STRUCTURAL EVALUATION OF

VALLEY VIEW 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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TABLE OF CONTENTS

List of Figures

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Valley View Elementary School in Richmond, 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 was built in 1962. There are three main buildings (permanent structures) and nine portable buildings (see figure 1). The original buildings are two one-story wood- and steel-framed structures with some CMU walls. A one-story wood- and steel-framed structure (multi-purpose building) was constructed in 1985. There is one 1962 portable, one 1965 portable, one 1966 portable, two 1967 portables, one 1989 portable, one 1990 portable, one 1997 portable, and one 1999 portable. The total square footage of the permanent structures is about 27,100 square feet.

10.3 Site Seismicity

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

The classroom buildings 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 1998 CBC of 1.15. The campus is located at a distance of about 3.9 kilometers from the Hayward fault. The main classrooms are light-framed wood structures with plywood shear walls in the longitudinal direction and a mixture of plywood and CMU block shear walls in the transverse direction. The plywood and non-bearing CMU walls both have response modification factors R=5.5. The multi-purpose building is a wood framed building with plywood shear walls, and has a response modification factor R = 5.5. 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.31x1.15)W}{5.5} = 0.301W$$

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. Sheldon School District, Contra Costa County, K-6 School, Valley View Site; Johnson, Poole, and Storm, Architects; sheets A1-A13 (A3 missing); structural engineer unknown; sheets S1-S5; March 9, 1962.
2. Sheldon School District, Contra Costa County, K-6 School, Valley View School Additions; Johnson, Poole, and Storm, Architects; sheets A1-A16; structural engineer unknown; sheets S1-S5; September 24, 1962.
3. Valley View Elementary School; Paul Y. Wong, Architect; sheets 1, A1; Shapiro, Okino, Hom, and Associates, Engineers; sheets S1-S3; April 30, 1985.
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 7th, 2001 and March 8th, 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

There are two permanent classroom buildings. Classroom wing A has the offices and rooms K1, K2, and 1. Classroom wing B has classrooms 2 through 8, the computer lab, and the library (see figure 1). The main classroom buildings are two one-story wood-framed structures with transverse CMU shear walls at the front and back end of classroom wing A and at the front end of classroom wing B (see figures 2 through 6). The roof has a ridge running longitudinally over the central corridor. The longitudinal faces of these buildings have multiple large window openings with some segments of shear wall in between. The central corridor appears to have long segments shear walls. The ceiling in the classrooms and corridor is acoustical tile.

At the front entrance of the school, there is a high covered walkway area running between the classroom wings (see figures 2 and 3). There is a plaster ceiling on the underside of the walkway. The covered walkway roof slopes up from the ridgelines of the classroom buildings to a high point near the middle of the main entryway. This covered walkway is supported by CMU walls and pilasters at the front and by steel tube columns at the rear side. There is significant cracking of the CMU walls at the ends of the covered walkway where the walkway beam bears on the wall (see figures 9 and 10). Where the covered walkway meets the classroom buildings at its rear edge, there is also some cracking of the stucco soffit and beam furring (see figure 12). There is also some minor cracking at the top of one of the concrete pilasters that support the front edge of the canopy that appears to be due to out-of-plane bending.

The multi-purpose building is a one-story wood and steel structure with stucco exterior (see figures 7 and 8) and a suspended T-bar ceiling.

The main group of portables (classrooms 9 to 14) have multiple window openings on their front face (see figures 13 and 14). There is some rusting of the metal frames at the base of these portables (see figure 15). These portables and the newer portables (classrooms 15 to 17) have electrical conduit running between them above the roof and near the roof level, respectively (see figures 14 and 16). The conduit does not have flexible connections.

10.6 Review of Existing Drawings

DASSE Design, Inc. has used its best judgement in interpreting the available copies of the construction drawings, which are difficult to read and, in some areas, illegible.

The main classroom buildings have a plywood-sheathed roof over 3x16 joists at 16” o.c. The roof joists span about 35 ft between the exterior and corridor longitudinal walls. The buildings have a combination of plywood and CMU shear walls. In general, all of the interior transverse walls have plywood sheathing and collectors have been provided across the full width of the building to transfer force into the wall. At the ends of the buildings, there are CMU shear walls. The exterior longitudinal walls have large window openings and very little shear panel. The corridor walls, however, have long sections of plywood shear panel. In general, the wood bearing walls rest on 16” wide strip footings. The plywood shear walls typically have steel angle holdowns at each end. The CMU walls are typically reinforced with 2-#4 bars at 16” o.c. each direction with 2-#6 verticals at each end. They are supported on 20” strip footings. There does not appear to be a positive connection from the CMU walls to the roof diaphragm to resist out-of-plane wall forces. At the front end of the school, the roof is discontinuous; there is a step up in the roof from the main classroom roof to the walkway roof, which slopes in the opposite direction (see figure 3). Because the wall below this discontinuity has multiple window openings, it is able to resist small overturning forces but the shear forces must be transferred across the discontinuity to the exterior CMU wall. The existing main classroom building roofing are about 14 years old and appear to be in acceptable condition.

The covered walkway that runs between the classroom buildings have a plywood roof diaphragm over 2x10 joists that span between steel wide-flange beams. At the front face, these steel beams span between the CMU end walls of the classroom buildings and the 6 ft. wide CMU pilasters at the front entrance (see figure 2). The beam is attached to the end walls by 2 bolts where it bears on the CMU wall. There are 3" diameter standard pipe columns embedded at each end of the CMU pilasters, and there is a bolted connection from the steel beam to these columns at the top. At the rear, the steel beams span between TS6x4x1/4 columns that sit on a strip footing. These slender tube steel columns do not appear to have adequate lateral bracing at the roof level (see figure 11). The roof diaphragm is about 24 ft wide and has a double 2x10 chord member at each edge. At its high point, the roof is approximately 19 ft. tall, and there is a re-entrant corner at this location. The diaphragm chords are connected to each other at this corner with steel clip angles. Where the covered walkway meets the classroom buildings, the roof is framed continuously and there is no seismic joint in the covered walkway to separate it from either of the classroom buildings (see figure 3). The covered walkway does not have its own lateral force resisting system, and therefore it spans about 110 ft between the two classroom buildings.

The multi-purpose building is a 60' x 72' modular building. The roof diaphragm is made of ¾" tongue and groove Sturd-I-Floor plywood. It is attached to 8" sheet metal purlins that span 12 ft between built-up tapered sheet metal rafters that vary from 14¾" to 24" in depth. The walls are 2x6 studs sheathed with plywood nailed with 8d nails at 6" o.c. and there are holdowns at the west wall shear panels only. The 5/8" sill bolts are spaced at 4 ft. o.c. The building rests on perimeter strip footings that are 12" wide at the east and west walls and 18" wide at the north and south walls. The existing roofing at the multi-purpose building is about 3 years old and appears to be in good condition.

At the rear end of classroom wing A, there appears to be a deviation between the original construction documents and the existing conditions observed during the site visit. The original drawings show the roof overhang spanning 8 ft. between the rear wall of the building and a steel channel over a row of pipe columns. The existing condition however is a much shorter overhang that is cantilevered over the rear wall of the building (see figure 3).

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.	There are cracks in the CMU wall at the main entrance where covered walkway beam is supported.
2.	There is a lack of lateral bracing at the top of TS columns at covered walkway.
3.	The covered walkway's roof diaphragm aspect ratio is very slender. This will lead to large lateral deflections in the transverse direction.
4.	The covered walkway roof is connected to both classroom buildings. As the buildings move toward or away from each other, it will cause large forces at the re-entrant corner.
5.	There is a discontinuity in the roof diaphragm where the covered walkway and classroom building roofs intersect. As they move differently, there may be some damage to the roof at these locations.
6.	Out-of-plane lateral support for CMU pilasters at the main entrance is provided by 3" diameter pipe columns embedded in them. The columns may be inadequate to carry the out-of-plane load of the pilaster. This may cause collapse of the walkway.
7.	The CMU shear walls at the front of the classroom buildings and at the rear of classroom wing A do not have positive connection to the roof diaphragm for resisting out-of-plane forces. Additionally, buildings with masonry walls and flexible diaphragms require cross-ties which are not provided in the longitudinal direction.
8.	The splices in the roof diaphragm chords at the wood end walls of the classroom buildings are overstressed.
9.	At the classroom buildings, the interior longitudinal and transverse shear walls are overstressed.
10.	The shear wall at the west side of the multi-purpose building is overstressed.
11.	The front wall of the portable units (classrooms 9 to 14) has multiple window openings and the shear wall may be overstressed.

12.	There is some rusting at the base frame of the portable units at classrooms 9 to 14.
13.	Conduit crossing the seismic joints between portable units may get damaged as the buildings move independently and is a life-safety hazard.

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.	Provide a new steel column at end of CMU wall to prevent collapse. Provide new straps at roof above collector.	1.1	9,10
2.	Provide new lateral bracing beams at top of existing columns.	1.5	11
3.	Provide seismic bracing or moment frame in transverse direction at covered walkway columns	2.5	2
4.	Provide new straps and blocking as collectors at the re-entrant corner	1.5	11
5.	Provide new straps and blocking as collectors at the Diaphragm discontinuity.	1.7	11
6.	Provide a positive connection at the top of the CMU pilasters to the covered walkway roof diaphragm.	1.0	2
7.	Provide new wall out-of-plane connection and cross-ties.	1.0	2, 3
8.	Provide new straps above the plywood at the roof.	1.3	3
9.	Provide new plywood sheathing at the unsheathed face of the wall. Strengthen existing collectors and add holdowns as required.	1.3	N/A
10.	Provide new plywood sheathing at the unsheathed face of the wall, or re-nail existing plywood at exterior. Strengthen existing collectors and add holdowns as required.	1.3	8
11.	Infill some windows with new framing and plywood. Strengthen existing collectors and add holdowns as required.	1.6	13, 14
12.	Repair as necessary and re-paint.	1.9	15
13.	Provide flexible connections in conduit at seismic joints.	1.9	16

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

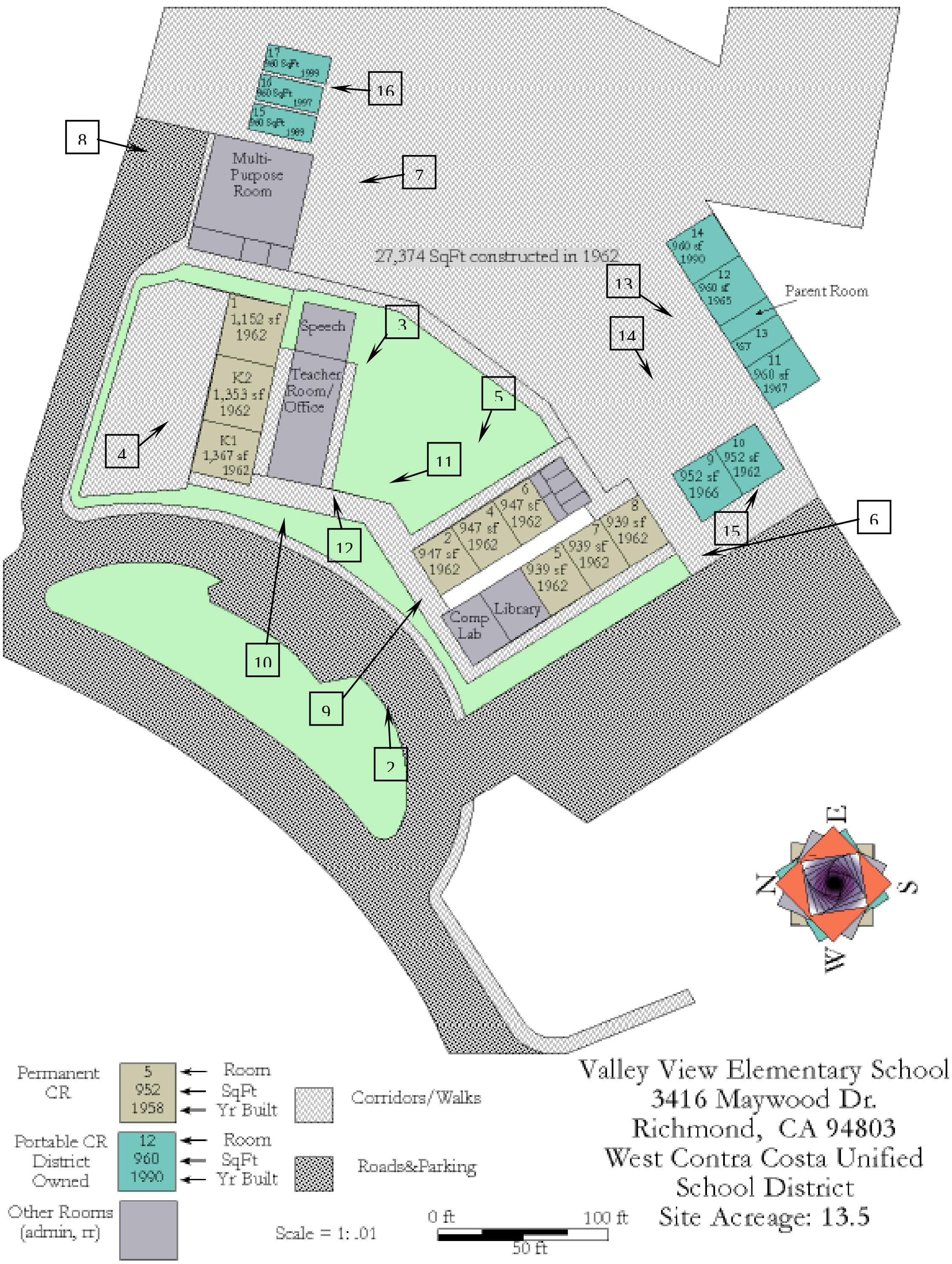

Figure 1: School Layout Plan

Figure 2: Front Entrance

Figure 3: Wing A Classrooms (front)

Figure 4: Wing A Classrooms (rear)

Figure 5: Wing B Classrooms (front)

Figure 6: Wing B Classrooms (rear)

Figure 7: Multi-Purpose Building (front)

Figure 8: Multi-Purpose Building (rear)

Figure 9: Cracking at Entrance Canopy

Figure 10: Cracking at Entrance Canopy

Figure 11: Columns at Entrance Canopy

Figure 12: Cracks at Rear Side of Entrance Canopy at Building

Figure 13: Portable Classrooms

Figure 14: Portable Classrooms

Figure 15: Rust at Base Frame of Portable Unit

Figure 16: Conduit Running between Portables