STRUCTURAL EVALUATION OF

LAKE ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
1300 Potrero Avenue
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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 Lake Elementary School in Richmond, CA. The structural assessment includes a site walk through. 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. The general structural condition of the buildings and any seismic deficiencies that are apparent during our site visit are documented in this report. This report includes a qualitative evaluation and, therefore, numerical seismic analysis of buildings is not included.

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 was originally built in 1956 and consists of the Office and Library Building as well as classrooms 1 through 12. There are four main buildings (permanent structures) and six portable buildings (see figure 1). The buildings are all one-story and consist of a wood framed Office and Library Building (1956), wood framed Classroom Building (1956), wood framed Multi-Purpose Building (1962), and a Classroom Building that is wood framed with a steel moment frame (1968). There are two 1969 portables, three 1997 portables, and one 1998 portable. The total square footage of the permanent structures is about 35,148 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 Multi-Purpose building has 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 less than 2.0 kilometers from the Hayward fault. The multi-purpose, office/Library, and 1956 classroom buildings are wood framed building with shear walls, and have a response modification factor R = 5.5. The 1968 classroom building is a wood framed building with a steel moment frame, and has 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.5x1.15)W}{5.5} = 0.345W \quad \text{for wood shear walls.}$$
$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.5x1.15)W}{4.5} = 0.422W \quad \text{for steel moment frame.}$$

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.

10.4 List of Documents

1. Lake School, dated Nov 1, 1955, by Schmidts & Hardman Architects, Sheets A1-A15 and Sheets S1-S6.
2. Second Addition to lake School, dated May 15, 1962, by Schachtman & Velikonia, Sheets A2-A6, S1-S3
3. Lake Elementary School, dated March 18, 1968, by Barbachano Ivanitsky and Associates Inc. Architects, Sheets AA, A1-A6, and Frank E. McClure & David L. Messinger Consulting Structural Engineers, Sheets S1-S7 (unreadable).
4. "Measure M" – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California.
5. "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.
6. "Measure M" roofing report by "the Garland Company Inc.", Orinda, California.

10.5 Site Visit

DASSE visited the site on November 6th, 2001 and March 7th, 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 Multi-Purpose, Office/Library (Figures 3, 4 & 5), and 1956 Classroom Buildings are wood framed with wood shear walls providing lateral resistance.

The Multi-Purpose building (Figure 7) roof is supported by glued-laminated beams that span the width of the building. Straight sheathing was observed spanning between the glu-laminated beams at the framing soffit.(Figure 10).

The Library has extensive windows on the wall facing the front of the school and the wall adjacent to the corridor has extensive clerestory windows (Figures 4&5). The office and administrative rooms have extensive windows on the wall facing the front of the school as well as continuous high windows in the exterior corridor wall.

The 1956 Classroom building has extensive windows on the exterior longitudinal walls (Figure 8). In addition the walls on each side of the corridor have clerestory windows (Figure 7) thus resulting in a lack of lateral resistance in the longitudinal direction.

The 1968 classroom building consists of several pods so as to accommodate an open classroom configuration. There are few exterior wall openings which should help limit damage in an earthquake.

The exterior covered walkway connecting the 1956 classroom building to the 1968 classroom building has a series of tubular moment frames that provide lateral bracing (Figure 11). A seismic joint seperates the 1968 Classroom building from the covered walkway. We observed electrical conduits that cross the seismic joint (Figure 14) and could experience damage and possible severing in a major earthquake.

Rigid electrical conduits were observed connecting the portable classrooms at the roof level (Figure 15) which could experience damage and possible severing in a major earthquake. In addition we found that the portable classrooms were supported on wood pads which rest directly on the ground (Figure 16). It is expected that these wood pads could decay and become a source of dry rot spreading to the framing under the portable classrooms.

10.6 Review of Existing Drawings

The drawings for the Nursery, which is shown on the aerial photograph but is not shown on the districts site layout plan, is missing. Additionally, the location of the Multi-Purpose Building as shown in the site layout plan is different from that in the aerial photograph.

The structural drawings for the 1968 classroom addition are not readable. This structure appears to be very similar to a building at Seaview Elementary School. From the partially readable drawings and the drawings for Seaview it appears that the structure consists of several steel moment frames that provide the gravity support for the wood framed roof. Lateral resistance is provided by the plywood roof diaphragm and perimeter plywood shear walls. The steel moment frames provides secondary lateral resistance against collapse in the event of damage to the plywood shear walls.

For Units B and C the roof loads are supported by ½" plywood spanning 24" to 2x joists which are in turn supported by beams and posts or walls. On each side of the classroom corridor there is a steel beam supported by steel columns. These loads are then transferred to continuous or spread footings which transfer the loads to the soil. The floor loads are resisted by a concrete slab on grade which sits on the ground.

The lateral system for Units B and C relies on the plywood roof sheathing to transfer the lateral loads to the plywood shear walls. The transfer walls between the classrooms and the exterior walls are sheathed with plywood.

The roof framing for the Multi-Purpose Building consists of 3/8" plywood roof sheathing over 4x6 T&G decking which spans to glu-lam beams at 16" oc that span the width of the building. At the east end of the building the low roof consists of 3/8" plyscord roof sheathing that is supported by 2x10 joists at 16" oc. The roof loads are transmitted to the spread and continuous footings by means of wood posts and the stud walls. The concrete floor rests directly on the ground.

The Multi-Purpose Building lateral loads are transmitted to the plywood shear walls by means of the plywood roof sheathing.

Because of the lack of readable drawings no review of the existing drawings was undertaken for the 1968 building.

The roofing report indicated that the roof should be replaced in the near future.

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 seismic evaluation methods, although no numerical structural analyses were performed. The seismic performance levels that the FEMA 310 document seeks to achieve are lower than the current Building Code. However, it attempts to identify potential for building collapse, partial collapses, or building element life safety falling hazards when buildings are subjected to major earthquake ground motion.

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.	At Library at the corridor inadequate length of shear walls as a result of clerestory windows in Library and continuous slit windows in exterior corridor wall.

2.	The continuous slit windows in the corridor wall in front of the Office prevent the transfer of roof diaphragm to shear wall.
3.	Office and Administrative rooms have extensive windows in the front wall which results in an inadequate length of shear wall.
4.	Classroom numbers 1 to 12 have continuous clerestory windows in the corridor walls.
5.	Classroom numbers 1 to 12 have extensive windows in the exterior longitudinal walls resulting in an inadequate length of shear walls.
6.	At the seismic joint between the covered walkway and Unit A rigid conduit crosses the joint without any provision to accommodate the seismic movement.
7.	Rigid conduit runs between portable classrooms at the elevation of the roof without any provision to accommodate the expected seismic movement..

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.	Add plywood shear walls at Library clerestory windows and provide new collectors.	1.5	4
2.	Fill in some of the existing slit windows with new plywood shear walls and provide new collectors.	1.5	4
3.	At Library, office , and administration rooms add plywood shear walls in the wall facing the front of the school. Provide new collectors and holdowns as required.	1.5	2, 3, 5
4.	Add plywood shear walls at Classroom clerestory windows.	1.5	7
5.	Add plywood shear walls at exterior longitudinal classroom walls. Provide new collectors and holdowns as required.	1.5	6, 8
6.	Reroute or provide flexible connection to allow conduit that crosses the seismic joint to accommodate the expected seismic movements.	1.9	14
7.	Reroute or provide flexible connection to allow conduit that connects the portable classrooms to accommodate the expected seismic movements.	1.9	15

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 and based on FEMA 310 requirements, 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 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 building 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, 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 3 and we recommend that seismic retrofit work be performed in Phase II.

10.13 Limitations and Disclaimer

This report includes a qualitative (visual) level of evaluation of each school building. Numerical seismic analyses of buildings are not included in this scope of work. The identification of structural element code deficiencies based on gravity and seismic analysis demand to capacity evaluations are therefore not included. Obvious gravity or seismic deficiencies that are identified visually during site visits or on available drawings are identified and documented in this report.

Users of this report must accept the fact that deficiencies may exist in the structure that were not observed in this 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

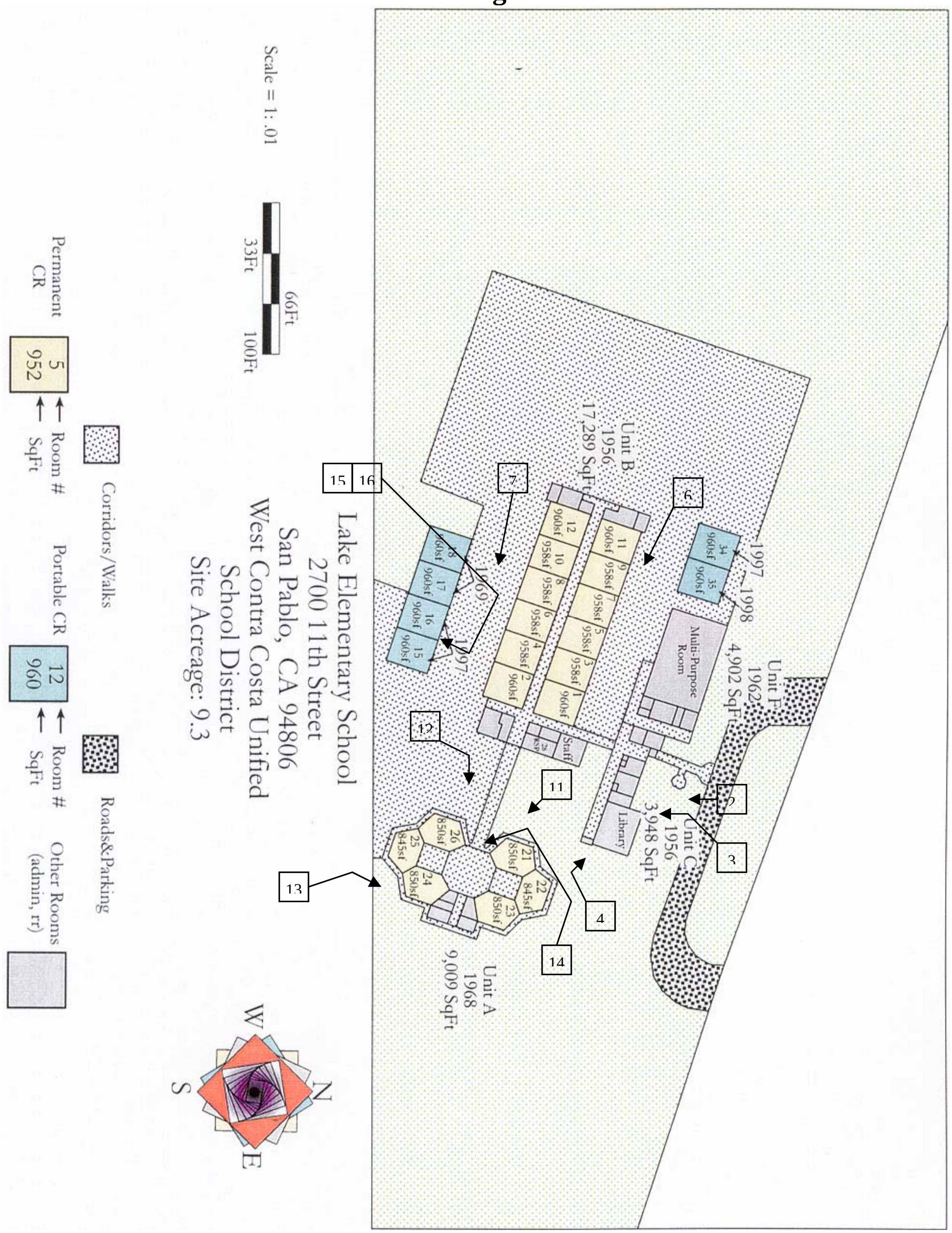

Figure 1: School Layout Plan

Figure 2: Main Entrance.

Figure 3: Library and Administrative Bldg.

Figure 4: Library

Figure 5: Interior Library.

Figure 6: North Wall Classroom Bldg.

Figure 7: Clerestory Windows at Classroom.

Figure 8: South Side Classroom Bldg.

Figure 9: Multi-Purpose Room.

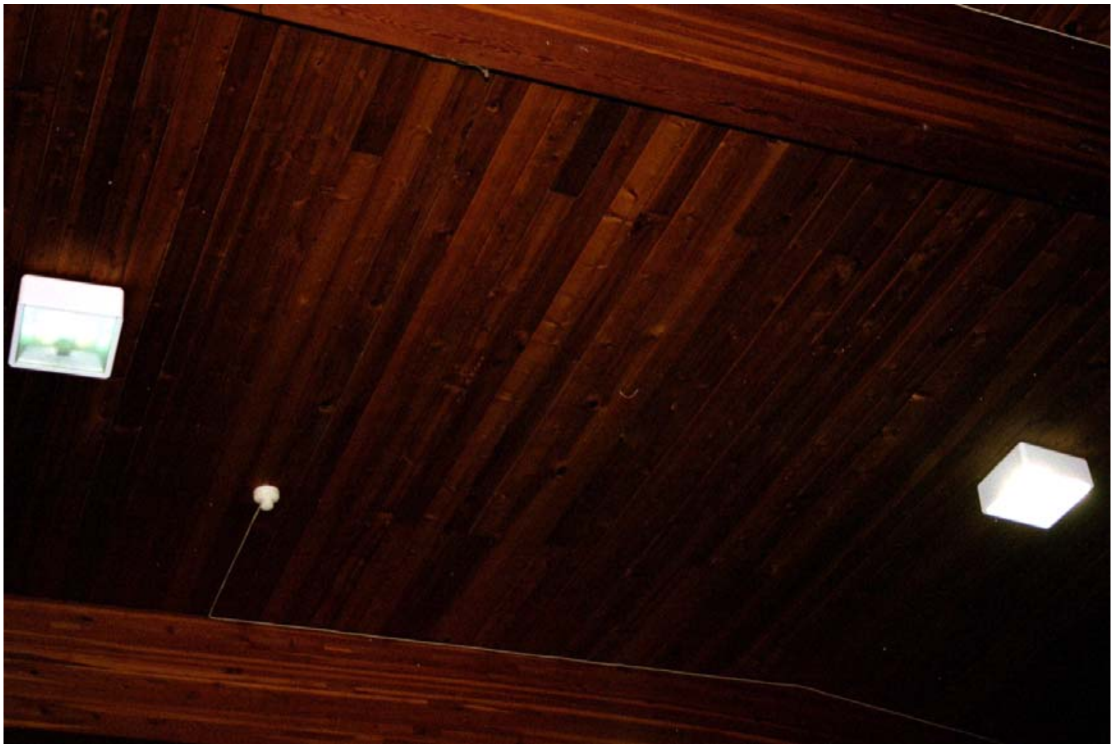

Figure 10: Ceiling Multi-Purpose Room.

Figure 11: New Covered Walkway.

Figure 12: Front of Pod Classroom Building

Figure 13: Pod Classroom Building

Figure 14: Conduit Crossing Seismic Joint at Unit A

Figure 15: Portable Classroom Building Connected with Electrical Conduit.

Figure 16: Portable Buildings Resting on Ground.