point of the walkway between the steel beams (12WF40) spanning between the concrete columns at the north and south edge of the covered walkway roof. These beams are supported on a common column. Anchor rods connecting the 12WF40 beams to the concrete columns, have 2" long slots in the bottom flange of the beam to allow for movement in the east-west direction. The foundation for concrete columns consists of 5’x5’x2’ deep isolated footings with a 4” thick slab-on-grade. There is a 14” wide by 24” deep grade beam connecting the columns in the east-west direction.

The lateral system for the covered walkway is primarily the cantilever action of the concrete columns resisting the roof diaphragm forces. The prescribed seismic demands on the columns are small compared to the available capacity of the columns. Thus, these columns do not pose a life safety hazard even though the detailing of reinforcement does not meet current code requirements.

10.7 Basis of Evaluation

The document FEMA 310, Federal Emergency Management Agency, *“Handbook for the Seismic Evaluation of Buildings – A Prestandard,”* 1998, is the basis of our qualitative seismic evaluation methods to identify the structural element deficiencies. The seismic performance levels included in FEMA 310 allow the engineer the choice to achieve the Life Safety Performance or the Immediate Occupancy Performance. We have based our evaluation of school buildings on the Life Safety Performance level for which is defined as “the building performance that includes significant damage to both structural and nonstructural components during a design earthquake, though at least some margin against either partial or total collapse remains. Injuries may occur, but the level of risk for life-threatening injury and entrapment is low.”

Because mitigation strategies for rehabilitating buildings found to be deficient are not included in FEMA 310 document, the California Building Code (CBC 2001) is used as the basis of our quantitative seismic evaluation methods and strategies for seismic strengthening of school buildings. The scope of our analyses were not to validate every member and detail, but to focus on those elements of the structures determined by FEMA 310 to be critical and which could pose life safety hazards. Element *strength* values not addressed in the California Building Code were based on the document FEMA 356, Federal Emergency Management Agency, *“A Prestandard and Commentary for the Seismic Rehabilitation of Buildings”* 2000.

10.8 List of Deficiencies

Building deficiencies listed below have corresponding recommendations identified and listed in Section 10.9, which follow the same order as the itemized list of deficiencies identified below. The severity of the deficiency is identified by a “structural deficiency hazard priority” system based on a scale between 1.0 and 3.9, which is described in Section 10.11. These priority ratings are listed in section 10.9. Priority ratings between 1.0 to 1.9 could be the causes for building collapses, partial building collapses, or life-safety hazards, if the corresponding buildings are subjected to major earthquake ground motions, which are possible at these sites. It is strongly recommended that these life safety hazards are mitigated by implementing the recommendations listed below.

Item	Building Structural Deficiencies
1.	Plywood shear walls at east face of classroom wings (longitudinal walls) lack

	adequate shear strength to resist the prescribed seismic forces
2.	Plywood shear walls at west face of classroom wings (longitudinal walls) rooms lack adequate shear strength to resist the prescribed seismic forces
3.	Plywood shear walls (transverse shear walls) at South face of Music Room and north face of Shop Building lack adequate shear strength to resist the prescribed seismic forces.
4.	Plywood shear walls at east face of multi-purpose room lack adequate shear strength to resist the prescribed seismic forces.
5.	Plywood shear walls at south face of Multi-Purpose Room lack adequate shear strength to resist the prescribed seismic forces
6.	North wall of Music Room has discontinuous shear (shear wall stops at mezzanine floor level) wall and also has numerous window openings.
7.	South longitudinal wall of Arts & Crafts and Home-Making Building lacks continuity required for collector elements and does not have adequate collector connection to transfer prescribed seismic forces to the end shear walls.
8.	Library building has continuous slit window openings just below the roof and thus does not have a load path to transfer prescribed seismic forces to the perimeter shear wall
9.	Top plate splice detail not shown on drawings
10.	North wall of Arts, Crafts and Home-Making Building does not have adequate length of shear wall to resist prescribed seismic forces.

10.9 Recommendations

Items listed below follow the same order as the itemized list of deficiencies identified in section 10.8 above.

Item	Recommended Remediation	Priority	Drawing Number
1.	Fill-in existing window openings with new plywood sheathing as shown in Drawing 1. Provide new collectors as required.	1.1	1 & 2
2.	Fill-in existing window openings with new plywood sheathing as shown in Drawing 1. Provide new collectors as required.	1.1	1 & 2
3.	Add new plywood sheathing on the other face of shear wall (making it a shear wall with plywood sheathing on both faces of wall)	1.1	1
4.	Fill-in existing window openings with new plywood sheathing as shown in Drawing 1. Provide new collectors as required	1.1	1
5.	Fill-in existing window openings with new plywood sheathing as shown in Drawing 1.	1.1	1
6.	Provide new plywood shear wall (from ground to Mezzanine	1.0	1

	level) and also provide new foundations for shear wall		
7.	Provide steel strap to ensure collector continuity and strengthen collector connection to existing shear wall	1.5	2
8.	Fill-in existing window openings with new plywood sheathing as shown in Drawing 2. Provide new collectors as required.	1.1	2
9.	Field verify top plate splice detail and strengthen as required	1.3	2
10.	Provide new shear wall, collector and hold downs	1.1	2

10.10 Portable Units

This report hazard rating system is based on a scale of 1.0 to 3.9 with 1.0 being the most severe and 3.9 being the least severe. Based on FEMA 310 requirements, building elements have been prioritized with a low rating of 1.0 to 1.9 if the elements of the building's seismic force resisting systems are woefully inadequate. Priority 1.0 to 1.9 elements could be the causes for building collapses, partial building collapses, or life-safety falling hazards if the buildings were subjected to major earthquake ground motion.

If elements of the building's seismic force resisting system seem to be inadequate based on visual observations, FEMA 310 requirements and limited lateral (seismic) calculations, but DASSE believes that these element deficiencies will not cause life-safety hazards, these building elements have been prioritized between a rating low of 2.0 to 3.9. These elements could experience and / or cause severe building damage if the buildings were subjected to major earthquake ground motion. The degree of structural damage experienced by buildings could cause them not to be fit for occupancy following a major seismic event or even not repairable.

The following criteria was used for establishing campus-phasing priority:

First, the individual element deficiencies which were identified during site visit and review of existing drawings were prioritized with a rating between 1.0 to 3.9 and as described in this section.

Next, based on the school district's budgetary constraints and scheduling requirements, each school campus was given a phasing number between one and three. Phase 1A represents a school campus with severe seismic deficiencies, Phase 1B represents a school campus with significant seismic deficiencies and Phase 2 represents a school campus with fewer seismic deficiencies.

10.11 Structural Deficiency Prioritization

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If elements of the building's seismic force resisting system seem to be inadequate based on visual observations, FEMA 310 requirements and limited lateral (seismic) calculations, but DASSE believes that these element deficiencies will not cause life-safety hazards, these building elements have been prioritized between a rating low of 2.0 to 3.9. These elements could experience and / or cause severe building damage if the buildings were subjected to major earthquake ground motion. The degree of structural damage experienced by buildings could cause them not to be fit for occupancy following a major seismic event or even not repairable.

The following criteria was used for establishing campus-phasing priority:

First, the individual element deficiencies which were identified during site visit and review of existing drawings were prioritized with a rating between 1.0 to 3.9 and as described in this section.

Next, based on the school district's budgetary constraints and scheduling requirements, each school campus was given a phasing number between one and three. Phase 1A represents a school campus with severe seismic deficiencies, Phase 1B represents a school campus with significant seismic deficiencies and Phase 2 represents a school campus with fewer seismic deficiencies.

10.12 Conclusions

1. Given the vintage of the building(s), some elements of the construction will not meet the provisions of the current building code. However, in our opinion, based on the qualitative and limited quantitative evaluations, the building(s) will not pose serious life safety hazards if the seismic deficiencies identified in section 10.8 are corrected in accordance with the recommendations presented in section 10.9.

2. Any proposed expansion and renovation of the buildings should include the recommended seismic strengthening presented in section 10.9. Expansion and renovation schemes that include removal of any portion of the lateral force resisting system will require additional seismic strengthening at those locations. It is reasonable to assume that where new construction connects to the existing building(s), local seismic strengthening work in addition to that described above will be required. All new construction should be supported on new footings.

3. Overall, we recommend that seismic retrofit work be performed to this school campus in Phase 2.

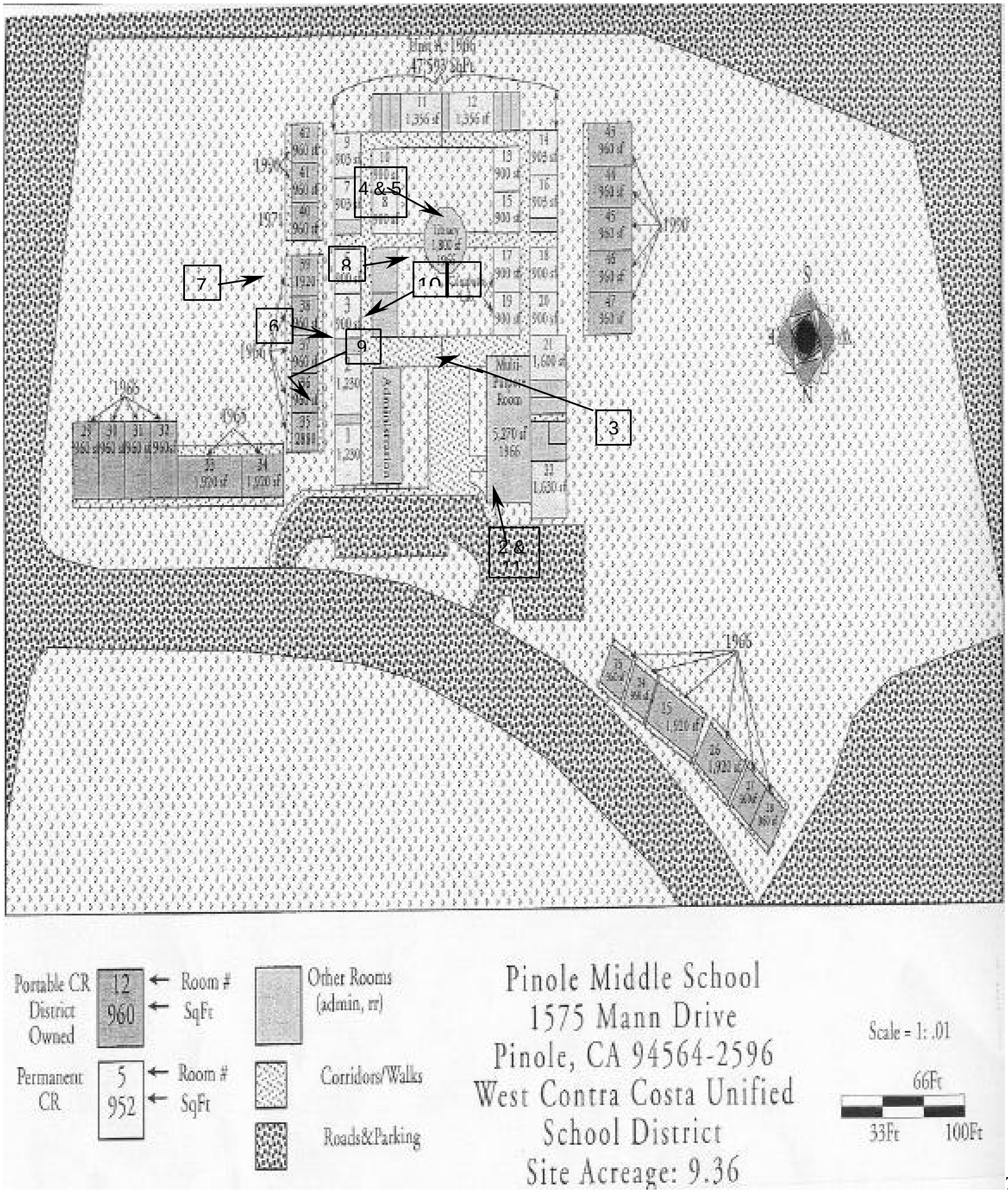
10.13 Limitations and Disclaimer

This report includes a qualitative (visual) evaluation and a limited quantitative seismic evaluation of each school building. Obvious gravity or seismic deficiencies that are identified visually during site visits or on available drawings are identified and documented in this report. Elements of the structure determined to be critical and which could pose life safety hazards are identified and documented during limited quantitative seismic evaluation of the buildings.

Users of this report must accept the fact that deficiencies may exist in the structure that were not observed in this limited evaluation. Our services have consisted of providing professional opinions, conclusions, and recommendations based on generally accepted structural engineering principles and practices.

DASSE's review of portable buildings has been limited to identifying clearly visible seismic deficiencies observed during our site visit and these have been documented in the report. Portable buildings pose several issues with regard to assessing their life safety hazards. First, drawings are often not available and when they are, it is not easy to associate specific drawings with specific portable buildings. Second, portable buildings are small one story wood or metal frame buildings and have demonstrated fairly safe performance in past earthquakes. Third, there is a likelihood that portable buildings (especially those constructed prior to 1982) are not in compliance with state regulations, either because they were not permitted or because the permit was for temporary occupancy and has expired.

Appendix A: Figures



7

Figure 1: School Layout Plan

Figure 2: Multi-Purpose Building

Figure 3: Covered Walkway to Administration Bldg.

Figure 4: Library Building

Figure 5: Interior of Library Bldg.

Figure 6: Interior Corridor with Skylights

Figure 7: Rear Wall of Classroom

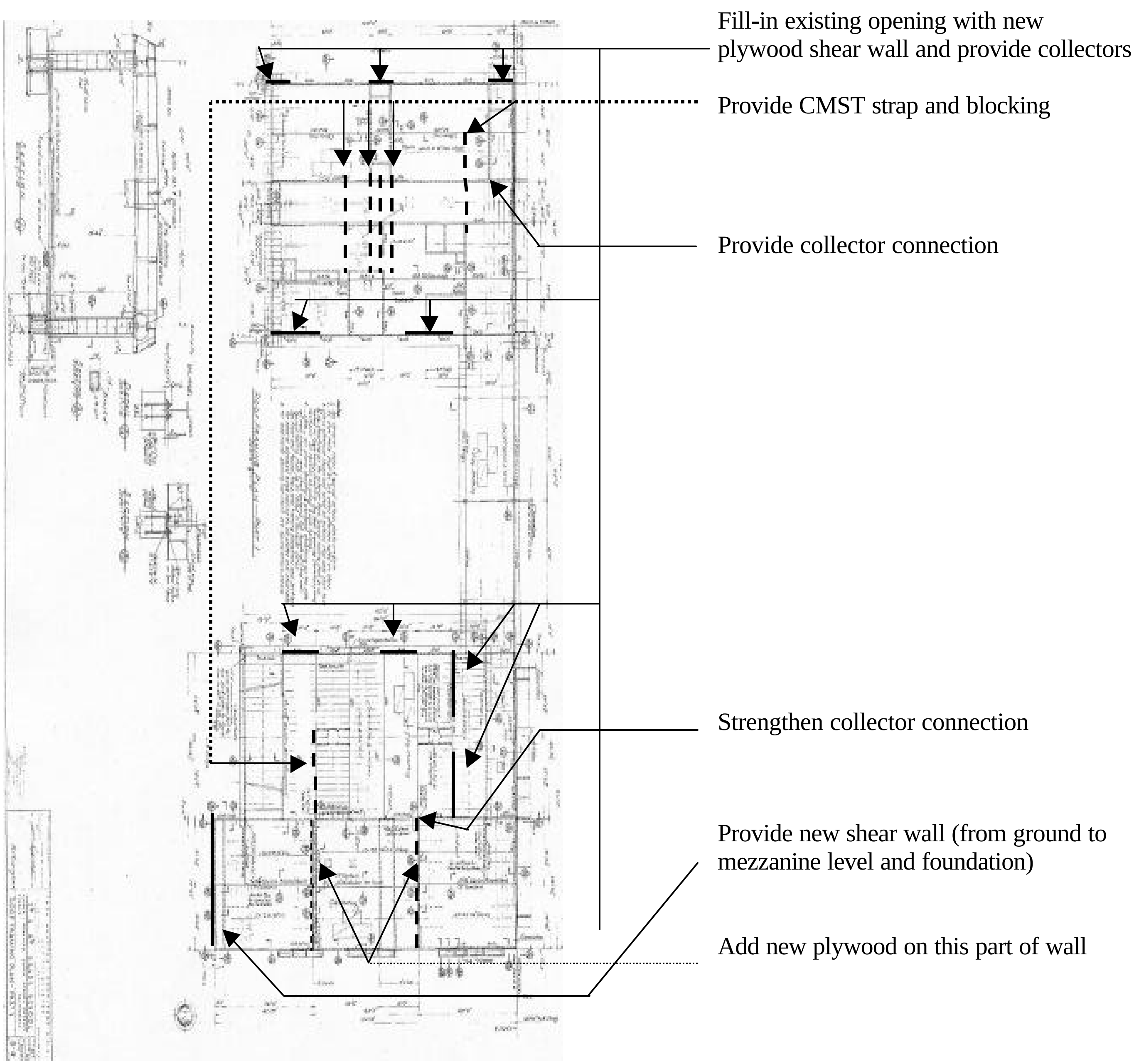
Figure 8: Covered Walkway linking classroom with Library

Figure 9: Interior of Typical Classroom

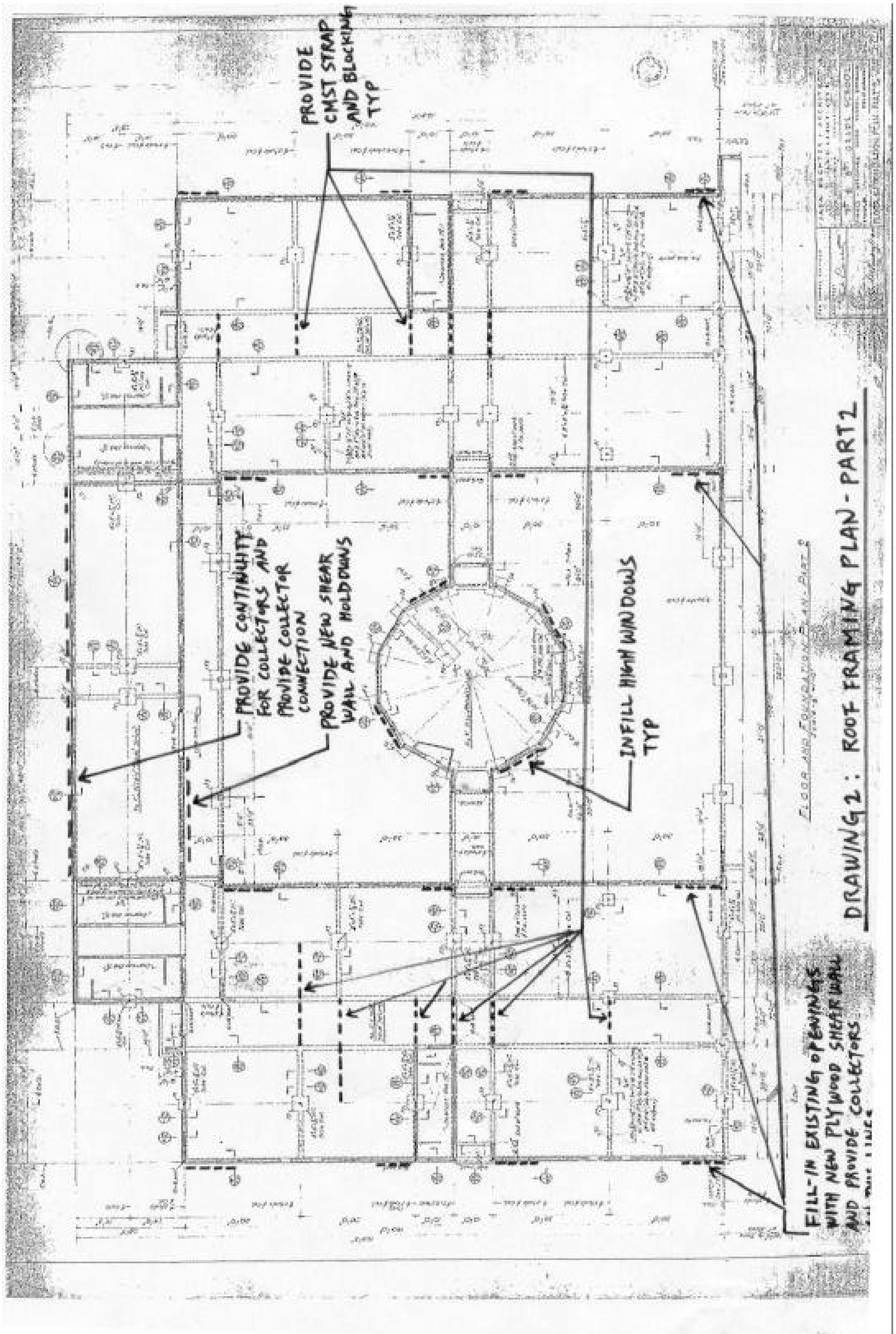
Figure 10: Classroom Bldg. Exterior Wall with window openings

Figure 11: East Wall of Multi-Purpose Room

Appendix B – Drawings



Drawing 1 – Roof Framing Plan (Part 1)



Drawing 2 – Roof Framing Plan (Part 2)