STRUCTURAL EVALUATION OF

WASHINGTON ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
1300 Potrero Avenue
Richmond, CA 94804

By

DASSE Design, Inc.
33 New Montgomery Street #850
San Francisco, CA 94105
(415) 243-8400

April 30, 2002

DASSE Design Project No. 01B300

TABLE OF CONTENTS

List of Figures

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Washington 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 1940. The main building is a one-story wood frame structure that includes classrooms and the auditorium (see figures 2-5). Two additional classroom buildings were constructed in 1948, with similar construction type to the original building (see figures 6-8). There are three main buildings (permanent structures) and seven portable buildings (see figure 1). There are two 1997 portable, two 1998 portables, two 2000 portable, and one portable of unknown age. The total square footage of the permanent structures is about 32830 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 classroom buildings have an educational occupancy (Group E, Division 1 and 2 buildings), and the auditorium building has an assembly occupancy (Group A, Division 2.1 or 3), both of which have an importance factor in the 1998 CBC of 1.15. The campus is located at a distance of about 6.0 kilometers from the Hayward fault. The buildings are wood framed structures with diagonally sheathed shear walls, and 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.16x1.15)W}{4.5} = 0.326W$$

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. Washington School, Dragon and Schmidts Architects, sheets 1-11, December 23, 1940.
2. 10 Classroom Addition, Washington School, Dragon, Schmidts and Hardman Architects, sheets 1-8, April 30, 1948.
3. “Measure M” – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California
4. “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.
5. “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 7th, 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, 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 and auditorium building is a one-story wood structure with brick veneer for the lower 3’ to 5’ of the exterior walls and stucco plaster finish above (see figures 2-5). The exterior longitudinal walls of the classroom portion building have multiple large window openings with shear walls in between. The auditorium has some longer segments of shear wall. The classroom, corridor, and auditorium typically have suspended cement plaster ceilings.

The classroom buildings are one-story wood structures with brick veneer for the lower 3' to 5' of the exterior walls and stucco plaster finish above (see figures 6-8). The ceiling appears to be cement plaster. Both classroom buildings have covered walkways attached to them on the south side. Above these covered walkways along the entire length of the building, there are clerestory windows that have been filled in with plywood (see figure 6). The manner in which this plywood has been connected to the rest of the structure is not readily visible. On the north face of each building, there are multiple window openings with shear wall panels in between. The end walls of the classroom buildings have long shear walls without openings. There is a large chimney at the auditorium roof (see figure 8).

There are covered walkways connecting all the buildings. The walkways are supported by wood posts and beams, and frame into the building walls along the length of the classroom buildings. The walkways are generally only attached to one of the buildings, but there is one location, at the east end of the classroom buildings, where the covered walkway frames into both buildings (see figure 9). The walkway at the west end of the classroom buildings appears to be deteriorated (see figure 10). There are electrical conduits between the buildings that are supported by the covered walkway. There is a large brick chimney at the west end of the south classroom building (see figure 8).

There are electrical conduits running between the portables near the roof level (see figure 13)

10.6 Review of Existing Drawings

The main building is an L-shaped wood-framed structure with a diagonally sheathed roof and walls. In the classroom wing, the typical roof is 2x14 rafters at 16"o.c. spanning between the exterior and central corridor bearing walls. The west wall of the corridor is diagonally sheathed, but the east wall of the corridor has only some nominal stability bracing above the roof level. The walls rest on a 10" deep x 18" wide strip footing. There are transverse shear walls between all the classrooms that rest on 12" wide strip footings. In the auditorium, 2x6 roof joists at 16"o.c. span between roof trusses. These trusses are spaced at 14' and are supported by 8x8 posts at each end. The bearing walls and posts rest on 12" deep x 24" wide strip footings. The auditorium ceiling consists of 2x6 framing spanning between the lower chords of the roof trusses. There is a system of diagonal tie rods just above the ceiling that act as a horizontal diaphragm. The exterior walls generally have large window openings with shear panels between them. At the auditorium, many of these wall piers have height to width ratios in excess of 3:1 (see figure 5), whereas the classroom wing wall piers usually have height to width ratios of 2:1 or less (see figure 2). None of the shear walls have holdowns. At the west end of the auditorium, there is a boiler room with 8" concrete walls on all sides which is significantly stiffer than the adjacent diagonally sheathed walls and can be expected to attract high loads. There is a large concrete chimney at the boiler room (see figure 5) with fire brick lining on its interior. The existing roofing at the main building is about 4 years old and appears to be in acceptable condition.

There are two long rectangular classroom buildings of similar light-framed wood construction. The major differences between the two buildings is that the northern building is one and one half bays longer (one additional classroom and restrooms) and southern building has a small concrete boiler room at its west end. A trussed roof spans 28' in the transverse direction between bearing walls, sloping down from south to north. The north wall of each building has large window and door openings for most of its length, with ¾" plywood shear panels in between. The south wall has diagonal sheathing interrupted only by the door openings below the ceiling level, and has clerestory window openings along the entire length of the building above the ceiling level. At the south side of the buildings, there is a covered walkway with 2x6 framing that is supported at the building by a ledger and by a beam over 6x6 posts at the outside. There are diagonally sheathed shear walls between the classrooms, spaced at about 32'-6". The north bearing wall and the east and west end walls rest on 8" deep x 12" wide strip footings. The south bearing wall rests on a 9" deep x 18" wide strip footing. The transverse shear walls typically rest on a 10" thickened slab. At the boiler room, there are 8" thick concrete walls resting on 16" deep x 24" wide strip footings. These support a 2½" thick concrete slab with 11½" deep concrete beams which is hidden below the wood-framed roof above. Because the concrete walls are relatively stiff, they will tend to drag in load from the rest of the building. The existing roofing at the classroom buildings are about 6 years old and appear to be in acceptable condition.

There are covered walkways between the classroom buildings and leading to the main building. At most locations, the walkways are only attached to one of the buildings, but near classrooms number 10 and number 15, the walkway connects the two classroom buildings together. There are two types of walkway covers, the awning type mentioned above that are connected to the south face of the classroom buildings (see figure 6), and the free-standing type (see figures 9-11). The free-standing covered walkways are framed with 2x rafters and tension struts that span 9' between beams. These beams are 2-2x10 members with a 2x filler between them. They span between 6x6 posts. At the end of the classroom portion of the main building, the adjacent covered walkway is supported by steel hanger rods from the main building.

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 avoid 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 classroom buildings have plywood infill in the clerestory windows. The connection of this plywood to the collector above and to the shear wall below may be inadequate.
2.	At the north exterior walls of the classroom buildings, the plywood shear walls are overstressed.
3.	There are electrical conduits attached to the walkway that may snap and fall when the corridor is damaged.
4.	The covered walkway near room number 19 has deteriorated.
5.	Where the covered walkway connects to the main building, the walkway is hung from the building roof by ¾" dia. rods. There is inadequate seismic bracing of the walkway at this location.
6.	The covered walkway from near room number 10 to room number 15 is connected to both classroom buildings and may be damaged and collapse as the buildings move independently.
7.	The brick chimney at the south classroom building that may collapse during an earthquake.
8.	The electrical conduit running between the portable classrooms near the roof level has no flexible connection. It may be damaged as the buildings move independently.
9.	The main building lacks collectors at re-entrant corners, at the boiler room concrete walls, and at the back of the stage where the auditorium area meets the main building area, which may result in damage to the roof diaphragm at these locations and may cause partial collapse.
10.	The collector connections from the concrete boiler room portions of the main building and the south classroom building to the rest of the structures may be overstressed.
11.	There are no holdowns at the ends of shear wall panels in either the main building or classroom buildings. The shear walls may uplift and overturn, causing partial collapse of the buildings.
12.	At the classroom wing of the main building, there are no collectors in the roof

	diaphragm across the ridgeline.
13.	At the classroom wing of the main building, the exterior longitudinal walls are overstressed.
14.	The north wall of the multi-purpose wing of the main building has excessive window openings. The shear wall panels are overstressed.
15.	The south and east exterior walls of the kindergarten area of the main building have excessive window openings. The shear wall panels are overstressed.
16.	At the main building, the north and west shear walls of the kindergarten area also carry loads from the classroom and multi-purpose wings, respectively. These shear walls are overstressed.

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 wall at clerestory windows. Strengthen collectors and provide new holdowns as required.	1.4	6
2.	Infill windows with new framing and plywood sheathing. Strengthen collectors and provide new holdowns as required.	1.2	7
3.	Provide new flexible conduit connections at seismic joints	1.9	10
4.	Demolish existing covered walkway and build a new one.	2.5	10
5.	Provide new steel posts and piers at ends of beams	2.5	12
6.	Provide a new seismic joint and add new columns and footings under the existing beams for gravity and lateral support	1.6	9
7.	Remove the existing chimney or provide new bracing of chimney to the roof	1.3	5, 8
8.	Provide new flexible conduit connections at seismic joints	1.9	13
9.	Add new blocking and straps at roof where roof is at same level. Add new posts or diagonal braces where roof levels differ. Some existing connections may need to be strengthened.	1.6	5
10.	Strengthen existing collectors and add new collectors where required	1.5	10
11.	Add new holdowns at the ends of shear walls.	1.0	N/A
12.	Provide new blocking and continuous straps above the existing roof sheathing, aligned with the shear walls below.	2.8	N/A
13.	Add new plywood sheathing to the unsheathed corridor wall. Provide new collectors and holdowns as required.	1.6	2
14.	Infill windows with new framing and plywood sheathing. Strengthen collectors and provide new holdowns as required.	1.3	5

15.	Infill windows with new framing and plywood sheathing. Strengthen collectors and provide new holdowns as required.	1.2	N/A
16.	Provide new plywood sheathing on the unsheathed face of the shear walls. Strengthen collectors and provide new holdowns as required.	1.1	N/A

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

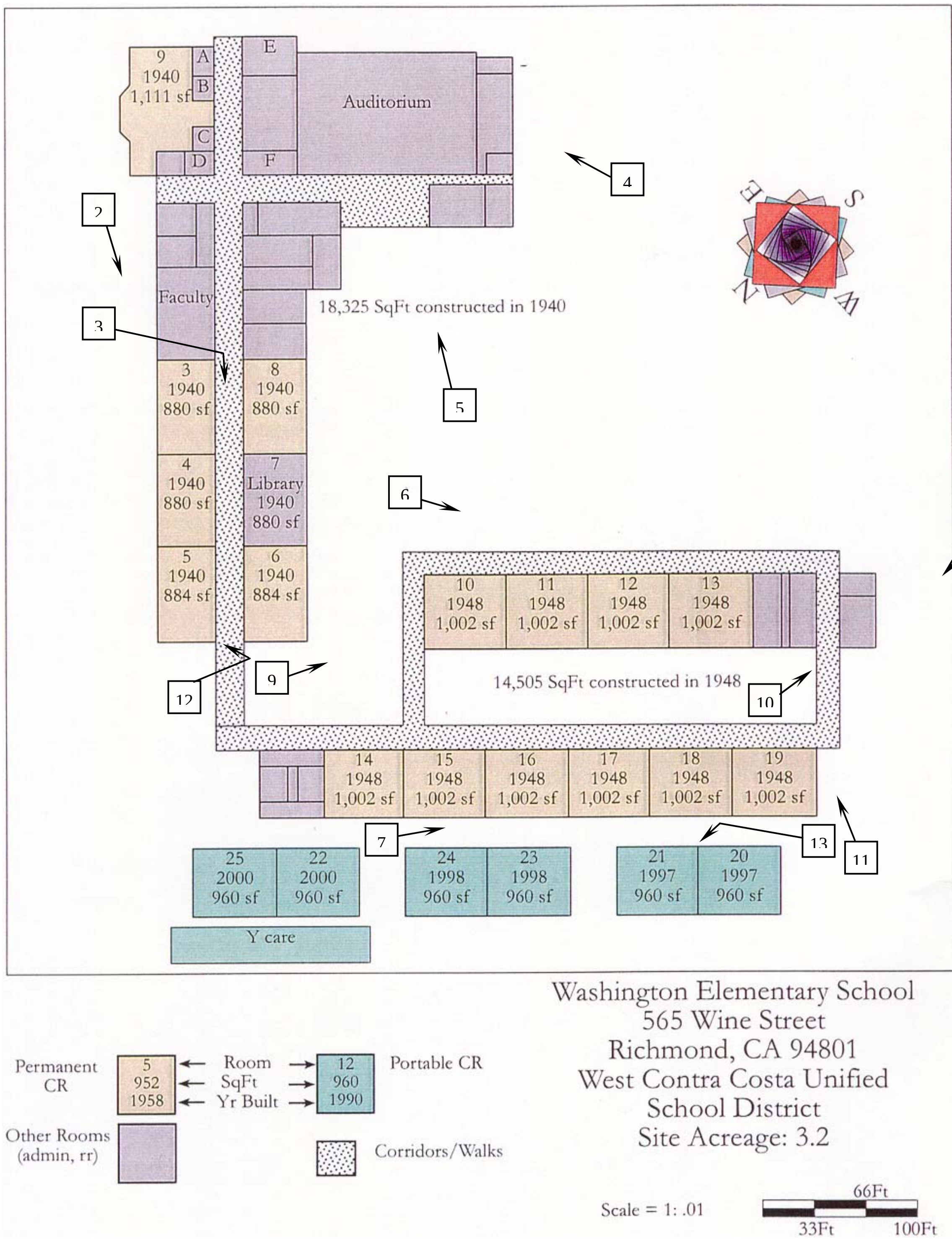

Figure 1: School Layout Plan

Figure 2: Main building (front)

Figure 3: Main building interior corridor

Figure 4: Auditorium entrance

Figure 5: Main building and auditorium

Figure 6: Classroom building, rooms 10-13 (south face)

Figure 7: Classroom building, rooms 14-19 (north face)

Figure 8: Classroom buildings (west side)

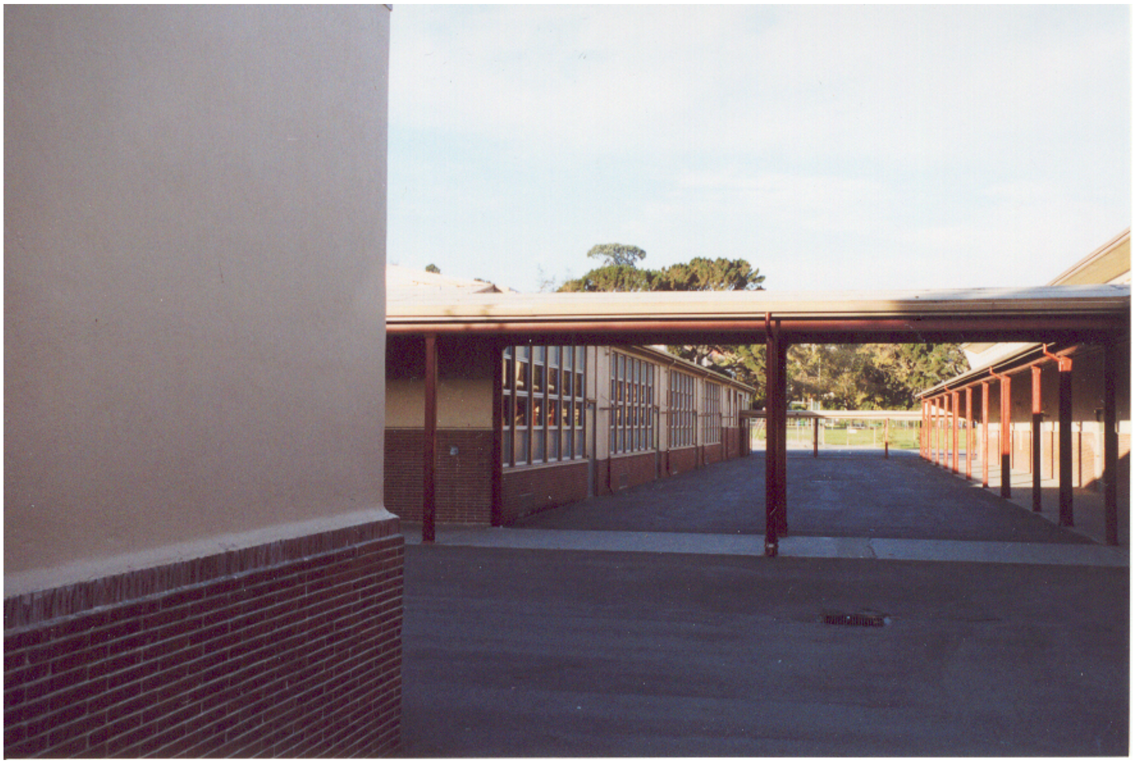

Figure 9: Covered walkway between classroom buildings

Figure 10: Covered walkway at classroom building (near room 13)

Figure 11: Covered walkway at classroom building (near room 19)

Figure 12: Hanger rods at covered walkway

Figure 13: Electrical conduit at portables