STRUCTURAL EVALUATION OF

DOWNER ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
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By

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10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Downer Elementary School in San Pablo, 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

The school is located in the city of San Pablo and was built in 1952 and consists of three classroom buildings, a Gymnasium/Classroom building as well as a Cafateria Building. The original buildings are one and two-story concrete structures with cement plaster finish on the exterior. There are five main buildings (permanent structures) and six portable buildings (see figure 1). There is two 1970 portables, two 1989 portables, and two 1999 portables. The total square footage of the permanent structures is about 115,326 square feet.

10.3 Site Seismicity

The site is a soil classification S_D in accordance with the 1998 California Building Code (CBC) and as per the consultants, Jensen Van Lieden Associates, Inc.

The main classroom building has an educational occupancy (Group E, Division 1 and 2 buildings) and the Cafeteria and Gymnasium buildings have an assembly occupancy (Group A, Division 3), both of which have an importance factor in the 1998 CBC of 1.15. The campus is located at a distance of about 2.2 kilometers from the Hayward fault. The main classroom building is a concrete structure with shear walls in the both directions. The concrete shear walls have a response modification factor R=4.5. The 1998 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 1998 CBC is:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.48x1.15)W}{4.5} = 0.416W$$

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. Edward M. Downer junior High School, dated March 11, 1955, by Donald L. Hardison Architect, Sheets A6, A7, A10-A15, A21-A32, S1-S9, S11-S17, S21-S23, S31-S34, S41-S44, and various change orders.
2. "Measure M" – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California.
3. "Geological Hazard Study – Recently constructed portable buildings – 24 school sites for Richmond Unified School District," by Jensen-Van Lienden Associates, Inc. dated March 7, 1990.
4. "Measure M" roofing report by "The Garland Company Inc.", Orinda, California.

10.5 Site Visit

DASSE visited the site on October 25th, 2001 and March 8th, 2002. The main purpose of the site visit 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 classroom building is a two-story concrete structure (Figures 2, 3, & 4). The North and South faces of the building have multiple large window openings with concrete columns in between. The east and west faces have long segment of shear wall. Some cracks were observed over the classroom doors.

The Cafeteria Building (Figure 9) has concrete walls with some openings. The concrete roof beams were boxed out, and thus were not visible.

Unit B is a tilt-up building with a wood roof and exterior concrete walls. The exterior concrete walls have concrete columns connecting the panels. The roof construction consists of wood beams at 4'-0" oc supported by steel beams, which in turn are supported by steel columns. One of the connections between the wood beams and exterior wall is in bad shape. Some cracks were observed in one of the wall panels on the West elevation (Figure 10). There does not appear to be ties between the concrete walls and wood roof.

The Gymnasium is a concrete building that is characterized by the 6 foot deep roof beams supporting a concrete slab.

Unit D is a one story cast-in-place concrete building. A crack was observed over one of the doors on the South wall (Figure 11).

There are numerous covered walkways (Figures 6, 8, & 12) connecting the several buildings, some of which appear to be in good repair. The covered walkways near Unit B, show signs of rust on the steel and rot on the wood. In addition there was extensive rusting in covered walkway next to the Gymnasium.

10.6 Review of Existing Drawings

The Main Classroom Building, Unit A, is a cast in place concrete building. The roof and floor slabs consist of 12" to 15" concrete slabs with tube void forms in the middle of the slab. Lateral resistance is provided by concrete shear walls on either side of the corridors as well as transverse concrete shear walls at the ends of the building and at the interior stair wells. The foundation system consists of continuous footings under the walls and continuous grade beams under the exterior and interior columns.

The Gymnasium building is a cast-in-place concrete building, which consists of the gymnasium in the middle with two story structures on either end. The roof consists of a 4" concrete slab supported by steel framing, which is in turn supported by the concrete walls. Over the Gymnasium 8 foot high steel trusses span across the building while at the end portions the girders are of rolled sections. The second floor is supported by one way concrete slabs supported by concrete beams which are supported by columns.

The foundation for the Gymnasium consists of spread footings under the columns and continuous footings under the walls.

Lateral resistance for the Gymnasium is provided by the North and south walls as well as by concrete walls on either side of the Gymnasium and at the end of the building.

Unit D is a one story cast in place concrete building. The roof structure consists of cast-in-place concrete slabs with tubular void forms that are supported by the concrete walls. At the high roof portion a W33 steel beam is used to support the concrete slab. The roof is supported by continuous concrete walls which rest on continuous footings. The lateral resistance for Unit D is provided by the concrete roof slab which transfers the lateral forces to numerous concrete shear walls in both the transverse and longitudinal directions.

The Cafeteria is a tall one story building with a steel and wood roof structure and precast concrete walls. The roof structure consists of 3/8" plywood supported by 2x sawn wood joists at

16” oc which are in turn supported by rolled steel beams. In the middle the roof is supported by steel columns, while around the perimeter the roof is supported by precast wall panels with cast-in-place pour joints.

The lateral forces are resisted by the plywood diaphragm, which distributes them to the perimeter concrete walls and the line of braced frames located between the kitchen and the dining area. The Steel beams are anchored into the concrete pour joints and the roof joists are positively to the concrete walls by means of metal straps embedded into the concrete and bolted to the joists.

At the foundation the Cafeteria loads are supported by end bearing drilled piers.

There is a low-level steel beam and metal deck roof on the West and South sides of the Cafeteria building. The gravity loads from the low roof are resisted by steel columns while the lateral resistance is provided by the Cafeteria walls.

Unit B is at the West side of the campus and consists of a one-story building with a wood roof and precast concrete walls. The wood roof consists of ½” plywood which spans 4’-0” to 3x10 roof joists which in turn are supported by steel girders. The roof framing is supported by interior steel columns and the perimeter concrete walls. At the foundation the loads are supported by end bearing drilled piers under columns and walls.

At two locations there is a mezzanine that runs across the Unit B building. The floor framing consists of 1x6 diagonal sheathing spanning to 2x12 joists @ 12”oc which in turn is supported by steel beams and columns. Lateral resistance for the mezzanines appears to be either the steel columns spanning between the floor and the roof or non-structural partitions.

The lateral forces for Unit B are resisted by the plywood diaphragm which transfers the lateral forces to the perimeter concrete walls and to one steel braced frame located in the middle of the building. The Steel beams are anchored to the concrete walls and the roof joists are positively anchored to the concrete walls by means of metal straps embedded into the concrete and bolted to the joists.

The roofing is reported to be 4 years old and no roofing is believed necessary.

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. The seismic performance levels that the FEMA 310 document seeks to achieve are lower than the current Building Code. However, it attempts to identify the potential for building collapse, partial collapses, or building element life safety falling hazards when buildings are subjected to major earthquake ground motion.

The California Building Code (CBC 1998) is the basis of our quantitative seismic evaluation methods. Base shears identified in section 10.3 were used to perform a limited lateral seismic analysis of the school buildings. The scope of the analysis was not to validate every member and detail, but to focus on those elements of the structure determined to be critical and which could pose life safety hazards. Member *strength* values are based on the document FEMA 356, Federal Emergency Management Agency, *"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.	The in-plane diaphragm strength and diaphragm ties to the concrete walls of Unit B are weak points that could lead to local collapse and result in a life safety hazard.
2.	The steel braced frame in Unit B is not strong enough.
3.	The in-plane diaphragm strength and the out-of-plane diaphragm ties to the concrete walls of the Cafeteria are not adequate and could lead to local collapse and could result in a life safety hazard.
4.	Covered walkway between Unit B and Unit A seem to be lacking sufficient lateral strength.
5.	The covered walkways near Unit B show evidence of rusting steel and a decay of wood.
6.	The Mezzanines of Unit B are not adequately braced.
7.	Metal deck roof adjacent to the Cafeteria shows signs of rust.

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	Figure Number
1.	Strengthen diaphragm and wall ties of Unit B	1.0	N/A
2.	Reinforce the braced frame in Unit B	1.0	N/A
3.	Strengthen diaphragm and wall ties of the Cafeteria.	1.0	N/A
4.	Provide lateral bracing of covered walkway between Units A and B.	1.9	8
5.	Remove decay and rust on the covered walkway near Unit B,	2.0	8

	repair members and paint the members.		
6.	Brace the Mezzanine in Unit B	1.2	N/A
7.	Repair rusted metal deck and protect by painting.	2.5	13

10.10 Portable Units

In past earthquakes, the predominant damage displayed by portable buildings has been associated with the buildings moving off of their foundations and suffering damage as a result. The portables observed during our site visits tend to have the floor levels close to the ground, thus the damage resulting from buildings coming off of their foundation is expected to be minimal. The life safety risk of occupants would be posed from the potential of falling 3 feet to the existing grade levels during strong earthquake ground shaking. Falling hazards from tall cabinets or bookshelves could pose a greater life safety hazard than building movement. The foundation piers supporting the portable buildings tend to be short; thus the damage due to the supports punching up through the floor if the portable were to come off of its foundation is not expected to be excessive.

Because of their light frame wood construction and the fact that they were constructed to be transported, the portable classrooms are not in general expected to be life safety collapse hazards. In some cases the portables rest directly on the ground and though not anchored to the ground or a foundation system could only slide a small amount. In these instances the building could slide horizontally, but we do not expect excessive damage or life safety hazards posed by structural collapse of roofs.

The regulatory status of portables is not always clear given that portables constructed prior to 1982 will likely have not been reviewed by DSA and thus will likely not comply with the state regulations for school buildings. Portables constructed after about 1982 should have been permitted by DSA. The permits are either issued as temporary structures to be used for not more than 24 months or as permanent structures.

10.11 Structural Deficiency Prioritization

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.

The next step was to arrive at a structural deficiency rating between 1 and 10, with a rating of 1 representing a school campus in which the building's seismic force resisting systems are woefully inadequate.

Based on the school district's budgetary constraints and scheduling requirements, each school campus was given a phasing number between one and three. Phase I represents a school campus with severe seismic deficiencies, Phase II represents a school campus with significant seismic deficiencies and Phase III 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, this school campus has a seismic priority of 2 and we recommend that seismic retrofit work be performed in Phase I.

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.

Figures

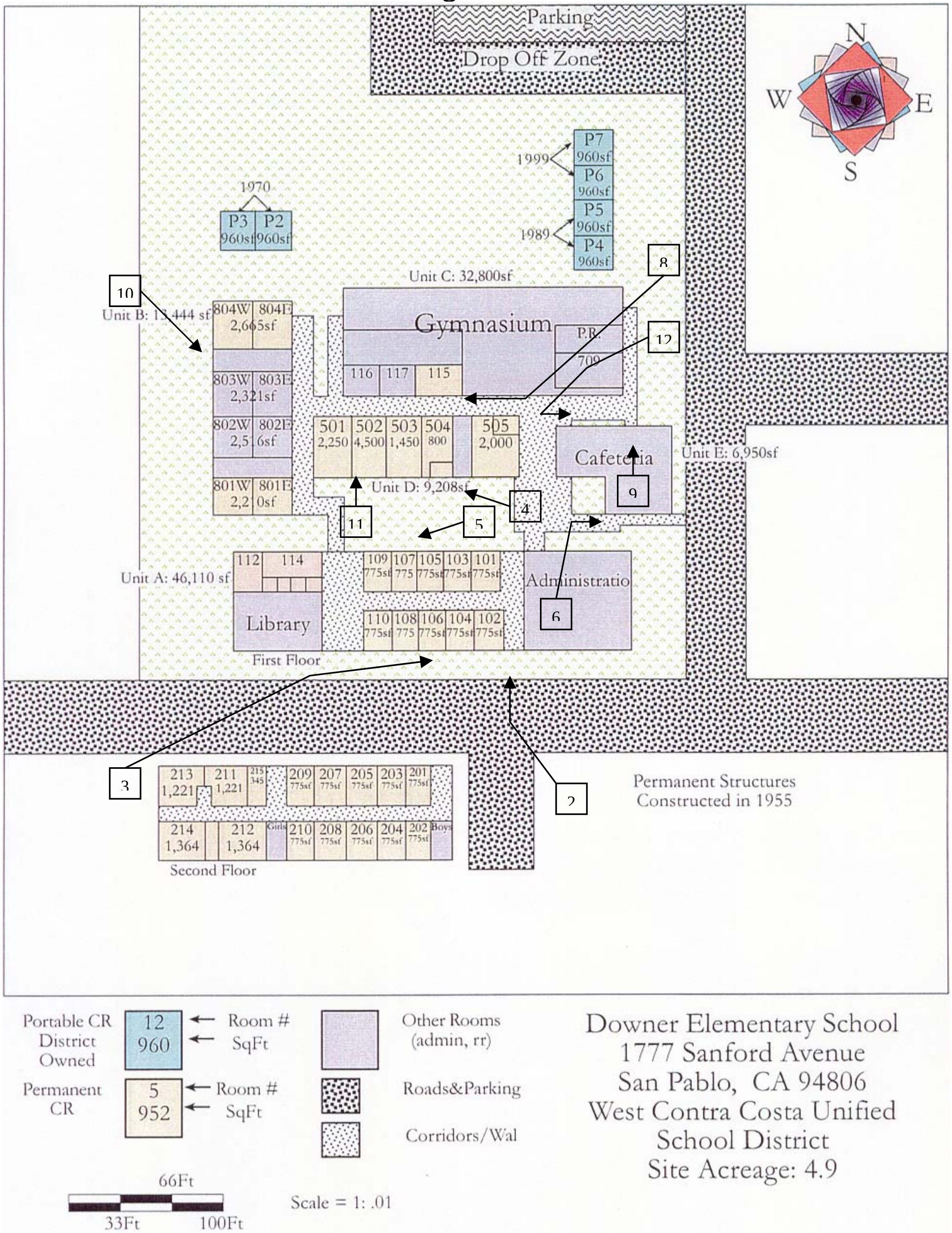

Figure 1: School Layout Plan

Figure 2: Front Entrance

Figure 3: South Side of Classroom Building

Figure 4: North Side of Classroom Building

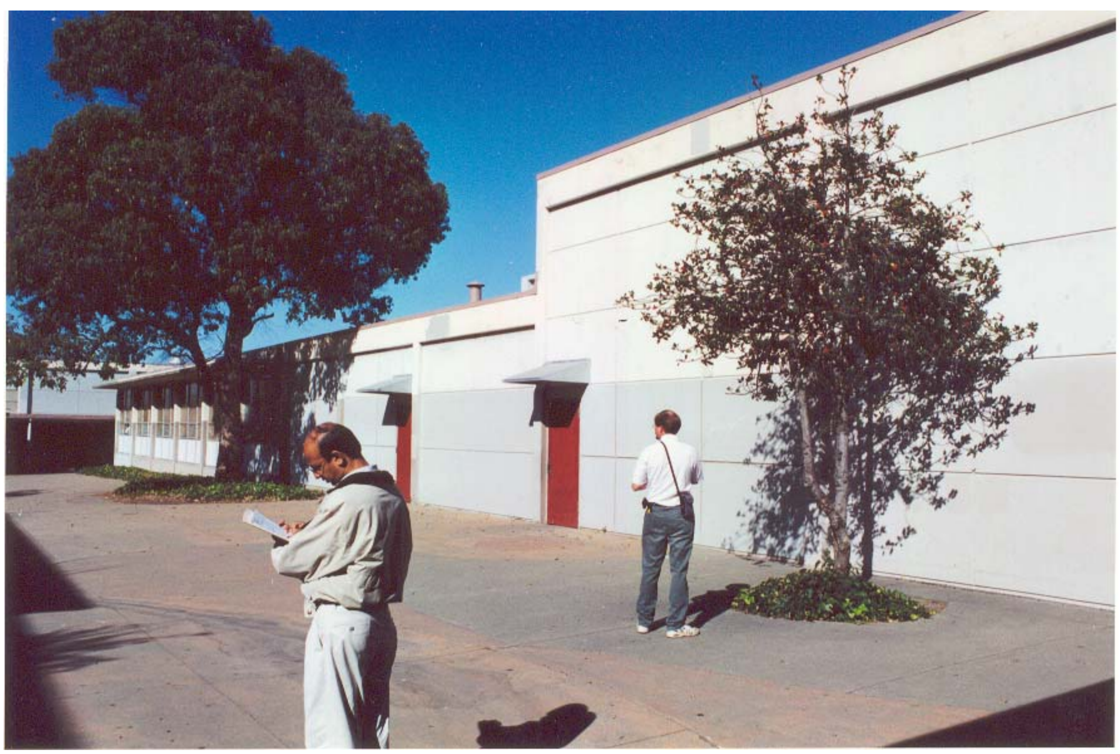

Figure 5: Classroom building:- Unit D

Figure 6: Covered Walkway

Figure 7: Interior Corridor Classroom Building

Figure 8: Covered Walkway Adjacent to Unit D

Figure 9: Cafeteria Building

Figure 10: West Wall of Unit B

Figure 11: South Wall Unit D

Figure 12: Covered Walkway Adjacent to Cafeteria.

Figure 13: Metal roof adjacent to Cafeteria.