

**BEFORE THE BOARD OF ZONING ADJUSTMENT
OF THE DISTRICT OF COLUMBIA**

Appeal of Patrick J. Carome

of Building Permit
No. B460927

4825 Dexter Terrace, NW
Frank & Dina Economides, Owners

BZA Appeal No. 17285

Hearing Date: May 24, 2005

APPELLANT'S REBUTTAL SUBMISSION

Appellant Patrick J. Carome hereby submits the following rebuttal materials:

- A. Photographs of the 27 other retaining walls within the Wesley Heights Overlay District that the owners assert are in excess of four (4) feet.
- B. Photographs rebutting Owners' contention that Walled Platform Structure does not impinge air and light of neighboring properties.
- C. Chart depicting yard and lot occupancy calculations, rebutting DCRA's contention that Walled Platform Structure has zero yard and lot occupancy.
 - 1. Derivation of Geogrid Footprint
 - 2. Footprint of Structure's Elevated Platform Component
 - 3. Calculation of Total Yard Area Occupied by Geogrid Material and Mesa Blocks
 - 4. Calculation of Area of "Required" Rear Yard
 - 5. Yard Occupancy Calculation: Mesa Block and Geogrid Only
 - 6. Yard Occupancy and WHOD Lot Occupancy Calculations: Entire Platform Structure
 - 7. Yard Occupancy and WHOD Lot Occupancy Calculations: Portion of Platform Structure Elevated at Least Six (6) Feet Above Pre-Construction Grade

BZA
Case No. 17285
Exhibit No. 87

Board of Zoning Adjustment
District of Columbia
CASE NO. 17285
EXHIBIT NO. 87

- D. Authorities showing that area of required rear yard should be measured from rear lot line inward (in rebuttal to DCRA assertion that measurement should be taken from rear of dwelling outward).
1. Decision and Order of Board of Zoning Adjustment regarding *Application No. 17188 of Deborah Miles*, Sept. 9, 2004 at p.2 (calculating occupancy of "required rear yard" with reference to twenty-foot wide area of rear yard *closest to rear lot line*, rather than the corresponding (and mostly open) area of the rear yard closest to the back of the dwelling).
 2. *Davidson v. Board of Zoning Adjustment*, 617 A.2d 977 (D.C. App. 1992), (stating that in R-1-A Zone District, dwellings "must be set back twenty-five feet *from the rear property line*," confirming that a "required" rear yard is measured from the rear property line).
 3. Decision and Order of Board of Zoning Adjustment regarding *Application No. 15718 of Donald and Carol Borut*, July 15, 1992 at p.2 (describing a 14.5 foot rear deck that would result in a rear yard that would be 22.05 deep as "*extend[ing] beyond the new addition and into the required rear yard*" by 2.95 feet, thus recognizing that the 25-foot required rear yard is measured from the rear lot line).
 4. Decision and Order of Board of Zoning Adjustment regarding *Application No. 14549 of Charles M. and Judith L. Kupperman*, January 28, 1987 at p.2 (finding that a proposed addition that "will extend 15 feet into the rear yard" will not "encroach upon a required rear yard," thus conceiving of the "required rear yard" as being measured from the rear lot line).
 5. Decision and Order of Board of Zoning Adjustment regarding *Application No. 13224 of Buchanan Street Limited Partnership* at p.2 (finding that rear walls of certain dwellings as "*encroached into the required rear yards*" by certain measured distances, necessarily indicating that the required rear yard is measured starting from the rear lot line, not starting at the rear of the building).
 6. Decision and Order of Board of Zoning Adjustment regarding *Application No. 12565 of Paul S. and Susan Au. Allen*, April 5, 1978 at p.2 (finding that pole supports at rear end of partially constructed deck (the end further from the house) "*are located 1.35 feet into the required rear yard*," necessarily indicating that the required rear yard is measured starting from the rear lot line).
- E. Authorities showing that "structures may be constructed partly or entirely with earthen material" (in rebuttal to DCRA assertion that structure here includes only Mesa bocks).
1. John S. Scott, *The (VNR) Dictionary of Civil Engineering* 435-36 (4th ed. 1993) (defining a structure as "anything built by people, from a hydraulic fill dam built of earth or a pyramid of stone to a hydroelectric power

station or an earth satellite” and noting that “a structure is not necessarily roofed, a building is”).

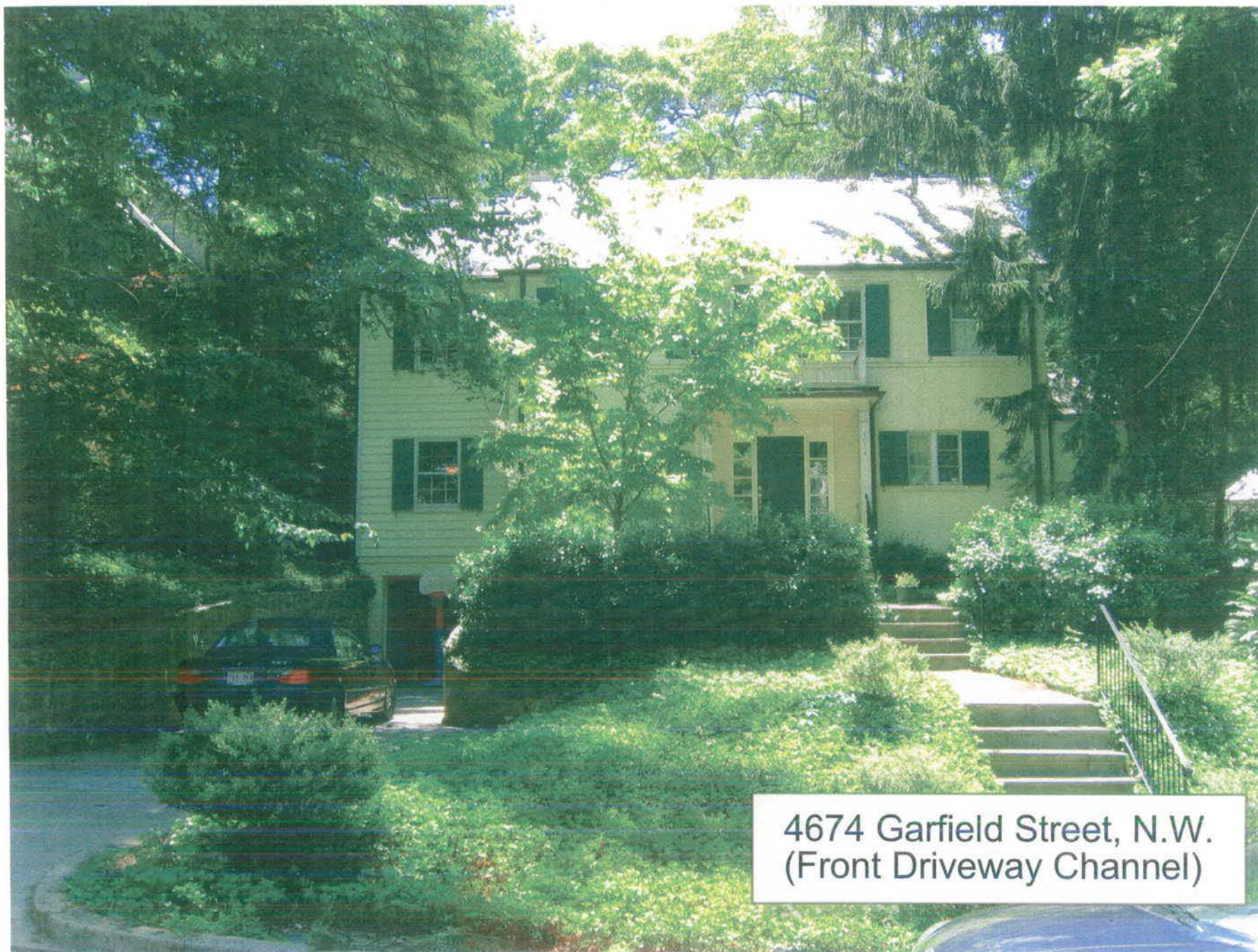
2. R.J. Mitchell, *Earth Structures Engineering*, Preface (1983) (“Earth structures engineering involves the analysis, design, and construction of structures, such as slopes and dams, that are composed mainly of earth materials, and this is a growth area in geotechnical engineering practice.”).

F. Authorities showing that Mechanically Stabilized Earth structures (MSEs) are a recognized category of structures that are distinct from “retaining walls.”

1. James Ambrose, *Building Structures* 333 (1993) (“Strictly speaking, any wall that sustains significant lateral soil pressure is a retaining wall. However, the term is usually used with reference to a *cantilever retaining wall*, which is a freestanding wall without lateral support at its top.”).
2. *The Design and Construction of Engineering Foundations* 557 (F.D.C. Henry, ed., 2d ed., Chapman and Hall 1986) (1956) (“An ingenious method of supporting fill by reinforcing it with metal strips or rods, attached to light metal or precast reinforced concrete fascia panels . . . is generally known as ‘reinforced earth.’”).
3. T. Yamanouchi & N. Fakuda, *The State of the Art of Geosynthetic Reinforced Soil Structures*, in *Geotechnical Engineering: Emerging Trends in Design and Practice* 305, 311-14 (K.R. Saxena, ed. 1994) (“PRACTICAL PERFORMANCE OF REINFORCED SOIL STRUCTURES . . . Steep-slope reinforced embankments or walls have been constructed at numerous sites. . . . The number of achievements in soil structure construction using geosynthetic reinforcement is also increasing steadily. These earth structures are designed on the principles of classical mechanics . . .”).
4. Fed. Highway Admin., U.S. Dep’t of Transp., Pub. No. FHWA-NHI-00-043, *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design & Construction Guidelines* 2-3 (2001) (“Mechanically Stabilized Earth Wall (MSEW) is a generic term that includes reinforced soil (a term used when multiple layers of inclusions act as reinforcement in soils placed as fill). . . . Facing is a component of the reinforced soil system used to prevent the soil from raveling out between the rows of enforcement.”).

G. Authorities showing that BOCA definition of “retaining wall” on which both DCRA and NPS relied represents the most recent definition of that term under current or predecessor versions of the D.C. Building Code.

1. *1996 BOCA National Building Code*, § 1812.2
2. *1999 BOCA National Building Code*, § 1812.2
3. *International Building Code 2000*, § 202



4674 Garfield Street, N.W.
(Front Driveway Channel)



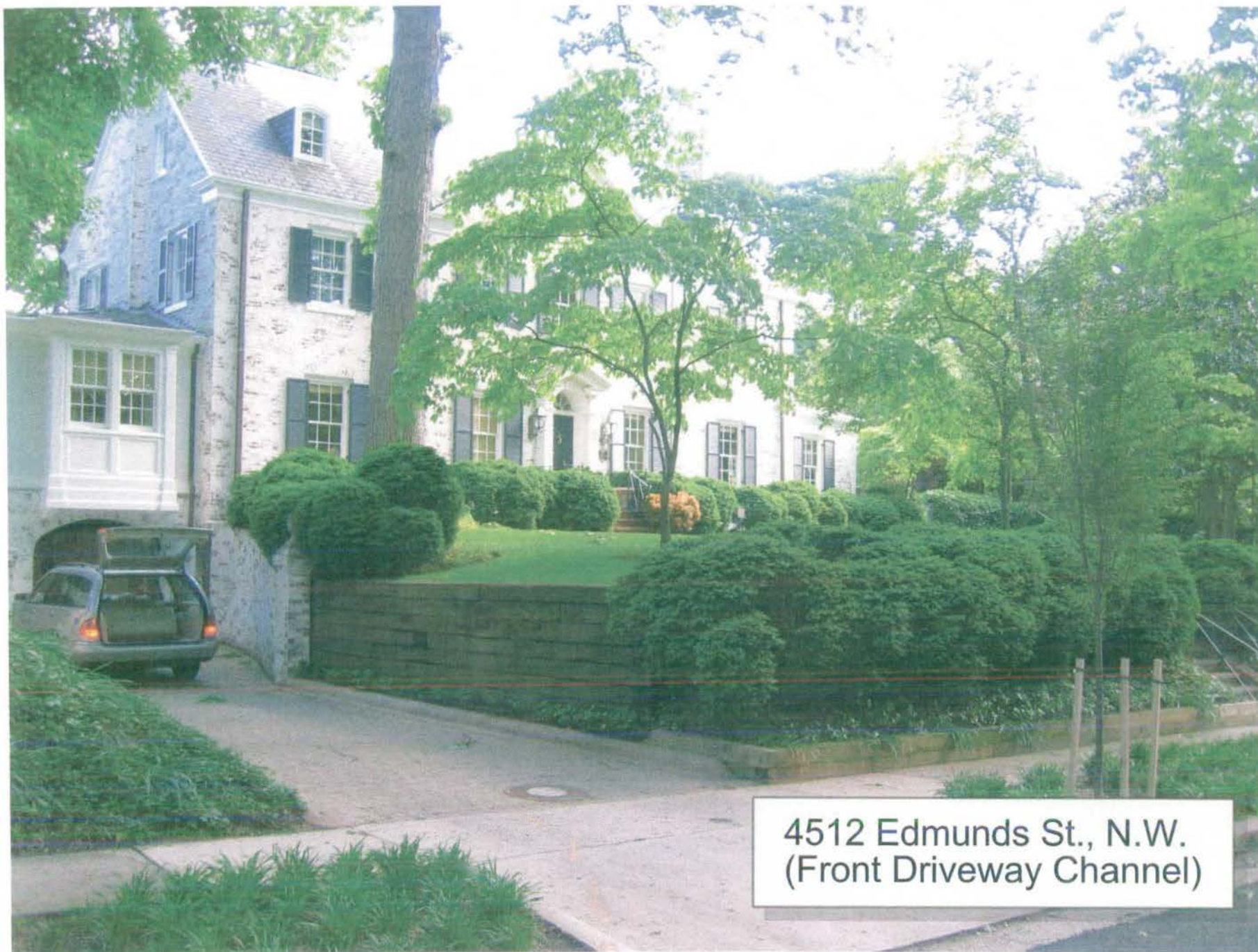
3021 45th St., N.W.
(Front Driveway Channel)



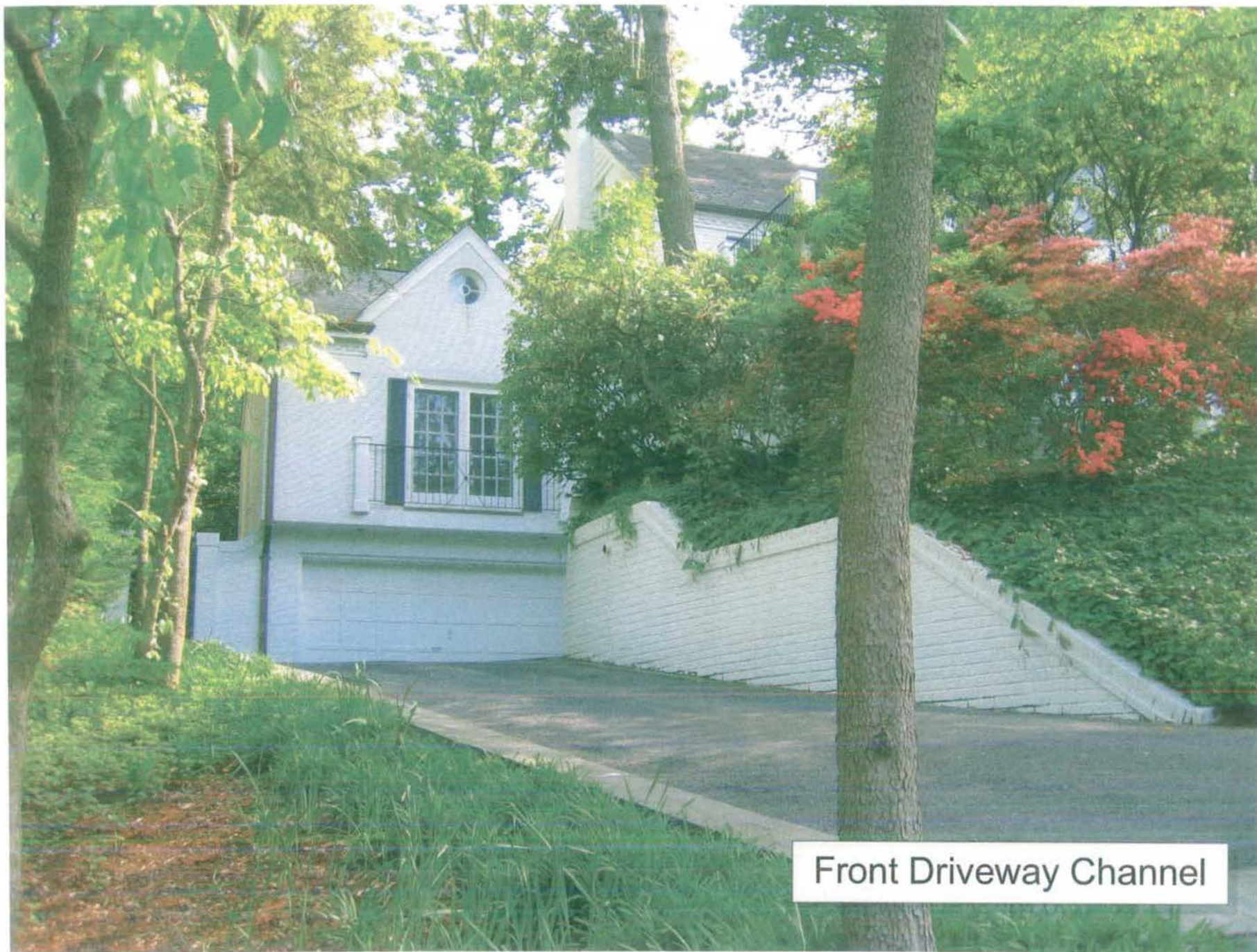
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(Front Driveway Channel)

4529 Lowell St., N.W.
(Front Driveway Channel)





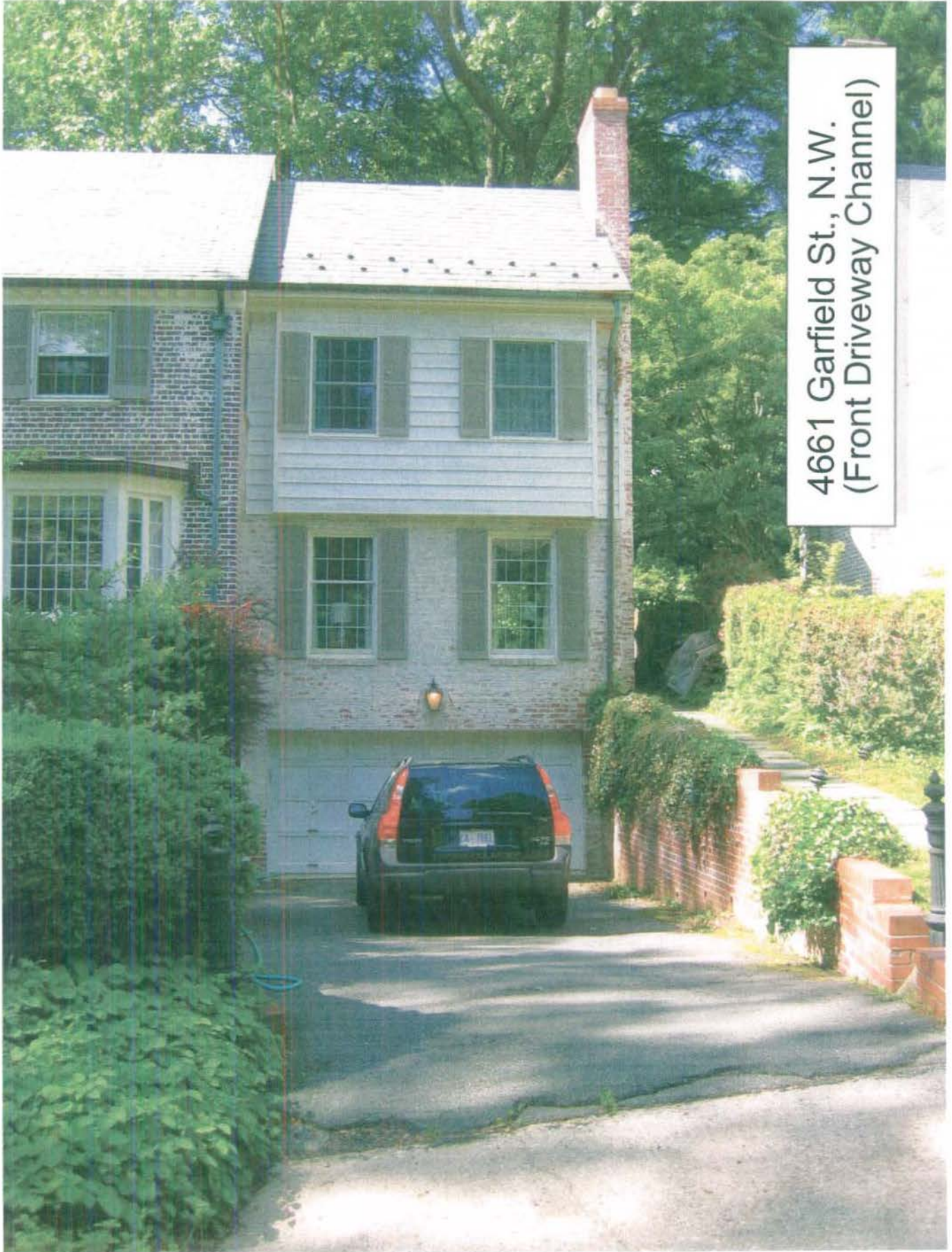
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(Front Driveway Channel)



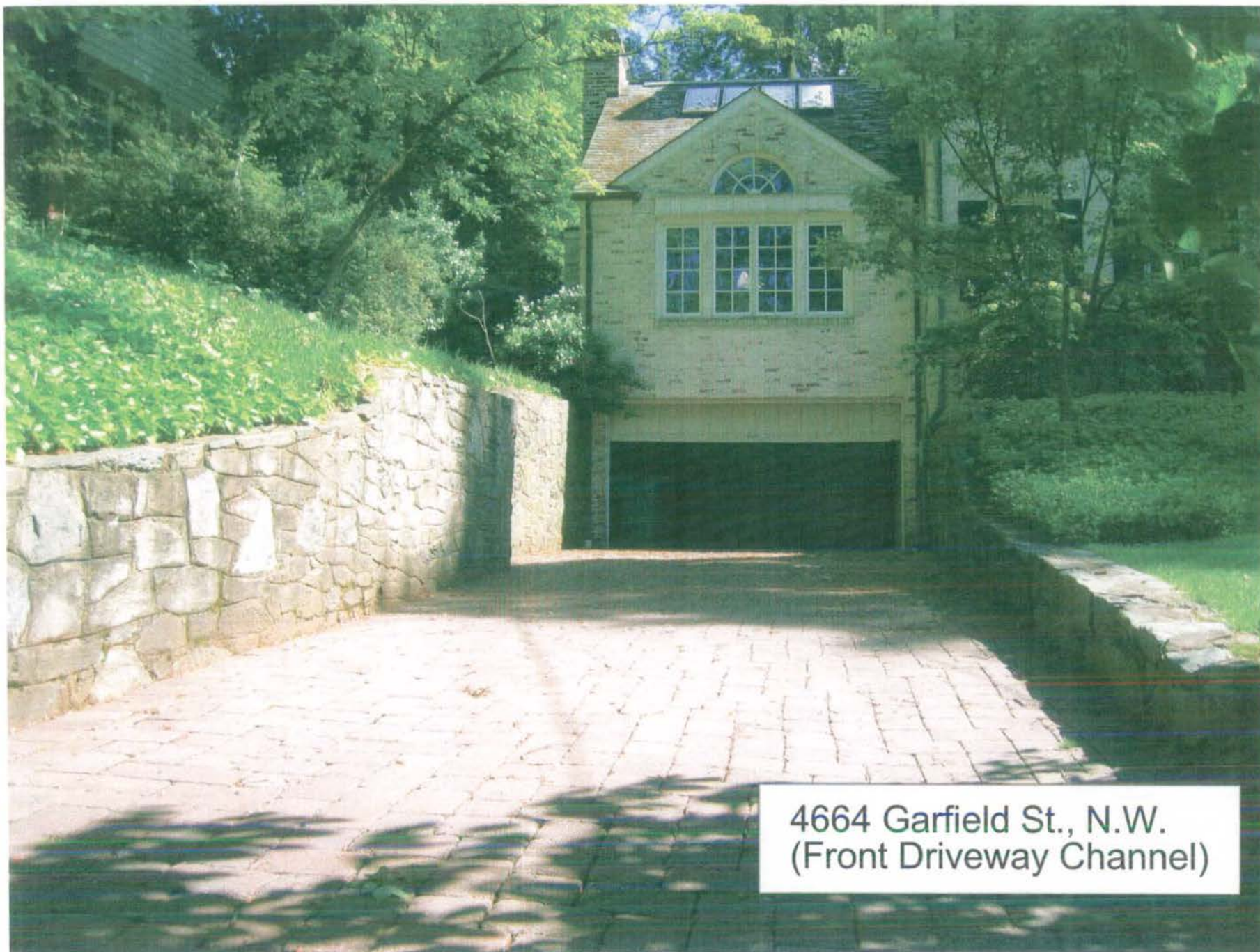
Front Driveway Channel



4747 Fulton St., N.W.
(Rear Driveway Channel)



4661 Garfield St., N.W.
(Front Driveway Channel)



4664 Garfield St., N.W.
(Front Driveway Channel)



4656 Garfield St., N.W.
(Front Driveway Channel)



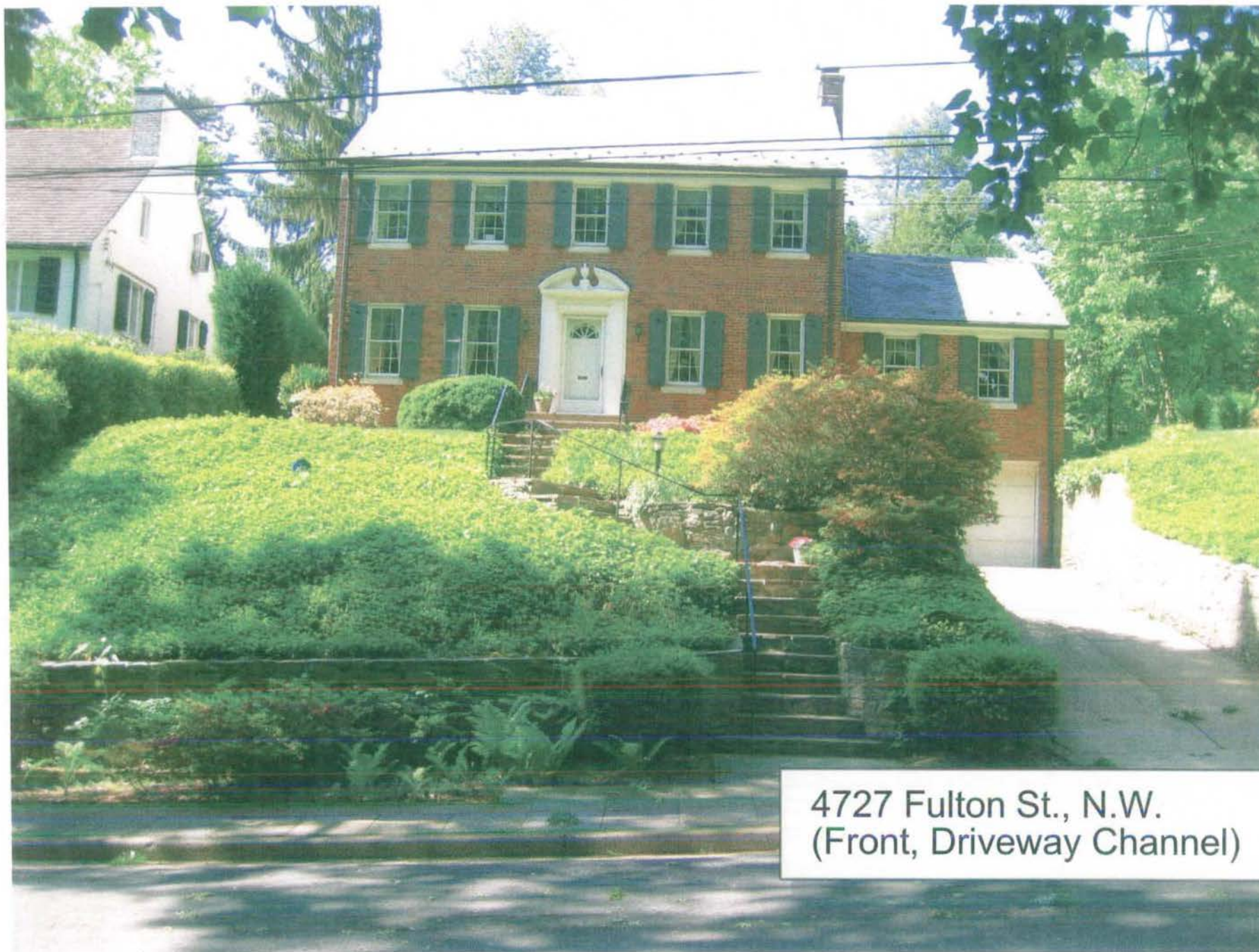
4711 Fulton St., N.W.
(Front, Driveway Bay)



4715 Fulton St., N.W.
(Front, Driveway Channel)



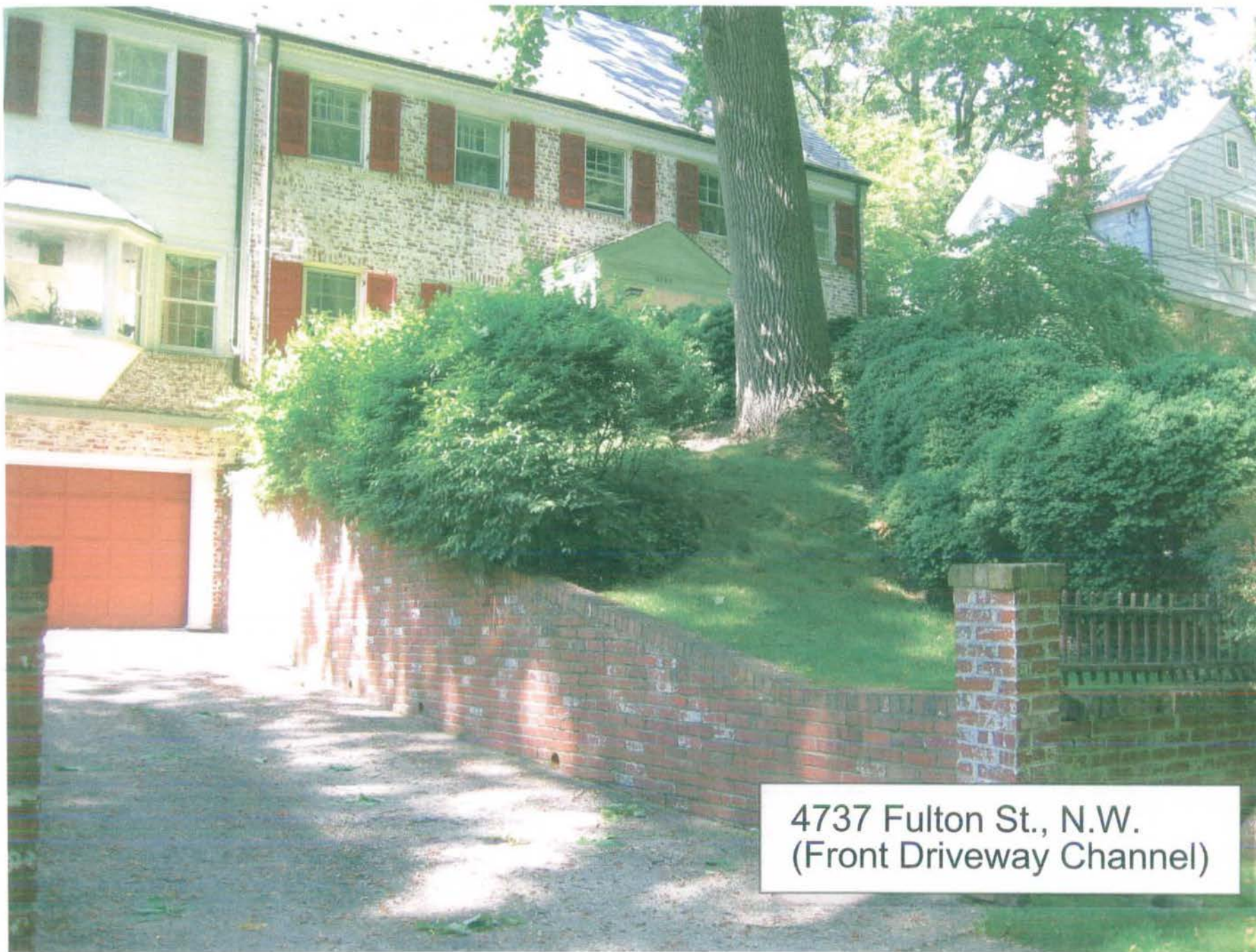
4731 Fulton St., N.W.
(Front, Driveway Channel)



4727 Fulton St., N.W.
(Front, Driveway Channel)



4733 Fulton St., N.W.
(Front Driveway Channel)



4737 Fulton St., N.W.
(Front Driveway Channel)



4415 Dexter St., N.W.
(back of driveway)



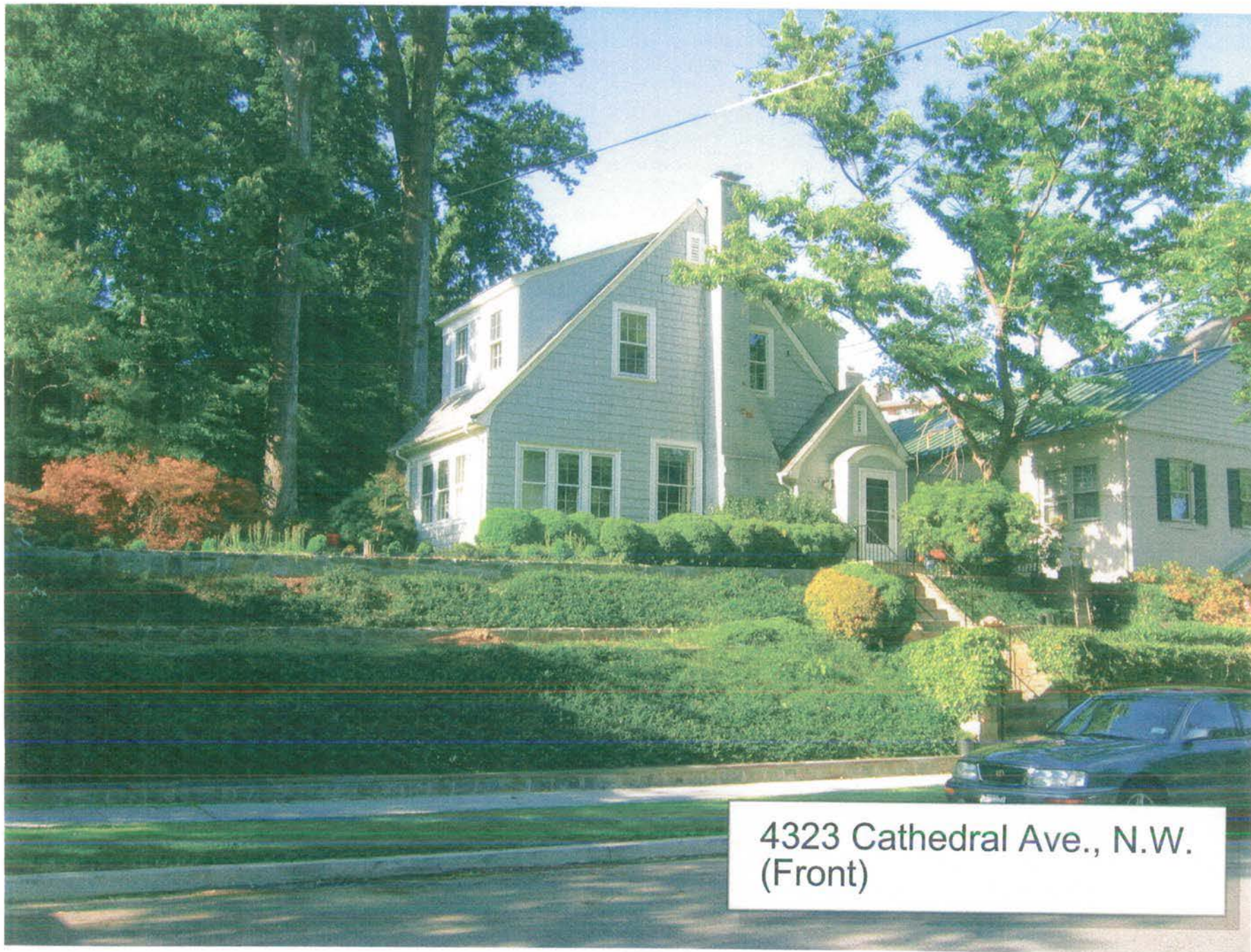
4851 Dexter St., N.W.
(Front)



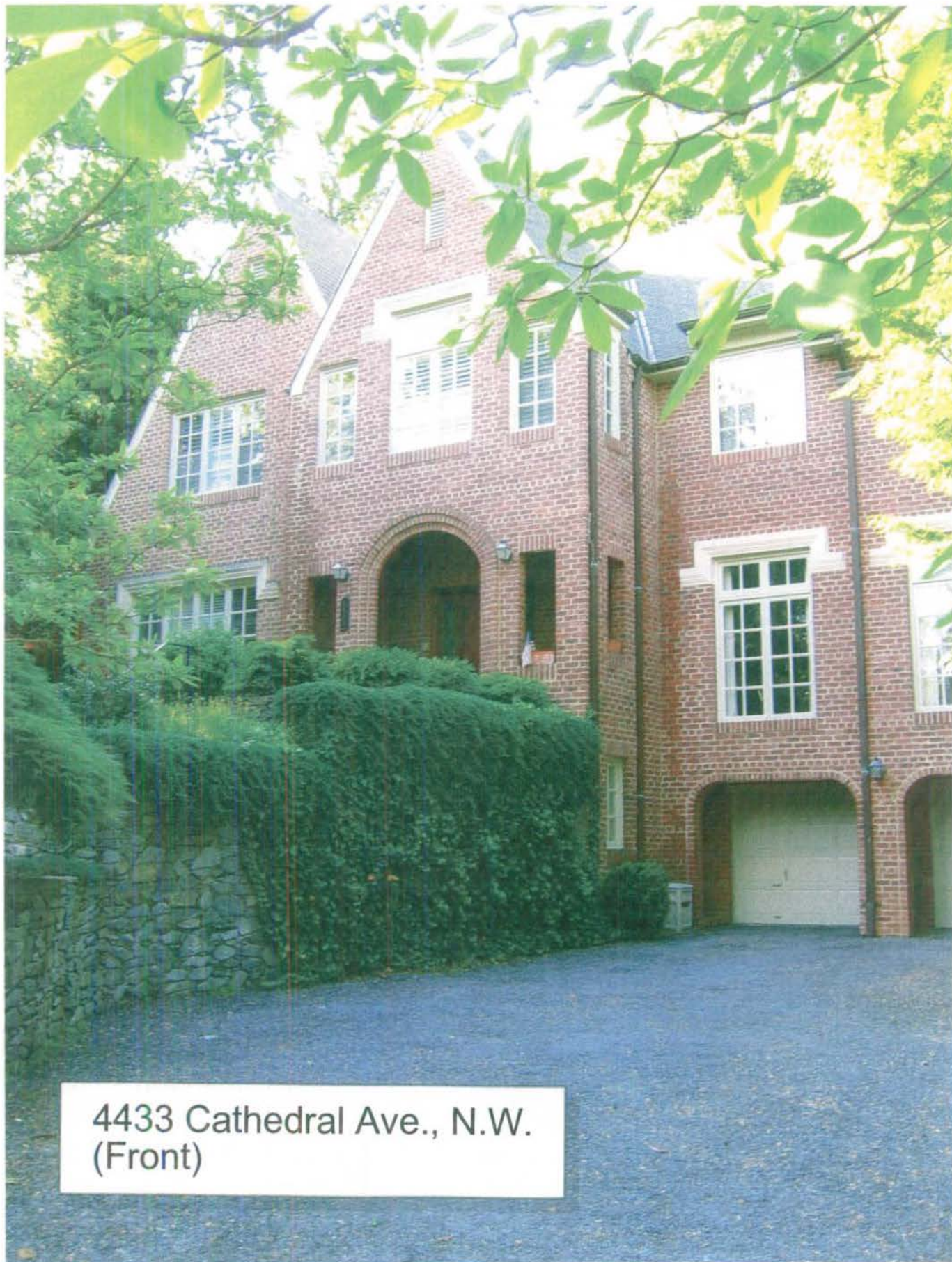
4331 Hawthorne Street,
N.W.(Front)



2900 45th Street, N.W.
(Front)



4323 Cathedral Ave., N.W.
(Front)



4433 Cathedral Ave., N.W.
(Front)

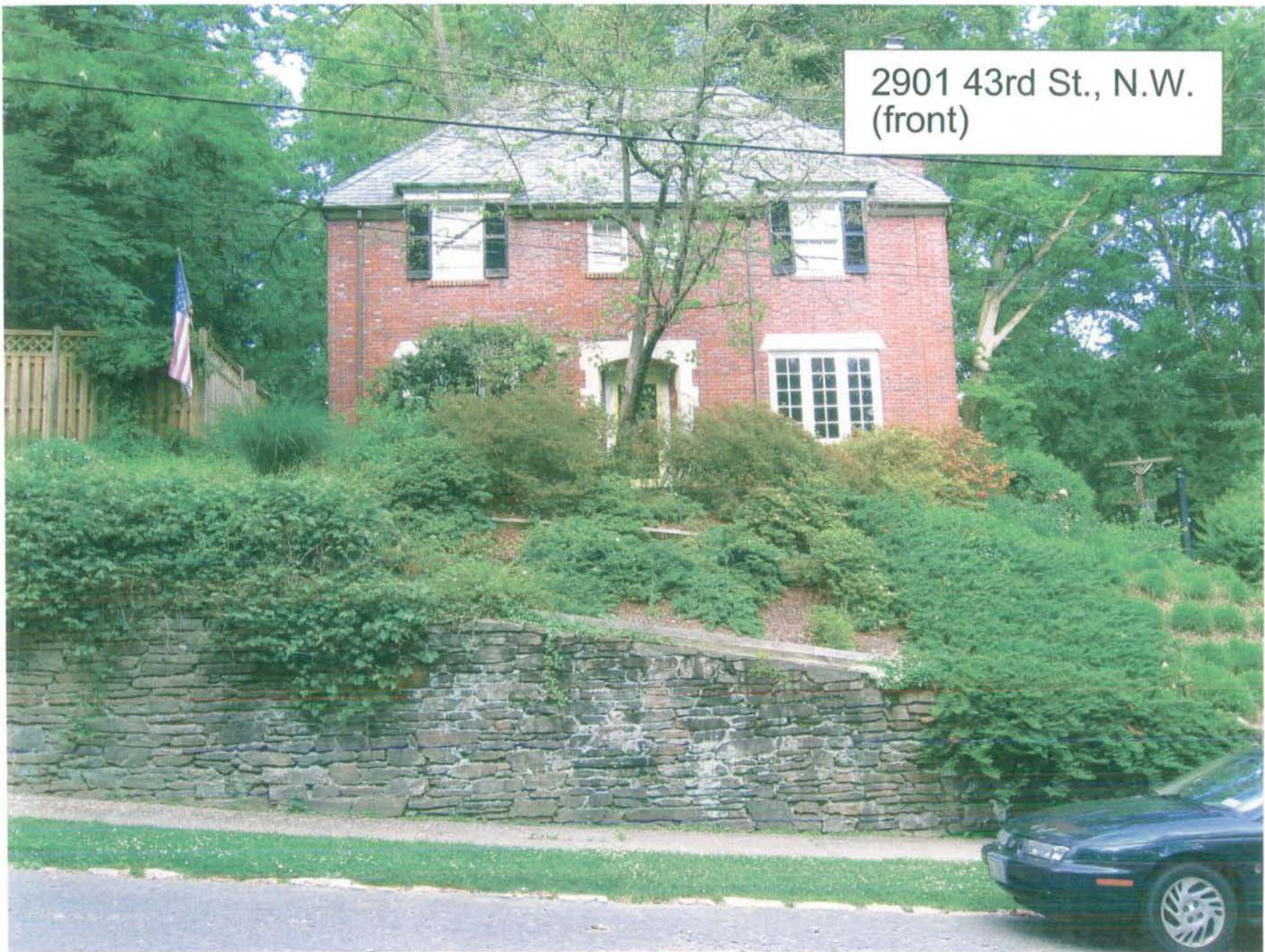


3001 44th Place, N.W.
(Front/side)



3000 44th St., N.W.
(Front)

2901 43rd St., N.W.
(front)





4720 Dexter St., N.W.
(Front)



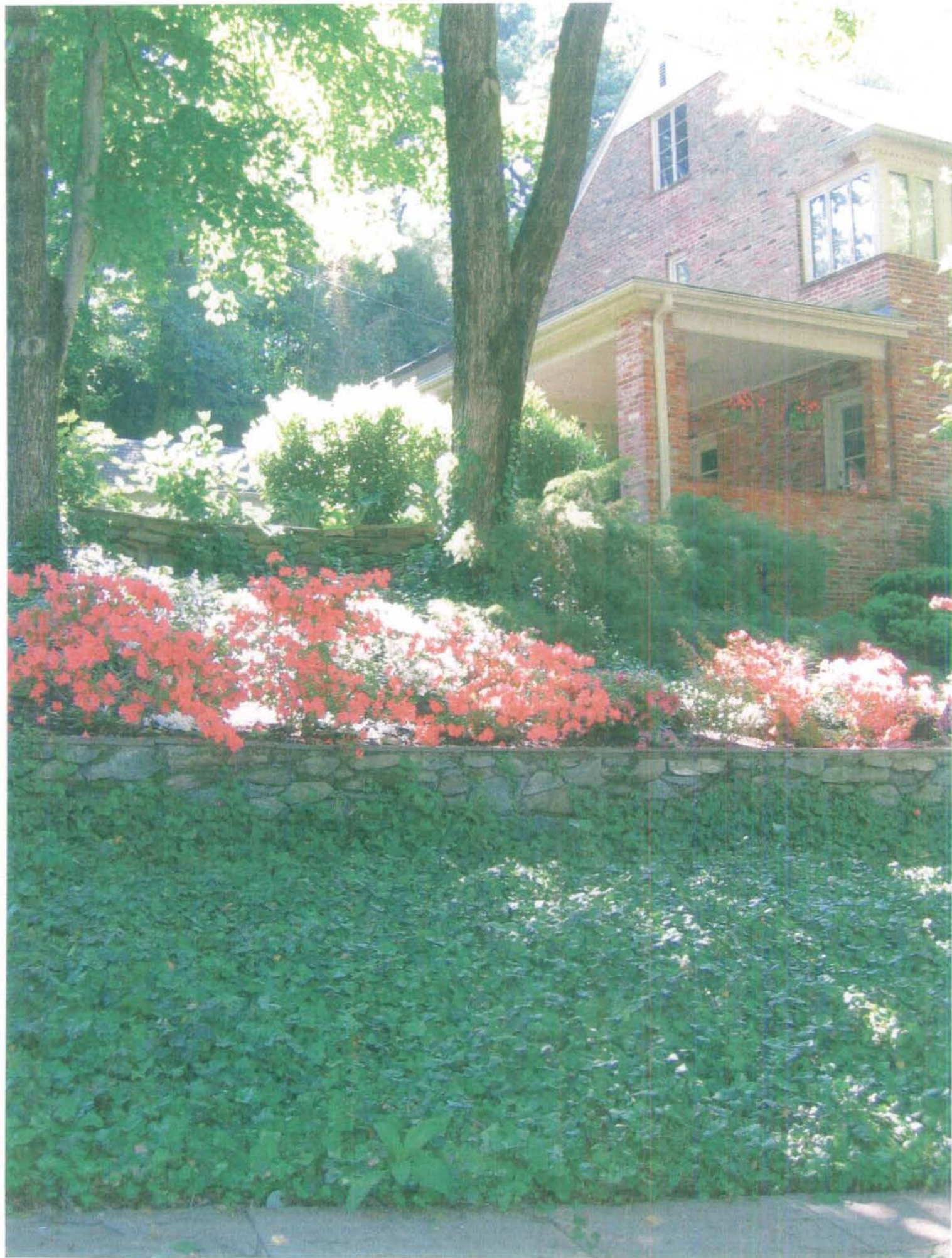
4635 Dexter St., N.W.
(Rear, not in required rear yard)











GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



Application No. 17188 of Deborah Miles, pursuant to 11 DCMR § 3103.2, for variances from the lot occupancy requirement under section 403, and a variance from the alley set-back requirement under subsection 2300.2(b), to construct an accessory garage serving a single-family row dwelling in the CAP/R-4 District at premises 409 Third Street, N.E. (Square 780, Lot 26).

HEARING DATE: July 13, 2004
DECISION DATE: September 9, 2004

DECISION AND ORDER

This application was submitted February 24, 2004 by Deborah Miles, also known as Deborah Miles Dominique ("Applicant"), the owner of the property that is the subject of this application ("subject property"). In a letter dated November 3, 2003, the Applicant had been advised by the Chief of the Zoning Review Branch of the D.C. Department of Consumer and Regulatory Affairs ("DCRA") that she needed to appear before the Board of Zoning Adjustment ("Board " or "BZA") for variance relief. DCRA advised the Applicant that she needed relief from 5 provisions of the Zoning Regulations in order to carry out her plans of constructing an addition to her dwelling and a garage in its rear yard.

Between her receipt of the letter from DCRA citing the necessary relief and her filing of this application with the Board, the Applicant revised her plans and decided not to construct an addition to her dwelling. Therefore, the amount of relief requested was reduced and applied only to the construction of the garage. This change was memorialized in a May 4, 2004 memorandum to the Board from the staff of the Office of Zoning ("OZ").

The Board held a public hearing on the application on July 13, 2004. After the hearing, the record was left open to receive further information from the Applicant and the D.C. Office of Planning ("OP"). This information was submitted, and the Board, at a September 9, 2004 decision meeting, decided to deny the application by a vote of 4-0-1.

PRELIMINARY MATTERS:

Notice of Application and Notice of Hearing. By memorandum dated May 4, 2004, the Office of Zoning sent notice of the filing of the application to the District Department of Transportation ("DDOT"), OP, the Councilmember for Ward 6, Advisory Neighborhood

Commission ("ANC") 6C, and the Single Member District ANC member for ANC 6A08. Pursuant to 11 DCMR § 3113.13, OZ published notice of the hearing in the *D.C. Register* and mailed letters to the Applicant, ANC 6C, and all owners of property within 200 feet of the subject property notifying them of the hearing date.

Requests for Party Status. There were no requests for party status in this case.

Applicant's Case. Due to illness, the Applicant herself could not attend the hearing, but her husband and her architect put on her case before the Board. The architect, Ms. Patrick, noted that the Applicant needed 3 variances – a variance from the maximum lot occupancy allowed by § 403, a variance from the requirement of § 2300.2(b) that an accessory building be set back at least 12 feet from the centerline of an adjacent alley, and a variance from § 404 to permit a rear yard of less than 20 feet in length. She explained that the lot is unique because it abuts a large private parking lot at the rear and the Applicant has security concerns arising out of the use of this parking lot. She also stated that the lot is too small to be able to add a garage while staying within the parameters of the Zoning Regulations.

Government Reports. By report dated July 6, 2004, OP recommended denial of the variance relief requested. OP opined that the Applicant required variances from 3 provisions of the Zoning Regulations – a variance from the maximum lot occupancy, a variance from the alley setback requirement, and a variance from the 30% maximum rear yard coverage for accessory buildings set forth in § 2500.3. The OP report stated that the presence of an internal commercial parking lot in the center of the Square was a unique circumstance, but that there was no exceptional condition of the subject property for purposes of granting a variance. The OP report also stated that granting the variances would be contrary to the intent of the Zoning Regulations and Map. In its report, OP quoted an e-mail communication from DDOT expressing concern about the ability of large vehicles, such as trash trucks, to maneuver in the alley, and asking if the Applicant's proposed garage could be set back 2 to 3 feet from the edge of the alley. There was, however, no separate report filed by DDOT.

At the hearing, OP stated that it had also received e-mail comments from the Fire Department which stated that the Department had no concerns with the Applicant's proposal, provided all fire codes were complied with.

OP filed a Supplemental Report dated July 20, 2004 explaining its review of a series of old and current maps which included the subject property. OP continued to conclude that, even if in the past there had been a structure in the subject property's rear yard, rebuilding such a nonconforming structure would be contrary to the intent of the Zoning Regulations and Map and that, therefore, the application still failed to meet the variance test.

ANC Report. By letter dated June 21, 2004, the chairman of ANC 6A indicated that at a properly noticed meeting on June 9, 2004, ANC 6C voted 5-2 (with 5 members constituting a quorum) to support the application.

Persons in Opposition. By letter dated June 21, 2004, the Capitol Hill Restoration Society informed the Board that it had considered the application at a meeting held on June 10, 2004, and had voted unanimously to oppose it. The Stanton Park Neighborhood Association, by letter dated July 12, 2004, also wrote to oppose the application.

FINDINGS OF FACT

1. The subject property is located in an R-4 zone district, in Square 780, Lot 26, at address 409 Third Street, N.E. It is one of a series of 13 lots fronting on Third Street within Square 780, each of which is improved with a row dwelling.
2. Square 780 is bounded by Third Street, N.E. to the west, Fourth Street, N.E. to the east, D Street, N.E. to the south, and E Street, N.E. to the north.
3. The subject property is a non-conforming lot, 16.5 feet wide and 80 feet deep, and is developed with a single-family row dwelling constructed prior to the enactment of the Zoning Regulations in 1958.
4. The subject property is a level, regularly-shaped, rectangular lot.
5. At its rear, the subject property abuts the west side of a 15-foot wide alley. Parking for the row dwelling is provided in the rear yard on a concrete pad accommodating two cars and accessed from the alley.
6. The Applicant proposes to construct a new 10-foot high detached garage over the location of the existing concrete parking pad.
7. The row dwelling has a lot occupancy of 65% and construction of the proposed garage would increase the lot occupancy to approximately 89%.
8. The proposed garage would cover 96.7% of the required rear yard space and would reduce the rear yard from the required depth of 20 feet to 14 feet.
9. The proposed garage would be located at the rear lot line and would not be set back from the alley at all.
10. Abutting the alley on its east side, and therefore behind the Applicant's row dwelling and the dwellings adjacent to it, is a large, square, open paved area used as a private (pay for use) parking area.

11. The private parking area occupies the center of the Square and is internal, with no street frontage. It is surrounded by alleys on all 4 sides, which form its perimeter. The rear lot lines of most of the lots in the Square abut these alleys.
12. The internal parking area is accessed by alleys perpendicular to its perimeter alleys. Two of these perpendicular alleys lead from Third Street, N.E., one from Fourth Street, N.E., and one from E Street, N.E.
13. At least 12, and possibly all, of the 13 lots facing Third Street, of which the subject property is one, appear to have the same 80 foot lot length and 16.5 foot lot width as the subject property. The lots within Square 780, but on the opposite side of the central parking area and fronting onto Fourth Street, are of a similar size.
14. At various times in the past, and as late as 1991, the subject property had an accessory structure in its rear, presumably a garage, a portion of one wall of which still remains. However, in 1991, it appears that 7 other lots of the 13 lots facing Third Street also had rear accessory structures, most of which appear to have been razed by 2002.
15. Of the similarly-sized and situated Square 780 lots fronting on Fourth Street, it appears that 9 lots had, in 1991, rear accessory structures, most of which appear to have been razed by 2002.

CONCLUSIONS OF LAW

The Board is authorized to grant variances from the strict application of the Zoning Regulations in order to relieve difficulties or hardship where "by reason of exceptional narrowness, shallowness, or shape of a specific piece of property ... or by reason of exceptional topographic conditions or other extraordinary or exceptional situation or condition" of the property, the strict application of any Zoning Regulation "would result in peculiar and exceptional practical difficulties to or exceptional and undue hardship upon the owner of the property...." D.C. Official Code § 6-641.07(g)(3) (2001), 11 DCMR § 3103.2. Relief can only be granted "without substantial detriment to the public good and without substantially impairing the intent, purpose, and integrity of the zone plan as embodied in the Zoning Regulations and Map." *Id.* The Applicant is applying for area variances and so must make the lesser showing of "practical difficulties," and not the more difficult showing of "undue hardship," which applies in use variance cases. *Palmer v. D.C. Board of Zoning Adjustment*, 287 A.2d 535, 541 (D.C. 1972). Therefore, in order to be granted any variance, let alone 3 or 4 variances, the Applicant must show an exceptional condition or "uniqueness" of the property, practical difficulties in

complying with the Zoning Regulations arising out of this uniqueness, and no detriment to the public good or impairment of the zone plan.

The Board concludes that the Applicant failed to show any exceptional situation or condition of the subject property to support the granting of variance relief. The property is a regularly-shaped, level, rectangular parcel. It has no distinguishing topographic features, has street and alley access, and provides parking for two vehicles. It is true that the Applicant's lot is nonconforming as to lot area and width and her structure as to lot occupancy, but there are other such nonconforming structures and lots in the neighborhood. Ownership of a nonconforming structure on a nonconforming lot cannot constitute the necessary uniqueness for variance purposes. Such nonconformities, rather than being unique to any particular structure or lot, are features common to many properties within the District.

The Applicant also claims that the existence of the internal commercial parking lot in the center of the Square, onto the perimeter alley of which her property abuts, makes her property unique. The internal parking lot, however, takes up the entire central portion of the Square. It is therefore similarly abutted by approximately 41 other lots, all of which would be similarly impacted by its existence. The Board concludes that even if the presence of this internal parking lot makes Square 780 unusual, it does not constitute an exceptional condition or situation of the subject property.

The Applicant stresses that she needs to construct the proposed garage for security reasons because of the use of the parking lot by various persons, but these security concerns would presumably be shared by the owners of the other 41 lots, and potentially by all the property owners in the Square. Granting variances to the Applicant could result in similar demands from other property owners in the Square, approval of which would "in effect be amending the Zoning Regulations," something which the Board is powerless to do. *See, Palmer* at 539.

The Board is sympathetic to the Applicant's desire to re-construct a rear garage for security reasons. Notwithstanding its understanding of the Applicant's situation, however, the Board must make its decision based on the application of the Zoning Regulations, specifically the 3 prongs of the variance test. Having found no extraordinary or exceptional condition of the subject property, and that therefore, the application does not meet the first prong of the test, the Board need not address the second and third prongs.

The Board is required to give "great weight" to issues and concerns raised by the affected ANC and to the recommendations made by the Office of Planning. D.C. Official Code §§1-309.10(d) and 6-623.04 (2001). Great weight means acknowledgement of the issues and concerns of these two entities and an explanation of why the Board did or did not find their views persuasive. ANC 6C supported the application, but did not address the

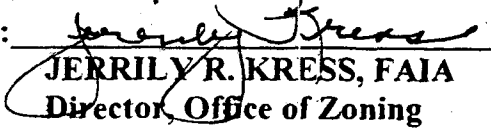
uniqueness requirement, except to point out that many other neighborhood properties share some of the nonconformities suffered by the subject property. This, in the Board's view, argues against granting of the application. OP did not support the granting of the variances and the Board agrees with its recommendation that the application be denied for failure to meet the variance test.

For the reasons stated above, the Board concludes that the Applicant has not satisfied the burden of proof with respect to the application for a variance from the lot occupancy requirement under § 403, and a variance from the alley set-back requirement under subsection 2300.2(b), to construct an accessory garage serving a single-family row dwelling.¹ Accordingly, it is therefore **ORDERED** that the application is **DENIED**.

VOTE: **4-0-1** (Geoffrey H. Griffis, John A. Mann, II,
Ruthanne G. Miller, and Curtis L. Etherly,
to deny the application. No Zoning
Commission Member participated in the case.)

BY ORDER OF THE D.C. BOARD OF ZONING ADJUSTMENT.

Each concurring Board member approved the issuance of this order.

ATTESTED BY: 
JERRILY R. KRESS, FAIA
Director, Office of Zoning

FINAL DATE OF ORDER: DEC 21 2004

UNDER 11 DCMR 3125.9, "NO DECISION OR ORDER OF THE BOARD SHALL TAKE EFFECT UNTIL TEN DAYS AFTER HAVING BECOME FINAL PURSUANT TO THE SUPPLEMENTAL RULES OF PRACTICE AND PROCEDURE FOR THE BOARD OF ZONING ADJUSTMENT."

¹These were the two variances that were advertised. The Board has concluded that the first prong of the variance test was not met and no variances can be granted. Therefore, the question of whether variances from the § 404 rear yard requirement and the § 2500.3 rear yard coverage requirement should also have been requested or advertised is moot.

GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



BZA APPLICATION NO. 17188

As Director of the Office of Zoning, I hereby certify and attest that on DEC 21 2004 a copy of the order entered on that date in this matter was mailed first class, postage prepaid or delivered via inter-agency mail, to each party and public agency who appeared and participated in the public hearing concerning the matter, and who is listed below:

Deborah Miles
409 3rd Street, N.E.
Washington, D.C.

Chairperson
Advisory Neighborhood Commission 6C
P.O. Box 77876
Washington, D.C. 20013

Commissioner 6C08
Advisory Neighborhood Commission 6C
P.O. Box 77876
Washington, D.C. 20013

Sharon Ambrose, City Councilmember
Ward Six
1350 Pennsylvania Avenue, N.W., Suite 102
Washington, D.C. 20004

Toye Bello, Zoning Administrator
Building and Land Regulation Administration
Department of Consumer and Regulatory Affairs
941 N. Capitol Street, N.E.
Washington, D.C. 20002

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Ellen McCarthy, Deputy Director
Office of Planning
801 North Capitol Street, N.E.
4th Floor
Washington, D.C. 20002

Alan Bergstein, Esq.
Office of the Attorney General
441 4th Street, N.W., 6th Floor
Washington, D.C. 20001

rsn

ATTESTED BY:

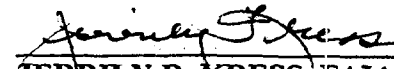

JERRILY R. KRESS, FAIA
Director, Office of Zoning

EXHIBIT D-2

a questionable candidate for a substantial mortgage loan.

The basic theme of the judge's decision was that negligible income, poor credit performance, and general financial plight would probably disqualify someone in Peter Lynn's position from borrowing what he needed in order to make good on his offer. This reality of financial life is, I think, "well-known by all reasonably intelligent people in the community," *Poulnot, supra*, 608 A.2d at 141 (citations omitted), and is therefore subject to judicial notice.

Under these circumstances, I cannot agree with my colleagues' conclusion that the judge's findings were clearly erroneous or that the judge abused his discretion. In my opinion, the judgment should be affirmed in all respects. Accordingly, I respectfully dissent.



Ralph DAVIDSON, Petitioner,

v.

DISTRICT OF COLUMBIA BOARD
OF ZONING ADJUSTMENT,
Respondent,

Raimonda and Tyrus D.
Barre, Intervenor.

No. 91-AA-847.

District of Columbia Court of Appeals.

Argued Oct. 22, 1992.

Decided Dec. 15, 1992.

Property owner sought review of Board of Zoning Adjustment decision requiring him to alter plans for poolhouse or comply with setback requirements applicable to single family dwellings. The Court of Appeals, Rogers, C.J., held that board's interpretation of zoning ordinance was reasonable.

Affirmed.

* Charles L. Reischel, on behalf of the D.C. Board of Zoning Adjustment, filed a statement in lieu of brief, resting on the decision of the Board of Zoning Adjustment and intervenors' defense thereof.

1. Zoning and Planning §§605, 510

Court's review of Board of Zoning Adjustment decision is limited to determining whether decision is arbitrary, capricious, or otherwise not in accordance with the law, and on questions concerning interpretation of zoning regulations, court upholds Board's interpretation unless it is plainly erroneous or inconsistent with the zoning regulation.

2. Zoning and Planning §§307

While property owner is entitled to use property in conformance with physical restrictions in zoning regulations, nature or scale of permissible use of physically conforming accessory building is not unlimited.

3. Zoning and Planning §§307

Board of Zoning Adjustment determination that poolhouse was not an "accessory building" within meaning of setback provisions was reasonable interpretation of zoning regulations; even though poolhouse was within maximum size allowed for accessory buildings, architect's plans indicated that poolhouse was intended for use as single family dwelling or at least for uses beyond those of normal poolhouse.

C. Francis Murphy, with whom Louis P. Robbins and Jonathan L. Farmer, Washington, DC, were on the brief, for petitioner.

Richard B. Nettler, Washington, DC, for intervenors. Cynthia A. Giordano, Washington, DC, was on the brief, for intervenors.*

Before ROGERS, Chief Judge, and STEADMAN and FARRELL, Associate Judges.

ROGERS, Chief Judge:

Petitioner Ralph Davidson¹ appeals the decision of the Board of Zoning Adjustment that his poolhouse is not an accessory building under the zoning regulations and

1. Both Ralph and Louise Davidson were intervenors before the Board of Zoning Appeals, but the appeal was taken in Ralph Davidson's name only.

must therefore be modified. He contends that the Board's decision is arbitrary and capricious. We affirm.

I

In 1990, the Davidsons began major renovations on their property at 4524 Garfield Street, N.W., including replacing an existing poolhouse near their swimming pool with a larger poolhouse. Construction of the new poolhouse began in the summer, without a building permit. In August, after the Davidsons' architect showed the plans for the poolhouse to intervenor Tyrus Barre, who is the Davidsons' neighbor at the adjacent property at 2811 Foxhall Road, N.W., Mr. Barre contacted the Permit Branch of the Department of Consumer and Regulatory Affairs. On August 17, 1990, the Davidsons applied for a building permit by submitting plans and an application to the Permit Processing Division.

The plans described the poolhouse as a two story building. The upper story contained two rooms described as bedroom or office space, and consisted of approximately 350 square feet. The first floor included a living room with a fireplace, a kitchen with a microwave oven, dishwasher, and icemaker, and a "bedroom/office." The entire structure was approximately seventeen feet high (excluding the three feet to the top of the chimney stack). The building was 780 square feet in area and only 1.3 to 1.7 feet from the rear property line, which borders the Barres' property.

The Zoning Division of the Department of Consumer and Regulatory Affairs approved the Davidsons' application on September 4, 1990. The permit was subsequently revised to reflect electrical, mechanical, and plumbing work, and was re-issued on September 11. Mr. Barre again contacted the Consumer and Regulatory Affairs Department, which decided to investigate possible zoning violations and is-

sued a stop work order on September 14. Thereafter, a series of meetings ensued between the Davidsons' architect, Mr. Barre and his attorney, and District government officials. The Davidsons submitted revised plans to the department shortly after a September 28, 1990 meeting. A stop work order was issued on October 10, and further revisions were made to the plans.

The revised plans did not actually change the floor plans but did re-name many of the rooms. The rooms on the upper floor were referred to as "storage" instead of office or bedroom space, and rooms on the first floor were re-designated as the "pool room," the "changing and exercise room," and the "recreation/storage room." Also, the upper area was to be reached by a ladder rather than stairs. The height of the ceilings on the second level was also reduced to six feet five inches, one inch less than the six feet six inch minimum for a story or level. In addition, a retaining wall, approximately two feet high, was added on the side of the poolhouse facing the main house, raising the finished grade; measured from the top of the new grade the height of the pool house is fourteen feet nine and one-half inches, just under the fifteen foot maximum for accessory buildings.² The grade "slopes downward" on the side of the poolhouse facing the Barres' property. Because trees have been removed, the poolhouse is easily visible from the Barres' property.

The Zoning Administrator issued a building permit on October 15, but another stop work order was issued, followed by another permit on October 21.³ After an inspection of the property on October 22 by department officials, including the Zoning Administrator, an electrical work permit was issued on November 10 for electrical outlets, an electric range, heating and air condition-

2. See 11 DCMR § 2500.7 (1991) ("[t]he height of an accessory building ... shall be measured from the finished grade at the middle of the side of the accessory building that faces the main building to the highest point of the roof of the building").

3. According to Mr. Barre's testimony, revised plans had not been submitted to the department by October 15, and the Zoning Administrator halted construction. The record shows that another permit was issued on October 21, after revised plans had been submitted, but it mistakenly authorized three stories; a corrected permit for one story was issued on November 1.

ing; a revised permit, omitting the range, was issued on November 28.

The Barres appealed the issuance of the building permit to the Board of the Zoning Adjustment on the ground that the poolhouse was "of such a large size ... not customarily incidental to a single-family use as required by the Zoning Regulations." At the hearing before the Board, Mr. Barre testified about his efforts to stop construction of the poolhouse so close to his property line, claiming that to conform with the zoning regulations a poolhouse of that size had to be twenty-five feet from his property line. He described the poolhouse as a complete single family dwelling "in every regard."

The Barres also presented the testimony of Charles B. Soule, an expert architectural witness, who had inspected the poolhouse and the final plans for it. Observing that the poolhouse was "so much larger than any poolhouse structure that I had ever done myself, or ever seen anywhere," Mr. Soule described it as containing 1,275 square feet of floor space, with a second floor with two rooms large enough for bedrooms, and a main room on the ground floor with 894 square feet, including a bedroom, "a changing or exercise room," a kitchen, a closet, and a bathroom. Mr. Soule thought that the space on the first floor "called recreation/storage room ... would make a nice bedroom." There is also a "large stone fireplace which pierces the ceiling" in a "nearly 900 square foot room ... called the pool room." In his opinion, the building was not "in the classification of what should be a poolhouse, or what should be contained in a poolhouse."

Advisory Neighborhood Commission 3D appeared in support of the Barres' appeal. The commission took the position that "the original permit should never have been issued under the guise of an accessory building, [because] the structure was too tall; its size, mass and bulk was not appropriate for the intended use." In its view, the new poolhouse was "intended to be an integral

part of the family structure (main dwelling), not incidental to it," and therefore not an accessory building. The commission, like Mr. Soule, saw the upstairs space as "viable second story usage areas," and not merely as storage space.⁴

In addition to letters from neighbors and a three-page petition in support of the appeal, one neighbor appeared at the hearing to support the appeal on the ground that the poolhouse was too large and was not "routine, regular, or customary." The Wesley Heights Historical Society also submitted a statement in support of the appeal. This statement referred to a zoning overlay proposal, meant to preserve the character of the neighborhood, which was pending before the Zoning Commission and had been developed as the result of ongoing study and review of the zoning regulations with professional assistance. During this process, the statement indicated, there had been no indication that "there is any possibility that a structure of the size, type and obvious primary living function of the second house on the Davidson property would be allowed by the present code." The Historical Society was concerned, like the Advisory Neighborhood Commission, that the poolhouse would decrease the Barres' privacy, and the Historical Society was also concerned that the poolhouse would decrease the economic value of Barres' property.

Joseph Bottner, the Zoning Administrator, testified that his original concern about the poolhouse arose from the fact that it was too large and seemed designed for general living activities, rather than the more limited uses expected of an "accessory building." Because only an accessory building could be built closer than twenty-five feet to a rear property line in the Davidsons' R-1 zoning district,⁵ he was concerned that "[t]he building appeared to be more than a poolhouse. It identified areas that were indicated as living quarters." Mr. Bottner informed the Davidsons' architect that the plans violated the

abutting neighbor's privacy and quiet enjoyment of his property."

4. Advisory Neighborhood Commission 3D also submitted a letter of December 28, 1990, noting, among other things, that "[t]he current location of the structure results in a gross invasion of the

5. See 11 DCMR § 404.1 (1991).

zoning regulations applicable to accessory buildings because they showed a height of over fifteen feet, indicated that rooms would be used for sleeping and other ordinary living activities, and included a possible second story. The Zoning Administrator also informed the Davidsons that the poolhouse could not be used as a sleeping accommodation. He approved the revised plans as conforming with the accessory use requirements, however, for several reasons.

First, a poolhouse is, Mr. Bottner testified, "considered to be incidental and accessory to the pool." Here, there is a poolhouse with recreational and storage facilities, but no sleeping is allowed, and recreational use is a customarily incidental use. Second, the poolhouse occupies under 30 percent of the lot,⁶ and is clearly subordinate in size to the main house. The main dwelling is 85 feet wide while the poolhouse is 32 feet wide and only 14 feet nine and one-half inches high (measured from the finished grade at the center of the building).⁷ The poolhouse is located in the rear yard of a 31,655 square feet lot with a width of 168.73 feet along Garfield Street; the required lot and width sizes for the R-1-A Zone are 7,500 square feet and 75 feet, respectively.⁸ Third, it is a one story building, since the second floor's ceilings are one inch less than the minimum height for a story, and the second level is designed for use as storage.

However, in response to a question whether "there is a judgment issue here that goes beyond the technical aspect of the Zoning Regulations, and that judgment is made based upon, not only room description, but the size of the structure, as well as the intended use," the Zoning Administrator stated, "That is correct." He also conceded that in prior poolhouse plans which he had approved there had not been any clear intent to use the building for a living or bedroom area. He admitted that living quarters are not permitted in accessory buildings except for domestic employees,⁹ and that the grade was changed in

order to lower the height of the poolhouse. Mr. Bottner acknowledged, moreover, that "[i]f the grade drops toward the neighbor, in this case, to [the] Barre[s], it is only natural that the building would appear to be higher from the back."

The Davidsons presented Walter Lynch, an architect who worked on the poolhouse. He testified about the intended use of the upper level as storage areas with a changing room and a recreational room on the first level. He explained that there was very little difference between the height of the old and new poolhouses, and that after the plans were revised the owner had never indicated an intention to use the poolhouse as anything other than an accessory building. He admitted, however, that only the names of the rooms had been changed in the revised plans, and that there remained operable windows on the second story and air conditioning. He related that after the neighbors had seen the plans they had no trouble with them, and that the Davidsons had offered to shield the poolhouse from the Barres' view with trees.

Mr. Davidson testified that he wanted a poolhouse that would "take full cognizance of the fact that we do have a large family, and it would be a recreation area." Upon being informed the building could not be used for sleeping, he explained that the plans were changed to reflect a different use. He stated that the main use of the poolhouse for recreation would not be contrary to the zoning regulations.

The Board of Zoning Adjustment reversed the Zoning Administrator's decision to issue a building permit, and ordered the Davidsons to alter the design and reduce the scale of the building to bring it within the definition of an "accessory building." In its decision of June 23, 1991, the Board concluded that the poolhouse

contains some of the kinds of rooms and amenities that are customarily located in a main dwelling.... no adjustments were made to the design and size of the structure to make them consistent with

6. See *id.* § 2500.3 (1991).

7. See *id.* § 2500.7 (1991).

8. *Id.* § 401.3 (1991).

9. See *id.* § 2500.5 (1991).

the more limited use. This structure remains large enough and fully equipped to accommodate activities such as cooking, dining, studying, entertaining, and other activities associated with daily life. Many of these activities exceed what is customary for a poolhouse in the District of Columbia. They are not incidental to uses of the main building and should only occur in a structure that has been set back 25 feet from the rear property line. The Board, therefore, concludes that the poolhouse, as designed, is not an accessory building within the meaning of that term.

Mr. Davidson appeals.

II

The relevant zoning regulations for an R-1-A Zone District, such as the petitioner's, permit single family dwellings which must be set back twenty-five feet from the rear property line and eight feet from each side property line.¹⁰ The zoning regulations also allow accessory buildings, defined as "subordinate building[s] located on the same lot as the main building, the use of which is incidental to the use of the main building."¹¹ The accessory buildings allowed in R-1 Zone Districts include garages, private stables, and "[o]ther buildings or structures customarily incidental to the uses permitted in R-1 districts."¹² Such accessory buildings must occupy no more than 30 percent of the rear yard, be no taller than fifteen feet, and have only one story.¹³

[1] This court's review of the decision of the Board of Zoning Adjustment is limited to a determination of whether the decision is arbitrary, capricious, or otherwise

not in accordance with the law. *Salsbery v. D.C. Bd. of Zoning Adjustment*, 318 A.2d 894, 896 (D.C.1974) (citations omitted).¹⁴ On questions relating to the interpretation of the zoning regulations, such as the Board's interpretation of the "customarily incidental" definition of accessory buildings permitted in R-1 districts, this court's review is more deferential, upholding such interpretations unless they are "plainly erroneous or inconsistent with the [zoning] regulation." *Levy v. D.C. Bd. of Zoning Adjustment*, 570 A.2d 739, 746 (D.C.1990) (Board's interpretation of specificity required by zoning regulations in campus plan upheld, reversed on other grounds) (citations omitted). See also *Smith v. D.C. Bd. of Zoning Adjustment*, 342 A.2d 356, 360 (D.C.1975) (sun deck; minimum rear yard restriction); cf. *Pauley v. BethEnergy Mines, Inc.*, — U.S. —, —, 111 S.Ct. 2524, 2534, 115 L.Ed.2d 604 (1991) (courts should defer to an agency's interpretation of its own regulations where the agency decision requires "significant expertise and entails the exercise of judgment grounded in policy concerns"); *Hilton Hotels Corp. v. D.C. Bd. of Zoning Adjustment*, 363 A.2d 670, 671 (D.C.1976) (where conclusion follows as a matter of law from Board's findings, the court must uphold the Board's decision even if the court might have reached a different result were the court considering the case de novo).

Because only an accessory building could be allowed within twenty-five feet of the petitioner's rear property line, the poolhouse must be moved or modified unless it qualifies as an accessory building.¹⁵ The petitioner contends that the Board may not

Adjustment, 577 A.2d 757, 759 (D.C.1990) (citation omitted); *Dietrich v. D.C. Bd. of Zoning Adjustment*, 293 A.2d 470, 473 (D.C.1972) (citations omitted).

10. *Id.* §§ 201.1(a), 404.1, 405.9 (1991).

11. *Id.* § 199.9.

12. *Id.* § 204.1 (printed at 39 D.C.Reg. 4204 (1992) (errata)).

13. *Id.* §§ 2500.3, 2500.4 (1991). The only relevant exception allows the upper level of a garage to be used as housing for the domestic employees of the principal building's residents. See notes 5 and 8, *supra*.

14. See also *Wheeler v. D.C. Bd. of Zoning Adjustment*, 395 A.2d 85, 89 (D.C.1978) (substantial evidence review); *Myrick v. D.C. Bd. of Zoning*

15. 11 DCMR § 404.1 (1991) provides that a twenty-five foot rear yard is required "for each structure" in an R-1-A zoning district. The Zoning Administrator testified that "there is no restriction on how far an accessory building ... must [be] setback [sic] from the rear property line." See note 5, *supra*.

require him to reduce the height or square footage of the poolhouse because those measurements are within the physical maximums for accessory buildings under the Zoning Regulations. Reading the Board's decision to prohibit "cooking, dining, studying, entertaining, and other activities associated with daily life," he maintains that the Board's decision that "the stated activities can only occur in the main dwelling is plainly arbitrary and capricious." He argues that the Board's decision sets up an impossible standard by requiring elimination of any space which could conceivably be used for daily life activities.

[2] The District's zoning regulations on accessory buildings include use restrictions in addition to physical restrictions: the use of the accessory building must be "incidental to the use of the main building" and "customarily incidental to the uses permitted in R-1 districts."¹⁶ Thus, the petitioner's contention that he may build a poolhouse as a matter of right, upon compliance with the physical requirements of the zoning regulations, is not the end of the matter. Cf. *Porianda v. Amelkin*, 115 A.D.2d 650, 496 N.Y.S.2d 487, 488 (1985) (although "boating may be a popular hobby in [the] ... neighborhood," an "unusually large structure in which to store and service [a] boat" is not an accessory use in the absence of "proof that the type of structure proposed would be 'customarily found in connection with' the type of one-family residence to be built on the subject plot so as to qualify it as an 'accessory building'"). While a property owner has the right to use his or her property in conformance with the physical restrictions in the zoning regulations, the nature or scale of a permissible use in an accessory building is not unlimited. See generally Robert Roy, Annotation, *Zoning: What Constitutes "Incidental" or "Accessory" Use of Property Zoned, and Primarily Used, For Residential Purposes*, 54 A.L.R.4th 1034 (1987). Cf. *Sheridan-Kalorama Neighborhood Council v. D.C. Bd. of Zoning Adjust-*

ment, 411 A.2d 959, 961 (D.C.1979) (restrictions on what uses may follow an existing non-conforming use); *Dolan v. DeCapua*, 13 N.J.Super. 500, 80 A.2d 655, 658 (1951) (where there is pre-existing nonconforming use of property, property owner may be "within his [or her] rights in continuing such use ... but he [or she] may not enlarge the use" even though "new use would be 'no more harmful' than the old to the adjacent landowners") (citation omitted).

[3] We do not read the Board's decision, as does the petitioner, to prohibit all of the stated activities in a poolhouse.¹⁷ Rather, we understand the Board to view the accessory building regulations as including a scale requirement with regard to permissible uses. The plain language of the District's regulations, by referring not only to a "subordinate" building but to "customarily incidental" uses, makes clear that a building is not an accessory building where given its size, design and declared purposes, it can reasonably be expected to duplicate the functions of the main building rather than in fact serving as incidental to those uses. See *Maynard v. Tomy*, 347 Mass. 397, 198 N.E.2d 291, 292-93 (1964) (second house is not accessory use even though smaller than main residence, where it is "a dwelling with adequate facilities for occupancy apart from any other structure") (footnote omitted); *Yunker v. Means*, 271 Or. 56, 530 P.2d 846, 847 (1975) (deck used for sitting, eating, sleeping and other usual deck uses is not a detached accessory structure for set-back purposes, observing that "[a]n accessory building is a subordinate building incidental to the use of the main building. If it is an integral part of the main building, it cannot be accessory"); *Carney v. City of Baltimore*, 201 Md. 130, 93 A.2d 74, 76 (1952) (addition to main building not accessory use). See also *Borough of Chatham v. Donaldson*, 69 N.J.Super. 277, 174 A.2d 213, 216 (1961) ("accessory use has been defined as one

16. *Id.* §§ 199.9 (1991), 204.1 (printed at 39 D.C.Reg. 4204 (1992) (errata)).

17. The Board did not rule that recreational activities were impermissible at a poolhouse. Nor

did it suggest that other activities, such as all eating, reading and the like, were not permitted. Consequently, the petitioner's reliance on *Thomas v. Zoning Board of Adjustment*, 241 S.W.2d 955, 958-59 (Texas Civ.App.1951), is misplaced.

customarily incident to the principal use and so necessary or commonly to be expected that it cannot be supposed that the ordinance was intended to prevent it") (citations omitted); *see generally County Comm'rs of Carroll County v. Zent*, 86 Md.App. 745, 587 A.2d 1205 (1991) (reviewing definitions of accessory use adopted in different jurisdictions).

Accordingly, in determining whether or not uses are "customarily incidental," the Board could properly look at photographs of the building and the building plans in order to determine what would be the normal uses of the building. The term "customarily incidental" incorporates an objective, not subjective, standard. The Board determined that a building of the size of the petitioner's poolhouse is destined for a normal use which exceeds normal poolhouse use. In fact, the poolhouse is not similar in scale to the prior poolhouse on the property, but is approximately twice as long and three times as wide as the old poolhouse, and it includes a variety of rooms and facilities permitting independent daily living activities.¹⁸ In the Board's words: "[t]he subject structure is very large and contains some of the kinds of rooms and amenities that are customarily located in a main dwelling." Thus, the Board's decision does not focus on the size of the poolhouse alone, but on an objective evaluation of its size *in conjunction with* the design and contents of the structure in concluding that the poolhouse would not be used only for the "customarily incidental" purposes allowed for accessory buildings in an R-1 district.

In our opinion, the petitioner has failed to demonstrate that this is an unreasonable interpretation of the accessory building regulations. The interpretation does not involve, as the petitioner suggests, a determination of whether the petitioner would use the building in a manner contrary to the representations in his plans. Rather, it involves a determination of what a property owner would normally do with a building of this size and configuration. That determination is required in order for the Board

to determine whether the poolhouse complies with the "customarily incidental" use restriction in the zoning regulations for accessory buildings. A requirement that the Board rely only on the owner's representations would clearly be inconsistent with the Board's responsibility for interpreting the zoning regulations.

The petitioner also contends that larger poolhouses have been approved at least once before. We need not decide whether or not this is sufficient proof that a use is "customarily incidental" to the permitted uses. *See* 54 A.L.R.4th, *supra*, at 1048 (citing *Salem v. Durrett*, 125 N.H. 29, 480 A.2d 9, 11 (1984) ("one instance in another town does not rise to the level of custom")); *cf. Porianda v. Amelkin*, *supra*, 496 N.Y.S.2d at 488 (no proof of any similar structure). In the example on which the petitioner relies, the landowner obtained a height variance to build a poolhouse that exceeded the usual size limitations for accessory buildings. *See* Application No. 14385, of John D. Rockefeller IV, January 22, 1986. Similarly, the petitioner's reliance is misplaced on Appeal No. 12276 of Eva Robertson Hinton, February 8, 1977, where the Board upheld the issuance of a building permit for an accessory building that was being used as sleeping quarters. In that case there was no issue raised about the size or nature of the building itself but only with regard to the use that was being made of the innocuous structure; the Board determined that issue was more properly addressed under the housing code. By contrast, there was substantial evidence here to support the Board's finding that the physical size and design of the petitioner's poolhouse indicate that the building is meant for more than accessory, "customarily incidental" use in an R-1 district.

Accordingly, we hold that the Board's decision was not arbitrary or capricious or inconsistent with the zoning regulations. The Board's interpretation of the accessory building regulations to restrict the scale of activities that may be conducted in the

ing rooms, a storage area for some pool equipment, and a wet bar.

18. A letter (with photographs) from the prior owner of the Davidsons' property indicates that the prior poolhouse had consisted of two dress-

petitioner's poolhouse is not plainly erroneous. Not only does the large size of the building resemble that of a single family dwelling, but the record before the Board shows that the configuration of rooms and the equipment are consistent with a single family home and, thus, supports the Board's conclusion that the petitioner's poolhouse is not a "customarily incidental" accessory building in an R-1 district. See generally *New Jersey v. P.T. & L. Construction Co., Inc.*, 77 N.J. 20, 389 A.2d 448, 451 (1978) ("customary" means "so necessary or commonly to be expected that it cannot be supposed that the ordinance was intended to prevent it," and "incidental" is defined as "bear[ing] a close resemblance and obvious relation to the main use to which the premises are put") (citations omitted). The Zoning Administrator emphasized in his testimony the comparative sizes of the main house and the poolhouse in view of the size of the petitioner's lot, but he also agreed that under the accessory building regulations judgment was to be exercised beyond the technical aspect of the regulations. It is precisely that judgment to which the court must defer. We, therefore, affirm the June 23, 1991, decision of the Board.



**In the Matter of Edward Norman
REINER, Respondent.**

**A Member of the Bar of the District
of Columbia Court of Appeals.**

No. 90-SP-61.

District of Columbia Court of Appeals.

Submitted Nov. 24, 1992.

Decided Dec. 18, 1992.

In two reciprocal discipline cases, Board on Professional Responsibility recommended three-year suspension for one matter and one-year suspension for the other matter, with both suspensions to bear requirement that attorney demonstrate fitness to practice before being readmitted.

The Court of Appeals held that recommended discipline was reasonable.

Suspended.

1. Attorney and Client ⇐58

A member of the bar who was the subject of a pending disciplinary proceeding may acquiesce in a disbarment by consent.

2. Attorney and Client ⇐58

An attorney who does not file any exceptions or opposition to disciplinary recommendation by the Board on Professional Responsibility should, as a general rule, be considered to have acquiesced, in effect, to the proposed sanction. Bar Rule XI, § 12.

3. Attorney and Client ⇐57

In reciprocal discipline matters where the Board on Professional Responsibility recommends that identical discipline be imposed, the Court of Appeal shall impose such discipline unless the attorney demonstrate or the court finds on the face of the record on which the discipline is predicated, by clear and convincing evidence, that one of the grounds stated in the rules for not imposing such discipline exists. Bar Rule XI, § 11(f).

4. Attorney and Client ⇐58

In reciprocal discipline matter in which Board on Professional Responsibility recommended a different discipline from that imposed in the foreign jurisdiction, but based upon the foreign proceeding, recommended discipline of three years suspension from practice *nunc pro tunc* and one-year suspension *nunc pro tunc*, with reinstatement in each case to be subject to proof of rehabilitation, was reasonable, absent any showing that Board's findings were unsupported by the record or that recommended discipline was not in accord with criteria for disciplinary proceedings. Bar Rule XI, § 16.

Before TERRY, STEADMAN and KING,
Associate Judges.

GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



Application No. 15718 of Donald and Carol Borut, pursuant to 11 DCMR 3107.1, for a variance from the rear yard requirement (Sub-section 404.1) for a deck addition to a single-family dwelling in an R-1-B District at premises 6401 31st Place, N.W. (Square 2349, Lot 143).

HEARING DATE: July 15, 1992
DECISION DATE: July 15, 1992

SUMMARY OF EVIDENCE OF RECORD:

1. The property which is the subject of this application is located at 6401 31st Place, N.W., on the east side of 31st Place, N.W. between Washington and Tennyson Streets, N.W. The site is rectangular in shape and contains 5,875 square feet of land area. The site has a lot width of 50 feet with eight-foot wide side yards and a rear yard depth of 25 feet. It is similar in size and shape to other lots in the immediate neighborhood. The subject site is developed with a two-story, detached, single-family dwelling.

2. The site does not abut a public alley. The residential area surrounding the site is characterized by having large, single-family, detached dwellings on large lots. The property is zoned R-1-B.

3. The applicants are proposing to construct a rear deck addition to the existing single-family detached dwelling. The proposed deck would measure 18.98 feet in width by 14.5 feet in depth and would be ten feet above grade. The deck would have a surface area of approximately 275 square feet. Access to the deck would be from the existing dwelling and via a staircase from the rear yard of the property.

4. The property is located in the R-1-B District which permits matter of right development of single-family residential uses for detached dwellings with a minimum lot area of 5,000 square feet, a minimum lot width of 50 feet, a maximum lot occupancy of 40 percent, a maximum height of three stories/40 feet, and a minimum rear yard depth of 25 feet.

5. The applicants' property, which contains 5,875 square feet, exceeds the 5,000 square feet required in an R-1-B District. The applicants' lot has an average width of 50 feet which meets the 50-foot lot width required in the R-1-B District. With the proposed deck, the rear yard would measure an average of 22.05

feet, 2.95 feet (or 12 percent) less than the 25-foot rear yard required. Based on these measurements, the applicants are requesting a variance from the rear yard requirement.

6. The applicants' architect (applicants' representative) stated that the lot configuration and the position of the structure thereon present the applicants with a practical difficulty in expanding the house and improving the value, use and appearance of the property. He went on to state that since the main floor is a story above grade at the rear, a deck is required for convenient outdoor living space. Given the configuration of the existing house and addition, and restrained by existing eight-foot side yards, the applicant can expand only to the rear. He also stated that the applicant could build an 11-foot, 6-inch deep deck without a variance but they considered this dimension to be too narrow to be functional for group seating, and therefore require variance relief to expand by 2.95 feet.

7. The applicants' architect maintains that granting the variance will not be of substantial detriment to the public good. He stated that there are porches and decks in the backs of the houses to either side of the subject property and that the proposed deck would project only about four feet past an existing deck to the west. It is the architect's belief that the proposal is consistent with the intent of the zoning regulations and that neighbors' light and ventilation will not be adversely affected by the proposed deck extension.

8. By report dated July 8, 1992, and through testimony at the public hearing, the Office of Planning (OP), noted the physical characteristics of the subject site, the proposed use, and the requested relief. With regards to the rear yard variance, OP stated that the existing rear yard depth of the subject property would be reduced from 25 feet to 22.05 feet with the construction of the proposed deck. OP believes that although the variance relief requested in this case is minimal, there is no uniqueness inherent in the property or other extraordinary or exceptional condition or situation which would create a practical difficulty depriving the applicants of reasonable use of the property. OP stated that a large addition is currently being built onto the rear of the applicants' dwelling. To allow a rear yard deck to extend beyond the new addition into the required rear yard (although only by 2.95 feet) does not appear to be justifiable. The applicants could construct a rear deck as a matter of right if its depth were reduced from the proposed 14.5 feet to 11.5 feet. Therefore, OP recommends denial of this application.

9. Advisory Neighborhood Commission (ANC) 2C filed a letter recommending approval of the subject application based on neighbor support and no objections reported to the ANC.

10. Letters in support of the application were filed by five neighbors who had no objections to the proposed deck addition.

11. No one appeared at the hearing to testify in opposition to the application.

FINDINGS OF FACT:

Based on the evidence of record the Board finds as follows:

1. The subject lot is rectangular in shape with slightly sloping terrain.

2. The applicant can construct a deck with a depth of 11.5 feet as a matter of right.

3. There is no extraordinary or exceptional condition or situation of the property.

4. The Board agrees with the recommendation of the OP.

5. The Board disagrees with the recommendation of the ANC. No issues and concerns were expressed by the ANC.

CONCLUSION OF LAW AND OPINION:

Based on the foregoing findings of fact and evidence of record the Board concludes that the applicant is seeking a variance from the rear yard requirement to construct a deck addition to a single-family dwelling.

Granting such variance requires a showing through substantial evidence of a practical difficulty upon the owner arising out of some unique or exceptional condition of the property such as exceptional narrowness, shallowness, shape or topographical conditions. Further, the Board must find that the application will not be of substantial detriment to the public good and will not substantially impair the intent, purpose and integrity of the zone plan.

The Board concludes that the applicants have not met the burden of proof relative to the zoning relief requested in this application.

The Board further concludes that there is no uniqueness inherent in the subject property which would create a practical difficulty for the applicants and deprive them of reasonable use of the property. A rear yard deck could be built on the subject property as a matter of right if its depth were reduced.

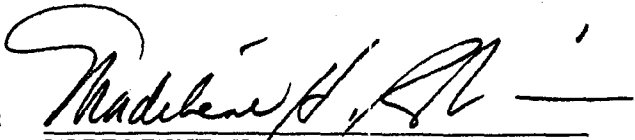
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Based on the foregoing, the Board ORDERS that the application be DENIED.

VOTE: 4-0 (Maybelle Taylor Bennett, Paula L. Jewell, Angel F. Clarens and Carrie L. Thornhill to deny; Sheri M. Pruitt not present, not voting).

BY ORDER OF THE D.C. BOARD OF ZONING ADJUSTMENT

ATTESTED BY:


MADELIENE H. ROBINSON
Director

FINAL DATE OF ORDER: JUN 23 1994

UNDER 11 DCMR 3103.1, "NO DECISION OR ORDER OF THE BOARD SHALL TAKE EFFECT UNTIL TEN DAYS AFTER HAVING BECOME FINAL PURSUANT TO THE SUPPLEMENTAL RULES OF PRACTICE AND PROCEDURE BEFORE THE BOARD OF ZONING ADJUSTMENT."

15718Order/JM/bhs

GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



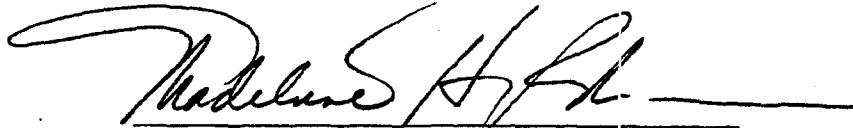
BZA APPLICATION NO. 15718

As Director of the Board of Zoning Adjustment, I hereby certify and attest to the fact that on JUN 23 1994 a copy of the order entered on that date in this matter was mailed postage prepaid to each party who appeared and participated in the public hearing concerning this matter, and who is listed below:

Dickson Carroll
2910 Ordway Street, N.W.
Washington, D.C. 20008

Donald and Carol Borut
6401 31st Place, N.W.
Washington, D.C. 20015

Anne M. Renshaw, Chairperson
Advisory Neighborhood Commission 3G
P.O. Box 6252
Washington, D.C. 20015


MADELIENE H. ROBINSON
Director

DATE: JUN 23 1994

15718Att/bhs

EXHIBIT D-4

GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



Application No. 14549, of Charles M. and Judith L. Kupperman, pursuant to Paragraph 8207.11 of the Zoning Regulations, for a variance from the side yard requirements (Sub-section 3305.1) to construct a rear addition to a dwelling in an R-1-B District at premises 3328 Northampton Street, N.W., (Square 2013, Lot 18).

HEARING DATE: January 28, 1987
DECISION DATE: January 28, 1987 (Bench Decision)

FINDINGS OF FACT:

1. The site, known as premises 3328 Northampton Street, N.W., is located on the south side of Northampton Street between Broad Branch Road and 33rd Street, N.W. The site is located in an R-1-B District.
2. The lot is trapezoidal in shape, having a width of 52.97 feet at the front lot line and 7.91 feet at the rear. The east side lot line is perpendicular to Northampton Street. The west side lot line abuts a fifteen foot alley which is parallel to Broad Branch Road but at an angle to Northampton Street.
3. The property is improved with a two-story, colonial, detached single-family dwelling. The existing residence contains 1,344.42 square feet of living space with a kitchen and living room on the first floor and three bedrooms and two baths on the second floor. The structure has a basement and a third floor full attic.
4. The structure was constructed prior to May 12, 1958, the effective date of the current Zoning Regulations on that date the structure became nonconforming with regard to the lot area, lot width and side yard requirements for the R-1-B District. The Zoning Regulations require a minimum lot area of 5,000 square feet. The subject site has a lot area of 3,957 square feet. The minimum lot width required is 50 feet. The subject site has a maximum lot width of 53 feet in the front which tapers to approximately eight feet in the rear yard. The property is directly adjacent to a public alley. The minimum required side yard is eight feet. The site provides an eight foot side yard on the west side of the dwelling (front) which tapers to a one foot side yard in the rear. The side yard to the east of the dwelling provides a 5.5 foot side yard.

5. Pursuant to Paragraph 8207.11 of the Zoning Regulations, the applicants are seeking area variances from the side yard requirements (Sub-section 3305.1) to construct a two-story rear addition to the dwelling. The proposed addition will add the space necessary for the applicant to provide a dining area on the first floor level and enlarge a bedroom and a bath on the second floor level.

6. The addition as proposed will extend 15 feet into the rear yard and will be on line with the side alley of the existing dwelling's property line.

7. If the applicant were required to provide an eight foot side yard on the alley side, the width of the addition would be limited to only two and one-half feet due to the trapezoidal nature of the property.

8. The adjacent properties to the east and west of the site are also non-conforming with the side yard requirement. The rear addition to the residence to the east of the site extends approximately 15 feet beyond the rear wall of the dwelling and is one story in height. The addition to the structure located on the lot to the west of the residence is approximately 70 feet from the rear wall of the subject dwelling and is one story in height.

9. The proposed addition to the subject structure will not reduce the width of the existing side yards nor will it cause the property to exceed the permitted lot occupancy or encroach upon a required rear yard.

10. By letter dated January 13, 1987, Advisory Neighborhood Commission (ANC) 3G reported that it voted unanimously not to oppose the subject application.

11. There was no opposition to the application at the public hearing or of record.

CONCLUSIONS OF LAW AND OPINION:

Based on the foregoing findings of fact and the evidence of record, the Board concludes that the applicant is seeking an area variance, the granting of which requires a showing of a practical difficulty that is inherent in the property itself, and that the relief can be granted without substantial detriment to the public good and without substantially impairing the intent, purpose and integrity of the zone plan.

The Board concludes that the applicants have met the burden of proof. Sub-section 3305.1 requires a proposed addition will provide no side yard on the west side necessitating a variance of eight feet or 100 percent. The Board concludes that no side yard is currently provided to the west.

The Board concludes that the nonconforming size of the lot, the size of the existing dwelling and its configuration on the site constitutes an exceptional condition of the property. The Board further concludes that no reasonable addition could be made to the existing structure without the granting of a variance.

The Board further concludes that the proposed addition will not be objectionable to nearby property owners. The Board concludes that the requested relief can be granted without substantial detriment to the public good and without substantially impairing the intent, purpose and integrity of the zone plan. Accordingly, it is ORDERED that the application is GRANTED SUBJECT to the CONDITION that construction shall be in accordance with the plans marked as Exhibit No. 8 of the record.

VOTE: 4-0 (William F. McIntosh, Paula L. Jewell, Lindsley Williams and Carrie L. Thornhill to grant;
Charles R. Norris not present, not voting).

BY ORDER OF THE D.C. BOARD OF ZONING ADJUSTMENT

ATTESTED BY:


EDWARD L. CURRY
Acting Executive Director

FINAL DATE OF ORDER: MAR 5 1997

UNDER SUB-SECTION 8204.3 OF THE ZONING REGULATIONS, "NO DECISION OR ORDER OF THE BOARD SHALL TAKE EFFECT UNTIL TEN DAYS AFTER HAVING BECOME FINAL PURSUANT TO THE SUPPLEMENTAL RULES OF PRACTICE AND PROCEDURE BEFORE THE BOARD OF ZONING ADJUSTMENT."

THIS ORDER OF THE BOARD IS VALID FOR A PERIOD OF SIX MONTHS AFTER THE EFFECTIVE DATE OF THIS ORDER, UNLESS WITHIN SUCH PERIOD AN APPLICATION FOR A BUILDING PERMIT OR CERTIFICATE OF OCCUPANCY IS FILED WITH THE DEPARTMENT OF CONSUMER AND REGULATORY AFFAIRS.

14549order/LJP16

EXHIBIT D-5

GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



Application No. 13224 of Buchanan Street Limited Partnership, pursuant to Paragraph 8207.11 of the Zoning Regulations, for a variance from the rear yard requirements (Sub-section 3304.1) to construct semi-detached dwellings in an R-2 District at the premises 4705-4719 and 4736-46 - 6th Place, N.E., (Square 3796, Lots 75-82, 63-67 and 87).

HEARING DATES: April 23 and June 11, 1980
DECISION DATE: July 2, 1980

FINDINGS OF FACT:

1. The subject site is located east of the Metrorail line between 6th and 7th Streets, N.E., north of Buchanan Street, and is known as premises 4705-4719 and 4736-46 - 6th Place, N.E. It is in an R-2 District.
2. North and east of the site are single family semi-detached homes which reflect the underlying R-2 zoning. To the south is the Stanley-Martin development which was approved to be developed with a variety of housing types, BZA Case No. 11631, but is currently being built with semi-detached units. The zoning for the Stanley-Martin tract of land is R-5-A while the subject property is zoned R-2.
3. The subject application is a request for rear yard variances for fourteen semi-detached structures which are in various stages of completion. This application is one of the two applications before the BZA of the same applicant related to the same development known as the Buchanan Mews. The other application, BZA No. 13206, is for five lots and requires parking space and rear yard variances.
4. The R-2 District requires a minimum rear yard of twenty feet with a minimum lot area of 3,000 square feet.
5. There is a ten foot building restriction line at the front of each of the lots for which a rear yard variance is requested.
6. The plans for this project were submitted and approved by the Zoning Administrator in June of 1979. At that time all of the dwellings on the lots met the rear yard requirements.

7. Wall checks which were done in January of 1980 revealed that the rear walls of the fourteen dwellings encroached into the required rear yards. The degree of encroachment varies from approximately 0.13 feet to 0.98 feet.

8. The applicant stated that the engineering firm which surveyed the property re-sited the proposed buildings further to the rear of the lots in order to move the houses further away from the building restriction line at the front of the lots. In so doing, the encroachments on the rear yard were inadvertantly made.

9. The Office of Planning and Development, by report dated June 9, 1980, recommended that the application be approved. The OPD noted that the proposed development is designed very tightly in accordance with the minimum requirements of the R-2 District. Lot areas vary from a maximum 3,017 square feet to a minimum of 3,000 square feet, the minimum required in the R-2 District. The OPD noted further that the encroachment into the rear yards varies from approximately 1/2 inch to just over 11 inches or between 0.65% and 4.90%. The OPD did not believe, due to the topography, that such a situation would cause adverse impacts upon the potential buyers of these properties of substantially reduce the outdoor recreational space for family purposes. In addition, it would not appear in the long run, economically practical to require that the rear walls and foundations of the offending dwellings be rebuilt in conformity with the rear yard requirements of the R-2 District. The costs of such a solution would undoubtedly be passed on to the consumer without substantial benefit or improvement. It was OPD's opinion that, weighing the cost and benefit factors for the public good, the requested variances could be granted without impairing the intent, purpose and integrity of the Zoning Regulations. The Board so finds.

10. There was opposition to the application at the public hearing on the part of the North Michigan Park Civic Association on the grounds that the applicant had never conferred with neighborhood associations as to its plans. Such objection is not addressed to the merits of whether the application meets the requirements of Paragraph 8207.11.

CONCLUSIONS OF LAW:

Based on the record the Board concludes that the applicant is seeking area variances the granting of which requires a showing of a practical difficulty in the property itself. The Board concludes that the variances from the rear yard requirements ranging from one half inch to eleven inches are minimal. Requiring the applicant to reconstruct the foundations to achieve the required rear yard would create a practical difficulty for

the developer without achieving any significant public benefit. The Board concludes that the requested relief can be granted without substantial detriment to the public good and without substantially impairing the intent, purpose and integrity of the zone plan. Accordingly, it is ORDERED that the application is GRANTED.

VOTE: 5-0 (Connie Fortune, Ruby B. McZier, Charles R. Norris, William F. McIntosh and Leonard L. McCants to grant).

BY ORDER OF THE D.C. BOARD OF ZONING ADJUSTMENT

ATTESTED BY: Steven E. Sher
STEVEN E. SHER
Executive Director

FINAL DATE OF ORDER: 25 AUG 1980

UNDER SUB-SECTION 8204.3 OF THE ZONING REGULATIONS "NO DECISION OR ORDER OF THE BOARD SHALL TAKE EFFECT UNTIL TEN DAYS AFTER HAVING BECOME FINAL PURSUANT TO THE SUPPLEMENTAL RULES OF PRACTICE AND PROCEDURE BEFORE THE BOARD OF ZONING ADJUSTMENT."

THIS ORDER OF THE BOARD IS VALID FOR A PERIOD OF SIX MONTHS AFTER THE EFFECTIVE DATE OF THIS ORDER, UNLESS WITHIN SUCH PERIOD AN APPLICATION FOR A BUILDING PERMIT OR CERTIFICATE OF OCCUPANCY IS FILED WITH THE DEPARTMENT OF LICENSES, INVESTIGATIONS AND INSPECTIONS.

EXHIBIT D-6

GOVERNMENT OF THE DISTRICT OF COLUMBIA
BOARD OF ZONING ADJUSTMENT



Application No. 12565, of Paul S. and Susan Au Allen, pursuant to Paragraph 8207.11 of the Zoning Regulations, for variances from the percentage of lot occupancy (Sub-section 3303.1) and rear yard (Sub-section 3304.1) requirements to permit a rear deck in the R-5-B District at the premises 2009 "Q" Street, N.W., (Square 93, Lot 802).

HEARING DATE: January 25, 1978
DECISION DATE: April 5, 1978

FINDINGS OF FACT:

1. The subject property is located on the north side of "Q" Street between 20th and 21st Streets, N.W., and is in an R-5-B District.
2. The applicant seeks the Board's permission to finish constructing and maintain a rear deck as an addition to the subject flat which deck was partially constructed without proper permits.
3. Construction of the rear deck was undertaken by a contractor hired by the applicant. The contractor had the responsibility to secure proper permits, and the applicant believed that such permits had been secured. After the deck had been partially constructed, the applicant was served with a stop work order from the Permit Branch because proper permits had not been issued. After the issuance of the stop work order, the applicant did not continue with construction of the deck except to erect a railing around it and place additional support beams.
4. The applicants applied for a building permit on July 12, 1977. By letter of September 13, 1977, the applicants were advised by the Zoning Administrator that the deck would require the approval of the Board. On December 1, 1977, the applicant filed an application with the Board.

5. The proposed deck as now constructed covers the entire area which it would cover when finished. The deck is located at the level of the main floor, which is approximately eight feet off the ground at the rear of the house. There are steps leading to the ground from the deck along the east lot line of the property. The deck is supported by six three-inch standard pipe columns, has two-by-six inch floor joists running across the width of the lot, and is enclosed by a railing three feet, three-inches in height.

6. The application requests lot occupancy and rear yard variances. In an R-5-B District, the maximum lot occupancy permitted is sixty per cent. For this lot of 1933.03 square feet, a maximum occupancy of 1159.82 square feet would be permitted. The applicant proposes an occupancy of 1660.00 square feet, thus requiring a variance of 500.18 square feet or forty-three per cent. In an R-5-B District, a rear yard of fifteen feet is required, while an average of only 13.65 feet has been provided. Thus, a variance of 1.35 feet, or nine per cent, is required.

7. The existing building on the lot already occupies very close to the maximum permitted occupancy. If the Board were to allow any reasonable deck on the rear of the house, a lot occupancy variance would be required.

8. There are already three support columns in place at the rear end of the deck. These columns are located 1.35 feet into the required rear yard.

9. A deck is required in order for the applicant to have some reasonable use of the rear of the property in relation to the main floor, which is one-story above grade at the rear of the house.

10. At the public hearing, the adjoining home owners to the west of the subject property objected to the granting of the application on the grounds that the proposed addition would intrude into their privacy and would restrict their sunshine and ventilation.

11. The wall of the adjoining building to the east is a solid masonry wall with no windows, and extends as far back as the deck. There would thus be no adverse effects on that building from the deck.

12. There are letters on file in support of the application by neighboring residents. One letter is signed by nine residents in favor of the application.

13. At the Board's suggestion, the applicant and the opposition attempted to work out a design of the deck acceptable to both. The parties eventually informed the Board that no such arrangement could be concluded.

14. On March 16, 1978, members of the Board made an inspection of the subject site, accompanied by both the applicant and the parties in opposition.

15. Advisory Neighborhood Commission 2B, made no recommendation on the application.

CONCLUSIONS OF LAW AND OPINION:

Based on the Findings of Fact, and the evidence of record including the personal inspection of the site made by members of the Board, the Board concludes that the requested variances are area variances, the granting of which requires the showing of a practical difficulty upon the owner of the property. The Board concludes that the applicants have demonstrated that strict compliance with the regulations would create such difficulties for them, in that they would have no reasonable method for using the rear yard from the main floor of the building.

The Board notes that the deck has been partially constructed without a proper building permit having been secured. The Board views such violations of the law with great concern, and will not lightly accept as a basis for granting a variance, the fact that actions have already been undertaken without a building permit. The Board notes that as to the rear yard variance requested in this case, to require the applicant to remove the support posts and set the rear edge of the deck back less than two feet would be so minimal as to be unreasonable and unnecessary.

In concluding that an exceptional situation exists and that a practical difficulty would result, the Board is mindful of the request that a variance can be granted only "without substantial detriment to the public and without substantially impairing the intent, purpose and integrity of the zone plan." The Board notes that the abutting owners to the west have objected to the deck.

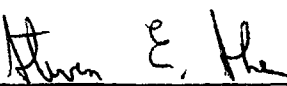
The Board further notes that if the house and deck had been arranged differently, the applicant could construct a deck along the full length of the west lot line except for the rear fifteen feet. The Board however, concludes that the objections raised by the opposition also have some validity, and the Board is in the position of having to weigh and balance the concerns of both the applicants and the opposing parties.

The Board therefore hereby Orders that the application is GRANTED subject to the CONDITION that the floor and west wall of the deck shall be set back a minimum of eight feet from the west lot line of the lot. The support columns and floor joists may remain as they were constructed prior to this grant of approval.

VOTE: 4-0 (Chloethiel Woodard Smith, William F. McIntosh, Charles R. Norris and Leonard L. McCants).

BY ORDER OF THE D. C. BOARD OF ZONING ADJUSTMENT

ATTESTED BY:



STEVEN E. SHER
Executive Director

THAT THE ORDER OF THE BOARD IS VALID FOR A PERIOD OF SIX MONTHS ONLY UNLESS APPLICATION FOR A BUILDING AND/OR OCCUPANCY PERMIT IS FILED WITH THE DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT WITHIN A PERIOD OF SIX MONTHS AFTER THE EFFECTIVE DATE OF THIS ORDER.

FINAL DATE OF ORDER: 8 MAY 1978

THE



Dictionary of Civil Engineering

FOURTH EDITION

JOHN S. SCOTT

stress-free temperature

is usual. As the name suggests, the surface material is structural and not, like slate, a mere weather-resisting cladding. It has been used by the makers of plywood houses, in which the plywood wall cladding is glued to the load-bearing members. *Shells* are special examples of it.

In buildings clad or roofed with steel troughing, the troughing can carry forces in its own plane (not at right angles to it) provided it is securely fixed by *self-tapping screws* (B), bolts or pins fired through the troughing into the frame. Hook bolts are unsuitable. Seam fasteners must not work loose. *Pop rivets*, bolts or deep self-tapping screws are adequate. Purlin-rafter connections must be designed to resist the forces transmitted by the skin. Ideally sheeting should be considered to add strength in stressed-skin construction only when it forms part of a building mainly intended to exclude the weather (snow, wind). Removal of sheeting then implies removal of load.

stress-free temperature [riv] The temperature, 27°C. (81°F), at which British Rail's *continuously welded rail* becomes free of stress after *destressing*.

stress/number curve, SN c. [mech.] A curve obtained in *fatigue testing*. It shows the range of stress in a material plotted against the number of cycles to failure.

stress probe A British type of push-in *pressuremeter*.

stress raiser See *stress concentration*.

stress relieving [mech.] Heating steel to a temperature below the *critical point*, followed by slow cooling to relieve internal stress. Cf. *normalizing*.

stress/strain curve A curve, showing the result of a (usually tensile) test on a

metal test piece, in which the *stresses* are plotted against *strains*. The stresses are calculated as the load divided by the original area of the piece, in spite of its *contraction in area* above the *yield point*. Cf. *load/extension curve*.

stretcher A liner. See also (B).

striding level [sur.] A sensitive *level* tube used for cross-leveling a *leveling* telescope. It is fitted at each end with a leg projecting downwards from the tube. These legs stand on the *striding* trunnions.

strike [min.] The horizontal line in the plane of a fault or a sedimentary rock, at right angles to the *dip*.

strike off To draw a *screed board* across fresh concrete between edge forms and remove the excess.

striker [mech.] A helper to a *blacksmith* or *angle-iron smith*.

striking (1) Removing *formwork* or other temporary supports from a structure.

(2) See *struck capacity*.

striking plate A piece of waste metal kept close to the workpiece in *arc welding* before the *electrode* and arc are transferred to the work.

stringer, a. beam [stru.] A long horizontal member which ties together the heads of *trestles* in wooden *trestle bridges* or provides support under a *rail*, parallel to it, in a steel railway bridge.

strip (1) To strike *formwork*.

(2) [air sur.] See *vertical photo-graph*, also (B).

strip footing, a. foundation A foundation for a wall or for a close succession of piers. It is ribbon-shaped, projecting slightly each side of the wall, and may

be of brickwork, timber (if permanently submerged), mass concrete or reinforced concrete.

stripping (1) Clearing a site of turf, brushwood, topsoil or the first layer of soil.

(2) Striking *formwork*.

(3) Loss of binder or aggregate from a road surface. See *ravelling*, *scabbing*, also (B).

(4) **air stripping** [sewage] An advanced treatment, blowing air through sewage effluent to remove carbon dioxide, hydrogen sulphide or (after the addition of lime) ammonia from it. A disadvantage is that the ammonia pollutes surrounding air, water or snow. Air stripping may be used also to remove nitrogen and carbon dioxide from the *deep-shaft process*, but air pollution laws limit its use in the UK. Cf. *breakpoint chlorination*.

struckback A spreader beam or a proprietary steel or aluminium *soldier* in *shoring*.

struck capacity The capacity of a *water*, mine car, *hibble*, skip or other container, calculated as if it were full of material, as that all material above the *strike* is imagined to be struck off with a straight edge. The rated capacity of an excavator bucket is its struck capacity.

structural analysis The early part of *structural design*, which consists of determining what forces are carried by the parts of a structure and what proportions the forces bear to the loads.

structural design [d.o.] Calculating the sizes of members to carry loads in a structure in the most economical way. *Structural design* is carried out in two main parts, the first being a rough estimate of the loads with the *structural engineer*. When the structural analysis is checked and found satisfactory the

structure

loads are more accurately estimated. The second half of the design consists of the proportioning of the members according to the calculations of the first half, together with the adjustment of the original calculations to any final altered sizes of parts. This is the main work of a *structural engineer*, since most conventional building types have been sufficiently analysed and need no further analysis in the drawing office. See *theory of structures*.

structural designer [d.o.] One who makes *structural designs*. He or she is an experienced *draughter* and usually though not necessarily a *chartered engineer*.

structural designer-draughter [d.o.] A designer who draws his or her own designs and generally has no draughtsman working for him or her.

structural draughter [d.o.] One who makes structural drawings, i.e. drawings of those parts which carry load in buildings and structures, usually in metal or concrete but sometimes in brickwork or masonry. He or she may be, but does not need to be, a qualified structural engineer. The main tools are a ruling pen, some scales and a set-square.

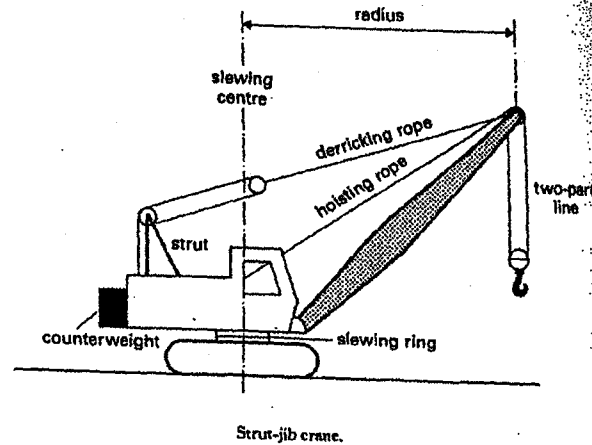
structural engineer A *chartered engineer*, in Britain a corporate member of the ICE or IStructE. His or her main abilities are in *structural design*.

structural steelwork Rolled-steel *joints* or built-up members fabricated as building frames, by riveting, welding or bolting, or all three.

structure (1) The load-bearing part of a building.

(2) Anything built by people, from a hydraulic fill dam built of earth or a pyramid of stone to a hydroelectric power station or an earth satellite. A

structure gauge



Strut-jib crane.

[structure is not necessarily roofed, a building is.]

structure gauge [rly] The outline of a tunnel which the tunnel builder must work to. It is bigger at all points than the loading gauge.

strut [stru.] A long column, usually of wood or metal, not necessarily vertical.

strut-jib crane (see diagram) A crane which has a strut projecting from the top of the cab, carrying the pulley for the derricking rope, as opposed to a cantilever crane.

Stub's iron wire gauge See Birmingham wire gauge.

stub wall A hicker.

stucco See (B).

stud [mech.] A rod threaded for its full length, a screw with no head. See (B); also stud gun, stud welding (B).

student member, s. engineer A man or woman studying civil engineering in a recognized course of study may join an engineering institution from the age of 17. This makes it easy for young people to join their chosen institution at low cost. After obtaining an engineering degree and full-time work, the student normally becomes a graduate engineer.

stuffing box [mech.] A recess, filled with packing, fitting tightly round a piston rod to prevent leakage of steam from an engine or water from a pump.

stumper A tree-cutter.

stunt end, form stop, stop end, day joint Vertical shuttering placed across a wall, slab or trench to form a construction joint which ends the day's concreting.

sub-base A bed of suitable material such as gravel, laid sometimes under

a base course of a road to strengthen it, improve the drainage, etc.

subcontract A contract between a specialist firm and a main contractor.

subcontractor A firm doing specialist work for a main contractor. Subcontractors should be approved by the client or consultant before they are engaged. Many large British contractors began as railway subcontractors from 1840 onwards, including McAlpine, Monk, Mowlem and Wimpey. See nominated subcontractor.

subcritical flow [hyd.] In an open channel, flow is said to be slow, tranquil or subcritical when the Froude number is less than 1. See hydraulic jump.

sub-grade, formation The natural ground below a road, airstrip, or other structure or foundation.

sub-irrigation Irrigation by raising the water level near the roots of plants.

submerged-arc welding An automatic welding method in which a bare or covered consumable wire electrode travels along the weld under a mound of flux. The lower part of the molten flux protects the weld. The method is used for joining thick steel plates in a horizontal position.

submerged float [hyd.] (1) A rod float.

(2) A subsurface float.

submerged tunnel See immersed tube.

submerged weir [hyd.] A drowned weir.

submersible A submarine to carry one or more persons, designed for work in deep water where divers cannot work. It may have a mechanical hand (manipulator), television cameras or geophysical survey equipment for examining a pipeline or the seabed. A

subsidence

2800 ton Vickers submersible surveyed 21 km of seabed pipeline in 13 days in 1972. It was claimed to work at 420 m depth.

submersible pump [mech.] A centrifugal pump which may be driven by compressed air or electricity and can be wholly submerged in water. A submerged pump can lift water much higher than one on the surface, which is always limited by the maximum suction head. See borehole/deep-well/sinking pump, filter well.

subsidence, settlement (see diagram, p. 438) Downward movement of the ground surface. South-east England is subsiding at 3 mm yearly, with the north and west of Britain rising at the same rate. Land drainage increases the sinking, especially on peat.

(1) Filling of a mined void reduces settlement, but in Britain most coal mining subsidence amounts to more than half the seam thickness over the years even though some filling is used.

(2) Bulk removal of fluid from a borehole causes settlement. By 1987, because of the removal of gas and oil from the chalk 3000 m below the seabed, the six Ekofisk oil and gas production platforms in the North Sea had sunk 6 m, being at the centre of a cone of depression 6 km across. They were then jacked up a total of 6 m (20 ft). Phillips Petroleum used 104 jacks each able to lift 700 tons, and raised them in five days, cutting through their supports above water level and re-fixing them after the jacking, to make them 1 m longer. The high porosity of the reservoir rocks is believed to have caused both the rich yield and the settlement.

In Mexico City subsidence from the pumping of water is so serious that pumping in the city is prohibited.

At Terminal Island, California, extraction caused 6 m (20 ft) of subsi-

EXHIBIT E-2

TITLES OF RELATED INTEREST

Physical processes of sedimentation

J. R. L. Allen

Elements of geographical hydrology

B. J. Knapp

Geology for civil engineers

A. C. McLean and C. D. Gribble

Water planning in Britain

D. Parker and E. C. Penning-Rowse

Geomorphology and engineering

Edited by D. R. Coates

Environmental hazards in the British Isles

A. Perry

Terrain analysis and remote sensing

Edited by J. R. G. Townshend

British rivers

Edited by J. Lewin

Geomorphological techniques

Edited by A. S. Goudie

Soils and landforms

A. J. Gerrard

Soil survey and land evaluation

D. Dent and A. Young

Sedimentology: process and product

M. R. Leeder

Applied geomorphology

Edited by R. Craig

Adjustments of the fluvial system

Edited by D. Rhodes and G. Williams

Sedimentary structures

J. Collinson and D. Thompson

Geomorphological field manual

V. Gardiner and R. Dackombe

Boundary element methods in solid mechanics

S. Crouch and A. Starfield

The boundary integral equation method for porous media flow

J. Liggett and P.-L. Liu

*Theory of vibration with applications (2nd edn)**

W. T. Thomson

* Co-published with Prentice-Hall Inc. in North America.

Earth Structures Engineering

R.J. Mitchell

Queen's University, Kingston, Ontario

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Preface

Earth structures engineering involves the analysis, design and construction of structures, such as slopes and dams, that are composed mainly of earth materials, and this is a growth area in geotechnical engineering practice.

This growth is due largely to increased involvement in designing various types of earth structures for the resources industries (slopes, impoundment structures, offshore islands, mine backfills), to the development of increasingly large hydroelectric projects, to the need for more freshwater storage and diversion schemes, and to the need for transportation, communications and other facilities in areas where the natural earth materials are occasionally subject to mass instabilities.

Although geotechnical engineering transects traditional disciplinary boundaries of civil, geological and mining engineering, the majority of geotechnical engineers are graduates from civil engineering schools. Here the geotechnical instruction has been concentrated on soil mechanics and foundation engineering because foundation engineering has traditionally been the major component of geotechnical practice. Geotechnical specialists, however, generally have acquired considerable formal or informal training beyond their first engineering degree, and an advanced degree with considerable cross-discipline course content is still considered an advantage for a young engineer entering a career in geotechnical engineering. Practical job experience is, of course, a necessary part of professional development but is readily interpreted and assimilated only if the required background training has been obtained. In recent years many engineering schools have, for a variety of reasons (including improved computational abilities and the changing role of professional engineers with the availability of more technologists) found room in their programs for more technical options (hence greater specialization) at the undergraduate level. In the geotechnical area, options in various aspects of earth structures engineering are an obvious choice and such course offerings can be found in many university calendars. Although texts, detailed design manuals, research papers and state-of-the-art reports have been published in most areas of geotechnical engineering, earth structures engineering is one area where there does not appear to be a publication of sufficient scope to serve as a basis for instruction. It is the purpose of this text to present the basic concepts, principles and procedures used in earth structures engineering at a senior undergraduate to graduate university level, and it is assumed that the reader has a basic knowledge of earth materials (basic geology) and earth mechanics (basic soil and rock mechanics).

Chapters 1 and 2 are to some extent a review of concepts, material properties and analyses detailed in basic geotechnical courses, but are also

EXHIBIT F-1

BUILDING STRUCTURES

JAMES AMBROSE

Professor of Architecture
University of Southern California

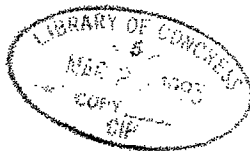


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$$A_s = \frac{M}{f_s j d} = \frac{4938(12)}{20,000(0.9)(9)} = 0.366 \text{ in.}^2/\text{ft}$$

which could be furnished with

No. 5 bars at 10 in., $A_s = 0.37 \text{ in.}^2/\text{ft}$.

No. 6 bars at 14 in., $A_s = 0.38 \text{ in.}^2/\text{ft}$.

Note from the Fig. 32.3 that the required support force at the bottom of the wall is 1980 lb. Unless there is considerable dead load on the top of the wall, it will probably be necessary to require that the basement floor slab be placed before the backfill is deposited against the wall.

It is possible, of course, that with a considerable vertical load the wall may have a critical combined stress or load/moment interaction. It is also possible that the vertical load may be sufficiently off center of the wall to produce significant moment, which may add to the bending due to the soil pressure. These conditions, plus any others due to grade beam action, load distributing, and so forth, should be considered in the full design of a basement wall.

Table 32.1 gives reinforcing recommendations for some concrete walls as determined by the procedures illustrated in Example 1.

32.5. RETAINING STRUCTURES

Strictly speaking, any wall that sustains significant lateral soil pressure is a retaining wall. However, the term is usually used with reference to a cantilever retaining wall, which is a freestanding wall without lateral support at its top. For such a wall the major design consideration is for the actual dimension of the ground-level difference that the wall serves to facilitate. The range of this dimension establishes some different categories for the retaining structure as follows:

Curbs. Curbs are the shortest freestanding retaining structures. The two most common forms are as shown in Fig. 32.4a, the selection being made on the basis of whether or not it is necessary to have a gutter on the low side of the curb. Use of these structures is typically limited to grade level changes of about 2 ft or less.

Short Retaining Walls. Vertical walls up to about 10 ft in height are usually built as shown in Fig. 32.4b. These consist of a concrete or masonry wall of uniform thickness. The wall thickness, footing width and thickness, vertical wall reinforcing, and transverse footing reinforcing are all designed for the lateral shear and cantilever bending moment plus the vertical weights of the wall, footing, and earth fill.

When the bottom of the footing is a short distance below grade on the low side of the wall and/or the lateral passive resistance of the soil is low, it may be necessary to use an extension below the footing—called a *shear key*—to increase the resistance to sliding. The form of such a key is shown in Fig. 32.4c.

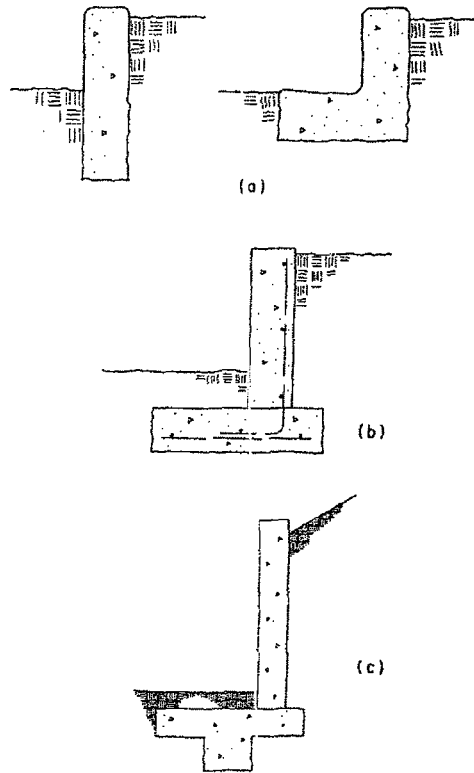


FIGURE 32.4. Retaining structures.

Tall Retaining Walls. As the wall height increases it becomes less feasible to use the simple construction shown in Fig. 32.4b or c. The overturning moment increases sharply with the increase in height of the wall. For very tall walls one modification used is to taper the wall thickness. This permits the development of a reasonable cross section for the high bending stress at the base without an excessive amount of concrete. However, as the wall becomes really tall, it is often necessary to consider the use of various bracing techniques, as shown in the other illustrations in Fig. 32.5.

Under most circumstances it is reasonable to design short retaining walls (up to about 10 ft high) by the equivalent fluid method. The following example illustrates this simplified method of design, using the working stress method for the investigation of the concrete elements.

Example 1. Short Concrete Retaining Wall. The wall is to be of reinforced concrete with the proposed profile shown in Fig. 32.6a. Design data and criteria are as follows:

Cement
[50mm] clear
side of wall
.4 at 18/450
.4 at 18/450
.4 at 18/450
.4 at 18/450
.4 at 18/450
.4 at 18/450
.4 at 18/450
ne layer
no layers

imum value of 450 lb/ft² at the
of the span and the unit of the
imum moment produced for
mately

$$1^2 + 0.375 ph^2$$

$$(12)^3$$

$$30(12)^2$$

$$1620 = 4938 \text{ lb-ft}$$

mpared to the balanced mo-
consider the concrete bending
s to be used for k and j :

$$= Rbd^2$$

$$= 226(12)(9)^2\left(\frac{1}{12}\right)$$

$$= 18,306 \text{ lb-ft}$$

te stress is not critical and the
underreinforced, permitting a
r higher for j .

f 9 in. for the effective depth of
tion, which assumes the rein-
ie minimum clearance of $\frac{3}{4}$ in.
il. With these approximations
el required is determined as

EXHIBIT F-2

**THE DESIGN
AND CONSTRUCTION OF
ENGINEERING
FOUNDATIONS**

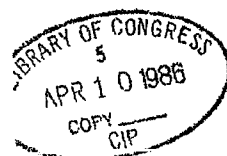
EDITED BY

The late F.D.C. Henry

*BSc (Eng), PhD, FICE, FAmSocCE
FIStructE, FIMunE, FGS*

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A range of more complex retaining structures is shown in Fig. 6.35(b) to (e). These consist of rather substantial, precast or *in situ*, counterforts with precast retaining panels spanning between them; the backfill at the lower levels is, wherever possible, allowed to spill through to reduce the total lateral thrust on the wall (Fig. 6.35c to e). The retaining panels either slope backwards to reduce the lateral stresses on them (Fig. 6.35b), or are arranged so that the weight of some of the backfill is utilized in increasing the stability of the wall (Fig. 6.35c and e); distributions of the lateral stresses used in the design of the precast retaining panels and counterforts are shown in the same figures. A detailed treatment of such complex structures has been presented by Rossyskii (1961).

An ingenious method of supporting fill by reinforcing it with metal strips or rods, attached to light metal or precast reinforced concrete fascia panels, was introduced by Vidal (1966) and is generally known as 'reinforced earth', the use of this method is still under license held by the inventor. The basic principles of the 'reinforced earth' are the same as those of the laminated rubber bridge bearings; the presence of the horizontal laminar reinforcement transforms rubber into a strongly anisotropic material capable of carrying much greater vertical loads than the rubber alone, and at the same time exhibiting considerably reduced deformations. In the case of the 'reinforced earth', the closely spaced horizontal metal strips transform a granular soil into a coherent material capable of supporting its own weight as well as applied vertical loading. The retaining structure so formed does not require any special foundations, is very flexible and thus can withstand large differential movements. Fascia units are necessary to retain the soil and protect it against erosion.

6.2.7 Strutted excavations

The evaluation of forces necessary for the design of struts, walings and sheet piles or timbering used in supporting the sides of narrow deep trenches is discussed in Section 6.1.3(b). However, provision of adequate bracing to deep excavations

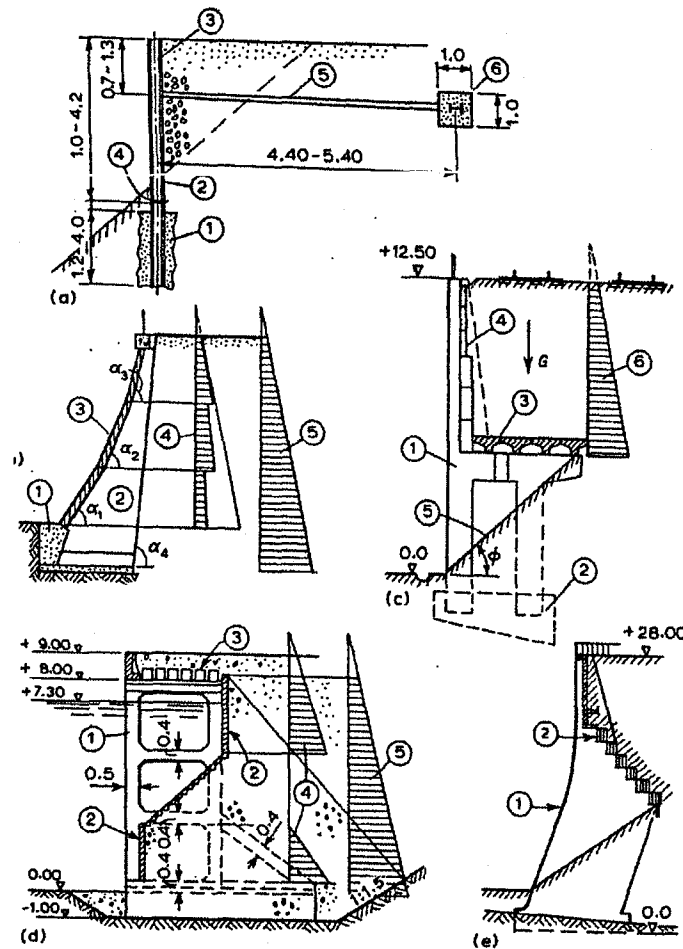


Figure 6.35 Composite precast concrete retaining walls: (a) anchored composite wall, (1) concrete base, (2) H-Pile column, (3) precast wall panels, (4) steel angle supporting slabs, (5) 38 to 100 mm $\times$ 10 mm steel tie bar, (6) lean concrete encasement; (b) wall with sloping panels, (1) foundation block, (2) counterfort, (3) retaining panels, (4) lateral soil distribution on retaining panels, (5) loading on counterforts; (c) wall with relieving form, (1) counterfort frame at 5.5 m centres, (2) reinforced concrete foundation, (3) cast T-beams, (4) precast retaining slabs, (5) spill-through soil, (6) lateral reduced thrust on counterforts; (d) composite construction wall, (1) counterfort, (2) prestressed concrete retaining slabs, (3) prestressed concrete ribbed beams, (4) lateral soil distribution on retaining panels, (5) loading on counterforts; (e) 28 m high wall in Tiblisi, USSR, (1) *in situ* counterfort at 6 m centres, (2) retaining panels in groups of 2, 3 or 4.

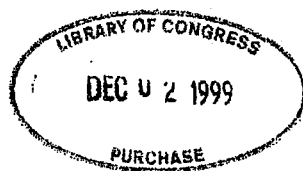
EXHIBIT F-4

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Emerging Trends in
Design and Practice

Editor
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The State of the Art of [Geosynthetic Reinforced Soil Structures]

T. Yamanouchi and N. Fukuda

INTRODUCTION

Since ancient times natural geotextiles such as timber, bamboo, twigs, reeds, tile, hemp, and palm fibre have been used for the reinforcement of the earth together with the enrichment of it with additional bending and tensile strength in the construction of embankments, stabilisation of weak foundations, and flood control. In some cases these materials are employed to achieve structural effectiveness by means of laying them in the earth in one or multiple layers or by integrating the earth and gravels within mats, cells, and gabions (Yamanouchi 1992). These techniques were handed down from generation to generation and they are, at present, replaced by methods using steel and synthetic materials. However, in some countries the natural geotextiles are still used as effective reinforcing materials (Datye 1987). The use of soil walls for housing construction that gives the earth tensile strength by composing it with straw is known, at present, as the art of Texsol (Lefflaive 1982); it integrates the earth by means of long filaments.

The reticulated root pile method and the soil nailing method that increase the stability of the earth structure by insertion of steel bars into the ground are supposed to originate from the idea of stabilising the earth with roots of growing trees.

As to most of these methods the design procedure using limit equilibrium method has been proposed in accordance with the industrially specified reinforcing materials and the mechanical characteristics of the soil and foundation, and thus numerous cases of construction achievement have been reported.

These methods, however, do not necessarily fully reflect the reinforcing mechanism and they are designed adopting high safety factors to compensate for the discrepancy between the design assumptions and the actual performance

of the structure. The results of numerous experiments and the structure's actual instrumented observation show that the present design method is so much on the conservative side that it is to be considered uneconomical. Moreover, some are of the opinion that the design will become more rational if the necessary measures for permanent or temporary structure, measures for vitality and safety, and measures for seismic design are taken into consideration. Thus, various future works should be carried out by adopting the approach from the research point of view.

In the present report the fundamental concepts of the reinforcement technique are first compiled and then the present state of the art of design based upon the testing and analysis of geotextile-reinforced embankments and soil walls is described with an emphasis on Japan's research and achievement in the earth reinforcement field.

TYPE OF EARTH REINFORCEMENT METHOD AND PREVAILING CONDITIONS

Table 1 shows types of reinforcement methods and their functions. The reinforcement is expected to achieve tensile resistance, anchor resistance, shear resistance, and bonding resistance resulting from the interaction between soil and reinforcement, and in some cases compression resistance is also expected. In some methods multiple effects can be achieved from reinforcement.

The research and development activities on all methods of reinforced embankment construction that are described in Table 1 are compiled in Table 2.

PRESENT DESIGN METHOD FOR GEOSYNTHETIC REINFORCED EMBANKMENTS AND WALL STRUCTURES

Corresponding Reinforced Soil Structures

In this section the present design method of reinforced embankments or walls that have facings from gentle slopes to almost vertical ones (Fig. 1) is described.

General Outline of the Design Method

In conducting stability analysis based on limit equilibrium method of reinforced embankment or reinforced wall, Tatsuoka (1986) has classified stability into two kinds, as shown in Table 3. I-B and II are, in some case, called 'internal stability analysis'. I-B is a stability analysis method like Coulomb's earth pressure theory that takes into account the overall limit equilibrium state. On the other hand, II is a method like Rankine's earth pressure theory that takes into consideration the local or partial limit equilibrium state relating to the strain and displacement of localised soil and reinforcement. In I-A the stabilities against sliding, overturning and lack of bearing capacity are checked. And in II-A the partial limit equilibrium state is checked for all reinforcement members

Table 1. Classification of soil reinforcement construction methods

Group	Sub-group	Representative method	Function of reinforcement	
Embankment reinforcement and soil wall	With discrete facing	Terre Annee method	Tensile reinforcement due to friction, partly shear reinforcement	
		York method	Ditto	
		Geogrid reinforcement method	Ditto	
		Websoil system	Ditto, partly anchor resistance	
	With rigid facing	TRRL method	Anchor resistance against thrust	
		Multi-anchor method	Ditto	
		RRR method	Tensile reinforcement and retaining wall effect	
		Without facing (gentle slope)	Steel mesh reinforcement	Tensile reinforcement, partly shear reinforcement
			Non-woven fabric reinforcement	
			Geonet reinforcement	
Foundation reinforcement	Without facing (steep slope)	Geogrid reinforcement	Tensile reinforcement, partly shear reinforcement (non-woven: drainage effect)	
		Woven fabric reinforcement		
	Without rigidity	Non-woven fabric reinforcement	Tensile reinforcement, separation	
		Sheet laying method		
		Geonet laying method		Ditto, restraining
		Geogrid laying method		Ditto
	With rigidity	Steel mesh laying method	Ditto	
		Mattress reinforcement	Tensile and bending reinforcement	
		Natural slope reinforcement	Multi-anchored bars	Ditto
			Soil nailing	Tensile, shear, and bending reinforcement
	Long steel bars	Reticulated root pile	Tensile, shear, bending, and compression reinforcement	

that can stand against the pull out and rupture conditions under the exerting forces.

The procedure for stability analysis is generally classified into three types as follows.

- A) The method of approach from the point of partial internal stability
 - 1) Determine the resultant of horizontal external forces, $(\sigma T_{eq})_{max}$, required to make the reinforced embankment stable.

Table 2. Chronology of activities on development of reinforced soil structures and their environs

Year	Events
1952	Reticulated root piles were developed in Italy (adopted according to underpinning)
1959	Woven fabrics were laid for rehabilitation works of Isewan Typhoon disasters (Japan)
1962	Development of non-woven fabrics of continuous fibres by spun bond method (USA)
1963	Development of Terre Armee (France) by Vidal (patent 1966)
1968	Development of woven sheets (Fukuzumi) or geonet laying method (Yamanouchi) for weak ground (Japan)
1970s	Development of soil nailing method for underground excavation (France and Germany)
1974	Development of reticulated root piles for slope stabilisation works
1977	The use of geosynthetics to reinforce the backfill behind retaining walls (US Forest Service and Sweden) Int. Conf. the Use of Geotextiles (1st Int. Geotextiles Conf.) (Paris)
1978	Symp. Reinforced Soil Structures by ASCE, Pittsburgh, Pennsylvania (USA) Development of a temporary support system for excavation by soil nailing system (Shen et al.)
1979	Development of polymer grid reinforcement (UK)
1980	Successful construction of Wehsol system (UK)
1981	State of the art report on reinforced soil structures (J.K. Mitchell et al.), 10th Int. Conf. SMPE, Stockholm, Sweden.
1982	2nd Int. Geotextile Conf., Las Vegas (USA) Continuous synthetic fiber method for granular soil reinforcement by E. Leflaive
1983	Session on Reinforced Soil Structures, 8th Symp. European Society of SMPE (Helsinki) Case study of embankment construction using polymer grids, UK's success story
1984	Symp. Polymer Grid Reinforcement in Civil Engineering (London) Announcement of Steep Reinforced Embankment Design by Jewell et al. (London) Symp. Geomembranes (Denver) Int. Geotextile Society (IGS) founded (presided over by J.P. Giroud) Geotextiles and Geomembranes, an Int. Jour. Publication (Ed. by T.S. Ingold) Geotextiles and Geomembranes by Int. Information Source (Ed. by J.D. Scott and E.A. Ricards)
1985	Technical Committee on Geotextiles, ISSMFE (TC9) established 11th Int. Conf. SMPE, Geotextiles sectional meeting (chaired by J.P. Giroud, San Francisco) Earth Reinforcement and Soil Structures (Ed. by C.J.F.P. Jones)
1986	3rd Int. Geotextile Conf. (Vienna) Geotextile Testing, an Inventory of Current Geotextile Test Method and Standard (Ed. IGS)
1987	Publication of Guide to Design and Construction on Reinforced Slope with Steel Bars (Japan Highway Public Corporation)
1988	Publication of ASTM Standards on Geosynthetics (1st ed., 2nd ed. in 1991) Report on Strengthened Reinforced Soils and Other Fills by British Standards Institute Int. Symp. Theory and Practice of Earth Reinforcement (chaired by T. Yamanouchi, Fukuoka, Japan)
1990	Specification for the Use of Geotextiles and Related Materials by Ground Engineering Group Board, ICE 4th Int. Geotextile Conf. (Hague)

Table 2. Contd.

Year	Events
1991	Successful Construction of Geosynthetic-reinforced Soil Retaining Wall (RRR method) for Railway by Railway Technical Research Institute (Japan) Publication of <i>Recommandations Clouterre</i> by Ponts et Chaussees (France) Int. Symp. Geosynthetic-reinforced Soil Retaining Walls (chaired by Wu, Denver, Colorado) ASTM standards on geosynthetics (USA)
1992	Publication of <i>Manual for Design and Construction of Geotextile Reinforced Soil Method</i> , Public Works Research Institute (Japan) Int. Symp. Earth Reinforcement Practice (chaired by Ochiai et al., Fukuoka, Japan)

Table 3. General outline of the method of stability analysis for reinforced earth structure (after Tatsuoka, 1986)

I. Checking of overall stability	I-A. Check external stability assuming the reinforced zone as a rigid body I-B. Check overall stability assuming not only the reinforced zone as a rigid body, but also slip circle passing the inner part of reinforced zone	Checking internal stability
II. Checking of partial stability	II-A. Determine the forces acting on each reinforcement using equilibrium condition of section-area around the reinforcement and check its stability II-B. Check against sectional extra-deformation and sectional rupture	

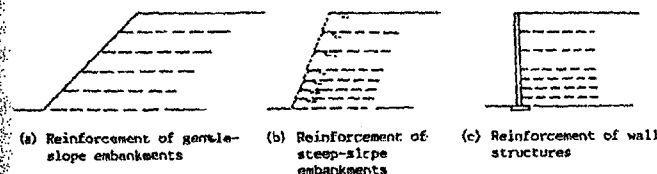


Fig. 1. Various kinds of reinforced embankments and walls

- 2) Compute the required tension (T_{req}) for each reinforcement member from the assumption that the tensile forces are distributed in the depth direction and resisting the required external resultant obtained from (1).
- 3) Secure the fixing length and the material strength to keep the material stable under the T_{req} determined in (2).
- 4) The above is the partial internal stability of the reinforcement members and from this condition the laying pattern of the reinforcements is determined.

- 5) Check the overall external stability of the reinforced zone (slipping, sliding, and overturning).
- 6) Check the overall internal stability (slipping) for the area other than the slip area that has the maximum value of ΣT_{req} .

B) The method of approach from the overall internal stability of reinforced zone

- 1) Assume the strength and the layout of the reinforcements.
- 2) Check the integration of the reinforced zone by checking the overall internal stability as to various slipping surfaces that pass through the reinforced zone.
- 3) Check the overall stability of the reinforced zone (slipping, sliding, and overturning).

C) The method of approach from the external stability of reinforced zone

This method is similar to method (A). According to step (5), the required width of reinforced zone is first determined and then the internal stability is checked in this method.

The representative method of (A) is the method of Terre Armee, and the Design and Construction Manual (1992) of geotextile reinforcement method by Public Works Research Institute, Ministry of Construction, in Japan (hereinafter PWRI) also corresponds to this method (A).

On the other hand method (B) is adopted in the Reinforced Embankment Manual (1992) for Railway Structures by the Railway Technical Institute in Japan. This method positively uses the integration of the zone reinforced by laying of reinforcements. For this integration effect, not only the reinforcements but also the treatments for rigid facing are the predetermined conditions.

Moreover, the representative method (C) is used for the design of geogrid-reinforced wall by Jones (1984).

Besides the above-mentioned basic design method, the kind of failure mode, the form or pattern of the slip-failure plane, the definition of safety factor and design method, and the way of thinking for the tension-distribution of the reinforcement should be taken into consideration.

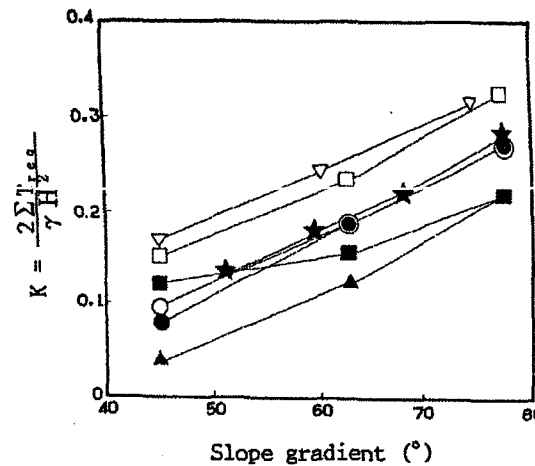
Table 4 gives comparative design considerations of the reinforced embankments or reinforced walls. In that Table, the failure mode of Jones (1984) coherent gravity method is the same as that of Terre Armees.

Figure 2 shows the comparison of how the coefficient of earth pressure, K , is affected by the type of slip failure mode and the kind of stability analysis method. The value of K is calculated by the following equation:

$$K = \frac{2\Sigma T_{req}}{\gamma H^2}$$

where ΣT_{req} is the total required reinforcement's tensile force and H is height of embankment.

Different slip failure modes, such as two-part wedge of Jewell *et al.* (1984), Schmertmann *et al.* (1987), Fukuda *et al.* (1989b) (a part of Geogrid Research



note: ● Jewell, ○ Schmertmann, □ Ruegger (include safety factor 1.3), ■ Leshchinsky, ★ geogrid research board, ▽ Onodera (PWRI), ▲ straight wedge

Fig. 2. Comparison of K values of various proposed design methods. (Modified version of Fukuda *et al.* 1989a)

Board's proposal 1990) and the slip circle of Ruegger (1986) and Onodera *et al.* (originated from PWRI proposal 1992), log spiral of Leshchinsky *et al.* (1987), are proposed and adopted. These are also added by the linear failure mode of Fukuda *et al.* (1989a). In the case of slip circle method, the safety factor is adopted as 1.2 by Onodera *et al.* (1992). This value is higher than that of any other method. From this fact it can be inferred that the required quantity of reinforcements is different from one method to another under similar design conditions.

[PRACTICAL PERFORMANCE OF REINFORCED SOIL STRUCTURES]

Steep-slope reinforced embankments or walls have been constructed at numerous sites. There are more than 16,000 cases of practical reinforced soil wall construction based on the Terre Armees method, which is considered the principle of all reinforced soil wall construction techniques. The number of achievements in soil structure construction using geosynthetic reinforcement is also increas-

Table 4. Development of design methods for embankment structures reinforced with polymer grids or other geotextiles

Author	Reinforce material (RM)	Length of RM	Strength of RM	Soil constant	Pore water pressure $\gamma_w = u/\gamma_z$	Interacting friction coefficient	Slope angle ($^\circ$)	Ultimate equilibrium model	Layer spacing	Crest surcharge	Notes
Ingold (1982) (design chart)	Geotextile	Parallel, same length	—	ϕ'	—	—	30–80	Endless slope slip circle	Constant	—	Safety of slope
Jewell <i>et al.</i> (1984) (design chart)	Geogrid	Parallel, same length	Safe design strength at end of design	ϕ'_c	$\delta = 0.5\phi'_c$ 0.025, 0.5	(Pullout) $\delta = 0.8\phi'_c$	30–80	Two-part wedge	Arbitrary	Uniform distribution	Most used chart (design method) Safe design strength = specified inservice strength/safety factor = $f_t/\gamma_z F_s$
Jones <i>et al.</i> (1984) (design chart)	Geogrid	Parallel, same length	Same as Jewell's	ϕ'	—	*Refer to notes	90	Slip plane	Arbitrary	Uniform distribution	Design procedure Coherent gravity and tie-back wedge
Yamanouchi <i>et al.</i> (1986)	Geogrid	Parallel, same length	40% of tensile strength	Shirasu ϕ' $\left[\frac{\phi'}{1.5}\right]$	—	Same as Jewell's	30–80	Two-part wedge	Arbitrary	Uniform distribution	• Basically same as Jewell's method • Apply Richardson's method for seismic design • Tensile strength during earthquake = 1.4 × that of static condition
Homopape <i>et al.</i> (1986) (design chart)	Geogrid	Parallel, same length	50% of maximum strength	ϕ'_w	—	Determine by shear box test	45–90	Two-part wedge	Constant	—	Seismic design based on static design method (charting the ratio of dynamic force/static force)
Hirota and Yamaoka (1986) (design chart)	Geotextile	Parallel	Long-term tensile strength	ϕ'	Arbitrary γ_w	$\delta = 2/3\phi'$	Steep slope	Slip circle log-spiral	Constant	Uniform distribution	Proposed the safety factor map
Schneider and Holtz (1986) (design chart)	Geogrid	Parallel	Strength determined from test	ϕ'	0.35	$0.5\phi' < \delta < \phi'$	0–40	Two-part wedge	—	—	Extension of Murray's research, consider the cohesion
Leshchinsky and Perry (1987) (design chart)	Geotextile	Parallel	25–50% of tensile strength	ϕ'	—	$\delta = 2/3\phi'$	15–90	Plane slip log-spiral	Constant	Uniform distribution	Refer to the report of Delaware University, 1985
Schmertmann <i>et al.</i> (1987) (design chart)	Geogrid	Parallel, different length	< 20–40% of tensile strength	ϕ'_f $\left[\frac{\phi'}{1.5}\right]$	—	0.9 times shear strength of soil	30–80	Two-part wedge slip plane	Arbitrary	Uniform distribution	Extension of Jewell's research

Geotechnical Engineering

T. Yamanouchi and N. Fukuda

ing steadily. These earth structures are designed on the principles of classical mechanics taking large safety factors including long-term durability problems on the conservative side. Various laboratory tests, prototype model tests, and instrumented measurement of completed structures are conducted with a view to checking the viability of design method, realising the reinforcement mechanism, and monitoring the structure during and after construction. Several design methods proposed on the basis of the available data do not necessarily reflect the real reinforcing mechanism of reinforced soil structure and some structures are to be assessed as over-designed or very conservative designs. At present, consequently, a series of researches are conducted with the objective of establishing a rational approach to design with practical consideration of reinforcing mechanism and also an economic design. Here some differences between the design and the constructed structure are described on the basis of results from several research works.

Behaviour of Geosynthetic Reinforced Soil Structures

It is clear from the results of field measurement that the tensions in the reinforcements of reinforced soil structures tend to be less than those of the design computation (Fukuda *et al.* 1986 and others).

Field measurements and their comparisons of partial factors of safety were conducted by Rimoldi (1988) on two types of steep-slope reinforced embankments, by Yamanouchi *et al.* (1986a, Kagoshima) and Cazzuffi *et al.* (1988, Modena) on five types of concrete-face reinforced soil walls, by Berg *et al.* (1986, Tucson, Lithonia, Gaspé) on three types of reinforced embankments, and by Christopher (1987, Cascade) and Bathurst *et al.* (1987, Kingston) on two types of reinforced embankments (Table 5). Rowe and Ho (1992) also compared the measured tensions and the results computed by 12 proposed design methods for four types of wall. The 12 proposed design methods are Jewell (1987), Schlosser (1990), Bonaparte *et al.* (1987), Forest Service (1983), Broms (1978), Collin (1986), Tensar Corporation (1986), Murray (1980), Simac *et al.* (1990), Leschinsky and Perry (1989), Schmertmann *et al.* (1987), and Ruegger (1986). As to walls 1 to 3, the designed values are 1.6 to 2.5 times larger than the measured values and hence the design parameters are overestimated. As to wall 4 with plywood facing, 4 m high test wall by Minami *et al.* (1987), the designed values are equal to the measured values.

The above-mentioned trend shows the same result even if the designed parameters of fill material are taken on the safe side. Thus, caution is necessary in the evaluation of reinforcement effect.

Reduction of Earth Pressure on the Wall

In a reinforced soil wall the earth pressure acting on the facing is generally taken at active state. And the reinforced wall with reinforcements of high-tensile stiffness is designed with earth pressure at rest acting at the upper section of the

Table 5. Partial factors of safety for eight instrumented reinforced soil walls steep slopes (Rimoldi 1988, modified by Rowe and Ho, 1992)

Factor of safety	Kagoshima	Tucson	Lithonia	Caspe	Cascade	Kingston'	Kingston''	Modena
FS1	0.9-2.3	0.9-3.2	—	1.05-2.4	0.75	2.16	1.93	2.9
FS2	2.7	1.2	11.6	1.21	1.14	—	—	3.6
FS3	2.5-6.1	1.2	—	1.28-2.9	0.85	—	—	10.9
FS4	11.3-27.0	11.5-32.0	—	9.1-21.0	3.0	32.0	11.4	27.2
FS5	4.5-10.8	4.2-11.6	—	2.4-5.6	2.4	11.6	4.1	13.6

FS1 = α_c/α_m , FS2 = α_f/α_c , FS3 = α_f/α_m , FS4 = α_f/α_m , FS5 = α_c/α_m

α_c = average tensile force using *in situ* parameters

α_m = measured tensile force or tensile force deduced from strain

α_f = average tensile force calculated using design parameters

α_f = peak tensile strength

α_c = allowable tensile strength

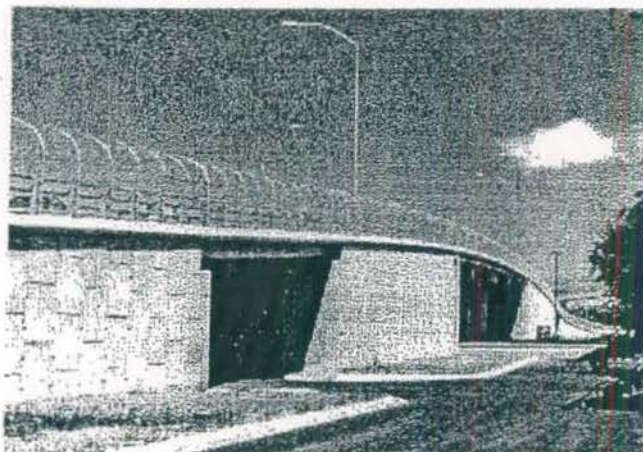
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**U.S. Department of Transportation
Federal Highway Administration**

Publication No. FHWA-NHI-00-043

NHI Course No. 132042

**MECHANICALLY STABILIZED EARTH WALLS AND
REINFORCED SOIL SLOPES
DESIGN & CONSTRUCTION GUIDELINES**



**NHI – National Highway Institute
Office of Bridge Technology**

March 2001

PREFACE

Engineers and specialty material suppliers have been designing reinforced soil structures for the past 25 years. During the last decade significant improvements have been made to design methods and in the understanding of factors affecting the durability of reinforcements.

In order to take advantage of these new developments the FHWA developed a manual (in connection with Demonstration Project No. 82, Ground Improvement), FHWA SA96-071, which is the basis for this updated version. The primary purpose of this manual is to support educational programs conducted by FHWA for transportation agencies.

A second purpose of equal importance is to serve as the FHWA standard reference for highway projects involving reinforced soil structures.

This Mechanically Stabilized Earth Walls (MSE) and Reinforced Soil Slopes (RSS), Design and Construction Guidelines Manual which is a current update of FHWA SA-96-071, has evolved from the following AASHTO and FHWA references:

- ! Reinforced Soil Structures - Volume I, Design and Construction Guidelines - Volume II, Summary of Research and Systems Information, by B.R. Christopher, S.A. Gill, J.P. Giroud, J.K. Mitchell, F. Schlosser, and J. Dunncliff, FHWA RD 89-043.
- ! Geosynthetic Design and Construction Guidelines, by R.D. Holtz, B.R. Christopher, and R.R. Berg, FHWA HI-95-038.
- ! AASHTO, 1992, 1996, 1997, 1998 and 1999 Interims, Section 5.8.
- ! Design and Construction Monitoring of Mechanically Stabilized Earth Structures, by J.A. DiMaggio, FHWA, March 1994.
- ! Guidelines for Design, Specification, and Contracting of Geosynthetic Mechanically Stabilized Earth Slopes on Firm Foundations, by R.R. Berg, FHWA-SA-93-025, January 1993.
- ! AASHTO Bridge T-15 Technical Committee unpublished working drafts for the update of Section 5.8 of the AASHTO Bridge Design Specifications.

The authors recognize the efforts of Mr. Jerry A. DiMaggio, P.E. who was the FHWA Technical Consultant for this work, and served in the same capacity for most of the above referenced publications. Mr. DiMaggio's guidance and input to this and the previous works has been invaluable.

The authors further acknowledge the efforts of Mr. Tony Allen, Washington DOT, members of the AASHTO T-15 committee and the following Technical Working Group members who served as a review panel listed in alphabetical order:

Dr. Donald Bruce	-	ECO Geosystems Inc.
Dr. James Collin	-	The Collin Group
Mr. Albert DiMillio	-	FHWA
Mr. Richard Endres	-	Michigan DOT
Mr. John Hooks	-	FHWA
Dr. John Horvath	-	Manhattan College
Mr. Richard Sheffield	-	Mississippi DOT
Mr. Michael Simac	-	Ground Improvement Technologies
Mr. Ed Tavera	-	Louisiana DOT

Lastly, the authors wish to thank the clerical and computer graphics staff of Earth Engineering and Sciences, Inc. for their vital contributions and significant effort in preparing the earlier version of this manual.

CHAPTER 1

INTRODUCTION

1.1 OBJECTIVES

New methods and technologies of retention and steepened-slope construction continue to be developed, often by specialty contractors and suppliers, to solve problems in locations of restricted Right-of-Way (ROW) and at marginal sites with difficult subsurface conditions and other environmental constraints. Professionals charged with the responsibility of planning, designing, and implementing improvements and additions in such locations need to understand the application, limitations and costs associated with a host of measures and technologies available.

This manual was prepared to assist design engineers, specification writers, estimators, construction inspectors and maintenance personnel with the selection, design and construction of Mechanically Stabilized Earth Walls (MSEW) and Reinforced Soil Slopes (RSS), and the monitoring of their long-term performance.

The design, construction and monitoring techniques for these structures have evolved over the last two decades as a result of efforts by researchers, material suppliers and government agencies to improve some single aspect of the technology or the materials used. This manual is the first single, comprehensive document to integrate all design, construction, materials, contracting and monitoring aspects required for successful project implementation.

This manual has been developed in support of FHWA educational programs on the design and construction monitoring of MSEW retaining structures and RSS construction. Its principal function is to serve as a reference source to the materials presented. The manual serves as FHWA's primary technical guideline on the use of this technology on transportation facilities.

a. Scope

The manual addresses in a comprehensive manner the following areas:

- ! Overview of MSE development and the cost, advantages, and disadvantages of using MSE structures.
- ! Available MSE systems and applications to transportation facilities.
- ! Basic soil-reinforcement interaction.
- ! Design of routine and complex MSE walls.
- ! Design of steepened RSS.

- ! Design of steepened RSS over soft foundations.
- ! Specifications and contracting approaches for both MSE walls and RSS construction.
- ! Construction monitoring and inspection.
- ! Design examples as case histories with detailed cost savings documented.
- ! A separate companion Manual addresses the long-term degradation of metallic and polymeric reinforcements. Sections of the Degradation manual address the background of full-scale, long-term evaluation programs and the procedures required to develop, implement, and evaluate them. These procedures have been developed to provide practical information on this topic for MSE users for non corrosion or polymer specialists, who are interested in developing long-term monitoring programs for these types of structures.

As an integral part of this Manual, several student exercises and workshop problems are included with solutions that demonstrate individual design aspects.

b. Source Documents

The majority of the material presented in this Manual was abstracted from FHWA RD89-043 *"Reinforced Soil Structures, Volume I Design and Construction Guidelines"*, 1996 AASHTO Specifications, both Division I, Design and Division II, Construction, and direct input from the AASHTO Bridge T-15 Technical Committee as part of their effort to update Section 5.8 of the AASHTO Bridge Specifications which resulted in the 1997, 1998, 1999 and 2000 AASHTO Interims.

Additional guidance, where not available from other sources, was specifically developed for this Manual.

c. Terminology

Certain interchangeable terms will be used throughout this Manual. For clarity, they are defined as follows:

Inclusion is a generic term that encompasses all man-made elements incorporated in the soil to improve its behavior. Examples of inclusions are steel strips, geotextile sheets, steel or polymeric grids, steel nails, and steel tendons between anchorage elements. The term *reinforcement* is used only for those inclusions where soil-inclusion stress transfer occurs continuously along the inclusion.

Mechanically Stabilized Earth Wall (MSEW) is a generic term that includes **reinforced soil** (a term used when multiple layers of inclusions act as reinforcement in soils placed as fill). Reinforced Earth is a trademark for a specific reinforced soil system.

Reinforced Soil Slopes (RSS) are a form of reinforced soil that incorporate planar reinforcing elements in constructed earth-sloped structures with face inclinations of less than 70 degrees.

Geosynthetics is a generic term that encompasses flexible polymeric materials used in geotechnical engineering such as geotextiles, geomembranes, geonets, and grids (also known as geogrids).

Facing is a component of the reinforced soil system used to prevent the soil from raveling out between the rows of reinforcement. Common facings include precast concrete panels, dry cast modular blocks, metal sheets and plates, gabions, welded wire mesh, shotcrete, wood lagging and panels, and wrapped sheets of geosynthetics. The facing also plays a minor structural role in the stability of the structure. For RSS structures it usually consists of some type of erosion control material.

Retained backfill is the fill material located between the mechanically stabilized soil mass and the natural soil.

Reinforced backfill is the fill material in which the reinforcements are placed.

Generic cross sections of a mechanically stabilized soil mass in its geotechnical environment is shown in figures 1 and 4.

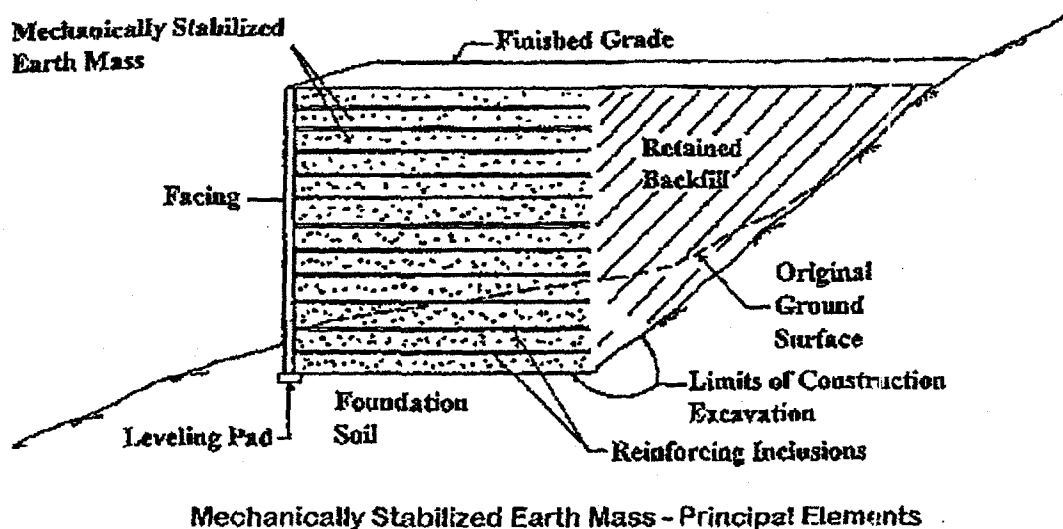


Figure 1. Generic cross section of a MSE structure.

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ance with AWP C22 listed in Chapter 35 and shall be identified in accordance with Section 2311.3.1.

SECTION 1809.0 STEEL GRILLAGES

1809.1 General: All steel grillage beams shall be separated with approved steel spacers and shall be entirely encased in at least 3 inches (76 mm) of concrete and the spaces between the beams shall be completely filled with concrete or cement grout. Where used on yielding soils, steel grillages shall rest on approved concrete beds not less than 6 inches (152 mm) thick.

SECTION 1810.0 CONCRETE FOOTINGS

1810.1 Concrete strength: Concrete in footings shall have a specified compressive strength of not less than 2,500 psi (17235 kPa) at 28 days.

1810.2 Design: Concrete footings shall comply with Chapter 19 and ACI 318 listed in Chapter 35.

1810.2.1 Footing seismic ties: Individual spread footings, located on soil-profile type S_1 , S_2 , or S_3 , in accordance with Section 1610.3.1, and supporting buildings assigned to Seismic Performance Category D or E, in accordance with Section 1610.1.7, shall be interconnected by ties. All ties shall be capable of resisting, in tension or compression, a force equal to 25 percent of the effective peak velocity-related acceleration (A_v) times the column *dead plus live load*. Individual tie beams are not required when it is demonstrated that equivalent restraint will be provided by structural members within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils, very dense granular soils or other approved means.

1810.3 Thickness: The thickness of concrete footings shall comply with Sections 1810.3.1 and 1810.3.2.

1810.3.1 Plain concrete: In plain concrete footings, the edge thickness shall not be less than 8 inches (203 mm) for footings on soil; except that for occupancies of Use Group R-3 and buildings less than two stories in *height* of Type 5 construction, the required edge thickness shall be reduced to 6 inches (152 mm), provided that the footing does not extend beyond 4 inches (102 mm) on either side of the supported wall.

1810.3.2 Reinforced concrete: In reinforced concrete footings, the thickness above the bottom reinforcement shall not be less than 6 inches (152 mm) for footings on soil, nor less than 12 inches (305 mm) for footings on piles. The cover provided for reinforcement shall comply with Section 1910.6.

1810.4 Deposition: Concrete footings shall not be placed through water unless otherwise approved. Where placed under or in the presence of water, the concrete shall be deposited by approved means to ensure minimum segregation of the mix and negligible turbulence of the water.

1810.5 Protection of concrete: Concrete footings shall be protected from freezing during depositing and for a period of not less than 5 days thereafter. Water shall not be allowed to flow through the deposited concrete.

1810.6 Forming of concrete: Concrete footings shall not be cast against the earth where, in the opinion of the code official, soil conditions warrant forming. Where forming is required, forming

shall be in accordance with Chapter 6 of ACI 318 listed in Chapter 35.

SECTION 1811.0 MASONRY-UNIT FOOTINGS

1811.1 Dimensions: Masonry-unit footings shall be laid in Type M or S mortar complying with Section 2104.7, and the depth shall not be less than twice the projection beyond the wall, pier or column. The width shall not be less than 8 inches (203 mm) wider than the wall supported thereon.

1811.2 Offsets: The maximum offset of each course in brick foundation walls stepped up from the footings shall be 1½ inches (38 mm) if laid in single courses, and 3 inches (76 mm) if laid in double courses.

SECTION 1812.0 FOUNDATION WALLS

1812.1 Design: Foundation walls shall be designed to resist frost action and the structural *loads* of Chapter 16 in accordance with the provisions of this section.

1812.2 Definitions: The following words and terms shall, for the purposes of this section and as used elsewhere in this code, have the meanings shown herein.

Wall

Foundation wall: A wall below the floor nearest grade which serves as a structural support for a wall, pier, column or other part of a building, or the wall of a *basement* that resists *lateral soil load*.

Retaining wall: A wall that is not laterally supported at the top, designed to resist *lateral soil load*.

1812.3 Minimum thickness: The minimum thickness of concrete and masonry foundation walls that are laterally supported at the top and bottom shall comply with Sections 1812.3.1 through 1812.3.3, or shall be designed in accordance with ACI 530/ASCE 5/TMS 402 or ACI 318 listed in Chapter 35. Foundation walls that are not laterally supported at the top and bottom and foundation walls that are not within the parameters of Table 1812.3.2(1) or Table 1812.3.2(2) shall be designed in accordance with ACI 530/ASCE 5/TMS 402 or ACI 318 listed in Chapter 35.

1812.3.1 Thickness based on walls supported: The thickness of foundation walls shall not be less than the thickness of the wall supported, except that foundation walls of at least 8-inch nominal width shall be permitted to support brick-veneered frame walls and 10-inch-wide (254 mm) cavity walls where the total height of the wall supported, including gables, is not more than 20 feet (6096 mm), provided the requirements of Section 1812.3.2 are met. Corbeling of masonry shall be in accordance with Section 2111.2. Where an 8-inch (203 mm) wall is corbeled, the top corbel shall be a full course of headers at least 6 inches (152 mm) in length, extending not higher than the bottom of the floor framing.

1812.3.2 Thickness based on soil loads, unbalanced back-fill height and wall height: The thickness of foundation walls shall comply with the requirements of Table 1812.3.2(1) for plain masonry and plain concrete walls or Table 1812.3.2(2) for reinforced masonry walls.

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1808.2 Pole buildings: Pole-type buildings shall be designed and erected in an approved manner. The poles shall be treated in accordance with AWPAC2 or C4 listed in Chapter 35.

1808.3 Wood foundations: Wood foundation systems shall be designed and installed in accordance with AFPA TR7 listed in Chapter 35. All lumber and plywood shall be treated in accordance with AWPAC22 listed in Chapter 35 and shall be identified in accordance with Section 2311.3.1.

SECTION 1809.0 STEEL GRILLAGES

1809.1 General: All steel grillage beams shall be separated with approved steel spacers and shall be entirely encased in at least 3 inches (76 mm) of concrete and the spaces between the beams shall be completely filled with concrete or cement grout. Where used on yielding soils, steel grillages shall rest on approved concrete beds not less than 6 inches (152 mm) thick.

SECTION 1810.0 CONCRETE FOOTINGS

1810.1 Concrete strength: Concrete in footings shall have a specified compressive strength of not less than 2,500 psi (17235 kPa) at 28 days.

1810.2 Design: Concrete footings shall comply with Chapter 19 and ACI 318 listed in Chapter 35.

1810.2.1 Footing seismic ties: Individual spread footings, located on soil-profile type S_2 , S_3 or S_4 , in accordance with Section 1610.3.1, and supporting buildings assigned to Seismic Performance Category D or E, in accordance with Section 1610.1.7, shall be interconnected by ties. All ties shall be capable of resisting, in tension or compression, a force equal to 25 percent of the effective peak velocity-related acceleration (A_v) times the column *dead plus live load*. Individual tie beams are not required when it is demonstrated that equivalent restraint will be provided by structural members within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils, very dense granular soils or other approved means.

1810.3 Thickness: The thickness of concrete footings shall comply with Sections 1810.3.1 and 1810.3.2.

1810.3.1 Plain concrete: In plain concrete footings, the edge thickness shall not be less than 8 inches (203 mm) for footings on soil; except that for occupancies of Use Group R-3 and buildings less than two stories in *height* of Type 5 construction, the required edge thickness shall be reduced to 6 inches (152 mm), provided that the footing does not extend beyond 4 inches (102 mm) on either side of the supported wall.

1810.3.2 Reinforced concrete: In reinforced concrete footings, the thickness above the bottom reinforcement shall not be less than 6 inches (152 mm) for footings on soil, nor less than 12 inches (305 mm) for footings on piles. The cover provided for reinforcement shall comply with Section 1910.6.

1810.4 Deposition: Concrete footings shall not be placed through water unless otherwise approved. Where placed under or in the presence of water, the concrete shall be deposited by approved means to ensure minimum segregation of the mix and negligible turbulence of the water.

1810.5 Protection of concrete: Concrete footings shall be protected from freezing during depositing and for a period of not less than 5 days thereafter. Water shall not be allowed to flow through the deposited concrete.

1810.6 Forming of concrete: Concrete footings shall not be cast against the earth where, in the opinion of the code official, soil conditions warrant forming. Where forming is required, forming shall be in accordance with Chapter 6 of ACI 318 listed in Chapter 35.

SECTION 1811.0 MASONRY-UNIT FOOTINGS

1811.1 Dimensions: Masonry-unit footings shall be laid in Type M or S mortar complying with Section 2104.7, and the depth shall not be less than twice the projection beyond the wall, pier or column. The width shall not be less than 8 inches (203 mm) wider than the wall supported thereon.

1811.2 Offsets: The maximum offset of each course in brick foundation walls stepped up from the footings shall be 1½ inches (38 mm) if laid in single courses, and 3 inches (76 mm) if laid in double courses.

SECTION 1812.0 FOUNDATION WALLS

1812.1 Design: Foundation walls shall be designed to resist frost action and the structural *loads* of Chapter 16 in accordance with the provisions of this section.

1812.2 Definitions: The following words and terms shall, for the purposes of this section and as used elsewhere in this code, have the meanings shown herein.

Brick ledge: A recess in the thickness of a foundation wall for bearing support of a masonry wythe. The recess is constructed from the top of the foundation wall for a certain depth and from the exterior face of a foundation wall for a certain width.

Wall

Foundation wall: A wall below the floor nearest grade which serves as a structural support for a wall, pier, column or other part of a building, or the wall of a *basement* that resists *lateral soil load*.

Retaining wall: A wall that is not laterally supported at the top, designed to resist *lateral soil load*.

1812.3 Minimum thickness: The minimum thickness of concrete and masonry foundation walls that are laterally supported at the top and bottom shall comply with Sections 1812.3.1 through 1812.3.3, or shall be designed in accordance with ACI 530/ASCE 5/TMS 402 or ACI 318 listed in Chapter 35. Foundation walls that are not laterally supported at the top and bottom and foundation walls that are not within the parameters of Table 1812.3.2(1) or Table 1812.3.2(2) shall be designed in accordance with ACI 530/ASCE 5/TMS 402 or ACI 318 listed in Chapter 35.

1812.3.1 Thickness based on walls supported: The thickness of foundation walls shall not be less than the thickness of the wall supported, except that foundation walls of at least 8-inch nominal width shall be permitted to support brick-veneered frame walls and 10-inch-wide (254 mm) cavity walls provided the requirements of Section 1812.3.2 are met. Corbeling of masonry shall be in accordance with Section 2111.2.

EXHIBIT G-3

International Building Code



McKenna Long & Aldridge
1900 K St., N.W. #100
Washington, DC 20006

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1900 K St., N.W. #100
Washington, DC 20006

2000



- POSITIVE ROOF DRAINAGE.** See Section 1502.1.
- PRECAST CONCRETE.** See Section 1902.1.
- PRESERVATIVE-TREATED WOOD.** See Section 2302.1.
- PRESTRESSED CONCRETE.** See Section 1902.1.
- PRISM.** See Section 2102.1.
- PROSCENIUM WALL.** See Section 410.2.
- PUBLIC ENTRANCE.** See Section 1102.1.
- PUBLIC-USE AREAS.** See Section 1102.1.
- PUBLIC WAY.** See Section 1002.1.
- [F] PYROPHORIC.** See Section 307.2.
- [F] PYROTECHNIC COMPOSITION.** See Section 307.2.
- QUALITY ASSURANCE PLAN.** A written procedure complying with the requirements of Section 1705.
- RAMP.** See Section 1002.1.
- RAMP-ACCESS OPEN PARKING GARAGES.** See Section 406.3.2.
- [F] RECORD DRAWINGS.** See Section 902.1.
- REFERENCE RESISTANCE (*D*).** See Section 2302.1.
- REGISTERED DESIGN PROFESSIONAL.** An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.
- REINFORCED CONCRETE.** See Section 1902.1.
- REINFORCED PLASTIC, GLASS FIBER.** See Section 2602.1.
- REINFORCEMENT.** See Section 1902.1.
- REPAIR.** The reconstruction or renewal of any part of an existing building for the purpose of its maintenance.
- REQUIRED STRENGTH.** See Sections 1602.1 and 2102.1.
- REROOFING.** See Section 1502.1.
- RESHORES.** See Section 1902.1.
- RESIDENTIAL AIRCRAFT HANGAR.** See Section 412.3.1.
- RESIDENTIAL CARE/ASSISTED LIVING FACILITIES.** See Section 310.2.
- RESISTANCE FACTOR.** See Section 1602.1.
- REVIEWING STANDS.** See Section 1002.1.
- ROOF ASSEMBLY.** See Section 1502.1.
- ROOF COVERING.** See Section 1502.1.
- ROOF COVERING SYSTEM.** See Section 1502.1.
- ROOF DECK.** See Section 1502.1.
- ROOF RECOVER.** See Section 1502.1.
- ROOF REPAIR.** See Section 1502.1.
- ROOF REPLACEMENT.** See Section 1502.1.
- ROOF VENTILATION.** See Section 1502.1.
- ROOFTOP STRUCTURE.** See Section 1502.1.
- RUBBLE MASONRY.** See Section 2102.1.
- Coursed rubble.** See Section 2102.1.
- Random rubble.** See Section 2102.1.
- Rough or ordinary rubble.** See Section 2102.1.
- RUNNING BOND.** See Section 2102.1.
- SALLYPORT.** See Section 408.1.1.
- SCUPPER.** See Section 1502.1.
- SELF-CLOSING.** See Section 702.1.
- SELF-SERVICE STORAGE FACILITY.** See Section 1102.1.
- [F] SERVICE CORRIDOR.** See Section 415.2.
- SERVICE ENTRANCE.** See Section 1102.1.
- SHAFT.** See Section 702.1.
- SHAFT ENCLOSURE.** See Section 702.1.
- SHALLOW ANCHORS.** See Section 1602.1.
- SHEAR PANEL.** See Section 1602.1.
- SHEAR WALL.** See Sections 1602.1 and 1613.1.
- Detailed Plain Masonry Shear Wall.** A masonry shear wall designed to resist lateral forces neglecting stresses in reinforcement, and designed in accordance with Section 2106.1.1.3.
- Intermediate Reinforced Masonry Shear Wall.** A masonry shear wall designed to resist lateral forces considering stresses in reinforcement, and designed in accordance with Section 2106.1.1.4.
- Ordinary Plain Masonry Shear Wall.** A masonry shear wall designed to resist lateral forces neglecting stresses in reinforcement, and designed in accordance with Section 2106.1.1.1.
- Ordinary Reinforced Masonry Shear Wall.** A masonry shear wall designed to resist lateral forces considering stresses in reinforcement, and designed in accordance with Section 2106.1.1.2.
- Special Reinforced Masonry Shear Wall.** A masonry shear wall designed to resist lateral forces considering stresses in reinforcement, and designed in accordance with Section 2106.1.1.5.

- SHELL.** See Section 2102.1.
- SHORES.** See Section 1902.1.
- SHOTCRETE.** See Section 1914.1.
- SINGLE-PLY MEMBRANE.** See Section 1502.1.
- [F] SINGLE-STATION SMOKE ALARM.** See Section 902.1.
- SITE.** See Section 1102.1.
- SKYLIGHTS AND SLOPED GLAZING.** Glass or other transparent or translucent glazing material installed at a slope of 15 degrees or more from vertical. Glazing material in skylights, solariums, sun spaces, roofs and sloped walls are included in this definition.
- SLEEPING ACCOMMODATIONS.** See Section 1102.1.
- [F] SMOKE ALARM.** See Section 902.1.
- SMOKE BARRIER.** See Section 702.1.
- SMOKE COMPARTMENT.** See Section 702.1.
- SMOKE DAMPER.** See Section 702.1.
- [F] SMOKE DETECTOR.** See Section 902.1.
- SMOKE-DEVELOPED INDEX.** See Section 802.1.
- SMOKE-PROTECTED ASSEMBLY SEATING.** See Section 1002.1.
- SMOKEPROOF ENCLOSURE.** See Section 902.1.
- [F] SOLID.** See Section 415.2.
- SPECIAL AMUSEMENT BUILDING.** See Section 411.2.
- SPECIAL INSPECTION.** See Section 1702.1.
- Special continuous inspection.** See Section 1702.1.
- Special periodic inspection.** See Section 1702.1.
- SPECIAL TRANSVERSE REINFORCEMENT.** See Section 1602.1.
- SPECIFIED.** See Section 2102.1.
- SPECIFIED COMPRESSIVE STRENGTH OF MASONRY ($f'm$).** See Section 2102.1.
- SPIRAL REINFORCEMENT.** See Section 1902.1.
- SPIRAL STAIRWAY.** See Section 1002.1.
- SPLICE.** See Section 702.1.
- SPRAYED FIRE-RESISTANT MATERIALS.** See Section 1702.1.
- STACK BOND.** See Section 2102.1.
- STAGE.** See Section 410.2.
- STAIR.** See Section 1002.1.
- STAIRWAY.** See Section 1002.1.
- STAIRWAY, EXTERIOR.** See Section 1002.1.
- STAIRWAY, INTERIOR.** See Section 1002.1.
- STAIRWAY, SPIRAL.** See Section 1002.1.
- [F] STANDPIPE SYSTEM, CLASSES OF.** See Section 902.1.
- Class I system.** See Section 902.1.
- Class II system.** See Section 902.1.
- Class III system.** See Section 902.1.
- [F] STANDPIPE, TYPES OF.** See Section 902.1.
- Automatic dry.** See Section 902.1.
- Automatic wet.** See Section 902.1.
- Manual dry.** See Section 902.1.
- Manual wet.** See Section 902.1.
- Semiautomatic dry.** See Section 902.1.
- STEEL CONSTRUCTION, COLD-FORMED.** See Section 2202.1.
- STEEL JOIST.** See Section 2202.1.
- STEEL MEMBER, STRUCTURAL.** See Section 2202.1.
- STEEP SLOPE.** A roof slope greater than two units vertical in 12 units horizontal (17-percent slope).
- STIRRUP.** See Section 2102.1.
- STONE MASONRY.** See Section 2102.1.
- Ashlar stone masonry.** See Section 2102.1.
- Rubble stone masonry.** See Section 2102.1.
- [F] STORAGE OF HAZARDOUS MATERIALS.** See Section 415.2.
- STORY.** That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above (also see "Basement" and "Mezzanine"). It is measured as the vertical distance from top to top of two successive tiers of beams or finished floor surfaces and, for the topmost story, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.
- STORY ABOVE GRADE PLANE.** Any story having its finished floor surface entirely above grade plane, except that a basement shall be considered as a story above grade plane where the finished surface of the floor above the basement is:
1. More than 6 feet (1829 mm) above grade plane;
 2. More than 6 feet (1829 mm) above the finished ground level for more than 50 percent of the total building perimeter; or

3. More than 12 feet (3658 mm) above the finished ground level at any point.

STRENGTH. See Section 2102.1.

Design strength. See Section 2102.1.

Nominal strength. See Sections 1602.1 and 2102.1.

STRENGTH DESIGN. See Section 1602.1.

STRUCTURAL CONCRETE. See Section 1902.1.

STRUCTURAL GLUED-LAMINATED TIMBER. See Section 2302.1.

STRUCTURAL OBSERVATION. See Section 1702.1.

STRUCTURE. That which is built or constructed.

SUBDIAPHRAGM. See Section 2302.1.

[F] SUPERVISING STATION. See Section 902.1.

[F] SUPERVISORY SERVICE. See Section 902.1.

[F] SUPERVISORY SIGNAL. See Section 902.1.

[F] SUPERVISORY SIGNAL-INITIATING DEVICE. See Section 902.1.

SWIMMING POOLS. See Section 3109.2.

T RATING. See Section 702.1.

TECHNICALLY INFEASIBLE. See Section 1102.1.

TENDON. See Section 1902.1.

TENT. Any structure, enclosure or shelter which is constructed of canvas or pliable material supported in any manner except by air or the contents it protects.

THERMOPLASTIC MATERIAL. See Section 2602.1.

THERMOSETTING MATERIAL. See Section 2602.1.

THROUGH-PENETRATION. See Section 702.1.

THROUGH PENETRATION FIRESTOP SYSTEM. See Section 702.1.

TIE, LATERAL. See Section 2102.1.

TIE, WALL. See Section 2102.1.

TIE-DOWN (HOLD-DOWN). See Section 2302.1.

TILE. See Section 2102.1.

TILE, STRUCTURAL CLAY. See Section 2102.1.

[F] TIRES, BULK STORAGE OF. See Section 902.1.

[F] TOXIC. See Section 307.2.

TREATED WOOD. See Section 2302.1.

TRIM. See Section 802.1.

[F] TROUBLE SIGNAL. See Section 902.1.

UNDERLAYMENT. See Section 1502.1.

[F] UNSTABLE (REACTIVE) MATERIAL. See Section 307.2.

Class 4. See Section 307.2.

Class 3. See Section 307.2.

Class 2. See Section 307.2.

Class 1. See Section 307.2.

[F] USE (MATERIAL). See Section 415.2.

VAPOR RETARDER. A material having a permeance rating of 1.0 perm or less, when tested in accordance with ASTM E 96, such as foil, plastic sheeting, or insulation facing, installed to resist the transmission of water vapor through the exterior envelope.

VENEER. See Section 1402.1.

VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

[F] VISIBLE ALARM NOTIFICATION APPLIANCE. See Section 902.1.

WALKWAY, PEDESTRIAN. A walkway used exclusively as a pedestrian trafficway.

WALL. See Section 2102.1.

Cavity Wall. See Section 2102.1.

Composite Wall. See Section 2102.1.

Dry-stacked, surface-bonded wall. See Section 2102.1.

Masonry-bonded hollow wall. See Section 2102.1.

Parapet wall. See Section 2102.1.

WALL FRAME. See Section 2102.1.

WALL, LOAD BEARING. See Section 1602.1.

WALL, NONLOAD BEARING. See Section 1602.1.

[F] WATER-REACTIVE MATERIAL. See Section 307.2.

Class 3. See Section 307.2.

Class 2. See Section 307.2.

Class 1. See Section 307.2.

WEATHER-EXPOSED SURFACES. See Section 2502.

WEB. See Section 2102.1.

[F] WET-CHEMICAL EXTINGUISHING SYSTEM. See Section 902.1.

WHEELCHAIR SPACE. See Section 1102.1.

WHEELCHAIR SPACE CLUSTER. See Section 1102.1.

WIND-BORNE DEBRIS REGION. See Section 1609.2.

WIRE BACKING. See Section 2502.

[F] WIRELESS PROTECTION SYSTEM. See Section 902.1.

WOOD SHEAR PANEL. See Section 2302.1.

WOOD STRUCTURAL PANEL. See Section 2302.1.

[F] WORKSTATION. See Section 415.2.

WYTHER. See Section 2102.1.

YARD. An open space, other than a court, unobstructed from the ground to the sky, except where specifically provided by this code, on the lot on which a building is situated.

[F] ZONE. See Section 902.1.

①

DERIVATION OF GEOGRID FOOTPRINT
(BASED ON SPECIFICATIONS IN RYAN & ASSOC.'S FINAL DESIGNS)

Ryan Section #	Exterior Wall Face	Start Point	End Point	Segment Width (feet)	Geogrid Length (feet)	Moss Depth (feet)	Total Depth (feet)
1	East	0 + 00	0 + 45	45	13.5	1	14.5
1	North	0 + 45	0 + 63	18	13.5	1	14.5
2	North	0 + 63	1 + 18	55	17	1	18
3	North	1 + 18	1 + 88	70	24	1	25
4	North	1 + 88	2 + 27	40	27	1	28
4	N.W.	2 + 27	2 + 55	28	27	1	28
4	West	2 + 55	2 + 80	25	27	1	28
3	West	2 + 80	3 + 35	55	24	1	25
1	West	3 + 35	3 + 98	63	13.5	1	14.5

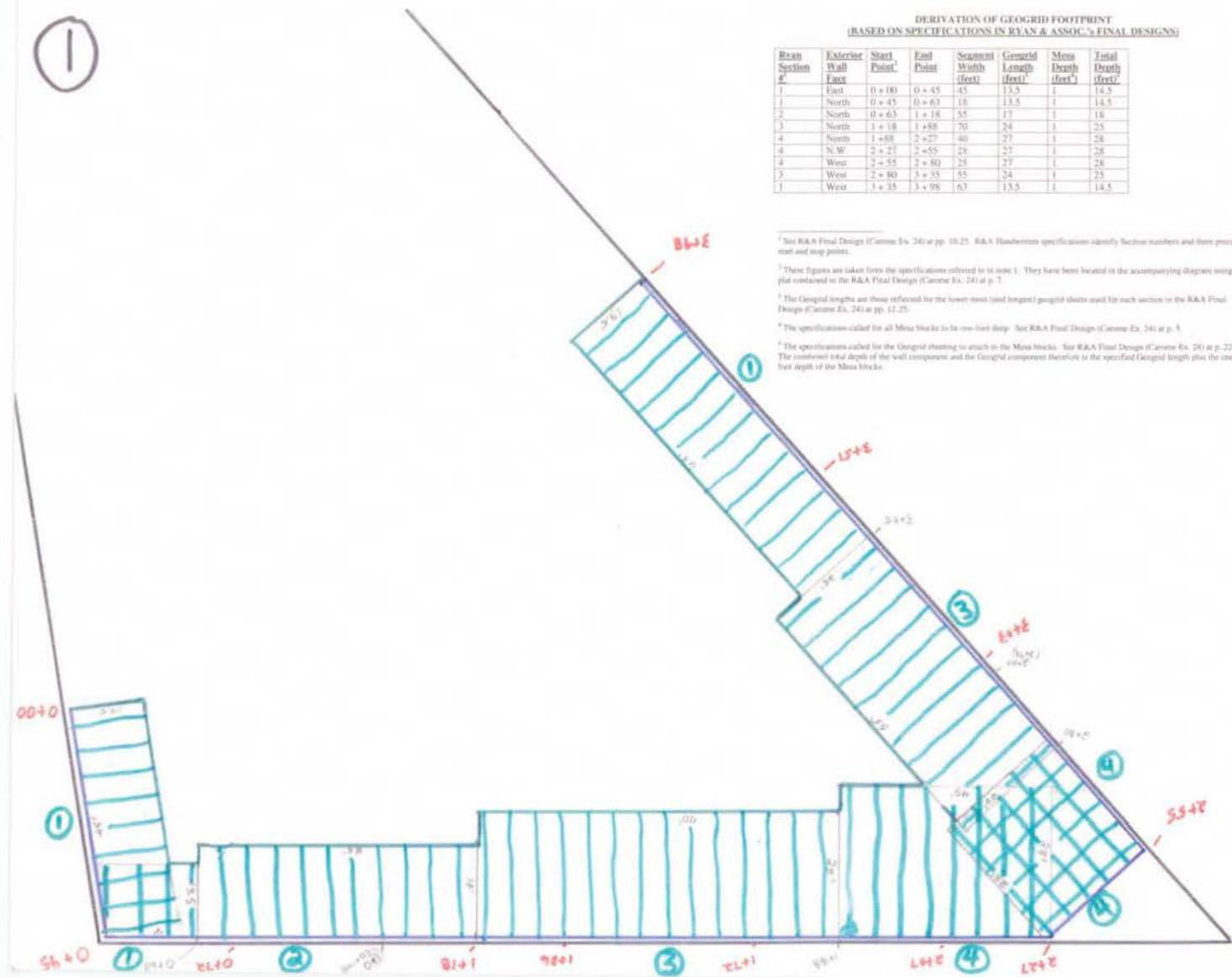
¹ See R&A Final Design (Carume Ex. 24) at pp. 10-25. R&A Handwritten specifications identify Section numbers and their precise start and stop points.

² These figures are taken from the specifications referred to in note 1. They have been located in the accompanying diagrams using the plot contained in the R&A Final Design (Carume Ex. 24) at p. 7.

³ The Geogrid lengths are those reflected for the lower-most (and longest) geogrid sheets used for each section in the R&A Final Design (Carume Ex. 24) at pp. 12-25.

⁴ The specifications called for all Moss blocks to be one-foot deep. See R&A Final Design (Carume Ex. 24) at p. 5.

⁵ The specifications called for the Geogrid sheeting to attach to the Moss blocks. See R&A Final Design (Carume Ex. 24) at p. 22. The combined total depth of the wall component and the Geogrid component therefore is the specified Geogrid length plus the one-foot depth of the Moss blocks.

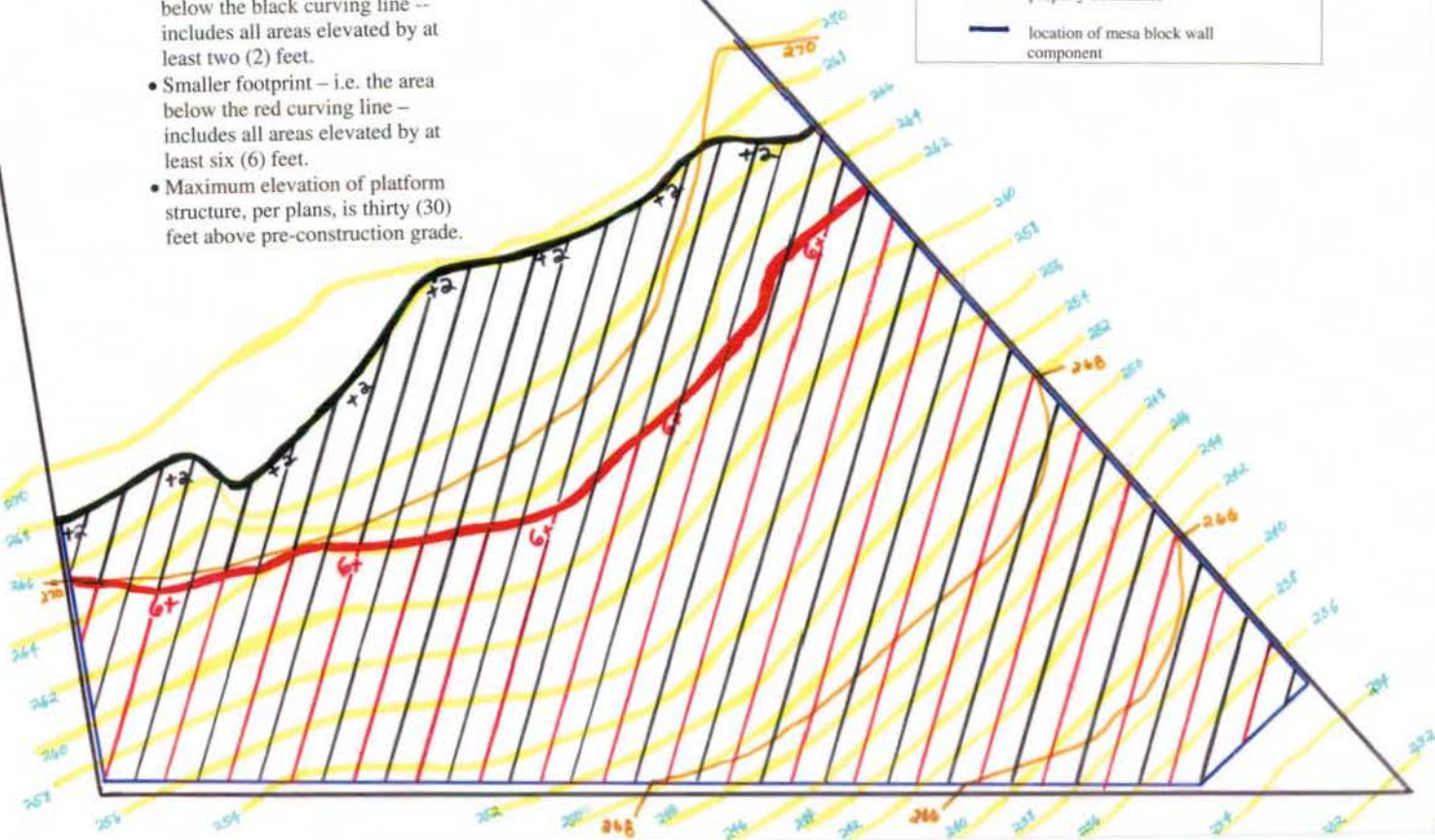


FOOTPRINT OF STUCTURE'S ELEVATED PLATFORM COMPONENT

- Footprint derived by comparing pre-construction elevations shown on 2002 CAS plans (Carome Ex. 25, p. 7) to post-construction elevations shown on 2004 CAS plans (Carome Ex. 23).
- Larger footprint – i.e., the area below the black curving line -- includes all areas elevated by at least two (2) feet.
- Smaller footprint – i.e. the area below the red curving line – includes all areas elevated by at least six (6) feet.
- Maximum elevation of platform structure, per plans, is thirty (30) feet above pre-construction grade.

②

- Key:
- pre-construction elevations
 - post-construction elevations
 - limit of platform area elevated at least 2 feet
 - limit of platform area elevated at least 6 feet
 - property boundaries
 - location of mesa block wall component

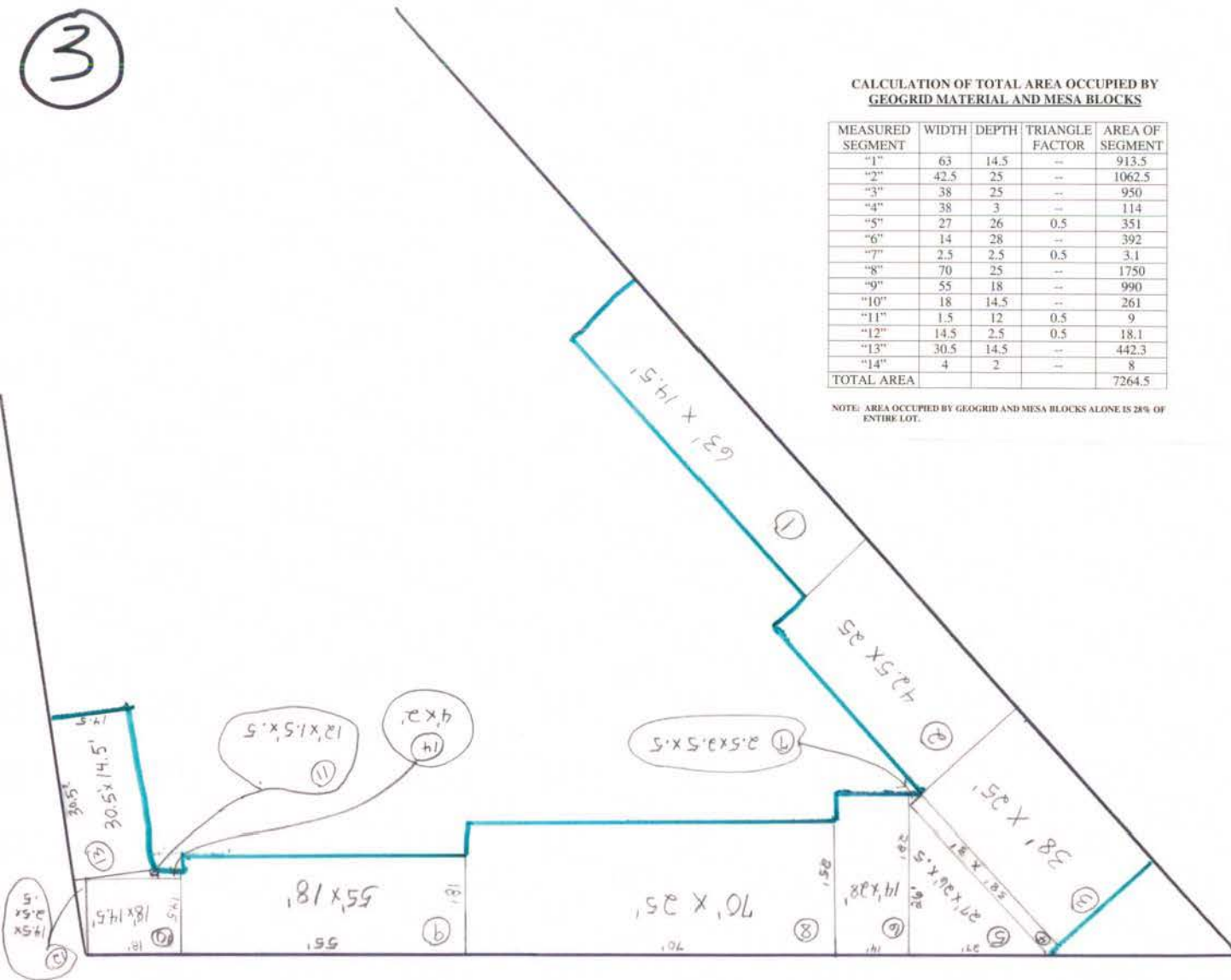


③

CALCULATION OF TOTAL AREA OCCUPIED BY GEOGRID MATERIAL AND MESA BLOCKS

MEASURED SEGMENT	WIDTH	DEPTH	TRIANGLE FACTOR	AREA OF SEGMENT
"1"	63	14.5	--	913.5
"2"	42.5	25	--	1062.5
"3"	38	25	--	950
"4"	38	3	--	114
"5"	27	26	0.5	351
"6"	14	28	--	392
"7"	2.5	2.5	0.5	3.1
"8"	70	25	--	1750
"9"	55	18	--	990
"10"	18	14.5	--	261
"11"	1.5	12	0.5	9
"12"	14.5	2.5	0.5	18.1
"13"	30.5	14.5	--	442.3
"14"	4	2	--	8
TOTAL AREA				7264.5

NOTE: AREA OCCUPIED BY GEOGRID AND MESA BLOCKS ALONE IS 28% OF ENTIRE LOT.



4

CALCULATION OF AREA OF "REQUIRED" REAR YARD

CODE METHOD (25 foot strip closest to rear lot line)

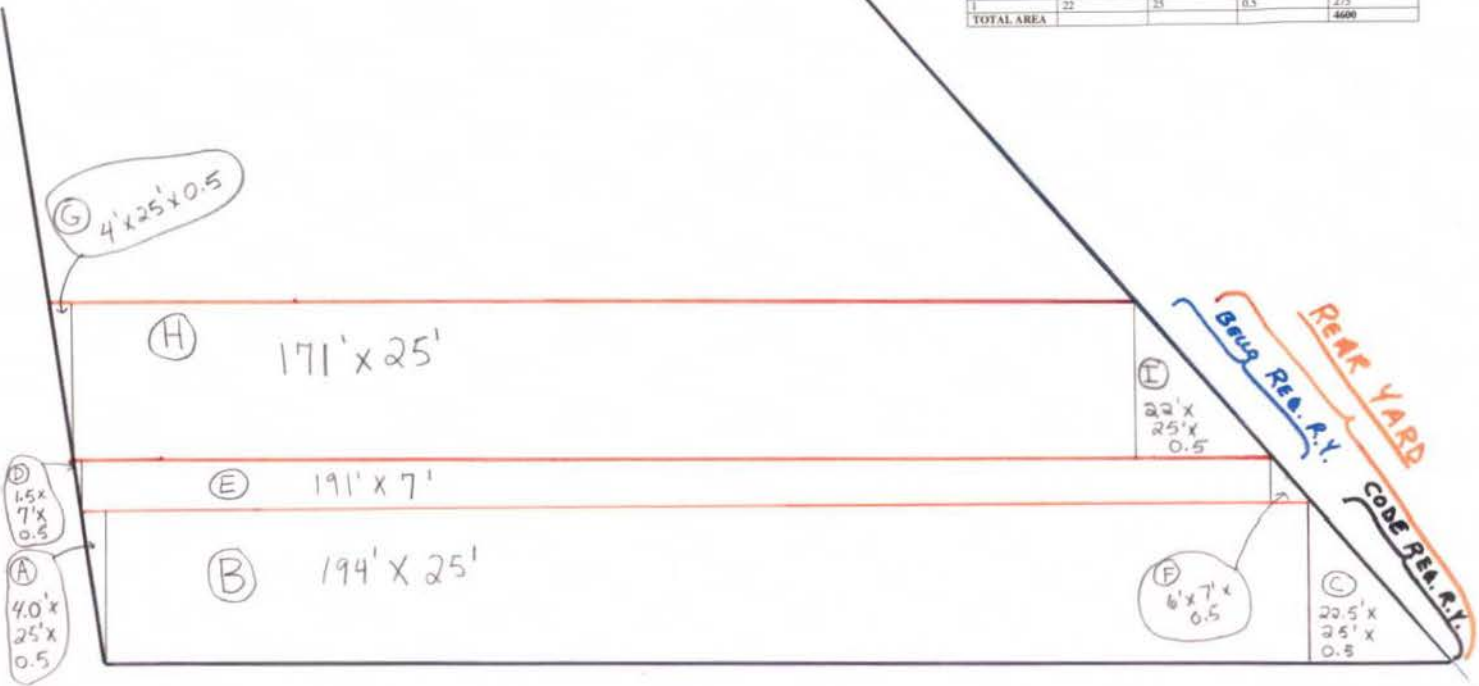
MEASURED SEGMENT	WIDTH	DEPTH	TRIANGLE FACTOR	SEGMENT AREA (sq. feet)
A	4	25	0.5	50
B	194	25	—	4850
C	22.5	25	0.5	913.5
TOTAL AREA				5813.5

WHOLE YARD METHOD (full area behind rear of dwelling)

MEASURED SEGMENT	WIDTH (feet)	DEPTH (feet)	TRIANGLE FACTOR	SEGMENT AREA (sq. feet)
A	4	25	0.5	50
B	194	25	—	4850
C	22.5	25	0.5	281.3
D	1.5	7	0.5	5.3
E	191	7	—	1337
F	6	7	0.5	21
G	4	25	0.5	50
H	171	25	—	4275
I	22	25	0.5	275
TOTAL AREA				11344.6

BE LO METHOD (first 25 feet behind rear of dwelling)

MEASURED SEGMENT	WIDTH	DEPTH	TRIANGLE FACTOR	SEGMENT AREA (sq. feet)
G	4	25	0.5	50
H	171	25	—	4275
I	22	25	0.5	275
TOTAL AREA				4600



5

YARD OCCUPANCY CALCULATION: MESA BLOCK AND GEOGRID ONLY

OCCUPANCY OF "CODE METHOD" REQUIRED REAR YARD

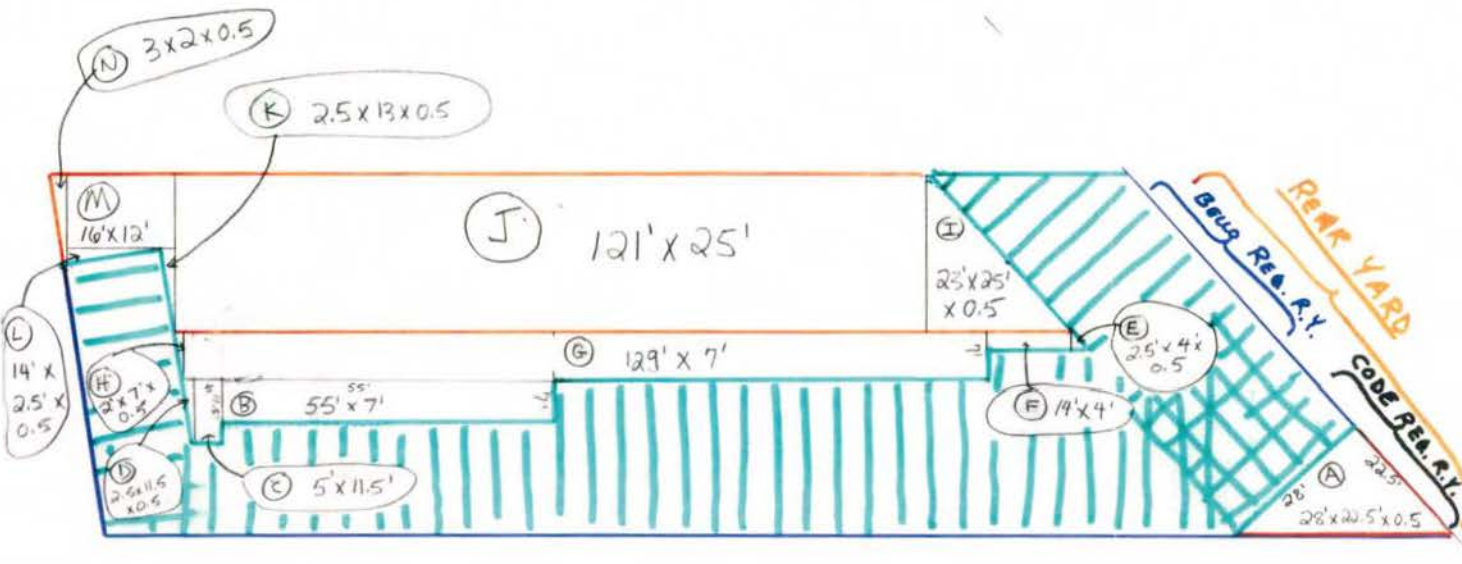
AREA OCCUPIED = TOTAL YARD AREA - (A+B+C+D)
 = 5813.5 - (315 + 385 + 57.5 + 14.4) = 5041.6
 OCCUPANCY RATIO = AREA OCCUPIED / TOTAL YARD AREA = 5041.6 / 5813.5
 OCCUPANCY RATIO = 86.7%

OCCUPANCY OF "WHOLE YARD" REQUIRED REAR YARD

AREA OCCUPIED = TOTAL YARD AREA - (A+B+C+D+E+F+G+H+I+J+K+L+M+N)
 = 11144.6 - 5284.2 = 5860.4
 OCCUPANCY RATIO = AREA OCCUPIED / TOTAL YARD AREA = 5860.4 / 11144.6
 OCCUPANCY RATIO = 52.5%

DATA TABLE

SUBTRACTION SEGMENT	WIDTH (feet)	DEPTH (feet)	TRIANGLE FACTOR	AREA (sq. feet)
A	22.5	28	0.5	315
B	35	7	—	385
C	5	11.5	—	57.5
D	2.5	11.5	0.5	14.4
E	2.5	4	0.5	5
F	14	4	—	56
G	120	7	—	840
H	2	25	0.5	25
I	25	25	—	3025
J	121	25	—	3025
K	2.5	13	0.5	16.3
L	14	2.5	0.5	17.5
M	16	12	—	192
N	3	2	0.5	3
TOTAL AREA				5284.2



6

LOT OCCUPANCY RATIO = AREA OCCUPIED / TOTAL YARD AREA
= 14975.1 / 25811"
LOT OCCUPANCY RATIO = 58%

ADDITION SEGMENT	WIDTH (feet)	DEPTH (feet)	TRIANGLE FACTOR	AREA (sq. feet)
Z	47	54	0.5	1269
Y	20	49	0.5	490
X	47.5	19	0.5	451.3
W	47.5	30	—	1425
V	11	28	0.5	154
U	26	28	0.5	364
T	14	14.5	—	203
S	13	7	0.5	45.5
TOTAL AREA				4401.8

OCCUPANCY OF "CODE METHOD" REQUIRED REAR YARD

AREA OCCUPIED = TOTAL YARD AREA - (D)
= 5813.5 - (312.5) = 5498.5
OCCUPANCY RATIO = AREA OCCUPIED / TOTAL YARD AREA = 5498.5 / 5813.5
OCCUPANCY RATIO = 94.6%

OCCUPANCY OF "WHOLE YARD" REQUIRED REAR YARD

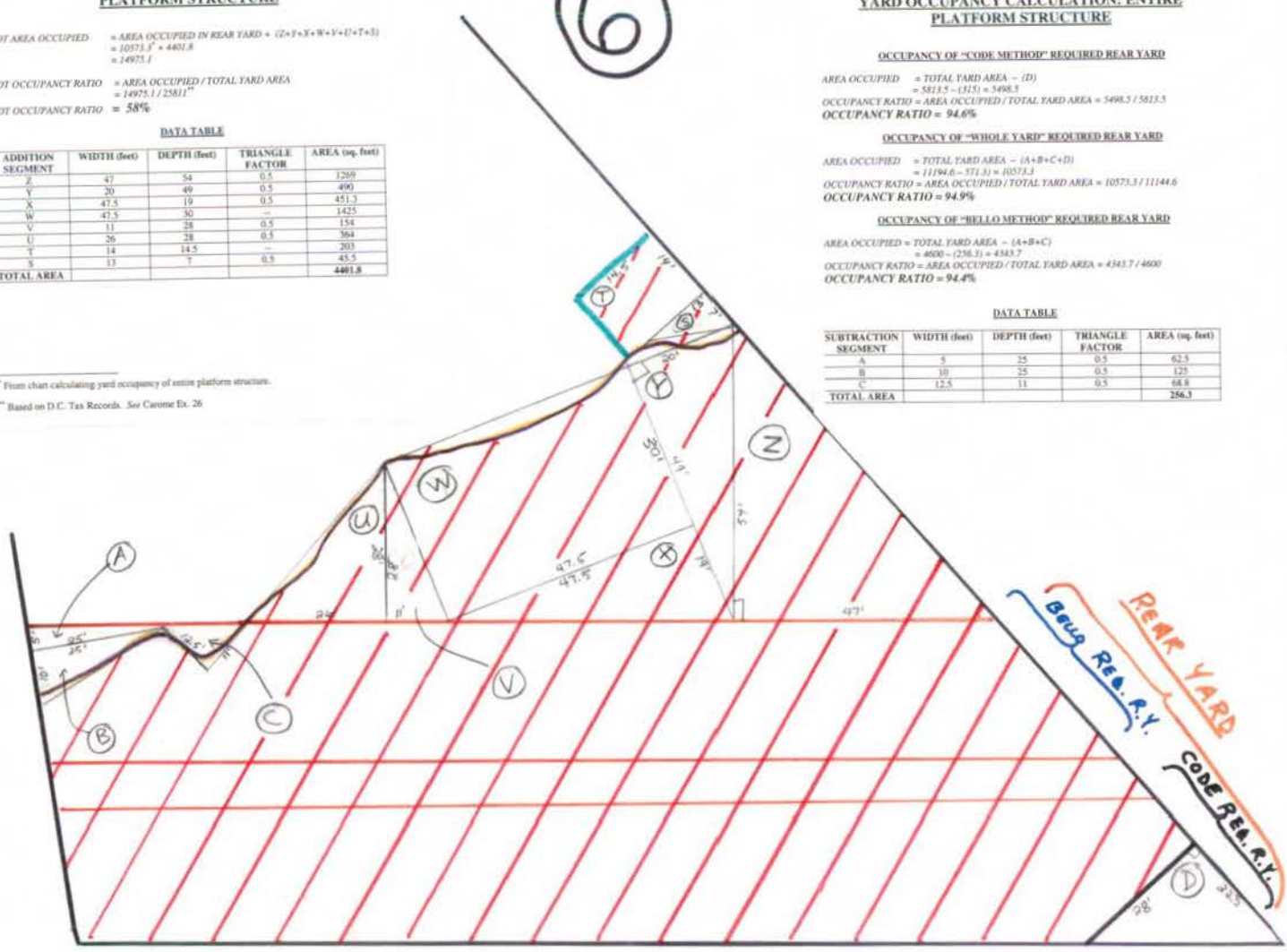
AREA OCCUPIED = TOTAL YARD AREA - (A+B+C+D)
= 11194.6 - 571.3 = 10573.3
OCCUPANCY RATIO = AREA OCCUPIED / TOTAL YARD AREA = 10573.3 / 11144.6
OCCUPANCY RATIO = 94.9%

OCCUPANCY OF "HELLO METHOD" REQUIRED REAR YARD

AREA OCCUPIED = TOTAL YARD AREA - (A+B+C)
= 4600 - (256.3) = 4343.7
OCCUPANCY RATIO = AREA OCCUPIED / TOTAL YARD AREA = 4343.7 / 4600
OCCUPANCY RATIO = 94.4%

DATA TABLE

SUBTRACTION SEGMENT	WIDTH (feet)	DEPTH (feet)	TRIANGLE FACTOR	AREA (sq. feet)
A	9	25	0.5	62.5
B	10	25	0.5	125
C	12.5	11	0.5	68.8
TOTAL AREA				256.3



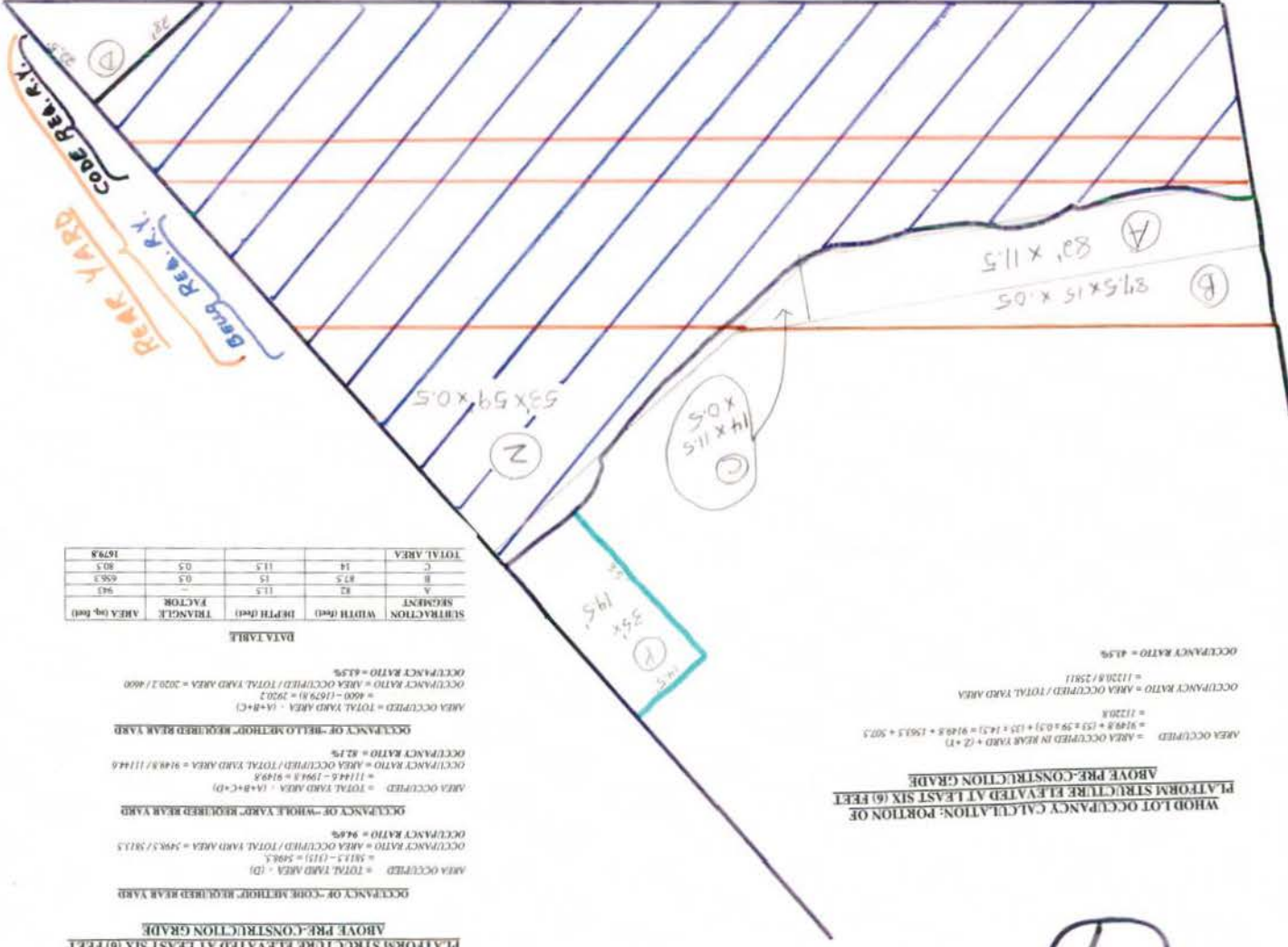
* From chart calculating yard occupancy of entire platform structure.

²² Based on D.C. Tax Records. See Carome Ex. 26.

**WHOLE LOT OCCUPANCY CALCULATION: PORTION OF
PLATFORM STRUCTURE ELEVATED AT LEAST SIX (6) FEET
ABOVE PRE-CONSTRUCTION GRADE**

$$\begin{aligned} \text{AREA OCCUPIED} &= \text{AREA OCCUPIED IN REAR YARD} + (2 \times 1) \\ &= 9149.8 + (2 \times 15) + 29 + (0.5) + (15 \times 14.5) = 9149.8 + 1563.5 + 507.5 \\ &= 11220.8 \\ \text{OCCUPANCY RATIO} &= \text{AREA OCCUPIED} / \text{TOTAL YARD AREA} \\ &= 11220.8 / 15811 \\ \text{OCCUPANCY RATIO} &= 41.5\% \end{aligned}$$

⑦



SEGMENT	WIDTH (ft)	DEPTH (ft)	TRIANGLE FACTOR	AREA (sq. ft)
A	80	11.5	1	920
B	84.5	15	0.5	633.75
C	14	11.5	0.5	80.5
D	35	19.5	1	682.5
E	53	59	0.5	1570.25
TOTAL AREA				1679.8

DATA TABLE

$$\begin{aligned} \text{AREA OCCUPIED} &= \text{TOTAL YARD AREA} - (A + B + C) \\ &= 1679.8 - (920 + 633.75 + 80.5) = 34.55 \\ \text{OCCUPANCY RATIO} &= \text{AREA OCCUPIED} / \text{TOTAL YARD AREA} \\ &= 34.55 / 1679.8 \\ \text{OCCUPANCY RATIO} &= 2.1\% \end{aligned}$$

$$\begin{aligned} \text{AREA OCCUPIED} &= \text{TOTAL YARD AREA} - (A + B + C + D) \\ &= 1144.6 - 1944.8 = 9149.8 \\ \text{OCCUPANCY RATIO} &= \text{AREA OCCUPIED} / \text{TOTAL YARD AREA} \\ &= 9149.8 / 11144.6 \\ \text{OCCUPANCY RATIO} &= 82.1\% \end{aligned}$$

$$\begin{aligned} \text{AREA OCCUPIED} &= \text{TOTAL YARD AREA} - (A + B + C + D + E) \\ &= 1144.6 - 1944.8 = 9149.8 \\ \text{OCCUPANCY RATIO} &= \text{AREA OCCUPIED} / \text{TOTAL YARD AREA} \\ &= 9149.8 / 11144.6 \\ \text{OCCUPANCY RATIO} &= 82.1\% \end{aligned}$$

$$\begin{aligned} \text{AREA OCCUPIED} &= \text{TOTAL YARD AREA} - (D) \\ &= 1679.8 - 682.5 = 997.3 \\ \text{OCCUPANCY RATIO} &= \text{AREA OCCUPIED} / \text{TOTAL YARD AREA} \\ &= 997.3 / 1679.8 \\ \text{OCCUPANCY RATIO} &= 59.5\% \end{aligned}$$