STRUCTURAL EVALUATION OF

WOODROW WILSON 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.

10.1 Introduction 1
10.2 Description of School 1
10.3 Site Seismicity 1
10.4 List of Documents 2
10.5 Site Visit 2
10.6 Review of Existing Drawings 4
10.7 Basis of Evaluation 5
10.8 List of Deficiencies 5
10.9 Recommendations 7
10.10 Portable Units 8
10.11 Structural Deficiency Prioritization 8
10.12 Conclusions 9
10.13 Limitations and Disclaimer 9

List of Figures

- Figure 1: School Layout Plan
- Figure 2: Main Entrance
- Figure 3: East Face of Multi-Purpose Building
- Figure 4: Rear View of Main Entrance
- Figure 5: South Face of Multi-Purpose Building
- Figure 6: West Face of Multi-Purpose Building
- Figure 7: Interior of Multi-Purpose Building
- Figure 8: West Longitudinal Wall of Classroom Building (Typical)
- Figure 9: East Longitudinal Wall of Classroom Building (Typical)
- Figure 10: South End of Classroom Buildings and Covered Walkway
- Figure 11: Trellis at East Face of Easternmost Classroom Building
- Figure 12: Trellis at East Face of Easternmost Classroom Building
- Figure 13: West Face of Permanent Portable Building (Typical)
- Figure 14: Longitudinal Walls of Permanent Portable Buildings (Typical)
- Figure 15: Interior of Permanent Portable Building
- Figure 16: Cracking at Foundation of Permanent Portable Building
- Figure 17: Dry Rot at Window of Permanent Portable Building
- Figure 18: East Face of Kindergarten Building
- Figure 19: West Face of Kindergarten Building
- Figure 20: Portable Classrooms
- Figure 21: Proposed Retrofit Sketch for Trellis

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Woodrow Wilson 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 are four one-story wood structures: three classroom buildings, a multi-purpose building, and a kindergarten building. There are two permanent portable buildings that were built in 1953 and five portable buildings (see figure 1). There is one 1989 portable and four 1997portables. The total square footage of the permanent structures is about 36,286 square feet. There are two portable buildings on the campus that are used by the YMCA that are not within the scope of this report.

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 less than 2 kilometers from the Hayward fault. The buildings are wood framed structures with a mixture of diagonally sheathed and plywood shear walls. Based on the diagonal sheathing, they 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. Woodrow Wilson School; Schmidts and Hardman, Architects; sheets 1-27, K2-K8; July 23, 1953.
2. Installation of Interior Fluorescent Fixtures and Acoustical Ceiling; Systems Architects Engineers, Inc.; sheets A1-A3; October 10, 1988.
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, and Walls
3. Type of Finishes
4. Type of Roof
5. Covered Walkways
6. Presence of Clerestory Windows
7. Presence of Window Walls or High Windows in exterior and interior walls
8. Visible cracks in superstructure, slab on grade and foundation

The multi-purpose building is a one-story wood structure with plaster finish. The interior of the building is divided into one large open area and a smaller service area at the north end of the building. The wall between these two areas has multiple door openings and therefore does not carry seismic loads. The transverse end walls have relatively few openings (see figure 5). The exterior longitudinal walls have continuous bands of high windows with some shear wall at the ends (see figures 2, 3, and 6). There is a covered walkway on the east face of the building. The main area has a suspended T-bar ceiling (see figure 7).

The classroom buildings are long one-story wood structures with plaster finish. Although the layout of mechanical and office areas differs between buildings, the three structures are very similar. The west longitudinal wall has bands of high window openings just below the roof level (see figure 8). At the east longitudinal wall, there are large areas of window openings (see figure 9). Although there are slender wall piers between these areas of windows on both faces of the building, the aspect ratio of most of these piers is too slender for them to perform well as shear walls. There are transverse walls between the classrooms that do not have any openings. At the western face of the building, the roof extends out about 8 ft and is supported by pipe columns to form a covered walkway that runs the entire length of the building (see figure 8). At the eastern face of the building, there is a trellis attached to the outside of the building (see figure 11). The connection of the trellis to the roof fascia appears to be deteriorating and in need of repair (see figure 12). Because the trellis condition is in immediate danger of collapse under its own weight, DASSE Design, Inc. sent a proposed retrofit detail to the West Contra Costa Unified School District on November 5, 2001 (see figure 21). The classrooms and offices have suspended T-bar ceilings.

The kindergarten building is a one-story wood structure with plaster finish. It has two classrooms with service areas in between them. The end walls and the one interior transverse shear wall have only minor openings. The exterior longitudinal walls have large window openings at the classroom area (see figures 18 and 19) and shear panels at the service areas. There is a covered walkway along the west side of the building that is similar to the classroom buildings. There are suspended T-bar ceilings in the classrooms.

There is a network of covered walkways connecting all of the buildings on the campus (see figures 1, 10, and 13). All of these walkways have plaster soffits. The majority of these walkways are along the longitudinal walls of the buildings and are described above. In between, there are walkway roofs supported on pipe columns. Where the covered walkways meet the buildings, the roof framing appears to be attached to the building wall, without any seismic joints. One exception to this is where the covered walkways attach to the permanent portable classrooms. At this location, there is a distinct seismic joint.

The permanent portables are manufactured wood buildings with glu-laminated wood frames at about a 4 ft spacing supporting the roof. These frames act as three-hinged arches, and therefore have a pinned connection at the ridge of the roof. The permanent portables have wood siding on their exterior longitudinal walls and a plaster finish at the end walls. There are large window openings along the east wall and high windows along the west wall of the building (see figures 13 and 14). Although there are slender wall piers between these areas of windows on both faces of the building, the aspect ratio of most of these piers is too slender for them to perform well as shear walls. The ceiling is acoustical tile attached to the bottom of the ceiling joists (see figure 15). There is some minor cracking present in the building foundation (see figure 16). It appears to be due to concrete shrinkage or minor settlement in combination with a low reinforcement ratio. There is also some dry rot in the east wall near classroom number 14 (see figure 17).

All of the buildings on the campus have built-up roofing. The roof at the permanent portable classrooms is about 3 years old and appears to be in good condition. The roofs on the rest of the buildings are about 15 years old and are in need of replacement.

The portable classrooms have electrical conduit running between them near the roof level. This conduit does not have a flexible connection at the separation between buildings.

10.6 Review of Existing Drawings

The multi-purpose, kindergarten, and classroom buildings were all built at the same time and have similar construction. All of these buildings have diagonally sheathed roof diaphragms with a ridge that runs the full length of the building in the longitudinal direction. The wall openings are described above in section 10.5. In general, the squat (height to width ratio less than 1) shear wall panels are diagonally sheathed and the narrow shear wall piers are sheathed with ¾” plywood. In many locations, there is straight sheathing below the bands of high windows. There are steel angle holdowns at the ends of all of almost all of the shear wall piers. The shear walls typically have 3” redwood sills connected to 16” wide strip footings (20” wide at multi-purpose building) with 5/8” diameter sill bolts at 4 ft o.c. max. The outer edge of the covered walkways is typically supported by 2½” diameter pipe columns. These columns are connected by two anchor bolts to the thickened edge of the concrete slab.

At the kindergarten and classroom buildings, the roof is supported on simple triangular roof trusses spanning 28 ft and spaced at 24” o.c. There are 2x8 joists spanning from the ridge to the exterior longitudinal walls and 2x6 horizontal members that serve both as support for the original ceiling framing and as a tie to resist the horizontal kickout force of the roof joists. There are vertical members near the ridge to shorten the span of the 2x6 ceiling joists. The top plate splices are relatively weak, having only 9-16d nails in each segment. When the T-bar ceiling was added in 1988, the original acoustical tiles were removed but the ceiling stripping was left in place. At the easternmost classroom building, there is a reinforced brick incinerator. There is a gap between the incinerator chimney and the roof framing.

At the multi-purpose building, the roof is supported on 2x8 joists that span 16 feet between roof trusses. These triangular roof trusses, which span 50 ft. between the longitudinal walls, have 8x8 top and bottom chords, 4x8 diagonals, and steel rod verticals of varying sizes. 2x8 ceiling joists span between the bottom chords. At the longitudinal walls, the top plate splices are significantly stronger, having 30-16d nails in each segment. The covered walkway at the east side of the building is attached to the wall studs through a 2x ledger bolted through the diagonal sheathing to blocking spaced every 4 ft. The ledger will be subjected to cross-grain bending to resist lateral loads in the transverse direction, which may lead to separation of the covered walkway from the supporting wall if subjected to strong earthquake ground motions.

The covered walkways that aren’t part of the buildings have an independent gravity load carrying system. The roof is a diagonally sheathed over 2x6 joists spaced at 24” o.c. These joists span between 4x8 beams and there are 2x8 outriggers that create a 1ft. overhang. The beams are supported on 2½” diameter pipe columns. These columns have four-bolt base plate connections that, although intended to provide a moment connection at the base, probably have inadequate capacity or stiffness. The columns are connected to 8” wide by 10” deep grade beams running in both directions. Where these covered walkway intersect with the buildings, the covered walkway depends on the building for gravity support, hanging on a wall ledger similar to the one at the multi-purpose building. There are no seismic joints to isolate the walkways from the classroom, kindergarten, or multi-purpose buildings.

The permanent portable buildings are manufactured buildings, and the drawings available for review are limited to the raised floor and foundation. The manufactured building was built over a floor system with oak flooring over 2x6 joists spanning 12 feet between concrete strip footings that range from 8” to 14” wide. Classrooms 14, 15, 17, and 18 were built first and classrooms 13 and 16 were added later. It does not appear that any provisions were made for attaching the portable building to the foundation to resist overturning forces.

The existing trellis on the eastern face of the kindergarten and classroom buildings does not appear to be built in accordance with the original construction drawings. The original drawings call for a joist that is lapped with the roof joist and cantilevers out to support the trellis. The existing construction has the trellis cantilevering out from the fascia board, held up by nails in withdrawal that are back-nailed through the fascia into the end-grain of the beam (see figure 12).

The existing roofing at the permanent portables is about 3 years old and appears to be in good condition. The roofing at the other buildings is about 15 years old and is in need of restoration.

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 east exterior longitudinal walls of the classroom buildings have excessive window openings, resulting in a lack of shear wall
2.	The west exterior longitudinal walls of the classroom buildings have bands of high windows, resulting in a lack of shear wall. The wall below the high windows has straight sheathing.
3.	At the mechanical room near room number 3, there is a gap between the roof framing and the reinforced brick incinerator chimney. The chimney lacks bracing at the roof level.
4.	At the administration area of the classroom building, the interior transverse shear wall is overstressed.
5.	The exterior longitudinal walls of the kindergarten building have excessive window openings, resulting in a lack of shear wall.
6.	The interior transverse wall at the kindergarten building is overstressed.
7.	The top plate collector splices at the longitudinal walls of the classroom and kindergarten buildings are overstressed.
8.	The covered walkway at the east face of the multi-purpose building and at the ends of the classroom buildings is attached to the wall using a ledger connection. This ledger is stressed in cross-grain bending for out-of-plane lateral forces.
9.	The multi-purpose building has a continuous band of high windows at the exterior longitudinal walls, resulting in excessive collector forces.
10.	The top plate splices at the exterior transverse walls of the multi-purpose building are overstressed.
11.	The covered walkways are attached to multiple buildings. As the buildings move independently, the covered walkways may be damaged or partially collapse.
12.	The covered walkways lack adequate lateral bracing at segments connecting the buildings to each other.
13.	There are continuous bands of high windows at the west walls of the permanent portables, resulting in a lack of shear wall.
14.	There are excessive window openings at the east walls of the permanent portables, resulting in a lack of shear wall.
15.	At the permanent portables, there may be a lack of cross-tie continuity at the ridge. It appears that there is no positive connection between the two halves of the glu-lam arch to transfer axial forces.
16.	At the permanent portables, there is no documentation available to determine if there is an adequate connection from the manufactured superstructure to the floor system and footings below. It appears that no provisions were made for providing holdowns into the footings.
17.	There is dry rot at the east wall of the permanent portable near classroom number 14.
18.	The electrical conduit running between the portable units near the roof level has a

	rigid connection. As the buildings move independently, the conduit may be damaged and is a life safety hazard.
19.	The trellis at the east face of the classroom and kindergarten buildings is in imminent danger of falling. There is a lack of adequate support at the cantilever for gravity forces.

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. Strengthen collectors and add new holdowns as required.	1.1	9
2.	Infill some windows with new framing. Add new full-height plywood sheathing to the interior of the wall. Strengthen collectors and add new holdowns as required.	1.1	8
3.	Provide lateral bracing of the chimney at the roof level	1.8	11
4.	Add new plywood sheathing to the unsheathed face of the wall. Strengthen collectors and add new holdowns as required.	1.1	N/A
5.	Infill some windows with new plywood shear wall and framing. Strengthen collectors and add new holdowns as required.	1.3	2
6.	Add new plywood sheathing to the unsheathed face of the wall. Strengthen collectors and add new holdowns as required.	1.1	N/A
7.	Provide new straps at roof and clip angles from blocking to top plates.	1.3	2, 8, 9
8.	Provide a direct connection from the covered walkway to wall for lateral forces	2.8	3, 10, 11
9.	Provide new straps at roof and clip angles from blocking to top plates	1.3	3
10.	Add new additional nailing at the existing top plate splices.	1.8	5
11.	Provide new seismic joints to separate the connecting walkways from the buildings. Add lateral bracing.	1.9	10
12.	Add lateral bracing.	1.5	10
13.	Infill some windows with new plywood shear wall and framing. Strengthen collectors and add new holdowns as required.	1.1	13
14.	Infill some windows with new plywood shear wall and framing. Strengthen collectors and add new holdowns as required.	1.1	14

15.	Verify existing conditions. Provide steel strap anchors across the ridge to connect the frames for axial forces	1.2	15
16.	Provide new holdowns through the existing floor system to the foundation at the ends of shear panels. Add new sill plate nailing if required.	1.1	15
17.	Remove and replace members with dry rot.	1.9	17
18.	Provide new flexible joint in conduit at building separations	1.9	20
19.	Provide new posts at 16 ft spacing to support the exterior edge of the trellis per detail provided to the school district on November 5, 2001.	1.0	11, 12

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

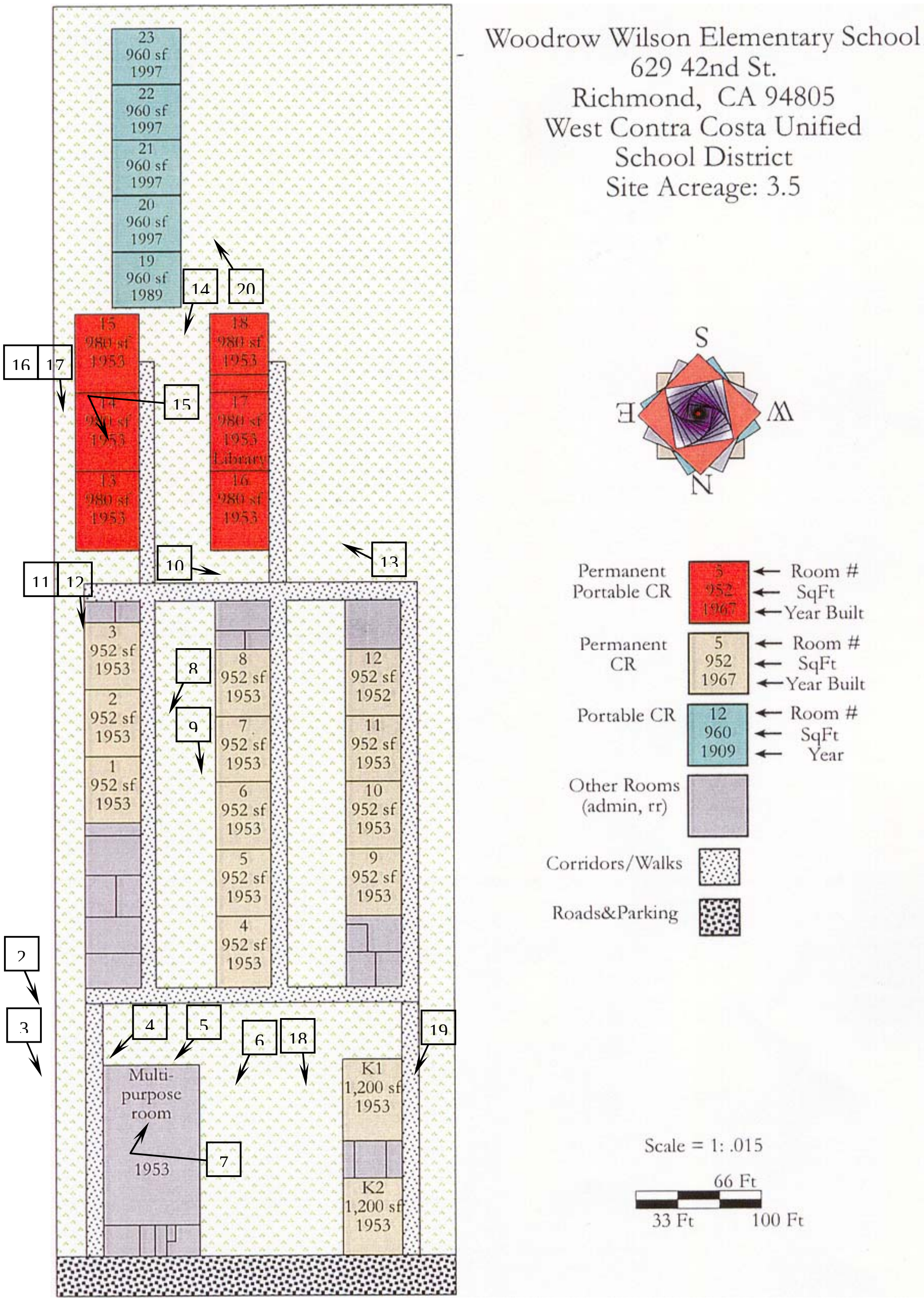

Figure 1: School Layout Plan

Figure 2: Main Entrance

Figure 3: East Face of Multi-Purpose Building

Figure 4: Rear View of Main Entrance

Figure 5: South Face of Multi-Purpose Building

Figure 6: West Face of Multi-Purpose Building

Figure 7: Interior of Multi-Purpose Building

Figure 8: West Longitudinal Wall of Classroom Building (Typical)

Figure 9: East Longitudinal Wall of Classroom Building (Typical)

Figure 10: South End of Classroom Buildings and Covered Walkway

Figure 11: Trellis at East Face of Easternmost Classroom Building

Figure 12: Trellis at East Face of Easternmost Classroom Building

Figure 13: West Face of Permanent Portable Building (Typical)

Figure 14: Longitudinal Walls of Permanent Portable Buildings (Typical)

Figure 15: Interior of Permanent Portable Building

Figure 16: Cracking at Foundation of Permanent Portable Building

Figure 17: Dry Rot at Window of Permanent Portable Building

Figure 18: East Face of Kindergarten Building

Figure 19: West Face of Kindergarten Building

Figure 20: Portable Classrooms

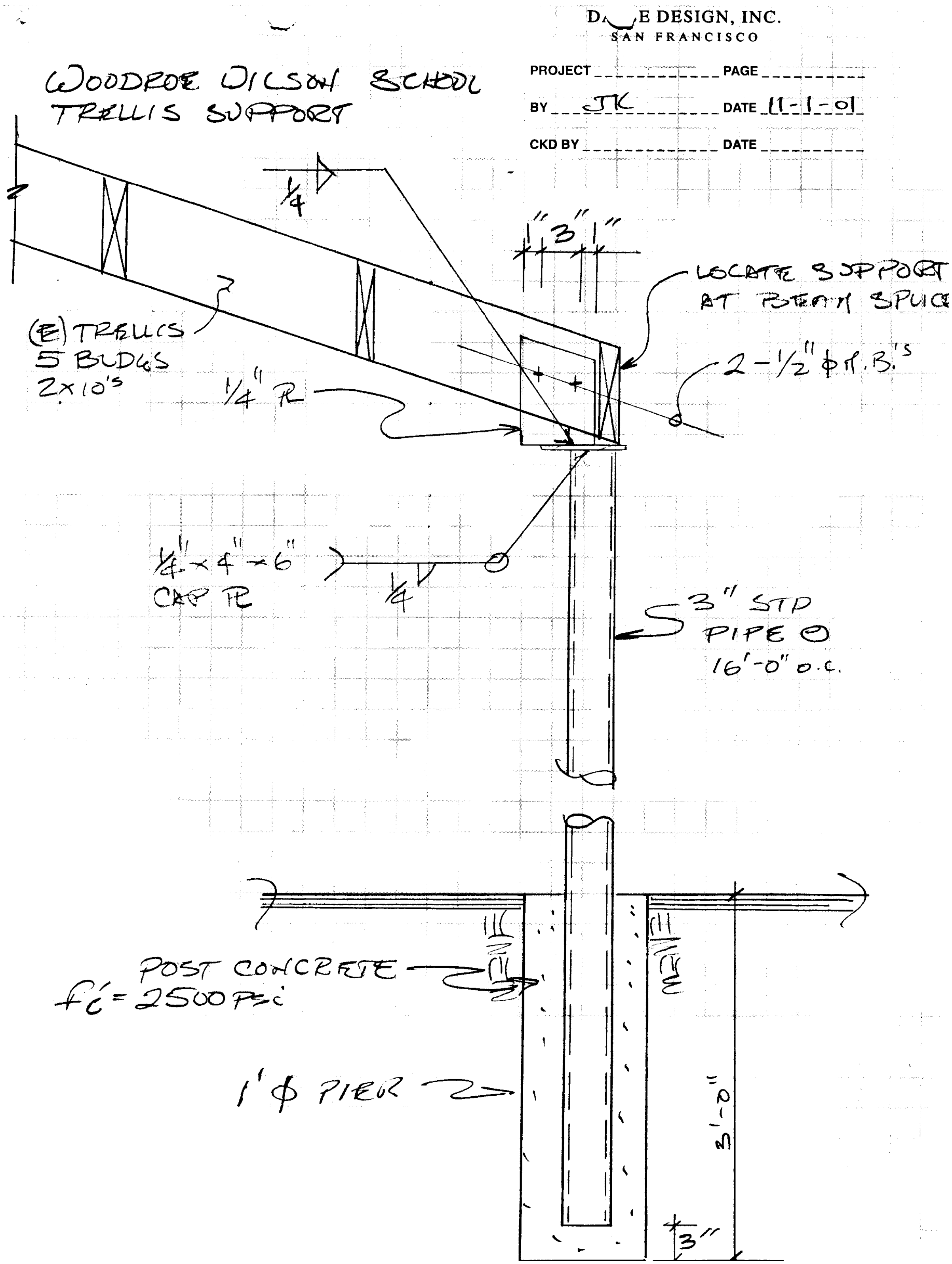

Figure 21: Proposed Retrofit Sketch for Trellis