STRUCTURAL EVALUATION OF

CORONADO 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

Page No.

List of Figures

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Coronado 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 1952. The original buildings include one one-story wood structure (office building) and three one-story wood- and steel-framed structures (multi-purpose, kindergarten, and 1952 classroom buildings). There are two additional one-story wood classroom buildings built in 1960 and 1962. There are three 1989 portables (see figure 1). The total square footage of the permanent structures is about 35547 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 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 3.6 kilometers from the Hayward fault. The 1952 construction has diagonally sheathed shear walls, which have a response modification factor R=4.5. The 1960 and 1962 classroom buildings have plywood shear walls, which have 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.34x1.15)W}{4.5} = 0.377W \text{ for diagonally sheathed shear walls}$$

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.34x1.15)W}{5.5} = 0.308W \text{ for plywood shear walls}$$

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. Coronado Elementary School; Charles E. Strothoff, Architect; sheets A1-A11; W. Adrian & Associates, Structural Engineers; sheets S1-S6; July 2, 1952.
2. Additions and Alterations to Coronado Elementary School; Charles E. Strothoff, Architect; sheets A1-A5; Structural engineer unknown; sheets S1-S3; April 20, 1960.
3. Additions and Alterations to Coronado Elementary School; Charles E. Strothoff, Architect; sheets A1-A4; Graham & Hayes, Structural Engineers; sheets S1-S3; May 11, 1962.
4. Coronado Elementary School Reconstruction; Gerson/Overstreet, Architects; sheets A1-A13; Beyaz & Patel, Structural Engineers; sheet S1; December 30, 1993.
5. “Measure M” – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California.
6. “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 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, 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 buildings are generally one-story wood-framed structures with a combination of wood siding and stucco finish. Generally, the roof overhangs have straight sheathing that is exposed from underneath. There are acoustical tile ceilings in all of the classrooms, the office, and in the multi-purpose building. All of the buildings have built-up roofing. All of the buildings are separated by seismic gaps, but in many areas there is electrical conduit that crosses these gaps with rigid connections (see figures 11 and 14).

The 1952 classroom building has windows along almost the entire northeast longitudinal wall. There is wood siding up to the bottom of the windows and stucco finish elsewhere (see figure 10). Where the southwest longitudinal wall is at the exterior, it has similar finishes, except that the windows are in a high band along the length of the exterior face of the building (see figure 12). Where the walkway has been enclosed (at room numbers 6 through 14), the southwest wall of the 1952 classroom building has plaster finished walls with wood wainscoting at the lower 3 ft (see figure 14). The northwest and southeast end walls of the building have brick veneer (see figure 2) and stucco finish (see figure 21) over their full heights, respectively. There is also brick veneer at the restrooms near the middle of the building (see figure 15).

The 1960 and 1962 classroom buildings have large windows along the southwest longitudinal wall with wood siding below (see figure 17). The northeast longitudinal walls have plaster finish and wood wainscoting similar to the enclosed portion of the 1952 classroom building. The transverse end walls of these buildings have wood siding over the entire height (see figures 13 and 21).

The office building has wood siding at the transverse end walls (see figure 2). The exterior longitudinal walls have stucco finish and openings along a large portion of their length (see figures 3 and 4). The roof overhang at the office building has a plaster soffit instead of exposed sheathing (see figure 4) and connects to the building at an angle, creating a valley along the length of the building where it intersects the main roof.

The kindergarten building has wood siding on all four walls. The longitudinal walls have a significant number of window openings. The wood siding at the southwest end wall of the kindergarten building is warped, apparently from water damage (see figures 5 through 9).

The multi-purpose building has a low roof at the front area and a high long-span roof over the main interior space. There are moderate-size openings on all four faces of the building. The northwest face of the building has stucco finish up to the level of the roof canopy, but otherwise the building has wood siding (see figures 21-23).

The covered walkways are generally roof overhangs supported by pipe columns at the open side of the walkway. There is one freestanding walkway, located between the classroom buildings and the multi-purpose building, There is electrical conduit that crosses the building separations at the covered walkways (see figures 7 and 11).

The freestanding covered walkway is supported both vertically and laterally by pipe columns (see figures 18 and 21) and is intended to be seismically separate from the adjacent buildings. It appears that a modification of the original design has been made at the covered walkway; one of the columns has been removed and a new bucket seat was installed to support the beam that it was underneath (see figure 19). This bucket seat is connected to the wall of the 1960 classroom building and crosses the seismic separation. There is also significant rusting at the base of the covered walkway columns (see figure 20).

There is electrical conduit that runs between the portable classroom units near the roof level. The conduit does not have flexible connections to allow for differential motion of the portable units.

10.6 Review of Existing Drawings

The office, kindergarten, and original classroom buildings were built in 1952. In general, they have diagonally sheathed roof diaphragms over 2x roof joists spaced at 16" o.c. With the exception of the office building, the roof sheathing at the roof overhangs switches orientation to straight sheathing. At the kindergarten and classroom buildings, 2x roof joists span from a steel wide-flange ridge beam out to the exterior longitudinal stud walls. The steel beams are supported on 6x8 posts that sit on spread footings ranging from 3'-3" to 3'-10" square. At the office building, the roof joists span between the exterior longitudinal walls and an interior shear wall. The exterior and other bearing walls are supported on 12" wide strip footings. The shear walls have diagonal 1x6 sheathing and 3x sill plates. The other exterior walls have straight sheathing and 2x sill plates. The wall openings are as described in section 10.5 above. There appear to be reasonable collectors along the exterior shear wall lines, but the interior shear walls at the office, which do not cover the full length of the building, do not have collector elements. There are holdowns at the ends of most shear walls. There are distinct seismic gaps between adjacent buildings.

The multi-purpose building is constructed similar to the 1952 classroom building, except that there is a high flat roof over the main area and a lower sloped roof at the front of the building. The 2x joists span between steel wide-flange beams that span 41 ft between exterior longitudinal walls. At the step in the roof height, straps and blocking were provided at the longitudinal walls to connect the high and low roof areas of the building to each other and avoid any displacement discontinuities. At the interior shear wall, there is diagonal sheathing on both sides of the wall, with the sheathing oriented in opposite directions.

The covered walkway that runs from the classroom buildings to the multi-purpose building was built in 1952. The roof is 2x6 tongue and groove sheathing over 3x6 joists. These joists span 10 ft. between 6x8 beams that are supported on 3" diameter columns. Because the connection from the top of the column to beam cannot adequately transfer moments, the columns act as cantilevers. These columns are attached to a 12" square by about 4 ft. deep concrete pier using a standard base plate connection with four 5/8" diameter bolts.

The classroom buildings, which at first glance appear to be one building, are actually three separate structures with seismic gaps between them. The 1952 classroom building, which includes rooms number 4 through number 14, originally had a covered exterior walkway along the entire southwest side. In 1960, classrooms number 15 through number 19 were added. This new building was built right next to the existing 1952 classroom building. The northeast wall of the 1960 building, together with the roof overhang and southwest wall of the 1952 building, effectively enclosed the existing walkway (see figure 13). Although small seismic gap was left between the two buildings and the roof was flashed so as to prevent the entry of water, some ductwork and electrical conduit crosses the building separation (see figure 14). A new ceiling joists was hung from the bottom of the original (1952) roof overhang and a new non-structural wall was added at the northeast side of the corridor, hiding the original wall with high windows from view. New doors were added at each end of the corridor. In 1962, rooms number 20 through number 22 were added in a similar manner.

The 1960 and 1962 classroom buildings are built similar to the 1952 classroom building. One major difference is that the roofs and shear walls are sheathed with blocked plywood diaphragms instead of diagonal sheathing. Unlike the 1952 classroom building, which has diagonal sheathing on all of the interior transverse walls, the 1960 and 1962 classroom buildings only have diagonal sheathing on every other interior transverse wall. Also, the sill plates are 2x redwood members. Although the 1960 and 1962 buildings are very similar to each other, their one major difference lies in the covered passageway next to room 20A. The seismic mass of the roof at this area applies additional forces to the northeast shear wall without any corresponding increase in length of shear wall to compensate for it.

There is a freestanding 5ft. tall, 9” thick brick wall next to the kindergarten building (see figure 8). The wall is reinforced with #3 bars at 12” on center in the mortar between the brick wythes. There are other freestanding brick walls on campus that are assumed to be similarly reinforced although they are not indicated on the drawings.

10.7 Basis of Evaluation

The document FEMA 310, Federal Emergency Management Agency, *“Handbook for the Seismic Evaluation of Buildings – A Prestandard,”* 1998, is the basis of our qualitative seismic evaluation methods. The seismic performance levels that the FEMA 310 document seeks to achieve are lower than the current Building Code. However, it attempts to identify the potential for building collapse, partial collapses, or building element life safety falling hazards when buildings are subjected to major earthquake ground motion.

The California Building Code (CBC 1998) is the basis of our quantitative seismic evaluation methods. Base shears identified in section 10.3 were used to perform a limited lateral seismic analysis of the school buildings. The scope of the analysis was not to validate every member and detail, but to focus on those elements of the structure determined to be critical and which could pose life safety hazards. Member *strength* values are based on the document FEMA 356, Federal Emergency Management Agency, *“Prestandard and Commentary for the Seismic Rehabilitation of Buildings”* 2000.

10.8 List of Deficiencies

Building deficiencies listed below have corresponding recommendations identified and listed in Section 10.9, which follow the same order as the itemized list of deficiencies identified below. The severity of the deficiency is identified by a “structural deficiency hazard priority” system based on a scale between 1.0 and 3.9, which is described in Section 10.11. These priority ratings are listed in section 10.9. Priority ratings between 1.0 to 1.9 could be the causes for building collapses, partial building collapses, or life-safety hazards, if the corresponding buildings are subjected to major earthquake ground motions, which are possible at these sites. It is strongly recommended that these life safety hazards are mitigated by implementing the recommendations listed below.

Item	Building Structural Deficiencies
1.	The exterior longitudinal walls of the 1952 classroom building lack adequate shear wall. The northeast face of the building has window walls and the southwest face has high windows.
2.	The transverse shear walls of the 1960 and 1962 classroom buildings are overstressed.
3.	The southwest longitudinal wall of the 1962 classroom building has windows along the entire length, resulting in a lack of shear wall.
4.	At the 1962 classroom building, there is a covered passageway near room 20A. The collector connection from this roof area to the shear walls on the northeast face of the building is overstressed.
5.	The interior longitudinal shear wall line of the office building is overstressed. Because no collector elements are present, there is a lack of continuity between the wall segments on this line.
6.	The interior transverse shear walls of the office building are highly overstressed, the existing holdowns are inadequate, and no collector elements are present.
7.	The northwest longitudinal wall of the office building has high windows along a significant portion of its length, resulting in a lack of shear wall.
8.	The exterior longitudinal walls of the kindergarten building lack adequate shear wall. The northwest face of the building has window walls and the southeast face has high windows.
9.	The wood siding at the southwest face of the kindergarten building is warped and appears to have water damage.
10.	The top plate splices at the exterior walls of the multi-purpose building are inadequate to carry the diaphragm chord forces.
11.	The covered walkway that runs between the classroom buildings and multi-purpose building lacks adequate lateral bracing.
12.	One of the columns at the freestanding covered walkway has been removed and replaced with a bucket seat that is attached to the wall of the 1960 classroom building. As the building and walkway move independently, this connection may be damaged and cause a partial collapse of the covered walkway.
13.	There is significant rusting at the base of the columns at the freestanding covered walkway.
14.	There is conduit attached to the covered walkways that crosses the seismic gaps between buildings. As the buildings move independently, the conduit may be damaged and is a life safety hazard.
15.	There is conduit and ducts that cross the building separation between the 1952 classroom building and the 1960 and 1962 classroom buildings. As the buildings move independently, they may be damaged and are a life safety hazard.
16.	There are conduits that runs between the portable units near the roof level. As the buildings move independently, they may be damaged and are a life-safety hazard.

17.	The freestanding brick walls next to the kindergarten building and at the campus perimeter have inadequate reinforcement and may collapse. This 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.	Infill some windows with new plywood shear wall and framing. Replace straight sheathing below windows with plywood where occurs. Strengthen existing collectors and provide new holdowns as required.	1.1	10, 12, 15
2.	Provide new plywood sheathing at the unsheathed side of the wall. Strengthen existing collectors and provide new holdowns as required.	1.7	N/A
3.	Same as item number 1.	1.8	17
4.	Provide additional strapping at the collector.	1.4	16
5.	Add new plywood to the unsheathed face of the walls. Provide new strapping and blocking at the roof. Strengthen existing collectors and provide new holdowns as required.	1.2	N/A
6.	Add new wall sheathing. Strengthen existing collectors and provide new holdowns as required.	1.0	N/A
7.	Same as item number 1.	1.1	3
8.	Same as item number 1.	1.1	6, 9
9.	Remove the existing siding and replace it with new T1-11 siding	3.0	8
10.	Provide new continuous straps at the roof above existing sheathing.	1.4	22, 23
11.	Provide new lateral bracing in both directions.	1.5	18, 21
12.	Re-install a column at that location	1.2	19
13.	Determine level of damage and replace column if necessary.	1.9	20
14.	Provide flexible connections in the conduit at building separations.	1.9	7, 11
15.	Same as item number 14.	1.9	11
16.	Same as item number 14.	1.9	24
17.	Remove the existing brick wall.	1.9	3, 8

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

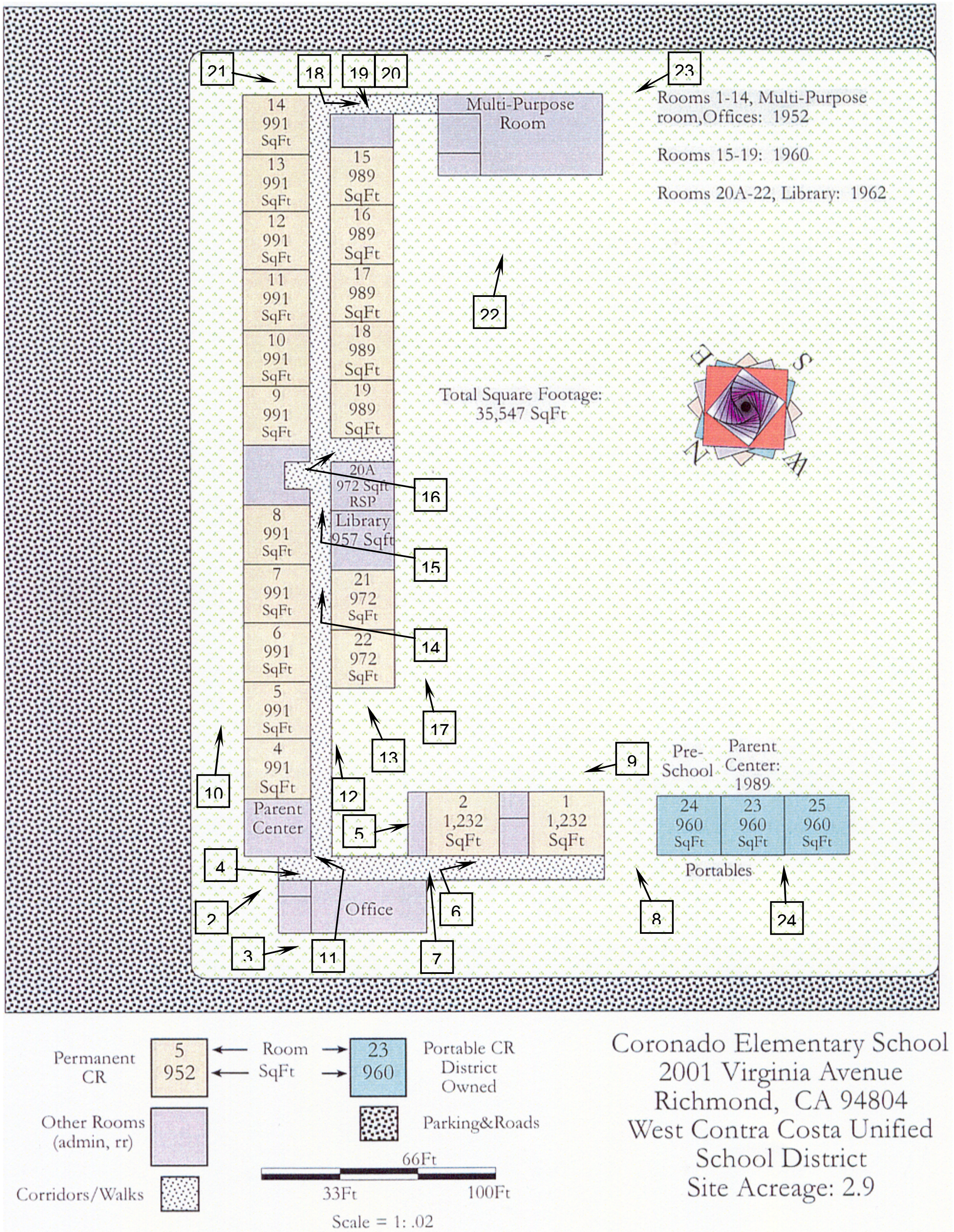

Figure 1: School Layout Plan

Figure 2: Front Entrance

Figure 3: North Corner of Office Building

Figure 4: Southeast Face of Office Building

Figure 5: Northeast Face of Kindergarten Building

Figure 6: Northwest Face of Kindergarten Building

Figure 7: Conduit at Seismic Joint Between Office and Kindergarten Buildings

Figure 8: Southwest Face of Kindergarten Building

Figure 9: Southeast Face of Kindergarten Building

Figure 10: Northeast Face of 1952 Classroom Building

Figure 11: Seismic Joint between Office Building and 1952 Classroom Building

Figure 12: Southwest Face of 1952 Classroom Building

Figure 13: Northwest Face of 1962 Classroom Building at 1952 Classroom Building

Figure 14: Corridor between Classroom Buildings

Figure 15: Corridor between Classroom Buildings at Restrooms

Figure 16: Corridor between 1960 and 1962 Classroom Buildings

Figure 17: Southwest Face of 1960 and 1962 Classroom Buildings

Figure 18: Covered Walkway at Southeast End of Classroom Buildings

Figure 19: Beam Support at Covered Walkway

Figure 20: Rust at Covered Walkway Column

Figure 21: East View of Classroom Buildings, Covered Walkway, and Multi-Purpose Building

Figure 22: Northwest Face of Multi-Purpose Building

Figure 23: Southwest Face of Multi-Purpose Building

Figure 24: Conduit between Portable Units