STRUCTURAL EVALUATION OF

BAYVIEW 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 Bayview 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 was built in 1952. There are five permanent buildings and eight portable classrooms. The original buildings are a long one-story wood-framed structure (main building) with varying roof heights and three one-story wood-framed classroom buildings with connecting covered walkways. There is a one-story wood-framed classroom building that was added in 1957. There is one 1988 portable, two 1989 portables, one 1996 portable, and four 1997 portables. The total square footage of the permanent structures is about 42100 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 and the northwest wing of the main building have an educational occupancy (Group E, Division 1 and 2 buildings) and the multi-purpose wing of the main 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 less than 2 kilometers from the Hayward fault. The buildings are all supported laterally by diagonally sheathed shear walls, which 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.5x1.15)W}{4.5} = 0.422W$$

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. Bayview Elementary School; Schmidts and Hardman, Architects; sheets 1-30; June 12, 1952.
2. First Additions to Bayview and Fairmede Schools; Schmidts, Hardman, and Wong, Architects; sheets S1-S5 (missing S3); October 31, 1957.
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.

10.5 Site Visit

DASSE visited the site on November 6th, 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 building is a one-story wood structure with stucco finish built in 1952. It can divided into three general areas: the main entrance, library, computer lab, and outreach rooms at the northwest end of the building (see figures 2-6); the offices in the middle section of the building (see figures 7 and 8); and the multi-purpose room at the southeast end (see figures 7 and 8). Although these three areas have different roof heights, it appears that they were built to be continuous with no seismic joints. These three areas have different widths as well, which creates re-entrant corners at numerous locations (see figure 1). All of these areas have acoustical tile ceilings.

The northeast area of the main building has clerestory windows above a covered walkway along most of its front face (see figure 3). Although these clerestory windows have been infilled with plywood, the connection of the plywood to the structure does not appear to be intended to or capable of transferring seismic forces. This results in a lack of adequate shear wall to resist seismic loads. The acoustical tile ceiling in the classrooms is flat in the rear half of the room and sloped up toward the clerestory windows at the front. At the main entrance, there is brick veneer over the full height of the wall (see figure 2) and the roof overhang is supported by two tall slender tube steel columns. At the rear of the building, there is a large covered storage area whose roof frames into the wall of the main building for gravity and lateral support (see figures 5 and 6). There are also multiple large window openings in the rear wall of the building. There do not appear to be major openings in the transverse walls.

The roof of the middle section of the main building is lower than both of the adjacent areas, and therefore frames into the wall at the change in roof elevation. The middle section of the main building also has a covered walkway attached to the front face of the building but, unlike the northwest area, there are no clerestory windows above. A portion of the walkway is enclosed by a 4 foot tall CMU wall and glazing at the front of the school (see figure 8). The rear face building has multiple large window openings.

The multi-purpose room has a high roof. There are high windows along a portion of the front and back faces of the building. The end walls of this area have only minor openings. The covered walkway at the front of the building is continuous with the covered walkway at the middle section of the building.

There are 3 similar 1952 classroom buildings that are linked at each end by covered walkways. The front walls of the 1952 classroom buildings have clerestory windows above a covered walkway. There are shear wall panels between the windows such that about 35% of the wall length is shear wall that is continuous from floor to roof (see figure 11). The rear walls of the 1952 classroom buildings have large window openings and an inadequate amount of shear wall (see figure 12). The transverse walls do not have major openings. The acoustical tile ceiling in the classrooms is flat in the rear half of the room and sloped up to allow lighting from the clerestory windows at the front. Two of the 1952 classroom buildings have restrooms at the southeast end. These restroom areas have lower roofs than the rest of the classroom building and that roof frames into the end wall of the classroom building (see figure 13).

In addition to the canopy roofs attached to the front of the classroom buildings, there are also covered walkways that run perpendicular to the classroom buildings connect them to each other (see figure 10) and to the main building and to the 1957 classroom building. These covered walkways are supported on 3” diameter pipe columns. These covered walkways do not appear to have their own lateral force resisting system and are therefore dependent upon the adjacent buildings for lateral support.

The 1957 classroom building has high windows on the exterior longitudinal walls (see figure 15). The central corridor that runs between the classrooms appears to have long shear wall panels along each side. Other than the central corridor, the transverse shear walls between the classrooms and at the ends of the building do not have any significant openings. The roof of the

1957 classroom building is not continuous across the building. Starting at an exterior longitudinal wall, the roof slopes up to the near side of the central corridor. At that point, the roof steps down a few feet and continues flat to the far side of the corridor, steps back up again, and slopes down to the other exterior longitudinal wall (see figure 16). As a result, the building is split into two essentially separate areas with only the corridor roof framing keeping them together. The classrooms and corridor have acoustical tile ceilings. At the southeast end of the building, there is a storage area with a lower roof than the rest of the building.

All of the buildings on the campus have built-up roofing that appear to be in adequate condition.

10.6 Review of Existing Drawings

The main building and 1952 classroom buildings were built at the same time and are of similar construction. All of the buildings have diagonally sheathed roof diaphragms and a combination of plywood and diagonally sheathed shear walls. In general, the shear wall piers with an aspect ratio of 1.5:1 or greater are sheathed with plywood.

The northwest and office areas of the main building and the 1952 classroom buildings have 2x8 roof joists that span 14 feet between the exterior longitudinal walls and glu-lam beams (typically 5¼" x 21", 7" x 21" at northwest area) that run longitudinally down the middle of the building. The glu-lam beams span 34 feet (about 48 ft at northwest area) between posts that are part of the transverse walls and rest on spread footings of varying sizes. The exterior longitudinal stud walls rest on strip footings that vary from 14" to 18" wide. 2x6 ceiling joists are suspended by 2x hangers from the roof near the glu-lam beams. At the classroom buildings and northwest area of the main building, the ceiling only extends across a portion of the building, allowing light in from the clerestory windows. At the front of the buildings, there is covered walkway that is framed with 2x8 joists spanning about 9 feet between the building wall and 6x8 beams. These beams span between 3" diameter standard pipe columns spaced from 11 feet to 13 feet o.c. There is a ledger connection from the walkway to the building wall for shear transfer. Every other joist is continuous through the exterior sheathing and is nailed to the side of the adjacent wall stud.

The multi-purpose room of the main building has 2x8 roof joists that span 14'-6" (typical) between 7" x 29" glu-laminated beams. These glu-lam beams span 50 feet between the exterior longitudinal walls and rest on 3'-6" x 4'-0" spread footings. The interior transverse shear wall is sheathed with plywood on both faces. The stud walls typically rest on 18" wide strip footings. At the longitudinal walls, the two 2x top plate chords are spliced with five ¾" diameter bolts and, at the transverse end walls, the top plate splices have nailing in addition to the typical splice detail.

At the front entrance of the main building, there is a mechanical room with CMU walls. These walls are reinforced with #5 bars at 16" o.c. The top of the wall is anchored to the roof diaphragm only with nominal nails from the rafters to a 2x nailer. This nailer is attached to the wall with 5/8" diameter bolts spaced at between 4'-0" and 6'-0" o.c.

The connecting covered walkways between buildings are framed with 2x8 shaped rafters that span 10 feet between 6x8 beams. These beams span between 3" diameter standard pipe columns spaced at 12'-6" o.c. The two-bolt column connection to the 6x8 beams is not capable of transferring moment for lateral support in the transverse direction.

The 1957 classroom building has ½" plywood sheathing on the roof and 3/8" plywood sheathing on the shear walls. The main roof framing consists of 2x14 joists spanning 28 feet between transverse bearing and shear walls. Along the central longitudinal line of the building, there is a light well with a low roof area. This roof is supported on 2x10 shaped joists that span 9 feet between the corridor bearing walls. The interior longitudinal shear walls are aligned directly underneath the edge of the light well above; there is a 3'-4" offset between the shear wall panels and the corridor walls at each side of the corridor. In this manner, the shear walls are aligned with the door openings, not the corridor wall (see figure 17). The side wall of the light well is supported by a 10WF21 steel beam that spans between 8WF17 steel columns that are aligned with the transverse shear walls. The bearing walls at the corridor are supported on a 10" thickened slab, whereas the other bearing walls rest on 12" wide strip footings. At the steel columns and interior longitudinal shear walls, there are 18" wide strip footings. At the southeast end of the building, the low roof area is framed with 2x8 joist that span about 15'-9" between bearing walls. Where the joists frame into the side of the wall, there is a ledger that is connected to the wall studs by carriage pins every 4' o.c.

No information about the age of the existing roofing was available.

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.	At the front longitudinal wall of the northeast portion of the main building, the clerestory windows have been infilled with plywood. The connection of the plywood infill to the rest of the structure is not adequate to transfer seismic shears.
2.	At the rear longitudinal wall of the northeast portion of the main building, there are excessive window openings. Therefore, the shear wall is overstressed.
3.	The interior transverse walls at the northeast portion of the main building are overstressed.
4.	The longitudinal walls at the middle portion (offices) of the main building have excessive window openings. The shear walls are overstressed.
5.	At the office area of the main building, the top plate chord splices of the longitudinal walls are overstressed.
6.	At the main entrance to the main building, the tube steel posts supporting the roof overhang are very slender and may require lateral bracing to reduce their unbraced length.
7.	There is reinforced masonry wall at the mechanical room near the front entrance to the main building. The anchorage of this wall to the roof diaphragm is overstressed and the wall may collapse.
8.	At the main building, the exterior longitudinal walls of the multi-purpose room have excessive window openings and are overstressed.
9.	At the main building, the interior transverse wall of the multi-purpose building has inadequate shear wall nailing.
10.	At the main building, the southeast transverse end shear wall of the multi-purpose room is overstressed.
11.	At the main building, the top plate chord splices at the longitudinal walls of the multi-purpose room are overstressed.
12.	There are abrupt changes in the height of the main building roof diaphragm. At these discontinuities, there is a lack of collector elements tying the walls together. This will cause localized damage to the walls
13.	There is a displacement incompatibility at the re-entrant corner where the middle section of the main building meets the multi-purpose room. This will cause localized damage to walls.
14.	There is cracking in the stucco finish at the southwest corner of the multi-purpose room. This cracking may lead to deterioration of the wall.
15.	There are clerestory windows at the 1952 classroom buildings. The shear walls between the windows may be overstressed.
16.	The rear faces of the 1952 classroom buildings have excessive window openings.

17.	The top plate chord splices at the longitudinal walls of the 1952 classroom buildings are overstressed.
18.	At two of the 1952 classroom buildings, there are restrooms with a low roof at the end of the building. There is a lack of collector continuity at this roof discontinuity that may lead to damage and partial collapse of the corridor roof at this location.
19.	The covered walkways lack bracing in the transverse direction. In combination with the slender diaphragm aspect ratio, this will lead to large lateral deflections and damage to the roof diaphragm.
20.	The covered walkways are connected to multiple buildings, linking them together. As these buildings move independently, the walkway may tear away from a building at one end, causing a partial collapse of the walkway.
21.	The exterior longitudinal walls of the 1957 classroom building have excessive window openings. There is a lack of shear wall at these locations that causes an overstress in the shear wall panels along the corridor.
22.	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.

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 new plywood shear wall at the clerestory windows. Strengthen existing collectors and add new holdowns as required.	1.2	3, 4
2.	Infill some windows with new plywood shear wall. Strengthen existing collectors and add new holdowns as required.	1.2	5, 6
3.	Add plywood sheathing to the unsheathed side of the wall. Strengthen existing collectors and add new holdowns as required.	1.2	4
4.	Infill some windows with new plywood shear wall. Strengthen existing collectors and add new holdowns as required.	1.1	7, 8
5.	Add a new continuous strap at the roof above the existing sheathing	1.4	7, 8
6.	Provide lateral bracing at 1/3 points. Connect the two posts by lacing them together at 12” intervals.	1.8	2
7.	Provide additional out-of-plane anchorage and wall cross-ties	1.0	2, 3
8.	Infill some windows with new plywood sheathing. Strengthen existing collectors and add new holdowns as	1.3	7, 8

	required.		
9.	Add additional nailing at the existing wall sheathing. Strengthen existing collectors and add new holdowns as required.	1.2	N/A
10.	Add new plywood sheathing a the unsheathed face of the wall. Strengthen existing collectors and add new holdowns as required.	1.0	8
11.	Provide a new continuous strap at the roof above the existing sheathing	1.4	7, 8
12.	Provide new strapping and blocking in walls that align with each other	2.1	2, 8
13.	Strengthen the existing connection of the office roof into the wall of the multi-purpose room.	2.1	6
14.	Patch the existing stucco	3.0	9
15.	Infill some of the clerestory windows with new plywood shear wall or add new plywood sheathing to the inside face of the existing shear wall. Strengthen existing collectors and add new holdowns as required.	1.7	11
16.	Infill some windows with new plywood shear wall. Strengthen existing collectors and add new holdowns as required.	1.0	12
17.	Add additional nailing at the existing top plate splices	1.6	11, 12
18.	Infill the adjacent windows and provide new collector elements to the longitudinal walls. Strengthen existing collectors and add new holdowns as required.	1.9	13
19.	Provide lateral bracing at the covered walkways	2.0	10, 13
20.	Add new beams and columns to provide a secondary system for gravity support of the walkway.	1.6	10, 13
21.	Infill windows with new plywood shear wall. Strengthen existing collectors and add new holdowns as required.	1.0	15
22.	Provide a flexible connection for conduit crossing the building separations	1.9	18

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

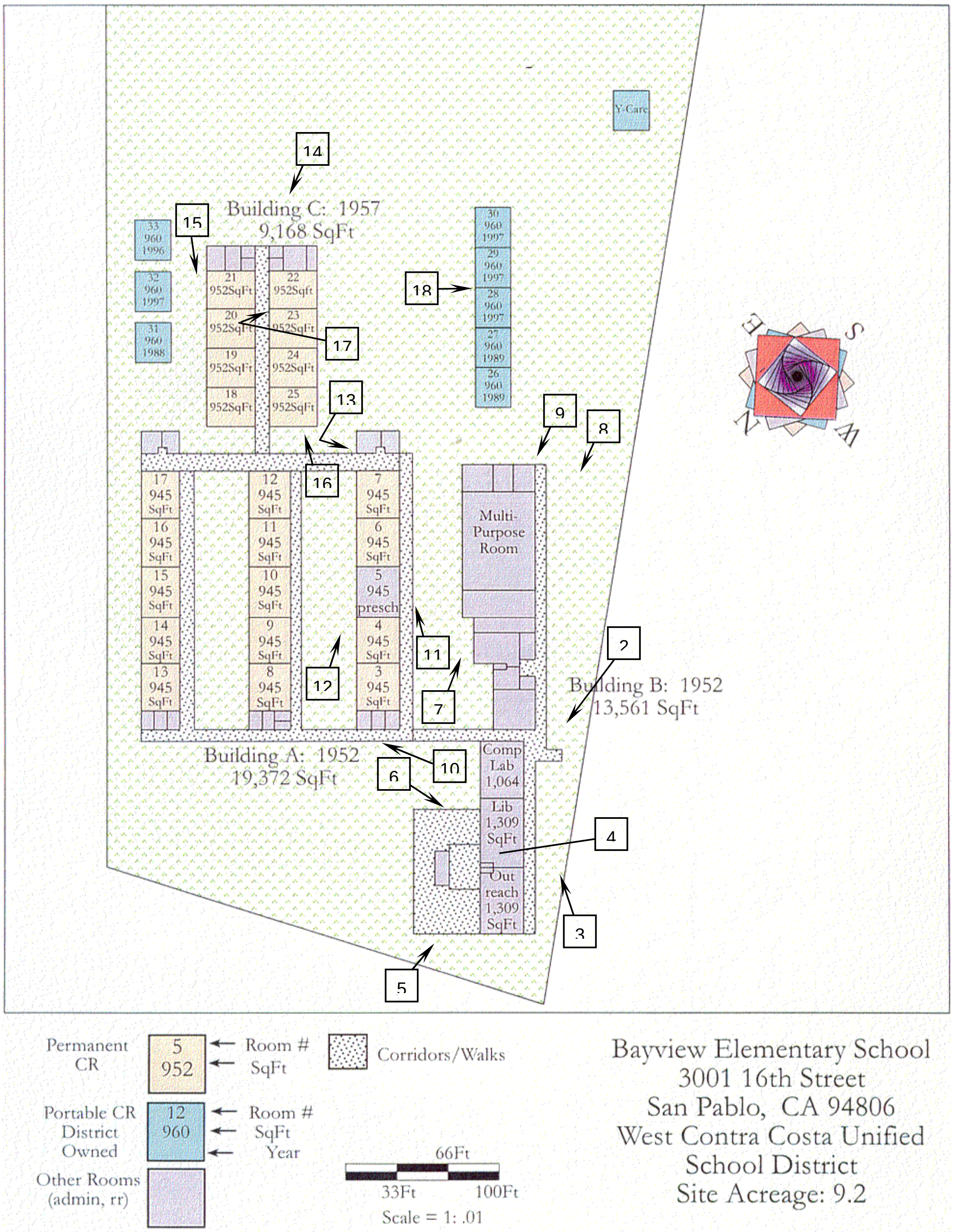

Figure 1: School Layout Plan

Figure 2: Main Entrance

Figure 3: Front View of Northeast Wing of Main Building

Figure 4: Interior of Library

Figure 5: Rear View of Northeast Wing of Main Building

Figure 6: Rear View of Northeast Wing of Main Building

Figure 7: Rear View of Offices and Multi-Purpose Room at Main Building

Figure 8: South Corner of Multi-Purpose Room

Figure 9: Cracks in Stucco at South Corner of Multi-Purpose Room

Figure 10: 1952 Classroom Buildings

Figure 11: Front View of 1952 Classroom Building (Typical)

Figure 12: Rear View of 1952 Classroom Building (Typical)

Figure 13: Covered Walkway and Restrooms at Southeast End of 1952 Classroom Building

Figure 14: Southeast end of 1957 Classroom Building

Figure 15: Exterior Longitudinal Wall of 1957 Classroom Building

Figure 16: Northwest Face of 1957 Classroom Building

Figure 17: Inset of Doors at Corridor of 1957 Classroom Building

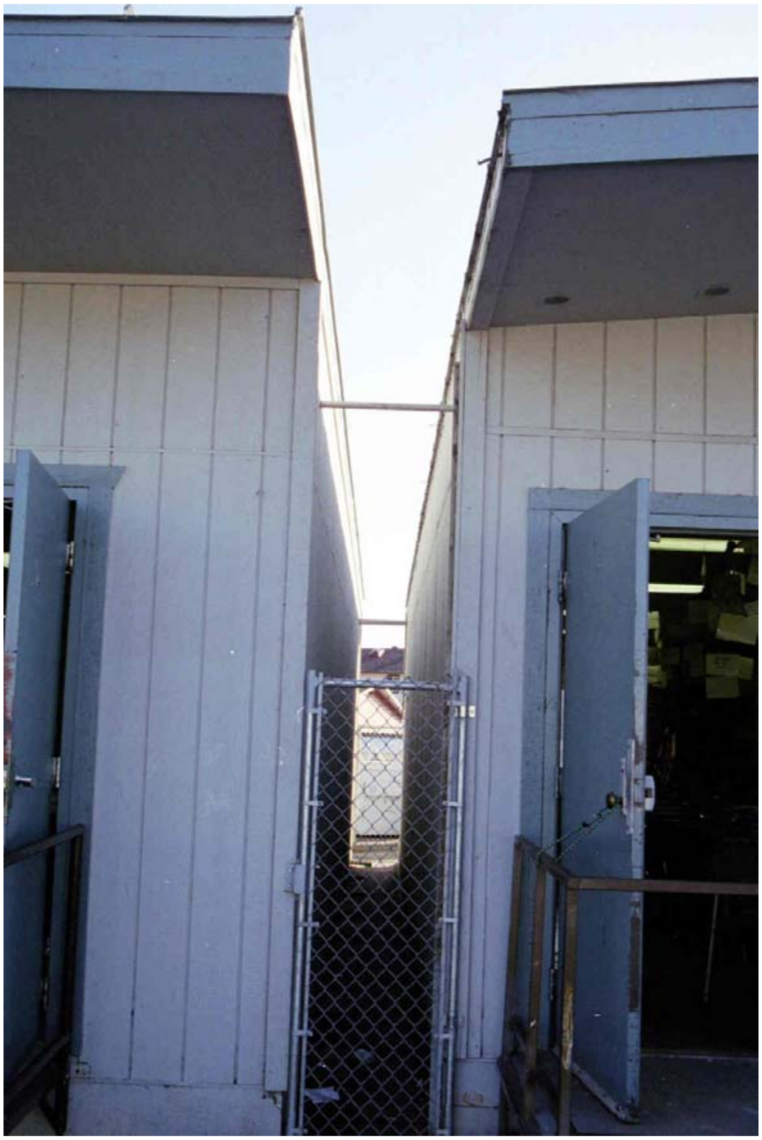

Figure 18: Electrical Conduit between Portable Classrooms