Supporting Document for Rehabilitation Cost Estimates of FEMA Existing Buildings

H. S. Lew

Building and Fire Research Laboratory
Gaithersburg, Maryland 20899

United States Department of Commerce
Technology Administration
National Institute of Standards and Technology
Supporting Document for Rehabilitation Cost Estimates of FEMA Buildings

II. S. Lew

Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

Prepared for

Federal Emergency Management Agency
Washington, D.C. 20472

March 1999
PREFACE

Pursuant to Executive Order 12941, Seismic Safety of Existing Federally Owned or Leased Buildings, all Federal agencies are required to inventory their owned and leased buildings, and to estimate the costs of mitigating unacceptable seismic risks in that inventory. The National Institute of Standards and Technology (NIST) performed these requirements for the Federal Emergency Management Agency (FEMA) under contract EMW-96-IA-0184.

The building data were collected and tabulated by Ann Bieniawski. Field evaluation of the selected buildings were performed by Drs. H. S. Lew and Michael Riley of NIST and Professor Bijan Mohraz of the Southern Methodist University who was on an "Intergovernmental-Personnel-Act" appointment at NIST. The buildings were evaluated jointly by Dr. Lew and Prof. Mohraz.
ABSTRACT

This report presents the results of seismic evaluation and cost estimates carried out by the National Institute of Standards and Technology (NIST) for rehabilitation of existing buildings owned by the Federal Emergency Management Agency (FEMA). The seismic evaluation and rehabilitation cost estimates were carried out in response to Executive Order 12941, Seismic Safety of Federally Owned or Leased Buildings. The seismic evaluation was performed based on ICSSC RP4, Standards of Seismic Safety for Existing Federally Owned or Leased Buildings and Commentary, and FEMA 178, NEHRP Handbook for the Seismic Evaluation of Existing Buildings. Rehabilitation costs were estimated using FEMA 156 and 157, Typical Costs for Seismic Rehabilitation of Existing Buildings, Second Edition, Volumes 1 and 2.

FEMA owns 137 buildings. Of these, 125 buildings are located in Maryland and Virginia (low seismic regions). Ten buildings were selected for evaluation, of which seven are located in Maryland and Virginia, two in Massachusetts (moderate seismic region), and one in Washington (high seismic region).

All sites where the 10 buildings are located were visited by the NIST team. None of these buildings has a complete set of architectural and structural drawings, particularly old buildings such as those at the Emmittsburg, Maryland site. For those buildings which are judged to have deficiencies according to the checklist in FEMA 178, additional analyses were carried out to determine whether in-situ structures are adequate for "life safety." If passed for life safety evaluation, the structure is judged to have no deficiencies.

Rehabilitation costs for the non-evaluated buildings were derived from the rehabilitation costs of the evaluated buildings. The location of building is considered in the estimation of the rehabilitation cost. The cost estimates are also adjusted to 1998. The rehabilitation costs include structural, non-structural, finishing and administration costs. The total estimated rehabilitation cost for the FEMA buildings is $13,910,000.

Keywords: buildings; costs; evaluation; existing; rehabilitation; seismic damage; structural performance; survey.
TABLE OF CONTENTS

Preface i
Abstract ii
1. Introduction 1
2. Inventory of FEMA buildings 1
3. Buildings for Essential Designation 2
4. Buildings for Exceptionally High Risk Designation 2
5. Selection of Buildings for Evaluation 3
   5.1 Screening process 3
   5.2 Selection process for buildings for evaluation 3
6. Seismic Evaluation of Buildings 4
7. Rehabilitation Costs of Evaluated Buildings 12
8. Rehabilitation Costs of Non-evaluated Buildings 13
   8.1 Assumptions 13
   8.2 Cost estimate procedures 14
   8.3 Rehabilitation costs 14
9. Building Inventory Data Base 15

Attachment A: Building Inventory
Attachment B: Seismic Evaluation and Rehabilitation Cost Data
Attachment C: Building Inventory and Rehabilitation Cost Database
1. Introduction

Executive Order 12941, Seismic Safety of Federally Owned or Leased Buildings, requires that Federal agencies develop a complete inventory of their owned and leased buildings, evaluate owned buildings for seismic performance, and develop cost estimates to rehabilitate those buildings found to be seismically deficient. The inventory, evaluations and cost estimates are to be completed following guidance published by the Interagency Committee on Seismic Safety in Construction (ICSSC) as RP4, Standards of Seismic Safety for Existing Federally Owned or Leased Buildings and Commentary; RP5, ICSSC Guidance on Implementing Executive Order 12941 on Seismic Safety of Existing Federally Owned or Leased Buildings; and TR-17, How-to Suggestions for Implementing Executive Order 12941 on Seismic Safety of Existing Federal Buildings, A Handbook.

This report presents the inventory of the FEMA buildings, the selection of buildings for evaluation, the descriptions and evaluation results of the evaluated buildings, and the rationale and process used to estimated the cost of rehabilitation of non-evaluated buildings. In addition to this written document, the inventory and cost data are prepared in electronic form which could be used in the Federal government-wide inventory and seismic rehabilitation cost development.

2. Inventory of FEMA Buildings

FEMA provided a list of sites where they owned buildings. The NIST personnel collected the building inventory data from the site representatives either by visits or by telephone. Because the Berryville, Virginia and Emmitsburg, Maryland sites had more than 90 percent of the FEMA buildings, these locations were visited.

A total of 137 buildings that FEMA owns are distributed as follows.

- Berryville, Virginia - 87
- Bothell, Washington - 1
- Denton, Texas - 6
- Emmitsburg, Maryland - 38
- Maynard, Massachusetts - 2
- Olney, Maryland - 3

A database of the building inventory was created and is attached with this report (Attachment A). This inventory includes all buildings listed in descending order of the "State Code." Other pertinent information about the buildings as specified in Section 2.3 of RP5 are also given according to the format described in Section 5.0 of TR-17.

This database identifies that forty-five (33 %) of the buildings are exempt from seismic evaluation per RP4, Section 1.3. The reasons for exemption are given in the database.
according to Table 5-2 of TR-17. The most common reason for exemption is that a building has only occasional human occupancy.

It should be pointed out that there are approximately 33 buildings at the Berryville, Virginia site, which are classified. These buildings are not part of the 137 buildings mentioned above, and are not included in the database.

3. Buildings for Essential Designation

Section 2.3 of RP5 defines essential buildings as those buildings which require a level of seismic resistance that is higher than life safety. These buildings have been designated in the database with an essential building code of Z1. Buildings which are recommended for this designation are listed in Table 1. Buildings which are on an historical registry are not included in this table. These buildings may need to be evaluated to a standard which is higher than life safety depending on the historical preservation requirements.

<table>
<thead>
<tr>
<th>BUILDING NAME</th>
<th>LOCATION</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building 311</td>
<td>Berryville, Virginia</td>
<td>Fire pumping station</td>
</tr>
<tr>
<td>Building 331</td>
<td>Berryville, Virginia</td>
<td>Houses emergency power</td>
</tr>
<tr>
<td>Building 420</td>
<td>Berryville, Virginia</td>
<td>Fire station</td>
</tr>
<tr>
<td>Bothell VSAB*</td>
<td>Bothell, Washington</td>
<td>MERS** garage and office</td>
</tr>
<tr>
<td>Denton Federal Regional Center</td>
<td>Denton, Texas</td>
<td>Communications center</td>
</tr>
<tr>
<td>Denton VSAB-Old</td>
<td>Denton, Texas</td>
<td>MERS garage and office</td>
</tr>
<tr>
<td>Denton VSAB #2</td>
<td>Denton, Texas</td>
<td>MERS garage and office</td>
</tr>
<tr>
<td>Maynard Federal Regional Center</td>
<td>Maynard, Massachusetts</td>
<td>Communications center</td>
</tr>
<tr>
<td>Maynard VSAB</td>
<td>Maynard, Massachusetts</td>
<td>MERS garage and office</td>
</tr>
<tr>
<td>Olney Federal Support Center</td>
<td>Olney, Maryland</td>
<td>Communications center</td>
</tr>
</tbody>
</table>

* VSAB: Vehicle Storage and Administration Building  
**MERS: Mobile Emergency Response System

4. Buildings for Exceptionally High Risk Designation

Section 3.1.1 of RP5 recommends that agencies identify all of their “exceptionally high risk” (EHR) buildings for evaluation. According to the guidance on identifying such
buildings in Section 3.1.1 of TR-17, the following buildings are identified as FHR buildings.

- Bothell VSAB at Bothell, Washington
  (MERS garage in a high seismic zone.)

- Maynard VSAB at Maynard, Massachusetts
  (MERS garage in a moderate seismic zone.)

Both buildings are essential buildings that house emergency response vehicles, and have unreinforced and partially reinforced concrete masonry walls.

5. Selection of Buildings for Evaluation

5.1 Screening Process

Buildings were screened after the completion of a Data Collection Sheet for each building. The information on the Data Collection Sheet was compiled during site visits and by telephone conversations with the site personnel. Exempt buildings were identified using the exemption criteria listed in Section 2.2.4 of TR-17. If a building met one of these exemption criteria but was on an historical registry or eligible to be on an historical registry, was designated as an essential building, or performed an industrial function (e.g. sewage pumping station), the building was not exempted. Forty five buildings are classified as "Exempt" for evaluation and are identified with "Exemption Code" of other than E0 in the inventory sheets (Attachment A).

5.2 Selection Process of Buildings for Evaluation

Section 3.1 of TR-17 recommends that agencies identify buildings for seismic evaluation in two categories. The first category is those buildings designated by the agency as "exceptionally high risk" (EIR). The EIR buildings have been identified in Sect. 4.

The second category of buildings to be identified for evaluation is a representative sample of the remaining non-exempt population. The guidance states that buildings in the low seismic areas may be excluded from this group. However, because the majority of FEMA’s buildings are in the low seismic areas, they are included in developing the representative sample.

FEMA owns two buildings in a moderate seismic area. These buildings are the Maynard Federal Regional Center and the Maynard VSAB. Both of these buildings have been recommended for seismic evaluation as the moderate area sample. Also, both are representative of the underground Regional Centers and the VSAB garages at other sites.
In the low seismic areas, FEMA owns 89 non-exempt buildings. In order to identify buildings for seismic evaluation, these buildings were divided into model building type and site. A total of six buildings were chosen between the Emmitsburg, Maryland site and the Berryville, Virginia site because the majority of buildings are located at these sites. Each specific building was chosen as a representative sample of the buildings on that particular site with that particular model building type. Whether or not a building was historic was also considered. Therefore, the following ten buildings at four sites were identified for evaluation:

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Location</th>
<th>Structure</th>
<th>Function</th>
<th>Size (m²)</th>
<th>Year Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building 411</td>
<td>Berryville, Virginia</td>
<td>steel light frame</td>
<td>office and conference center</td>
<td>819</td>
<td>1974</td>
</tr>
<tr>
<td>Building 420</td>
<td>Berryville, Virginia</td>
<td>unreinforced masonry</td>
<td>fire station</td>
<td>703</td>
<td>1955</td>
</tr>
<tr>
<td>Building 431</td>
<td>Berryville, Virginia</td>
<td>unreinforced masonry</td>
<td>office</td>
<td>1517</td>
<td>1974</td>
</tr>
<tr>
<td>Building 704</td>
<td>Berryville, Virginia</td>
<td>unreinforced masonry</td>
<td>office</td>
<td>1848</td>
<td>1955</td>
</tr>
<tr>
<td>Bothell VSAB</td>
<td>Bothell, Washington</td>
<td>comb. rein. masonry &amp; steel frame with metal cladding</td>
<td>MERS garage and office</td>
<td>2787</td>
<td>1983</td>
</tr>
<tr>
<td>Building D</td>
<td>Emmitsburg, Maryland</td>
<td>unreinforced masonry</td>
<td>dormitory</td>
<td>2665</td>
<td>1924</td>
</tr>
<tr>
<td>Building J</td>
<td>Emmitsburg, Maryland</td>
<td>concrete frame with infill shear walls</td>
<td>classrooms and offices</td>
<td>4243</td>
<td>1965</td>
</tr>
<tr>
<td>Building O</td>
<td>Emmitsburg, Maryland</td>
<td>unreinforced masonry - historic</td>
<td>chapel</td>
<td>1428</td>
<td>1839</td>
</tr>
<tr>
<td>Maynard Federal Regional Center</td>
<td>Maynard, Massachusetts</td>
<td>underground reinforced concrete bunker</td>
<td>communications center and office</td>
<td>7432</td>
<td>1968</td>
</tr>
<tr>
<td>Maynard VSAB</td>
<td>Maynard, Massachusetts</td>
<td>steel light frame with URM walls and metal cladding</td>
<td>MERS garage and office</td>
<td>3716</td>
<td>1988</td>
</tr>
</tbody>
</table>

6. Seismic Evaluation of Buildings

All four sites were visited by the NIST team. A complete set of architectural and structural drawings were not available for all ten buildings. Particularly, drawings for old buildings such as Buildings "D" and "O" at Emmitsburg, Maryland show only
general architectural layout of the buildings.

At each site, the NIST team met a representative who is responsible for the site. The team was briefed about the general history of the building including any remodeling and expansions since the original construction. Both structural and non-structural systems were visually examined. Absence or presence of the lateral load resisting systems and load transfer paths were checked and noted, and a quick evaluation was made at the site to determine the adequacy of the system. Supporting methods for electrical fixtures, suspended ceilings, and air conditioning ducts were examined visually. The condition of mortar of masonry walls was examined by scratching the surface with a nail. No attempts were made to remove any part of the structure to ascertain information on the anchorage and bearing condition of structural members. The exterior of the building was examined to note the general condition of the building, geologic site hazards, adjacency, and soil characteristics.

The buildings were evaluated in accordance with RP4 using the procedure presented in FEMA 178. To clarify evaluation procedures, FEMA 310 (Handbook for the Seismic Evaluation of Buildings - A Prestandard) was also referenced in some cases. The checklists given in Appendix B of FEMA 178 were the basis for evaluation and determination of further analysis if needed. If the structure is not compliant for one of the check list items, further analysis of the structure was carried out to determine whether the structure would satisfy the “life safety” requirement. For those cases where no engineering data are available, conservative assumptions were made on material properties and dimensions based on field observations and measurements.

For each of the ten buildings evaluated, the field data, the evaluation statements (checklists), and if applicable, structural calculations, and costs estimates for rehabilitation are given in Attachment B.

The results of the structural evaluation are given in Table 3.

<table>
<thead>
<tr>
<th>BUILDING NAME</th>
<th>LOCATION</th>
<th>STRUCTURE</th>
<th>SEISMICITY</th>
<th>STRUCTURAL EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building 411</td>
<td>Berryville,</td>
<td>MB05 steel light frame</td>
<td>Low</td>
<td>Pass*</td>
</tr>
<tr>
<td></td>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 420</td>
<td>Berryville,</td>
<td>MB15 unreinforced masonry</td>
<td>Low</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 431</td>
<td>Berryville,</td>
<td>MB15 unreinforced masonry</td>
<td>Low</td>
<td>Pass*</td>
</tr>
<tr>
<td></td>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5
| Building 704 | Berryville, Virginia | MB15 unreinforced masonry | Low | Fail |
| Bothell VSAB | Bothell, Washington | MB05 steel rigid frame | High | Pass |
| Building D | Emmittsburg, Maryland | MB15 unreinforced masonry | Low | Pass |
| Building J | Emmittsburg, Maryland | MB10 conc. frame with infill walls | Low | Pass |
| Building O | Emmittsburg, Maryland | MB15 unreinforced masonry | Low | Fail |
| Maynard Federal Regional Center | Maynard, Massachusetts | MD16 underground RC bunker | Moderate | Pass |
| Maynard VSAB | Maynard, Massachusetts | MB05 steel light rigid frame | Moderate | Fail |

* Marginal Pass

**Berryville, Virginia**

**Building 411**

The floor plan of this one-story building is rectangular. It is 24 m (80 ft) wide and 34 m (110 ft) long. A large unobstructed interior space can hold 200 to 250 people for meetings and conferences. The vertical load resisting system is comprised of pre-engineered and pre-fabricated rigid steel frames. Z-shape purlins spanning between the rigid frames support the metal roof deck. In the plane of the frame, lateral loads are resisted by frame action. The rigid frames are designed for 40 m/s (90 mph) wind load, and they are adequate for the seismic loads in a low seismic zone.

In the direction perpendicular to the plane of the rigid frames (the longitudinal axis), there is only one pair of diagonal bracing in place between the columns of two adjacent rigid frames along one of the exterior walls. On the opposite side, a section of field stone masonry wall about 6 m (20 ft) long balances lateral load resistance in the longitudinal direction of the building. In general, most of the exterior walls are clad with metal siding.

If the bracing were to fail, the lateral load in the longitudinal direction of the building would be resisted by the masonry wall alone, and consequently, torsion would be developed. Since the building is located in a low seismic region and the lateral load
produced by an earthquake is much smaller than the same produced by the design wind load, the likelihood of failure of the diagonal-bracing is small. Thus, this building is judged to have no structural deficiency. However, it is recommended that additional diagonal bracing be installed for improved seismic safety.

Building 420

This building is a fire station, and designated as an essential building. The floor plan of the building is rectangular, 19 m (62 ft) wide and 37 m (122 ft) long. This one-story URM (unreinforced masonry) building is comprised of 300 mm (12 in) partially reinforced concrete masonry walls with continuous bond beams at mid-height and at the top of the four exterior walls. Horizontal reinforcement was placed at all horizontal masonry joints. The roof framing is comprised of steel joists spanning between the exterior masonry walls and a row of steel beams supported on reinforced masonry columns located along the centerline of the building. Built-up roofing is applied on 45 mm (2 in) concrete roof planks. Steel angle bridgings between steel joists are placed at about 0.8 m (24 in) on center. This building is judged to have no deficiency.

Building 431

The building, constructed in 1974, is currently being used for office and storage. The original floor dimensions were 18 m (60 ft) wide and 49 m (160 ft) long. An addition in 1977 increased the width to 31 m (102 ft). The vertical load resisting system is comprised of long-span joists supported on square tubular steel columns. The roof load is carried by metal deck on Z-shape purlins spanning between the long-span steel joists. The joists span between square tubular columns spaced at 6 m (20 ft) on center in both directions. When the building was originally built, the perimeter tubular columns were imbedded in the exterior unreinforced masonry walls on all four sides which provided lateral load resistance. When new sections were added to make the building 31 m (102 ft) wide, light steel frames and metal siding replaced the two masonry end walls in the transverse direction. In addition, gypsum wall board partitions framed with 2x4\(^1\) lumber replaced one of the masonry walls in the longitudinal direction. Visual inspection did not reveal any diagonal braces between tubular columns within the wall board partitions. Research has shown that gypsum board walls perform well for in-plane shear loading. Thus, it is judged that even without any diagonal braces, the gypsum wall board partitions are adequate to resist the seismic force generated by light roof load of 1.9 k Pa (40 psf) which includes 1.4 k Pa (30 psf) of snow load.

\(^1\) 2x4 is a designation of dimension lumber 38 mm x 89 mm (1\(\frac{1}{4}\) in x 3\(\frac{3}{8}\) in) in cross section.
In the transverse direction, the lateral load is resisted by frame action provided by steel joists and tubular columns. Static analysis of the structure indicates that the columns can resist the seismic force with a small margin of safety. Thus, in the transverse direction, the lateral load resistance capacity of this building is marginal. Although the building is judged to have no deficiencies, it is recommended that this building be rehabilitated to improve its expected seismic performance.

**Building 704**

The plan of this two-story building is rectangular, 8.5 m (28 ft) wide and 55 m (180 ft) long. The building was originally constructed in 1955 as a dormitory and was remodeled in 1984. The building framing is comprised of wood above the first floor. The exterior walls are unreinforced concrete masonry. Continuous reinforced concrete bond beams of 200 mm x 355 mm (8 in x 14 in) and 140 mm x 355 mm (5.5 in x 14 in) are placed around the entire perimeter of the building at the second floor and roof level, respectively. The interior partitions are constructed of 2x4 wood studs. The 2x8\(^2\) floor joists are spaced at 400 mm (16 in) on center and the 2x6\(^2\) ceiling joists are spaced at 610 mm (24 in) on center. At the first floor, the joists are supported on concrete beams. The 2x8 roof rafters are spaced at 610 mm (24 in). The ceiling joists are anchored by metal plate to 2x6 top plates on the masonry wall. In turn, the top plates are anchored to the masonry wall with 16 mm (5/8 in) diameter steel bolts at 1.2 m (4 ft) on center. No specific details are shown on the drawing about the anchor condition of floor joists in the masonry walls.

Because of a large aspect ratio (7.2) of the floor plan, the effectiveness of the wood floor diaphragm is checked. The chord is comprised of concrete bond beams. Since the building is located in a low seismic region, the force developed in the chord is relatively small, and analysis shows that the bond beams would function safely as chords. Extreme fiber bending stresses in the plywood floor sheathing is very low 0.7 MPa (103 psi). Analysis shows that the plywood sheathing would be overstressed in shear if the diaphragm resists the total lateral load on the second floor.

In order for the floor to function as a diaphragm, the floor joists must be anchored adequately in the masonry walls or to the bond beams. A cross section of the building shows that the joists have fire-cut ends at the wall with about 90 mm (3 1/2 in) to 100 mm (4 in) bearing. Analysis showed that this bearing length may not be adequate for the joists to remain supported in the wall when the floor deflects during an earthquake. Because of inadequacies found in the horizontal load path, both in stiffness and shear

\(^{2,1}\) 2 x 8 and 2 x 6 are designations of dimension lumber 38 mm x 190 mm (1 1/2 in x 7 1/2 in) and 38 mm x 140 mm (2 1/2 in x 5 1/2 in) in cross section, respectively.
capacities, this building is judged to be deficient.

Bothell, Washington

Bothell VSAB (Vehicle Storage and Administration Building)

The floor plan of this one-story garage is an L-shape. The main garage portion is 30 m (100 ft) wide and 60 m (200 ft) long. The primary structural frame is comprised of pre-engineered rigid frames. The frames are spaced at 9 m (30 ft) on center along the length of the building. There is a two-story office building built at one end of the garage. The two story steel frame building is structurally independent from the rigid frames. The structure was designed in accordance with the 1982 Army Manual 5-809-10 (Tri-Service Manual). This structure was designed in accordance with the seismic design provisions developed after the 1976 Uniform Building Code which incorporated modern seismic design procedures. Therefore, the design of the structures may be considered adequate.

The lateral load resisting system is comprised of diagonal braces between rigid bent columns on one side of the building and partially reinforced masonry wall on the opposite side along the length of the building. Structural ties are provided between the footings which support the rigid bent columns, thereby preventing relative spread of the column bases.

The field investigation identified that the lateral load resisting system in the north-south direction of the west-end bay may be inadequate as the end wall has four large garage doors without any lateral bracing system. The structural framing of this bay is comprised of steel-channel columns and light I-shape beams. Assuming that the resistance to lateral displacement at the top of the end bay is provided by the roof framing, the lateral displacement is computed. The computed value is very small (6 mm) due to relatively lightweight of the structure. Analysis shows that the roof diaphragm has adequate capacity to resist the shear load generated by the lateral displacement of the end bay. Thus, the deficiency of the end bay as identified in the preliminary evaluation using the checklist is removed, and the structure is judged to have no deficiencies.

Emmitsburg, Maryland

All four buildings evaluated do not have architectural or structural drawings.
Building D

The floor plan of this building is rectangular, 14 m (45 ft) wide and 60 m (198 ft) long. It is a three story unreinforced brick masonry structure built in 1924. The exterior walls are stone masonry and the interior walls are brick. The first floor is comprised of reinforced concrete slab on steel beams spaced about 3.6 m (12 ft) on center. The second and third floors and the third floor ceiling are comprised of concrete slab on timber beams. This building has a most unusual roof framing in that it consists of concrete trusses and concrete slab made of fly ash concrete. This results in a large concentration of mass at the roof level. The ratio of the roof mass to the mass of the third floor is about 3.5. This would be a major concern if the building is located in a high seismic region. For a massive brick masonry structure in a low seismic region, it is reasonable to assume that the structure would respond in a first mode of vibration. A shear stress check in the masonry wall at the roof level and at the first floor indicates that the wall has adequate strength to resist horizontal shear. Thus, this building is judged to have no deficiency.

Building J

Building J is one wing of a complex of the three separate buildings (two wings and an auditorium) with connecting sections. In general, all three buildings consist of concrete frames and infill shear walls. The buildings were constructed in 1963-1965 and remodeled in 1992-1994. All floors and the roof are comprised of concrete joists. Building J, 18 m (59 ft) wide and 51 m (169 ft) long, has a partial basement comprised of reinforced concrete slab and exterior walls. A major concern of this building is the presence of gaps between the infill shear walls and concrete columns along the entire length of the building. Windows are placed in these gaps. No portion of the infill wall was removed during the field investigation to obtain information on wall anchor details to the concrete slab above and below. Due to the existence of the gaps and lack of information on the wall anchor details, the building is rated initially to have deficiencies. Since the building is located in a low seismic region, analysis was made to check whether the concrete frame alone could resist lateral loads without the aid of infill shear walls. The results of a linear elastic finite element analysis show that story drifts are relatively small and the columns have adequate strength to resist the seismic load. Based on the analysis, the building is judged to have no deficiency.

Building O

This chapel was constructed in 1839 and is on the Historic Register. The building is about 21 m (68 ft) wide and 38 m (124 ft) long. The exterior foundation of the building is stone and brick. The exterior walls are 600 mm (24 in) thick stone masonry and the interior walls are 450 mm (18 in) thick brick masonry. Timber columns and beams are
used in the structure. Timber trusses support the wood ceiling over the chapel. The wood lath and plaster ceiling is suspended from the bottom chords of the trusses. The building has an over 10 m (33 ft) high steeple of wood construction. The basement of the building was renovated in the late 1970s, and the timber columns in the basement below the altar were replaced with steel columns. Although the exterior masonry walls have many large window openings which may reduce the shear capacity of the walls, a check of shear stresses in the walls showed that the exterior walls have adequate capacity to resist seismic loads. Careful examination during the field investigation showed that there is no effective load path from the steeple to the foundation. Positive load path must be provided for the steeple to remain stable during an earthquake. For improved seismic safety, it is also recommended that the wood lath and plaster ceiling be replaced with one of lighter mass.

**Maynard, Massachusetts**

**Federal Regional Center**

This is a two-story underground reinforced concrete structure. The outer dimensions of the structure are 36.5 m (120 ft) and 43 m (14 ft). It was designed for nuclear blast loading. All interior fixtures are mounted on springs and shock absorbing cushions. All suspended ceilings are rigidly attached to the concrete slab above. At the present time, there is no generally accepted routine procedure to determine earthquake loading on a buried structure. Review of the structural drawings indicate that structural members, inter-member joints and connections have adequate reinforcement to provide adequate strength and ductility. Since the structure is designed for an event of nuclear blast, it is reasonable to postulate that the structure can be occupied during and after moderate seismic events. This structure is judged to have no deficiency.

**Maynard VSAB (Vehicle Storage and Administration Building)**

The floor plan of this one-story garage is L-shape. The main part of the garage (the longer leg of the L) is about 36 m (120 ft) wide and 82 m (270 ft) long. The primary structural system is comprised of pre-engineered rigid steel frames. A square steel tubular column supports the ridge of the rigid frame. At one end of the garage, two-story office spaces are framed using steel beams and columns. The office spaces are enclosed with partially reinforced infill concrete masonry walls. The walls along the building (perpendicular to the plane of the rigid frame) have large garage door openings between two bents. This allows large vehicles to drive through the building between two rigid bents. As a result there are no diagonal braces. Thus, in the direction perpendicular to the plane of the rigid frame (the longitudinal axis of the building), the garage portion of the structure relies on the masonry walls to resist the lateral load. The
masonry walls have reinforced concrete bond beams at two levels, one at the top of the first story and the other at the top of the second story.

The roof is comprised of steel decks on Z-shape purlins which span between the rigid frames. The out-of-plane stability of the rigid bents is provided by the steel deck and purlins plus steel rope X-bracing in one bay at the roof level. This building lacks a complete load path from the roof to the foundation for the load acting in the longitudinal direction of the building. Analysis shows that the purlins do not have adequate tension capacity to transfer the lateral load generated by the garage portion of the structure to the office portion (masonry walls). Therefore, the roof is deficient in transferring the lateral load to the vertical load resisting members (masonry walls).

7. Rehabilitation Costs of Evaluated Buildings


The following assumptions are used in estimating the rehabilitation costs.

1. The rehabilitation cost for historical buildings are estimated by multiplying the cost estimate obtained for the same building assuming "non-historical" by a factor of 3 (Sect. 1.6, FEMA-157).

2. The finishing costs are determined using the values obtained from the difference between "none" and "minimal" columns in Tables 1.1, 1.2, 1.3, and 1.4 of FEMA-157.

3. The project costs are determined by multiplying the sum of the structural, non-structural and finishing costs by 0.3.

Three of the ten buildings selected for evaluation failed, one of which is a historical building. The cost estimates for failed buildings are given in Attachment B. As required by TR-17, the estimated costs are divided into four categories: structural costs, nonstructural costs, finishing costs, and project costs.

The total rehabilitation cost of the evaluated buildings is $3,843,000.
8. Rehabilitation Costs of Non-Evaluated Buildings

Of 137 buildings in the inventory, 45 building are exempted from seismic evaluation. All eight underground structures in a low seismic zone are assumed to have no deficiencies. Including the Federal Regional Center at Maynard, Massachusetts, nine underground structures are removed from the inventory for seismic evaluation. The inventory has three buildings which are designated as "historical buildings." The rehabilitation costs for these buildings are treated separately. Since eight buildings (non-historic and non-underground buildings) have been evaluated, the rehabilitation costs of 72 non-evaluated buildings (137 - 45 - 9 - 3 - 8 = 72) need to be estimated.

8.1 Assumptions Made for Cost Estimate

The inventory of buildings revealed that the non-exempt FEMA buildings can be classified into nine different model building types. If an underground bunker and a historic building are treated separately, the evaluated buildings fall into three different model types. They are tabulated below with the associated floor areas. The floor areas in both columns do not contain the areas corresponding to the underground structures and historical buildings.

<table>
<thead>
<tr>
<th>Non-Evaluated Bldg. (Area in m²)</th>
<th>Evaluated Buildings (Area in m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB 01 (2 995)</td>
<td>MB 05 (7 322)</td>
</tr>
<tr>
<td>MB 04 (16 138)</td>
<td>MB 10 (4 243)</td>
</tr>
<tr>
<td>MB 05 (2 683)</td>
<td>MB 15 (6 733)</td>
</tr>
<tr>
<td>MB 08 (492)</td>
<td>MB 16 (1 342)</td>
</tr>
<tr>
<td>MB 10 (6 648)</td>
<td></td>
</tr>
<tr>
<td>MB 13 (1 014)</td>
<td></td>
</tr>
<tr>
<td>MB 14 (702)</td>
<td></td>
</tr>
<tr>
<td>MB 15 (111 049)</td>
<td></td>
</tr>
<tr>
<td>MB 16 (1 342)</td>
<td></td>
</tr>
<tr>
<td>Total Arca</td>
<td>18 298 m²</td>
</tr>
<tr>
<td>143 063 m²</td>
<td></td>
</tr>
</tbody>
</table>

Only three model building types are evaluated. The non-evaluated buildings that do not correspond to the evaluated building types are MB 01, 04, 08, 13, 14, and 16. However, these types represent a small portion of the total floor area of the non-evaluated buildings (16 % = 22 638 m² / 143 063 m²). It should be noted that none of the buildings in these types are exceptionally high risk buildings, and that all the buildings are located in a low seismic region. Therefore, it is reasonable to assume that the non-evaluated buildings of MB 01, 04, 08, 13, 14, and 16 do not need rehabilitation.
8.2 Procedure Used for Cost Estimate

1. Since all non evaluated MB 05 buildings are in Virginia, the evaluation result of Berryville Building 411 is applied to this group of buildings. Thus, their rehabilitation costs are zero. The VSAB buildings at Maynard, MA and Bothell, WA are garages located in a moderate and a high seismic area, respectively. They are structurally different from the MB 05 buildings in Virginia.

2. Since all non-evaluated MB 10 buildings are located in Emmitsburg, Maryland, and the MB 10 building at that site which was found to pass, it is assumed that the non-evaluated MB 10 buildings do not require rehabilitation.

3. All non-evaluated MB 15 buildings are located in Maryland and Virginia. Excluding one historical building, one of the four evaluated buildings “failed.” The area of the “failed” building (Building 704) is about 27% of the total area of the evaluated MB 15 buildings. The average rehabilitation cost per square meter for the MB 15 buildings is determined by dividing the rehabilitation cost of Building 704 by the total area of the MB 15 buildings, which is ($41 795/6 733 m² = $62.07/m²).

4. All three historical buildings are located at Emmitsburg, Maryland. Thirty three percent of the average rehabilitation cost of Emmitsburg Building O (chapel) is applied to Buildings N and Q as one is an office building and the other is a barn.

8.3 Rehabilitation Cost Estimates

The rehabilitation cost of the evaluated buildings is:

<table>
<thead>
<tr>
<th>Building</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berryville, Building 704</td>
<td>$418,000</td>
</tr>
<tr>
<td>Emmitsburg, Building O</td>
<td>$2,471,000</td>
</tr>
<tr>
<td>Maynard VSAB</td>
<td>$954,000</td>
</tr>
<tr>
<td>Total</td>
<td>$3,843,000</td>
</tr>
</tbody>
</table>

The rehabilitation cost of the non-evaluated buildings is:

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB 05</td>
<td>$0</td>
</tr>
<tr>
<td>MB 15</td>
<td>$6,892,800 ($62.07/m² x 111049 m²)</td>
</tr>
<tr>
<td>Others</td>
<td>$0</td>
</tr>
<tr>
<td>Historic</td>
<td>$3,114,000</td>
</tr>
<tr>
<td>Total</td>
<td>$10,006,800</td>
</tr>
</tbody>
</table>
The total estimated rehabilitation cost for the FEMA buildings is:

- Evaluated Buildings: $3,843,000
- Non-evaluated Buildings: $10,007,000
- Total: $13,910,000

9. Building Inventory Data Base

All pertinent data required by RP5 are entered in the database forms according to the instructions given in TR-17. The hard copies of the database forms are attached (Attachment C). The electronic form of the database is also provided in a diskette.
Attachment A: Building Inventory
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5800</td>
<td>Boathouse</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>46</td>
<td>1</td>
<td>E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB13</td>
<td>N01</td>
<td>Boathouse</td>
</tr>
<tr>
<td>5800</td>
<td>Building A</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3091</td>
<td>1</td>
<td>E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB10</td>
<td>N03</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building B</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>541</td>
<td>1</td>
<td>E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1956</td>
<td>MB15</td>
<td>N01</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building C</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>2492</td>
<td>1</td>
<td>E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1956</td>
<td>MB10</td>
<td>N03</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building C-West</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>4923</td>
<td>1</td>
<td>E7</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB14</td>
<td>N03</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building D</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>2665</td>
<td>1</td>
<td>E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1924</td>
<td>MB15</td>
<td>N03</td>
<td>Eligible for historic registry but not officially registered.</td>
</tr>
<tr>
<td>5800</td>
<td>Building E</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3252</td>
<td>1</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1923</td>
<td>MB15</td>
<td>N03</td>
<td>Contains an auditorium which can seat 500; Eligible for historic registry but not officially registered.</td>
</tr>
<tr>
<td>5800</td>
<td>Building F</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1875</td>
<td>1</td>
<td>E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1926</td>
<td>MB15</td>
<td>N03</td>
<td>Eligible for historic registry but not officially registered.</td>
</tr>
<tr>
<td>5800</td>
<td>Building G</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>649</td>
<td>1</td>
<td>E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1948</td>
<td>MB15</td>
<td>N02</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building H</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1871</td>
<td>1</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1923</td>
<td>MB15</td>
<td>N03</td>
<td>Contains recreation area (swimming pool, basketball court, weight room)</td>
</tr>
<tr>
<td>5800</td>
<td>Building I</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3344</td>
<td>1</td>
<td>E7</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1996</td>
<td>MB07</td>
<td>N02</td>
<td>Design looks at Map Area 1 in BOCA and NEHRP</td>
</tr>
<tr>
<td>5800</td>
<td>Building J</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>4243</td>
<td>1</td>
<td>E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB10</td>
<td>N02</td>
<td>Contains an auditorium and offices as well.</td>
</tr>
<tr>
<td>5800</td>
<td>Building K</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3786</td>
<td>1</td>
<td>E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1890</td>
<td>MB15</td>
<td>N03</td>
<td>Contains a cafeteria which seats about 350; eligible for historic registry but not officially registered.</td>
</tr>
<tr>
<td>5800</td>
<td>Building L</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1065</td>
<td>1</td>
<td>E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1959</td>
<td>MB10</td>
<td>N03</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building M</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>678</td>
<td>1</td>
<td>E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB14</td>
<td>N02</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building N</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>4449</td>
<td>1</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H1</td>
<td>1870</td>
<td>MB15</td>
<td>N04</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building O</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1428</td>
<td>1</td>
<td>E0</td>
<td>80</td>
<td>Z2</td>
<td>H1</td>
<td>1839</td>
<td>MB15</td>
<td>N02</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building P</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>280</td>
<td>1</td>
<td>E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB16</td>
<td>N01</td>
<td>Log Cabin; Can hold 150-200 people for recreational purposes.</td>
</tr>
<tr>
<td>5800</td>
<td>Building Q</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>948</td>
<td>1</td>
<td>E0</td>
<td>40</td>
<td>Z2</td>
<td>H1</td>
<td>1880</td>
<td>MB15</td>
<td>N02</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building R</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>459</td>
<td>1</td>
<td>E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1950</td>
<td>MB15</td>
<td>N01</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building S</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>626</td>
<td>1</td>
<td>E0</td>
<td>83</td>
<td>I-H</td>
<td>1926</td>
<td>MB15</td>
<td>N01</td>
<td>Eligible for historic registry but not formally registered; Currently undergoing major renovations. Will be used as a computer simulations laboratory.</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building T</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>110</td>
<td>1</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>I-2</td>
<td>1960</td>
<td>MB15</td>
<td>N01</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building U</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>156</td>
<td>#</td>
<td>E1</td>
<td>80</td>
<td>Z2</td>
<td>I-2</td>
<td>1982</td>
<td>MB16</td>
<td>N01</td>
<td>12x14 precast concrete buildings used as arson labs; Built from 1982-1996.</td>
</tr>
<tr>
<td>Building Code</td>
<td>Building Type</td>
<td>Number of Stories</td>
<td>Address</td>
<td>Floor Size (sq ft)</td>
<td>Construction Material</td>
<td>Exterior Color</td>
<td>Interior Color</td>
<td>Year Built</td>
<td>Code</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>---------</td>
<td>-------------------</td>
<td>-----------------------</td>
<td>--------------</td>
<td>--------------</td>
<td>------------</td>
<td>------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building V</td>
<td>24</td>
<td>021 L</td>
<td>90</td>
<td>1 E7 60 Z2 H2</td>
<td>1992 MB13</td>
<td>N01</td>
<td>Security Station</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Federal Support Center</td>
<td>24</td>
<td>031 L</td>
<td>6039</td>
<td>1 E0 29 Z1 H2</td>
<td>1970 MB18</td>
<td>N00</td>
<td>Building is underground and designed for nuclear blast; building is reinforced concrete encased in steel; building houses offices, communications center, overall agency network</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Fire Pump Station</td>
<td>24</td>
<td>021 L</td>
<td>372</td>
<td>1 E0 50 Z2 H2</td>
<td>1981 MB16</td>
<td>N00</td>
<td>Building is underground and constructed of poured concrete.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Morton Buildings</td>
<td>24</td>
<td>021 L</td>
<td>316</td>
<td>2 E1 40 Z2 H2</td>
<td>1980 MB02</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Olney Storage</td>
<td>24</td>
<td>031 L</td>
<td>0</td>
<td>2 E1 40 Z2 H2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Sewage Pumping Station A</td>
<td>24</td>
<td>021 L</td>
<td>15</td>
<td>1 E0 50 Z2 H2</td>
<td>1940 MB16</td>
<td>N00</td>
<td>Building is underground and constructed of poured concrete.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Sewage Pumping Station B</td>
<td>24</td>
<td>021 L</td>
<td>15</td>
<td>1 E0 50 Z2 H2</td>
<td>1995 MB16</td>
<td>N00</td>
<td>Building is underground and is constructed of poured concrete.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Region 1 Center</td>
<td>25</td>
<td>017 M</td>
<td>7432</td>
<td>1 E0 29 Z1 H2</td>
<td>1968 MB16</td>
<td>N00</td>
<td>Building is underground and designed for nuclear blast; building is reinforced concrete with 2 rooms in steel enclosures; building is communications center for Region 1 and also serves as regional conference center.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Region 1 MERS</td>
<td>25</td>
<td>017 M</td>
<td>2903</td>
<td>1 E0 50 Z2 H2</td>
<td>1988 MB05</td>
<td>N02</td>
<td>Building contains some office space.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Federal Regional Center</td>
<td>48</td>
<td>121 L</td>
<td>5110</td>
<td>1 E0 10 Z1 H2</td>
<td>1964 MB16</td>
<td>N00</td>
<td>Underground Reinforced Bunker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Reception and Breakroom</td>
<td>48</td>
<td>121 L</td>
<td>285</td>
<td>1 E0 60 Z2 H2</td>
<td>1994 MB05</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Storage Building - East</td>
<td>48</td>
<td>121 L</td>
<td>223</td>
<td>1 E1 40 Z2 H2</td>
<td>1990 MB04</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Storage Building - West</td>
<td>48</td>
<td>121 L</td>
<td>223</td>
<td>1 E1 40 Z2 H2</td>
<td>1990 MB04</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>VSAB - Old</td>
<td>48</td>
<td>121 L</td>
<td>4738</td>
<td>1 E0 10 Z2 H2</td>
<td>1985 MB04</td>
<td>N02</td>
<td>Garage and Office</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>VSAB #2</td>
<td>48</td>
<td>121 L</td>
<td>1858</td>
<td>1 E7 10 Z2 H2</td>
<td>1993 MB04</td>
<td>N02</td>
<td>Garage and Office</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 104</td>
<td>51</td>
<td>107 L</td>
<td>1014</td>
<td>1 E0 40 Z2 H2</td>
<td>1955 MB16</td>
<td>N04</td>
<td>Structure is reinforced poured concrete walls and roof; designed for blast loading.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 105</td>
<td>51</td>
<td>107 L</td>
<td>936</td>
<td>1 E0 10 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 106</td>
<td>51</td>
<td>107 L</td>
<td>347</td>
<td>1 E1 40 Z2 H2</td>
<td>1955 MB16</td>
<td>N07</td>
<td>Structure is poured concrete walls.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 110</td>
<td>51</td>
<td>107 L</td>
<td>1292</td>
<td>1 E0 10 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 114</td>
<td>51</td>
<td>107 L</td>
<td>1398</td>
<td>1 E0 10 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 123</td>
<td>51</td>
<td>107 L</td>
<td>22</td>
<td>1 E0 60 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td>Building is a Control Tower (Heliport)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 127</td>
<td>51</td>
<td>107 L</td>
<td>24</td>
<td>1 E0 60 Z2 H2</td>
<td>1955 MB16</td>
<td>N01</td>
<td>Building is a Security Gatehouse; Structure is reinforced poured concrete and cinder block.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 140</td>
<td>51</td>
<td>107 L</td>
<td>75</td>
<td>1 E0 50 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td>Sewage Treatment Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 146</td>
<td>51</td>
<td>107 L</td>
<td>28</td>
<td>1 E1 40 Z2 H2</td>
<td>1955 MB15</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 201</td>
<td>51</td>
<td>107 L</td>
<td>691</td>
<td>1 E1 40 Z2 H2</td>
<td>1985 MB05</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 205/211/230</td>
<td>51</td>
<td>107 L</td>
<td>2464</td>
<td>3 E0 30 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 217</td>
<td>51</td>
<td>107 L</td>
<td>821</td>
<td>1 E0 10 Z2 H2</td>
<td>1955 MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 218</td>
<td>51</td>
<td>107 L</td>
<td>874</td>
<td>1 E0 80 Z2 H2</td>
<td>1986 MB13</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 219</td>
<td>51</td>
<td>107 L</td>
<td>1348</td>
<td>1 E0 10 Z2 H2</td>
<td>1989 MB05</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 219A</td>
<td>51</td>
<td>107 L</td>
<td>678</td>
<td>1 E0 10 Z2 H2</td>
<td>1993 MB05</td>
<td>N03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 310</td>
<td>51</td>
<td>107 L</td>
<td>440</td>
<td>1 E0 60 Z2 H2</td>
<td>1955 MB15</td>
<td>N01</td>
<td>Building is a Motorpool.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Address</td>
<td>Tier</td>
<td>Use</td>
<td>Size</td>
<td>Height</td>
<td>Age</td>
<td>Condition</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>------</td>
<td>-----</td>
<td>------</td>
<td>-------</td>
<td>-----</td>
<td>-----------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 311</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>33</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>Building is a Fire Pumping Station</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 312/313</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>35</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 315</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>344</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>Building is a maintenance shop.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 317</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>42</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>Structure is cinderblock construction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 320</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>340</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 320A</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>302</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1988</td>
<td>MB05</td>
<td>N01</td>
<td>Building is a maintenance shop; Structure has a mezzanine.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 321</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>22</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB14</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 327</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>190</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB01</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 329</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>669</td>
<td>E0</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB05</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 331</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>161</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>Building houses Emergency Power.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 340</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>96</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 401</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>65</td>
<td>E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1975</td>
<td>MB13</td>
<td>N01</td>
<td>Building is a Guardhouse.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 403</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>358</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>Building contains health unit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 404</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>11</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB15</td>
<td>N01</td>
<td>Building houses electrical equipment - transformer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 405</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>929</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1900</td>
<td>MB01</td>
<td>N04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 406</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>394</td>
<td>E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB01</td>
<td>N01</td>
<td>Building is a covered walkway between buildings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 408</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>462</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB05</td>
<td>N01</td>
<td>Building is a Maintenance Shop.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 409</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>779</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB05</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 410</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>565</td>
<td>E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1900</td>
<td>MB01</td>
<td>N02</td>
<td>Building is a Maintenance Shop.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 411</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>819</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB05</td>
<td>N01</td>
<td>Building has conference capacity for 200-250.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 413</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>1104</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1900</td>
<td>MB01</td>
<td>N04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 415</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>132</td>
<td>E1</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB15</td>
<td>N01</td>
<td>Maintenance Building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 417/425</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>57</td>
<td>E1</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB12</td>
<td>N02</td>
<td>Guardhouses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 418</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>4</td>
<td>E1</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>Guardshack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 420</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>703</td>
<td>E0</td>
<td>60</td>
<td>Z1</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N01</td>
<td>This is the only fire station which serves the site.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 426</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>202</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB13</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 429</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>1468</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 430</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>1336</td>
<td>E0</td>
<td>7</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 430A</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>1778</td>
<td>E5</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB13</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 431</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>1517</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB15</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 431A</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>90</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB04</td>
<td>N01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 435</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>2585</td>
<td>E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>N02</td>
<td>Building is a cafeteria which seats about 250-300 people.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 444</td>
<td>5800</td>
<td>107</td>
<td>L</td>
<td>3626</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB04</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 500</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>39</td>
<td>E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB15</td>
<td>N02</td>
<td>Heliport.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 501</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>5</td>
<td>E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1972</td>
<td>MB15</td>
<td>N01</td>
<td>Used for Communication.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 505</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>5</td>
<td>E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1992</td>
<td>MB01</td>
<td>N01</td>
<td>Picnic Shelter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 604</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>5626</td>
<td>E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1986</td>
<td>MB04</td>
<td>N02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 701</td>
<td>5800</td>
<td>043</td>
<td>L</td>
<td>347</td>
<td>E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB16</td>
<td>N07</td>
<td>Structure is poured reinforced concrete walls.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEMA ID</td>
<td>Building Name</td>
<td>State</td>
<td>FIPS Code</td>
<td>Latitude</td>
<td>Longitude</td>
<td>Footprint</td>
<td>Year Built</td>
<td>FEMA ID</td>
<td>Use Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------------------</td>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>------------</td>
<td>---------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 702</td>
<td>51</td>
<td>043 L</td>
<td>1014</td>
<td>1 E1</td>
<td>40</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB16 N04 Structure is reinforced poured concrete walls and roof; designed for blast loading.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 703</td>
<td>51</td>
<td>043 L</td>
<td>109</td>
<td>1 E1</td>
<td>40</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB01 N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 704</td>
<td>51</td>
<td>043 L</td>
<td>1848</td>
<td>1 E0</td>
<td>10</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB15 N02 Fire Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 707</td>
<td>51</td>
<td>043 L</td>
<td>749</td>
<td>1 E1</td>
<td>40</td>
<td>Z2 H2</td>
<td>1990</td>
<td>MB01 N01 Polebarn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 708</td>
<td>51</td>
<td>043 L</td>
<td>1046</td>
<td>1 E0</td>
<td>10</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB15 N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 709</td>
<td>51</td>
<td>043 L</td>
<td>86</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1987</td>
<td>MB15 N01 Generator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 710</td>
<td>51</td>
<td>043 L</td>
<td>114</td>
<td>1 E1</td>
<td>80</td>
<td>Z2 H2</td>
<td>1989</td>
<td>MB15 N01 Trash Collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 712</td>
<td>51</td>
<td>043 L</td>
<td>1778</td>
<td>1 E0</td>
<td>10</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB15 N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 713</td>
<td>51</td>
<td>043 L</td>
<td>58</td>
<td>1 E1</td>
<td>40</td>
<td>Z2 H2</td>
<td>1992</td>
<td>MB06 N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 713A</td>
<td>51</td>
<td>043 L</td>
<td>131</td>
<td>1 E1</td>
<td>40</td>
<td>Z2 H2</td>
<td>1993</td>
<td>MB01 N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 718</td>
<td>51</td>
<td>043 L</td>
<td>25</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB15 N01 Generator Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 720</td>
<td>51</td>
<td>043 L</td>
<td>482</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB08 N03 Water Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 721+</td>
<td>51</td>
<td>043 L</td>
<td>8424</td>
<td>9 E0</td>
<td>30</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB15 N02 Building is a Security Gatehouse; Structure is reinforced poured concrete and cinder block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 752</td>
<td>51</td>
<td>043 L</td>
<td>24</td>
<td>1 E0</td>
<td>80</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB16 N01 Building is reinforced poured concrete and cinder block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 754</td>
<td>51</td>
<td>043 L</td>
<td>103</td>
<td>1 E3</td>
<td>80</td>
<td>Z2 H2</td>
<td>1985</td>
<td>MB01 N01 Picnic Shelter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 781</td>
<td>51</td>
<td>043 L</td>
<td>24</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB14 N01 Pumping Station - mostly underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 800</td>
<td>51</td>
<td>043 L</td>
<td>29</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB14 N00 River Intake Station - underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 810</td>
<td>51</td>
<td>043 L</td>
<td>77</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB13 N00 Generator Building - underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 820/830</td>
<td>51</td>
<td>043 L</td>
<td>171</td>
<td>2 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1955</td>
<td>MB13 N00 Booster Pumping Station - underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Bothell VSAB</td>
<td>53</td>
<td>061 H</td>
<td>2787</td>
<td>1 E0</td>
<td>50</td>
<td>Z2 H2</td>
<td>1983</td>
<td>MB05 N01 Garage and offices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Attachment B: Seismic Evaluation and Rehabilitation Cost Data
Building Designation: 411

Location: Berryville, VA

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1974  Year(s) remodelled: —
Date of Evaluation: 8/5/98
Area, (sq. ft.) 8810  Length 110'  Width 80'  Photo Roll No. —

CONSTRUCTION DATA

Roof framing: 2 - purlins + metal deck
Intermediate floor framing: —
Ground floor: concrete  Basement: none
Exterior walls: Masonry  Openings: —
Columns: steel  Foundations: spread footing + wall footing
General condition of structure: Very Good
Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB 05</td>
<td>MB 05</td>
</tr>
</tbody>
</table>

Model building type: Transverse
Building period, T: 32
Unreduced base shear, $V = ((0.854, x S)/(R x T^{2/3})) x (W)$ or $V = [2.124a/R] x W$

Response Modification Coefficient, $R$: 4.9

EVALUATION DATA

$A_a = 0.05  A_v = 0.05$

Site soil profile type: S1  Site soil coefficient, $s = 1.0$

REMARKS

Pre-engineered steel rigid frames. Blvdq designed for 90 mph Wind load.
EVALUATION STATEMENTS FOR BUILDING TYPE 5: STEEL LIGHT FRAME

These buildings are pre-engineered and pre-fabricated with transverse rigid frames. The roof and walls consist of light-weight panels. The frames are designed for maximum efficiency, often with tapered beam and column sections built up of light plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames, with loads distributed to them by shear elements. Loads in the longitudinal direction are resisted entirely by shear elements. The shear elements can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity ($A_v = 0.4$). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

T F LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)

T F REDUNDANCY: The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)

T F WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)

T F SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)

T F TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

B-15 (Type 5)
DETERIORATION OF STEEL: There is no significant visible rusting, corrosion, or other deterioration in any of the steel elements in the vertical or lateral-force-resisting systems. (Sec. 3.5.3)

MOMENT FRAMES

STRESS CHECK: The building satisfies the Quick Check of the stress in the diagonals. (Sec. 6.1.1)

BEAM PENETRATIONS: All openings in frame-beam webs have a depth less that 1/4 of the beam depth and are located in the center half of the beams. (Sec. 4.2.3)

DIAPHRAGMS

PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

CONNECTIONS

STEEL COLUMNS: The columns in the lateral-force-resisting system are substantially anchored to the building foundation. (Sec. 8.4.1)

WALL AND ROOF PANELS

LIGHT-GAGE METAL, PLASTIC, OR CEMENTITIOUS ROOF PANELS: All light-gage metal, plastic, or cementitious roof panels are properly connected to the roof framing at not more than 12 inches on center. (Sec. 8.6.1)

WALL PANELS: All wall panels (metal, fiberglass, or cement asbestos) are properly connected to the framing. (Sec. 8.6.2)
Wind load check.

Designed for 90 m/h

BOCA

\[ P = P_v \ i \ [K_z \ G_h \ C_p - K_h \ (G_t \ C_p)] \]

\[ P_v = 20.7 \ \text{#} \]

\[ I = 1.0 \]

\[ K_z = 0.8 \ (0-15 \text{ ft}) \]

\[ G_h = 1.32 \]

\[ C_p = 0.8 \]

\[ K_h = 0.8 \]

\[ G_t \ C_p = +0.75 \]

\[ -0.25 \]

\[ P = 20.7 \ [0.8 \times 1.32 \times 0.8 - 0.8 \times (-0.25)] \]

\[ = 20.7 \ (0.845 + 0.2) = 20 \ (1.045) = 20.9 \ \text{#} \]

Wind load

\[ H = \frac{80 \times 14}{2} \times 20.9 = 11704 \ \text{#} \]

Lateral load due to earthquake

Upper half of the wall

\[ W_w = \frac{1.15}{2} \times 102' \times 15 \ \text{#} \times 0.9 = 7917 \ \text{#} \]

Roof

\[ W_d = 40' \times 102' \times 20 \ \text{#} \times 4 = 8160 \ \text{#} \]

\[ A_r \ W_d = 0.1 \times 8160 \ \text{#} = 8160 \ \text{#} \]

\[ 0.1 \times W_w = 791 \ \text{#} \]

\[ \frac{8160}{8951} \ # < 11704 \ # \]

Wind bracing is o.k.
### OPTION 2 COST ESTIMATION FORM

**COST ESTIMATION OPTION 2**

1. **GROUP MEAN COST**
   - **Group:**
     - ☑️ URM
     - ☑️ S1
     - ☑️ W1, W2
     - ☑️ S2, S3
     - ☑️ PC1, RM1
     - ☑️ SS
     - ☑️ C1, C3
     - ☑️ C2, PC2, RM2, S4
   - **Cost Coefficient \( c_i \) from Table 4.3.2.**
     - \( c_i = 7.23 \)

2. **AREA ADJUSTMENT FACTOR**
   - **Area**
     - ☑️ Less than 10K sq. ft.  ☑️ 10K - 50K sq. ft.
     - ☑️ 50K - 100K sq. ft.  ☑️ 10K - 50K sq. ft.
   - **Cost Adjustment Factor \( c_2 \) from Table 4.3.3**
     - \( c_2 = 1.18 \)

3. **SEISMICITY/PERFORMANCE OBJECTIVE FACTOR ADJUSTMENT**
   - **Seismicity**
     - ☑️ Low (NEHRP 1 or 2)
     - ☑️ Moderate (NEHRP 3 or 4)
     - ☑️ High (NEHRP 5 or 6)
     - ☑️ Very High (NEHRP 7)
   - **Performance Objective**
     - ☑️ Life Safety
     - ☑️ Damage Control
     - ☑️ Immediate Occupancy
   - **Cost Adjustment Factor \( c_3 \) from Table 4.4.2**
     - \( c_3 = 0.61 \)

4. **LOCATION ADJUSTMENT FACTOR**
   - **City / State**:
     - Berryville, VA
   - **Cost Adjustment Factor \( c_4 \) from Table 4.3.4 or Table 4.3.5**
     - \( c_4 = 0.84 \)

5. **TIME ADJUSTMENT FACTOR**
   - **Year**:
     - 1998
   - **Inflation Rate**:
     - 2%
   - **Cost Adjustment Factor \( c_t \) from Table 4.3.6**
     - \( c_t = 1.10 \)

**TYPICAL STRUCTURAL COST**

\[
C = c_1 \times c_2 \times c_3 \times c_4 \times c_5
\]

\[
c = 481
\]

**Building Area (Square Foot):**

\[
A = 88160
\]

- **Estimated Structural Cost \( (A \times C) \)**
  - \( C_S = 42,405 \)

- **Non-Structural Cost \( (C_i \times C_L \times C_T) \)**
  - \( C_{NS} = 0 \)

- **Finishing Cost \( (estimated) \)**
  - \( C_F = 6,000 \)

- **Total (Structural + Non-Struc + Finishing)**
  - \( C_{ST} = 47,405 \)

- **Project Cost \( (C_{ST} \times 0.3) \)**
  - \( C_p = 14,221 \)

- **Total Cost**
  - \( \approx 61,600 \)
Building Designation: 420

Location: Berryville, VA

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1965 Year(s) remodelled:
Date of Evaluation: 8/5/98
Area, (sq. ft.) 1567 Length 122 Width 62 Photo Roll No.

CONSTRUCTION DATA

Roof framing: Steel Joists
Intermediate floor framing: -
Ground floor: None Basement: None
Exterior walls: Concrete Masonry Openings:
Columns: CMU Piers Foundations: Concrete Wall and Clay Footings
General condition of structure: Very Good Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB 15</td>
<td>MB 15</td>
</tr>
</tbody>
</table>

Unreduced base shear,
\[ V = [(0.804, x S)/(R x T^{0.3})] x (W) \] or \[ V = [2.124a/R] x W \]

Response Modification Coefficient, R: 1.5

EVALUATION DATA

\[ A_x = 0.05 \quad A_v = 0.05 \]

Site soil profile type: S2 Site soil coefficient, S = 1.2

REMARKS

Soil: weathered rock, clay silt mixture
Reinf.: conc. bond beams at the top and mid levels
Fire station
GEOMETRY: There are no significant geometrical irregularities; there are no setbacks (i.e., no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to the adjacent stories). (Sec. 3.3.3)

MASS: There are no significant mass irregularities; there is no change of effective mass of more than 50 percent from one story to the next, excluding light roofs. (Sec. 3.3.4)

VERTICAL DISCONTINUITIES: All shear walls are continuous to the foundation. (Sec. 3.3.5)

TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

ADJACENT BUILDINGS: There is no immediately adjacent structure that is less than half as tall or has floors/levels that do not match those of the building being evaluated. A neighboring structure is considered to be "immediately adjacent" if it is within 2 inches times the number of stories away from the building being evaluated. (Sec. 3.4)

MASONRY UNITS: There is no visible deterioration of large areas of masonry units. (Sec. 3.5.10)

MASONRY JOINTS: The mortar cannot be easily scraped away from the joints by hand with a metal tool, and there are no significant areas of eroded mortar. (Sec. 3.5.9)

For buildings with wood diaphragms and unreinforced masonry bearing and enclosure walls at the perimeter, complete the evaluation using the procedure given in Appendix C. For other buildings, continue with the following evaluation statements.

MASONRY WALLS

SHEARING STRESS CHECK: The building satisfies the Quick Check of the shearing stress in the unreinforced masonry shear walls. (Sec. 5.4.1)

PROPORTIONS: In areas of high seismicity $A_e$ greater than or equal to 0.2, the height-thickness ratio of the unreinforced masonry wall panels is as follows: (Sec. 5.5.1; also see Appendix C)

- One-story building: $h_w/t < 14$
- Multistory building:
  - Top story: $h_w/t < 9$
  - Other stories: $h_w/t < 20$

MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls have negligible voids. (Sec. 5.4.2)
DIAPHRAGMS

T  F  PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

T  F  REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

T  F  SPAN/DEPTH RATIO: If the span/depth ratios of wood diaphragms are greater than 3 to 1, there are nonstructural walls connected to all diaphragm levels at less than 40-foot spacing. (Sec. 7.2.4)

T  F  SHEATHING: None of the diaphragms consist of straight sheathing or have span/depth ratios greater than 7 to 1. (Sec. 7.2.1)

CONNECTIONS

T  F  MASONRY WALL ANCHORS: Wall anchorage connections are steel anchors or straps that are developed into the diaphragm. (Sec. 8.2.3)

T  F  ANCHOR SPACING: The anchors from the floor and roof systems into exterior masonry walls are spaced at 4 feet or less. (Sec. 8.2.4)
Building Designation: 431
Location: Berryville, VA

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1974  Year(s) remodelled: 1977
Date of Evaluation: 8/15/98

CONSTRUCTION DATA

Roof framing: Steel joists, metal deck
Intermediate/ floor framing: None
Ground floor: Core  Basement: None
Exterior walls: Masonry  Openings: None
Columns: Tubular steel  Foundations: One wall & spread foot
General condition of structure: Fair
Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB 16</td>
<td>MB 15</td>
</tr>
</tbody>
</table>

Unreduced base shear, \( V = \frac{(0.80A_v \times S)}{(H \times 1.23^2)} \times (W) \) or \( V = [2.124a/R] \times W \)

Response Modification Coefficient, \( R \): 1.5

EVALUATION DATA

\( A_a = 0.05 \quad A_v = 0.05 \)

Site soil profile type: 51  Site soil coefficient, \( S = 1.0 \)

REMARKS

Original CMU wall removed, replaced with 2x4 partitions.
EVALUATION STATEMENTS FOR BUILDING TYPE 15:
UNREINFORCED MASONRY BEARING WALL BUILDINGS

These buildings include structural elements that vary depending on the age of the building and, to a lesser extent, the geographic location of the structure. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In buildings built after 1950, unreinforced masonry buildings with wood floors usually have plywood rather than board sheathing. More recently, in regions of lower seismicity, these buildings can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possibly some interior walls, are unreinforced masonry. The walls may or may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity ($A_v = 0.4$). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

T  F  LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)

T  F  REDUNDANCY: The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)

T  F  WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)  One-story Struct.

T  F  SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)  One-story Struct.
GEOMETRY: There are no significant geometrical irregularities; there are no setbacks (i.e., no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to the adjacent stories). (Sec. 3.3.3)

MASS: There are no significant mass irregularities; there is no change of effective mass of more than 50 percent from one story to the next, excluding light roofs. (Sec. 3.3.4)

VERTICAL DISCONTINUITIES: All shear walls are continuous to the foundation. (Sec. 3.3.5)

TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

ADJACENT BUILDINGS: There is no immediately adjacent structure that is less than half as tall or has floors/levels that do not match those of the building being evaluated. A neighboring structure is considered to be "immediately adjacent" if it is within 2 inches times the number of stories away from the building being evaluated. (Sec. 3.4)

MASONRY UNITS: There is no visible deterioration of large areas of masonry units. (Sec. 3.5.10)

MASONRY JOINTS: The mortar cannot be easily scraped away from the joints by hand with a metal tool, and there are no significant areas of eroded mortar. (Sec. 3.5.9)

For buildings with wood diaphragms and unreinforced masonry bearing and enclosure walls at the perimeter, complete the evaluation using the procedure given in Appendix C. For other buildings, continue with the following evaluation statements.

MASONRY WALLS

SHEARING STRESS CHECK: The building satisfies the Quick Check of the shearing stress in the unreinforced masonry shear walls. (Sec. 5.4.1)

PROPORTIONS: In areas of high seismicity ($A_s$ greater than or equal to 0.2), the height-thickness ratio of the unreinforced masonry wall panels is as follows: (Sec. 5.5.1; also see Appendix C)

- One-story building: $h_{w/t} < 14$
- Multi-story building:
  - Top story: $h_{w/t} < 9$
  - Other stories: $h_{w/t} < 20$

MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls have negligible voids. (Sec. 5.4.2)
DIAPHRAGMS

F PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1) $\frac{\ell}{A}$

F REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3) $\frac{\ell}{A}$

F SPAN/DEPTH RATIO: If the span/depth ratios of wood diaphragms are greater than 3 to 1, there are nonstructural walls connected to all diaphragm levels at less than 40-foot spacing. (Sec. 7.2.4) $\frac{L_A}{D} = 2.3$

F SHEATHING: None of the diaphragms consist of straight sheathing or have span/depth ratios greater than 2 to 1. (Sec. 7.2.1)

CONNECTIONS

F MASONRY WALL ANCHORS. Wall anchorage connections are steel anchors or straps that are developed into the diaphragm. (Sec. 8.2.3)

F ANCHOR SPACING: The anchors from the floor and roof systems into exterior masonry walls are spaced at 4 feet or less. (Sec. 8.2.4)
Check square tubular column strength

Column size: 6 x 6 x 1/4
Steel: A36
Length of col: 12' - 6"
Tributary area for each col: 20' x 20'

- Assume no moment is transferred from steel joists or I purlins to the top of column.
- Lateral load is applied to the top of column.

Load:
- Roof: 10 psf
- Snow: 30 psf
- 40 psf

Vertical load on col:
40 x 20 x 20' = 16,000 $ or 16 k

Assume $V = 0.1$ sec.

$$ C_s = 2.12 \frac{A_a}{R} = \frac{2.12 \times 0.05}{2} = 0.053 $$

$$ V = C_s W = 0.053 \times 16 = 0.85 \text{ k} $$

Bending

$$ M = 0.85 \times 150" = 127.5 \text{ k-in} $$

$$ P = 16 \text{ k} $$

$$ K_L = 2L $$

$$ \frac{K_L}{r} = \frac{2.0 \times 150}{2.33} = 129 $$
\[ C_0 = \sqrt{\frac{2\pi^2 E}{F_y}} = \sqrt{\frac{2\pi^2 \times 29000}{36}} = 126.1 \]

\[ \frac{bL}{R} > C_0 \quad F_a = \frac{12\pi^2 E}{23 \left(\frac{bL}{R}\right)^2} = 9 \text{ ksi} \]

\[ F_b = 0.66 F_y = 24 \text{ ksi} \]

\[ F_e = \frac{12\pi^2 E}{23 \left(\frac{bL}{R}\right)^2} = 9 \text{ ksi} \]

\[ f_a = \frac{P}{bL} = \frac{16}{5.54} = 2.86 \text{ ksi} \]

\[ f_b = \frac{M}{s} = \frac{127.5}{10.1} = 12.62 \text{ ksi} \]

\[ C_m = 0.85 \]

\[ \frac{f_a + C_m f_b}{F_a} \left(1 - \frac{f_a}{F_a}ight) F_b = \frac{2.86}{9} + \frac{0.85 \times 12.62}{(1 - \frac{2.86}{9}) \times 24} \]

\[ = 0.318 + 0.655 = 0.973 < 1.0 \]

Marginaly O.K.
Building Designation: 704
Location: Ber
d ville, VA

DATA SUMMARY SHEET

BUILDING DATA
Year built: 1956  Year(s) remodelled: 
Date of Evaluation: 8/6/98
Area, (sq. ft.) 14892  Length 180'  Width 28'  Photo Roll No. 

CONSTRUCTION DATA
Roof framing: 2 x 8 Wood rafters @ 24" OC
Intermediate floor framing: 2 x 8 Wood joists @ 16" OC
Ground floor: 2 x 8 Wood joists
Basement: Partial / Concrete
Exterior walls: CMU  Openings: Windows
Columns: Steel pipes  Foundations: Concrete spread footing
General condition of structure: FAIR
Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model building type: MB 15</td>
<td>MB 15</td>
</tr>
<tr>
<td>Building period, T:</td>
<td></td>
</tr>
<tr>
<td>Unreduced base shear, V = [(0.80A_0 x S)/(R x T^{2/3})] x (W) or V = [2.124a/R] x W</td>
<td></td>
</tr>
</tbody>
</table>

Response Modification Coefficient, R: 1.5

EVALUATION DATA

A_d = 0.05  A_v = 0.05
Site soil profile type: S2  Site soil coefficient, S = 1.2

REMARKS
EVALUATION STATEMENTS FOR BUILDING TYPE 15:
UNREINFORCED MASONRY BEARING WALL BUILDINGS

These buildings include structural elements that vary depending on the age of the building and, to a lesser extent, the geographic location of the structure. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In buildings built after 1950, unreinforced masonry buildings with wood floors usually have plywood rather than board sheathing. More recently, in regions of lower seismicity, these buildings can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possibly some interior walls, are unreinforced masonry. The walls may or may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity (\(A_s = 0.4\)). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

<table>
<thead>
<tr>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>REDUNDANCY: The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)</td>
<td></td>
</tr>
</tbody>
</table>
GEOMETRY: There are no significant geometrical irregularities; there are no setbacks (i.e., no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to the adjacent stories). (Sec. 3.3.3)

MASS: There are no significant mass irregularities; there is no change of effective mass of more than 50 percent from one story to the next, excluding light roofs. (Sec. 3.3.4)

VERTICAL DISCONTINUITIES: All shear walls are continuous to the foundation. (Sec. 3.3.5)

TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

ADJACENT BUILDINGS: There is no immediately adjacent structure that is less than half as tall or has floors/levels that do not match those of the building being evaluated. A neighboring structure is considered to be "immediately adjacent" if it is within 2 inches times the number of stories away from the building being evaluated. (Sec. 3.4)

MASONRY UNITS: There is no visible deterioration of large areas of masonry units. (Sec. 3.5.10)

MASONRY JOINTS: The mortar cannot be easily scraped away from the joints by hand with a metal tool, and there are no significant areas of eroded mortar. (Sec. 3.5.9)

For buildings with wood diaphragms and unreinforced masonry bearing and enclosure walls at the perimeter, complete the evaluation using the procedure given in Appendix C. For other buildings, continue with the following evaluation statements.

MASS WAllS

SHEARING STRESS CHECK: The building satisfies the Quick Check of the shearing stress in the unreinforced masonry shear walls. (Sec. 5.4.1)

PROPORTIONS: In areas of high seismicity ($A_{s}$ greater than or equal to 0.2), the height-thickness ratio of the unreinforced masonry wall panels is as follows: (Sec. 5.5.1; also see Appendix C)

- One-story building: $h_{w}/t < 14$
- Multistory building:
  - Top story: $h_{w}/t < 9$
  - Other stories: $h_{w}/t < 20$

MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls have negligible voids. (Sec. 5.4.2)
DIAPHRAGMS

F PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

F REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

F SPAN/DEPTH RATIO: If the span/depth ratios of wood diaphragms are greater than 3 to 1, there are nonstructural walls connected to all diaphragm levels at less than 40-foot spacing. (Sec. 7.2.4)

F SHEATHING: None of the diaphragms consist of straight sheathing or have span/depth ratios greater than 2 to 1. (Sec. 7.2.1)

CONNECTIONS

F MASONRY WALL ANCHORS: Wall anchorage connections are steel anchors or straps that are developed into the diaphragm. (Sec. 8.2.3) Not known

F ANCHOR SPACING: The anchors from the floor and roof systems into exterior masonry walls are spaced at 4 feet or less. (Sec. 8.2.4) Not known
Weight of Building

Long. Walls  
180' x 10' x 15\text{\textdegree} = 99000 \quad (8\text{"\textdegree} \text{hollow c.b})

180 x 9.3 x 80 = 133920 \quad (12\text{"\textdegree} \text{hollow c.b})

End Walls  
28 x 10 x 15\text{\textdegree} = 15400

28 x 9.3 x 80 = 20832

Partitions  
3/4
2 nd fl  
2 x 180 x 28 = 10080

1\text{\textdegree} fl  
2 x 180 x 28 = 10080

Floor  
2 1/2 fl  
1/2\text{\textdegree} x 180 x 28 = 25200

1\text{\textdegree} fl  
1/2\text{\textdegree} x 180 x 28 = 25200

Ceiling  
1/2
2 nd fl  
1 x 180 x 28 = 5040

1\text{\textdegree} fl  
1 x 180 x 28 = 5040

Roof (Wood Veneers)  
1/2
5 x 180 x 28 = 25200

Roofing  
2 x 180 x 28 = 10080

L.L.  
2 nd fl only  
50 x 180 x 28 = \frac{252000}{637072} \#
B/1t Ratio

Top story = \(\frac{11.2}{8} = 14 > 9\) OK, for a low seismic region.

1st story = \(\frac{112}{12} = 9.33 < 20\)

\[ C_w = \frac{2.12 A_o}{R} = \frac{2.12 \times 0.1}{1.3} = 0.141 \]

\[ V = 0.141 \times 637.47 = 89.827 \text{ * } \]

Net Area = \(180 \times \frac{12}{12} \times 2 = 3600 \text{ sf} = 51840 \text{ in}^2\)

\[ V = \frac{89.827}{51840} = 1.73 \text{ psi } / \]

Critical Section Thru Windows

\((16 \times 6.01) = 96.31\)

\((180 - 22.3) \times \frac{12}{12} \times 2 = 315.4 \text{ sf} = 4341.7 \text{ in}^2\)

\[ V = \frac{89.827}{4341.7} = 2 \text{ psi } / \text{ Very low.} \]

Even w/ snow load acting \(V\) would be very low.
CHEEK DIAPHRAGM Action AT 2nd FL.

12" masonry wall

2x8 1/2 ply wood fl.
12"/14" conc bond beam

12' - 0" 9'-6"
9'-6" 18'-8"

\[ f_c = 3000 \text{ psi} \]
\[ f_y = 20,000 \text{ psi} \]
\[ f_{\text{wood}} = 1100 \text{ psi} \]

LATERAL LOAD ON CHORDS (Bond Beams)

\[ DL + LL = 40320 + 252000 = 292320 \text{ #} \]

\[ DL: \text{ Floor} \quad 25200 \text{ #} \]
\[ \text{Partition} \quad 10080 \text{ #} \]
\[ \text{Ceiling} \quad 5040 \text{ #} \]
\[ \text{Total} = 40320 \text{ #} \]

\[ LL: \quad 252000 \text{ #} \]

\[ F_x = C_{ux} \sqrt{V} \]

\[ C_{ux} = \frac{w_x h_x k}{2 \times w_i p_i k} \]

\[ T_a = \frac{0.05 h_n}{\sqrt{L}} \quad L = 180' \quad h_n = 20' \]

\[ T_a = \frac{0.05 \times 20}{\sqrt{180}} = 0.07 \text{ acre} \]

\[ \text{Lib. (q4)} \quad T = C_x (h_n)^{3/4} = 0.02 (20)^{3/4} = 0.189 \text{ acre} \]

\[ 1628 \times 2.2 \]
Building Period

Use 0.13 sec., \( k = 1 \)

Snow Load

\[ P_f = C_e I_p g = 0.7 \times 1.0 \times 25 = 17.5 \text{ #/ft} \]

\[ P_s = C_s P_f = \left[ 1 - \frac{22.6 - 30}{40} \right] 17.5 = 1.185 \times 17.5 = 20 \text{ #/ft} \]

Roof Level:

\[ w_n = \frac{25200}{5040} = 4.032 \text{ #} \]

\( h_r = 20' \)

2nd Floor:

\[ w_{\text{ud}} = \frac{29232 \text{ #} + 9960 + 15400}{101} = 143632 \text{ #} \]

\[ h_r = 10' \]

\[ C_{w_k} = \frac{143632}{(40320 \times 20) + (143632 \times 10)} = \frac{1436320}{2242720} = 0.64 \]

\[ F_x = 0.64 \times 898.27 = 575.28 \text{ #} \]

\[ f_x = \frac{57528}{17925} = 3.21 \text{ #/ft} \]

\[ M = \frac{321(17925)^2}{8} = 1289239 \text{ ft} \text{#} \]

Transformed section of bond beams:

\( #6 = 0.44 \text{ in}^2 \)

\( 2 \text{ steel area} = 4 \times 0.44 = 1.76 \quad E_c = 57000 \sqrt{3000} = 3122 \text{ ksi} \)

\( n = \frac{30}{3.172} = 9.6 \)
Total Conc. area = (12x14) + (9.6-1) 1.76 = 168 + 15.14
= 183 in²

\[ I = 2Ad² = 2 \times 183 \times \left(\frac{14 \times 12}{2}\right) = 97144.55 \text{ in}^4 \]

\[ \frac{Mc}{I} = \frac{1289.239 \times 12 \times 162}{97144.55} = 258 \text{ psi} < 328 \text{ psi} \]

Tensile strength of Conc
\[ f_c = 6\sqrt{f'c} = 6\sqrt{3000} = 328 \text{ psi} \]

Buckling Possibility Check
\[ C = 268 \times 12 \times 14 = 45024 \text{ in}^3 \]
\[ P = \frac{n^2EI}{L^2} \]
\[ J = \frac{bh^3}{12} + 2Ad^2 = \frac{14(12)^3}{12} + 2(183)(4)^2 \]
\[ = 20160 + 5856 = 7872 \text{ in}^4 \]
\[ P = \frac{(3.14)^2 \times 3122000 \times 7872}{(2152)^2} = 52323 \text{ psi} > 45024 \text{ psi} \]

No buckling.

Check Stress in Plywood
\[ E_w = 1.2(1 \text{ psi}) \]
\[ P_w = (1.2 \times 10^6) \times \left(\frac{258}{3 \times 10^6}\right) \]
\[ = 103 \text{ psi} < 328 \text{ psi} \]
End Wall Shear Stress of 2nd Fl. and 1st Fl. levels.

Check shear at mid height of 2nd story.

DL:
- Roof rafters & joists: 5 #/ft
- Roofing: 2 #/ft
- Ceiling: 1 #/ft
- Total: 8 #/ft

Total load = 8 x 180 x 28 = 40320 #

UL:
- Snow: 20 #/ft

Total snow load = 20 x 180 x 28 = 100800 #

w/ snow

C_w = 0.141

\[ v = \frac{0.141}{2} (40320 + 100800) = 9949 \text{ #} \]

Net area = 736 in²

\[ v \text{ (shear stress)} = \frac{9949}{736} = 13.5 \text{ psi} \leq 50 \text{ psi allowable} \]

\[ \frac{M}{V_d} = \frac{5}{28} = 0.12 \]

Check shear at mid height of 1st story.

Roof: 40320
Snow: 100800

\[ Lq. \text{ Walls } (99000 \times 2) - 55 \times 2 (6 \times 5) \times 17 \]
\[ = 198000 - 56100 = 141900 \text{ #} \]

Tr. Walls (15480 x 2) - 55 x 2 (6x5) x 3
\[ = 30800 - 9900 = 20900 \text{ #} \]

Partition: 10080 #

2nd fl: 25200
Ceiling: 5040
2nd fl. LL = 215200 #

Total load (including snow) = 596240 #

\[ V = \frac{0.141}{2} \times 596240 = 42035 \text{ #} \]

Net area of wall = \((28'-12'') \times 12\times 12''\times \frac{82.5}{181.6} = 1047 \text{ in}^2 \]

\[ \frac{42035}{1047} = 40 \text{ psi < 50 psi, O.K.} \]

Create shear in the plywood diaphnagu at 2nd fl.

---

Load:

- D.L. of floor: \( \frac{5.44}{4} \times 180' \times 28' = 23200 \text{ #} \)
- LL: \( 25\% \times 50 \times 4 \times 180 \times 28' = 63000 \text{ #} \)
- Partition: \( 10\% \times 180 \times 28' = 50900 \text{ #} \)
- Exterior wall: \( 8'' \times 180' \times 2.5' \times 55' = 54450 \text{ #} \)
  \( 12'' \times 180 \times 4.6 \times 80' = 66240 \text{ #} \)

\( \frac{54450 + 66240}{2} = 60345 \text{ #} \)

a) Assume all lateral loads are resisted by wood diaphnagu.

UBC 97: \( f_p = 1.0 \) Ca + Wp

\[ C_a = 0.12 \text{ (Sp soil, Zone 1)} \]

\[ W_p = \text{Floor load + Wall load} \]

\[ = 138600 + (2 \times 120690) = 379980 \text{ #} \]

\[ f_p = 1.0 \times 0.12 \times 1.0 \times 379980 = 45600 \text{ #} \]
\[
V = \frac{45600}{2 \times 28} = 814 \text{ #/ft} \geq 675 \text{ #/ft.}
\]

(FEMA 178, page C-10)

2) Assume wood partitions participate in resisting lateral load by 30%.

There are over twenty 2x4 Gypsum wall partitions in transverse directions. 2x4 plates are nailed to wood joints and to roof rafters.

\[
V = 70\% \times 814
\]

\[
= 570 \text{ #/ft} < 675 \text{ #/ft}
\]

3) Check Midspan Deflection.

(ACI 7, page 167; FEMA 305)

\[
\Delta = \frac{5VL^3}{384WEA} + \frac{VL}{4EI} + 0.188L\varepsilon_n + \frac{\sum (\Delta_c X)}{2W}
\]

\[
L = 180\text{ ft}
\]

\[
W = 28\text{ ft}
\]

\[
E_c = 3,220,000 \text{ psi (concrete)}
\]

\[
A_c = 8 \times 14 = 112 \text{ in}^2
\]

\[
G_f = 60,000 \text{ psi}
\]

\[
\varepsilon_n = 0.077\% \text{ (assumed 10d nail @ 3\text{ in.}) 240#/nail (largest value in the table)}
\]

\[
t = \frac{3}{4}\text{ in.}
\]
\[ \Delta = \frac{5 \times 814 \times (180)^3}{8 \times (28) \times (3222000) \times 112} + \frac{814 \times (180)}{4 \times (60,000) \times (0.15)} + 0.188 \times (180) \times 0.077 \]

\[ = 0.29'' + 0.81'' + 2.61'' = 3.71'' \text{ N.G. too close.} \]

Controlling factor is nail deformation

\[ \sqrt{3.5'' + 4''} \]

4) Assume interior partitions participate in resisting lateral deformation

\[ \Delta = (0.29 + 0.81) \times \frac{570}{814} + 2.61 = 0.77 + 2.61 = 3.38'' \]

It is concluded that

1. Diaphragm has enough strength to resist the lateral load.

2. It is most likely that either the joists fall off from the wall or the wall would move away from the joists.
### OPTION 2 COST ESTIMATION FORM

#### COST ESTIMATION OPTION 2

1. **GROUP MEAN COST**
   - **Group:**
     - ☒ URM
     - ☐ W1, W2
     - ☐ PC1, RM1
     - ☐ C1, C3
   - **Cost Coefficient \( C_i \) from Table 4.3.2.**
     - \( C_i = 13.79 \)

2. **AREA ADJUSTMENT FACTOR**
   - **Area**
     - ☒ Less than 10K sq. ft.
     - ☒ 10K - 50K sq. ft.
     - ☐ 50K - 100K sq. ft.
     - ☐ 10K - 50K sq. ft.
   - **Cost Adjustment Factor \( C_a \) from Table 4.3.3**
     - \( C_a = 1.01 \)

3. **SEISMICITY/PERFORMANCE OBJECTIVE FACTOR ADJUSTMENT**
   - **SEISMICITY**
     - ☒ Low (NEHRP 1 or 2)
     - ☐ Moderate (NEHRP 3 or 4)
   - **PERFORMANCE OBJECTIVE**
     - ☒ Life Safety
     - ☐ Damage Control
     - ☐ Immediate Occupancy
   - **Cost Adjustment Factor \( C_s \) from Table 4.4.2**
     - \( C_s = 0.61 \)

4. **LOCATION ADJUSTMENT FACTOR**
   - **City / State**
     - VA
   - **Cost Adjustment Factor \( C_l \) from Table 4.3.4 or Table 4.3.5**
     - \( C_l = 0.84 \)

5. **TIME ADJUSTMENT FACTOR**
   - **Year**
     - 1992
   - **Inflation Rate**
     - 2%
   - **Cost Adjustment Factor \( C_T \) from Table 4.3.6**
     - \( C_T = 1.10 \)

**TYPICAL STRUCTURAL COST**

\[
C = C_i 	imes C_a 	imes C_s 	imes C_l 	imes C_T
\]

\[
C = 7.85
\]

**Building Area (Square Foot):** \( A = 19892 \)

- **Estimated Structural Cost** \( (A 	imes C_s) \)
  - \( C_s = 156200 \)

- **Non-Structural Cost** \( (C_l 	imes C_T 	imes C_F) \)
  - \# 6.00 \$/f x 0.84 x 1.10 = 5.54
  - \( C_{NS} = 110200 \)

- **Finishing Cost** \( \frac{1}{2} \times 110200 \)
  - \( C_F = 55100 \)

- **Total (Structural + Non-Struc + Finishing)**
  - \( C_{ST} = 321500 \)

- **Project Cost** \( (C_{ST} \times 0.3) \)
  - \( C_F = 96450 \)

**Total Cost**

\[
417,950
\]
Building Designation: Bothell, WA
Location: Bothell, WA

DATA SUMMARY SHEET

BUILDING DATA
Year built: 1985
Year(s) remodelled: 
Date of Evaluation: 9/14/98
Area, (sq. ft.) 30,000
Length 200
Width 100
Photo Roll No. 

CONSTRUCTION DATA
Roof framing: Z-purlins + metal deck
Intermediate floor framing: Steel framing + Conc Slab
Ground floor: Conc
Basement: None
Exterior walls: CMU/metal
Openings: Overhead doors
Columns: Steel
Foundations: Conc spread footings, pile
General condition of structure: Good
Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

Transverse

Longitudinal

Model building type: MB05
Building period, T: MB05 + MB07
Unreduced base shear,

\[ V = \frac{(0.8A_v \times S)}{(R \times 7^{0.5})} \times (W) \ or \ V = \frac{(2.12A_v/R)}{W} \]

Response Modification Coefficient, R: 9.5

EVALUATION DATA

\[ A_v = 6.2 \quad A_v = 6.2 \]

Site soil profile type: S2
Site soil coefficient, S = 1.2

REMARKS

Designed for 90 mph wind load (20 psf/ ANSI A58.1)
Seismic design: Zone 3
EVALUATION STATEMENTS FOR BUILDING TYPE 5: STEEL LIGHT FRAME

These buildings are pre-engineered and pre-fabricated with transverse rigid frames. The roof and walls consist of light-weight panels. The frames are designed for maximum efficiency, often with tapered beam and column sections built up of light plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames, with loads distributed to them by shear elements. Loads in the longitudinal direction are resisted entirely by shear elements. The shear elements can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be false identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity ($A_s = 0.4$). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

T F LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)

F REDUNDANCY: The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)

F WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)

F SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)

F TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)
DETERIORATION OF STEEL: There is no significant visible rusting, corrosion, or other deterioration in any of the steel elements in the vertical or lateral-force-resisting systems. (Sec. 3.5.3)

MOMENT FRAMES

STRESS CHECK: The building satisfies the Quick Check of the stress in the diagonals. (Sec. 6.1.1)

BEAM PENETRATIONS: All openings in frame-beam webs have a depth less than 1/4 of the beam depth and are located in the center half of the beams. (Sec. 4.2.3)

DIAPHRAGMS

PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

CONNECTIONS

STEEL COLUMNS: The columns in the lateral-force-resisting system are substantially anchored to the building foundation. (Sec. 8.4.1)

WALL AND ROOF PANELS

LIGHT-GAGE METAL, PLASTIC, OR CEMENTITIOUS ROOF PANELS: All light-gage metal, plastic, or cementitious roof panels are properly connected to the roof framing at not more than 12 inches on center. (Sec. 8.6.1)

WALL PANELS: All wall panels (metal, fiberglass, or cement asbestos) are properly connected to the framing. (Sec. 8.6.2)
The rigid frame was designed for $Z = 3$. Using TM 5-809-10 (1982)

**Base shear** $V = Z I c K S W$

$Z = 0.75$
$I = 1.5$
$K = 1.33$
$S = 0.14$

Masonry was designed in accordance with TM-5-809-10.

The rigid frames and masonry walls are judged to be designed for UBC Zone 3.

The west end wall had large garage doors and judged to have inadequate lateral load resisting strength.
MORS GARAGE | Bothell, WA

The end wall is comprised of 10 8" C in the vertical direction, spaced 4' between two adjacent channels. Metal sheathing.

1) Assuming each channel is acting independently.

- \( c = 8 \times 11.5 \)
- \( I_{x-y} = 1.32 \text{ in}^4 \)

Lateral Load:

- Roof DL: \( 4.5 \text{ psf} \times 100 \times 15 = 6750 \) #
- Roof LL: \( 25 \times 100 \times 15 = 37500 \)
- End Wall: \( 15 \text{ psf} \times 100 \times \frac{9+23}{2} = 31500 \)

\[ V = \frac{7IC}{R_u} \text{ N} \]

\[ = 0.3 \times 1.5 \left( \frac{2}{7} \right) \times 75750 = 0.128 \times 75750 = 9739 \# \]

- \( 9739 \# \)

Check simple cantilever beam defl.

\[ \Delta = \frac{PE^3}{3EI} = \frac{9.7 \times 240^3}{3 \times 13.2 \times 29600} = 114'' = 0.475 \text{ ft} \ (\text{high}) \]
Participation of the roof in resisting the end wall deflection.

8" Z section @ 1'-0" o.c.

24 Z purlins

\[ I_{t-y} = 0.306 \text{ in}^4 \]

\[ 2I_{t-y} = 0.306 \times 24 = 7.344 \text{ in}^4 \]

1/2" metal roof panels.

\[ A_z = 0.706 \text{ in}^2 \]

\[ A_d^2 = 2(0.706 \times 600^2) + 2(0.706 \times 752^2) + 2(0.706 \times 456^2) + 2(0.706 \times 408^2) + 2(0.706 \times 384^2) + 2(0.706 \times 336^2) + 2(0.706 \times 288^2) + 2(0.706 \times 240^2) + 2(0.706 \times 192^2) + 2(0.706 \times 144^2) + 2(0.706 \times 96^2) + 2(0.706 \times 48^2) \]

\[ = 1,355,520 + 450,242 + 293,605 \]

\[ + 235,047 + 208,202 + 159,409 \]

\[ + 117,117 + 81,331 + 52,052 \]

\[ + 29,279 + 130,133 + 32,823 \]

\[ = 2,978,070 \text{ in}^4 \text{ Say effective on 30\%} \]

\[ \Delta = \frac{PL^3}{3EI} = \frac{4.4 \times (12 \times 30')^3}{3 \times 29,600 \times 29,780 \times 0.70 \times 0.3} = 0.24 \text{ in} \]

Very small

Diaphragm Shear Transfer

\[ V = 1.5 A V C P W_d \]

\[ = 1.5 \times 0.2 \times 0.6 \times 44,250 \text{#} = 7965 \text{#} \text{ OK} \]

Table C 6.1.1a

Capacity = 1900 \#/ft x 100 ft = 180,000 \#
Building Designation: D

Location: Emmitsburg, MD

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1929 Year(s) remodelled: 
Date of Evaluation: 6/23/98
Area, (sq. ft.) 28687 Length 212' Width 45' Photo Roll No.

CONSTRUCTION DATA

Roof framing: Concrete Trusses Intermediate floor framing: Wood beams
Ground floor: Concrete Basement: Concrete
Exterior walls: Brick Masonry Openings: Windows
Columns: None Foundations: Stone + Brick Masonry
General condition of structure: Fair / Good Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

Transverse Longitudinal

Model building type: MB 15 MB 15
Building period, T: 
Unreduced base shear, 
\[ V = \left( 0.804a_x S \right) / \left( R x T^{0.5} \right) \] x (W) or \[ V = \left( 2.12a_d/R \right) \] x W
Response Modification Coefficient, R: 1.25

EVALUATION DATA

\[ a_x = 0.05 \] \[ a_d = 0.05 \]
Site soil profile type: S2 Site soil coefficient, S = 1.2

REMARKS

Being used as dormitory
EVALUATION STATEMENTS FOR BUILDING TYPE 15:
UNREINFORCED MASONRY BEARING WALL BUILDINGS

These buildings include structural elements that vary depending on the age of the building and, to a lesser extent, the geographic location of the structure. In buildings built before 1950, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In buildings built after 1950, unreinforced masonry buildings with wood floors usually have plywood rather than board sheathing. More recently, in regions of lower seismicity, these buildings can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possibly some interior walls, are unreinforced masonry. The walls may or may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity ($A_s = 0.4$). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

1. **LOAD PATH:** The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)

2. **REDUNDANCY:** The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)

3. **WEAK STORY:** Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)

4. **SOFT STORY:** Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)
GEOMETRY: There are no significant geometrical irregularities; there are no setbacks (i.e., no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to the adjacent stories). (Sec. 3.3.3)

MASS: There are no significant mass irregularities; there is no change of effective mass of more than 50 percent from one story to the next, excluding light roofs. (Sec. 3.3.4)

VERTICAL DISCONTINUITIES: All shear walls are continuous to the foundation. (Sec. 3.3.5)

TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

ADJACENT BUILDINGS: There is no immediately adjacent structure that is less than half as tall or has floors/levels that do not match those of the building being evaluated. A neighboring structure is considered to be "immediately adjacent" if it is within 2 inches times the number of stories away from the building being evaluated. (Sec. 3.4)

MASONRY UNITS: There is no visible deterioration of large areas of masonry units. (Sec. 3.5.10)

MASONRY JOINTS: The mortar cannot be easily scraped away from the joints by hand with a metal tool, and there are no significant areas of eroded mortar. (Sec. 3.5.9)

For buildings with wood diaphragms and unreinforced masonry bearing and enclosure walls at the perimeter, complete the evaluation using the procedure given in Appendix C. For other buildings, continue with the following evaluation statements.

MASONRY WALLS

SHEARING STRESS CHECK: The building satisfies the Quick Check of the shearing stress in the unreinforced masonry shear walls. (Sec. 5.4.1)

PROPORTIONS: In areas of high seismicity ($A_s$ greater than or equal to 0.2), the height-thickness ratio of the unreinforced masonry wall panels is as follows: (Sec. 5.5.1; also see Appendix C)

- One-story building: $h_w/t < 14$
- Multistory building:
  - Top story: $h_w/t < 9$
  - Other stories: $h_w/t < 20$

MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls have negligible voids. (Sec. 5.4.2)
DIAPHRAGMS

F PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

F REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than *50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

F SPAN/DEPTH RATIO: If the span/depth ratios of wood diaphragms are greater than 3 to 1, there are nonstructural walls connected to all diaphragm levels at less than 40-foot spacing. (Sec. 7.2.4)

F SHEATHING: None of the diaphragms consist of straight sheathing or have span/depth ratios greater than *2 to 1. (Sec. 7.2.1)

CONNECTIONS

F MASONRY WALL ANCHORS: Wall anchorage connections are steel anchors or straps that are developed into the diaphragm. (Sec. 8.2.3)

F ANCHOR SPACING: The anchors from the floor and roof systems into exterior masonry walls are spaced at 4 feet or less. (Sec. 8.2.4)
Check h/i ratio:

Top story = \( \frac{14.7}{22} = 0.67 < 9 \quad \text{OK} \)

1st story = 6.54 < 20 \quad \text{OK}

Wgt of Bldg:

Longitudinal Wall: 148 x 36 = 7128

Windows: (19 windows x 28) x 3 = 1596

NET AREA = 5532 ft²

Transverse (End): 45 x 36 = 1620

(12 x 28) x 3 = 1008

NET AREA = 612 ft²

Wall surface area:

\((5532 + 612) \times 2 = 12288\) ft²

\[ \sum \text{Weight} \quad 12288 \times 243 \# / \text{ft} = 2,985,984 \# \]

Partition: (12 1/2'' Conc Block),

194' x 10' = 1940 ft²

Doors: 17 x 3.5' x 8' = 476

\(1464 \# / \text{Story} \times 80 \times 2 = 23,360 \# \)

Interior Part: (8'')

18' x 10' x 17' x 55 = 168,300 \# / Story

3 stories x (23,360 + 168,300) = 1,205,700 \#.
Roof: Conc.

Ceiling:
\[
\frac{110 \text{ ft}^2 \times 45 \text{ ft} \times 198 \text{ in} \times 0.83}{12} = 813,783 \text{ #}
\]

Roof:
\[
110 \times 50 \text{ in} \times 198 \text{ in} \times 0.67 = 694,465 \text{ #}
\]

Truss:
\[
694 \text{ A65} \times 0.2 = 139,293 \text{ #}
\]

\[
\frac{1,647,241}{13,484.8} \text{ #}
\]

2nd & 3rd fl:
\[
43 \text{ ft} \times 196 \text{ ft} \times 8 \text{ ft} = 67424 \text{ #}
\]

\[
\frac{67424}{13,484.8} \text{ #}
\]

Total Dead Load at 1st FL Level

2985984
1205700
1647241
134848
\[
6,973,800 \text{ #}
\]

\[
V = C_s \times W = 0.17 \times 5,973,800 = 1,015,500 \text{ #}
\]

\[
C_s = \frac{2 \times 12 \times A_e}{L^2} = \frac{2 \times 12 \times 0.1}{125} = 0.17 \text{ (Short period bldg.)}
\]

\[
N_{et} / A = \left( \frac{198 - 194}{2} \right) \times 2 = 447 \text{ #}
\]

\[
V = \frac{1,015,500}{447 \times 12 \times 12} = 151.8 \text{ psi} \times 1.25 = 191.75 \text{ psi}
\]

\[
V_m = 0.56 V_{w0} + \frac{0.75 P_e}{A} = 0.56 \times 60 + \frac{0.75 (50 \times 13800)}{447 \times 144}
\]

\[
= 33.6 + 69.6 = 103 \text{ psi}
\]
CHECK SPAN AT ROOFLINE

Total Roof + Ceiling load = 1647241 #

Available wall cross section = \[ (198 - 194) \times 18/12 \times 2 \times 366 \# \]

\[ V = \frac{1647241}{366 \times 144} = 31.2 \text{ psi} \]

\[ V_m = 0.56 \sqrt{V_w} + 0.75 \left( \frac{1647241}{366 \times 144} \right) = 33.6 + 23.4 \]

\[ = 57 \text{ psi} \]

CHECK MASS IRREGULARITY

Mass at 3rd floor ceiling level = 1647241 #

3rd floor + walls (3rd story) + partitions = 469329 #

67424 + 233600 + 168300

Ratio of masses = \[ \frac{1647241}{469329} = 3.5 > 1.5 \]
**Building Designation:** J

**Location:** Emmitsburg, MD

---

**DATA SUMMARY SHEET**

**BUILDING DATA**

- Year built: 1965
- Year(s) remodelled: 1972 (non-structural)
- Date of Evaluation: 6/23/88
- Area, (sq. ft.): 42,672
- Length: 154
- Width: 010
- Photo Roll No.

---

**CONSTRUCTION DATA**

- Roof framing: Concrete joists
- Intermediate floor framing: Concrete joists
- Ground floor: Concrete joists
- Basement: Concrete
- Exterior walls: Masonry
- Interior walls: Masonry
- Openings: 
- Columns: Concrete
- Foundations: Concrete wall and spread footing
- General condition of structure: Very Good
- Evidence of settling: None

---

**LATERAL FORCE RESISTING SYSTEM**

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model building type: MB10</td>
<td>MB10</td>
</tr>
<tr>
<td>Building period, T:</td>
<td></td>
</tr>
<tr>
<td>Unreduced base shear, V = [(0.804a x S)/(R x I^2/3)] x (W) or V = [2.124a/R] x W</td>
<td></td>
</tr>
</tbody>
</table>

Response Modification Coefficient, R: 

---

**EVALUATION DATA**

- Au = 0.05
- Av = 0.05
- Site soil profile type: S2
- Site soil coefficient, S = 1.2

---

**REMARKS**
EVALUATION STATEMENTS FOR BUILDING TYPE 10: CONCRETE FRAME WITH INFILL SHEAR WALLS

These buildings are similar to Type 7 except that the frame is of reinforced concrete. The analysis of this building is similar to that recommended for Type 7 except that the shear strength of the concrete columns, after cracking of the infill, may limit the semiductile behavior of the system. Research that is specific to confinement of the infill by reinforced concrete frames should be used for the analysis.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity ($A_s = 0.4$). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

T F LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)

T F REDUNDANCY: The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)

F WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)

F SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)

T F MASS: There are no significant mass irregularities; there is no change of effective mass of more than 30 percent from one story to the next, excluding light roofs. (Sec. 3.3.4)

T F VERTICAL DISCONTINUITIES: All infill walls are continuous to the foundation. (Sec. 3.3.5)

T F TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)
MASONRY JOINTS: The mortar cannot be easily scraped away from the joints by hand with a metal tool, and there are no significant areas of eroded mortar. (Sec. 3.5.9)

CRACKS IN INFILL WALLS: There are no diagonal cracks in the infilled walls that extend throughout a panel or are greater than 1.0 mm wide. (Sec. 3.5.11)

CRACKS IN BOUNDARY COLUMNS: There are no diagonal cracks wider than 1.0 mm in concrete columns that encase the masonry infills. (Sec. 3.5.7)

SHEAR WALLS

SHEARING STRESS CHECK: The building satisfies the Quick Check of the shearing stress in the masonry infill walls. (Sec. 5.3.1 for reinforced masonry; Sec. 5.4.1 for unreinforced masonry)

PROPORTIONS: In areas of high seismicity (\(A^o\) greater than or equal to 0.2), the height-thickness ratio of the unreinforced masonry wall panels is as follows: (Sec. 5.5.1; also see Appendix C)

- One-story building: 
  \[ \frac{h_w}{t} < 14 \]
- Multi-story building:
  - Top story: 
    \[ \frac{h_w}{t} < 9 \]
  - Other stories: 
    \[ h_w/t < 20 \]

SOLID WALLS: The infilled walls are not of cavity construction. (Sec. 5.5.2)

CAVITY WALLS: The infill walls are continuous to the soffits of the frame beams. (Sec. 5.5.3)

WALL CONNECTIONS: All infill panels are constructed to encompass the frames around their entire perimeter. (Sec. 5.5.4)

REINFORCING: In areas of high seismicity (\(A^o\) greater than or equal to 0.2), the total vertical and horizontal reinforcing steel in reinforced masonry walls is greater than 0.002 times the gross area of the wall with a minimum of 0.0007 in either of the two directions; the spacing of reinforcing steel is less than 48 inches; and all vertical bars extend to the top of walls. (Sec. 5.3.7) \( \nu/A \)

MOMENT FRAMES

COMPLETE FRAMES: The concrete frames form a complete vertical load carrying system. (Sec. 4.5.1)

DIAPHRAGMS

PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1) \( \nu/A \)

REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3) \( \nu/A \)
SPAN/DEPTH RATIO: If the span/depth ratios of wood diaphragms are greater than 3 to 1, there are nonstructural walls connected to all diaphragm levels at less than 40-foot spacing. (Sec. 7.2.4)

CONNECTIONS

WALL ANCHORAGE: The exterior concrete or masonry walls are anchored to each of the diaphragm levels for out-of-plane loads. (Sec. 8.2.2)
Wgt of Bldg

2nd Fl
200\' x 169' x 59' = 737854 #

2nd Fl
78' x 169' x 59' = 777738

\(4.4\times0.7\times0.7\times0.7\text{ tons } = 233321 \text{ (30\% D.C.)} \)

Wall
1.25' x 14.08' x 12' = 211.2 ft^3

94 (211.2 x 150) = 760,320 #

Ceiling
1+1

Partition
16 \(\frac{4}{12}' x 169' x 59' = 159,536 #

Roofing
6 \(\frac{4}{12}' x 169' x 59' = 59,826 #

Total D.C. + L.C. at the 1st fl. level

59,826
737,854
777738
233321
760,320
760,320
159,536
3488416 #

\(C_s = \frac{2.12 \text{ Aa}}{2} = \frac{2.12 \times 0.1}{5} = 0.0424 \)

\(V = 0.0424 \times 3488416 = 147930 #\)

Available wall area = \(24' \times 15' \times 78' = 280800\)
\[ v = \frac{147930}{28080} = 5.27 \text{ psi} \]

\[ V_{\text{allowable}} = 2 \sqrt{f_c} = 2 \sqrt{3000} = 109.5 \text{ psi} \]
Emmitsburg, MD

Assumptions:

- $f_c = 4000$ psi
- Floors: Concrete joist construction $12 + 4.5 \times 6 + 30$
- Columns: Perimeter $12'' \times 24''$
  interior $12'' \times 12''$
- Live Load: 50 psf
- Snow Load: 30 psf
- $E_{\text{conc.}} = 3,640,000$ psi
- Floor height = 12'
- Floors act as rigid diaphragms

PLAN:
Loads /floor: Joist Floor: 85 psf
bridging: 2
Partitions: 20
Ceiling /mech: 12
DL 119 psf

Lateral Force Estimation

* Roof weight including 30 psf snow load:
  \[ W_r = (119 + 30) \times 57 \times 12 = 1437.016 \text{ lbs} \]
  \[ = 1437 \text{ k} \]

* 1st floor weight including 25% of L.L.
  \[ W_1 = (119 + 50) \times 57 \times 12 = 1268.239 \text{ lbs} \]
  \[ = 1268 \text{ k} \]

\[ W = 1437 + 1268 = 2705 \text{ k} \]

* Assume natural Period & Building = 0.2 s

* \[ C_s = \frac{2.12 A_a}{R} \]

  Maryland \[ A_a = 0.5 \]
  Ordinary moment frame \[ R = 2 \]
  \[ C_s = \frac{2.12 \times 0.5}{2} = 0.053 \]

* Base Shear \[ V = C_s W = 0.053 \times 2705 = 143.365 \text{ k} \]

* Force at top floor \[ = \frac{1437 \times 2}{1437 + 2 + 1268} \]
  \[ = \frac{2874}{2613} \times 1437 = 99.5 \text{ k} \]
  \[ = 43.9 \text{ k} \]

* Vertical Reactions in Columns

  Roof load = (119 + 30) \times 14.1 = 2101 p/ft = 2.1 k/ft
  floor load = (119 + 50) \times 14.1 = 2383 p/ft = 2.4 k/ft

  interior Col. Ground 160 k
  exterior Col. Level 50 k
Frames in Y direction

for an intermediate frame, force at top floor = $99.5/2 = 8.3k$

" " 1st " = $43.7/2 = 3.7k$

$A_{col.0} = 12 \times 24 = 288 \text{ in}^2$

$A_{col.1} = 12 \times 12 = 144 \text{ in}^2$

$A_{beam} = 12 \times 16.5 = 198 \text{ in}^2$

$I_{col.0} = 12 (24)^3/12 = 13,824 \text{ in}^4$

$I_{col.1} = 12 (12)^3/12 = 1,728 \text{ in}^4$

$I_{beam} = 12 (16.5)^3/12 = 4,492 \text{ in}^4$

Analysis Results:

Lateral drift

Top floor $\Delta = 2 \times 0.265 = 0.493''$

1st floor $\Delta = 2 \times 0.094 = 0.190''$

$\delta = 0.2465$

$\delta = 0.094$
* Interior Column:

\[ P_n = 4.6 \times 160 = 256 \text{ kips} \]

\[ M_n = 143 \text{ kips in} \]

\[ \frac{P_n}{f_c' A_g} = \frac{256}{(4 \times 12 + 12)} = 0.444 \]

From interaction diagram \( \frac{(M_n)_{\text{max}}}{f_c' A_g h} = 0.14 \)

\( (M_n)_{\text{max}} = 0.14 \times 4 \times (12 + 12) + 12 = 970 \text{ kips in} \)

Safe

* Exterior Column:

\[ P_n = 1.6 \times 50 = 80 \text{ kips} \]

\[ M_n = 706 \text{ kips in} \]

\[ \frac{P_n}{f_c' A_g} = \frac{80}{(4 \times 12 + 24)} = 0.07 \]

\( \frac{(M_n)_{\text{max}}}{f_c' A_g h} = 0.08 \)

\( (M_n)_{\text{max}} = 0.08 \times 4 \times (12 + 24) + 24 = 2212 \text{ kips in} \)

Safe
Frames in X direction

The 3 Column Lines are lumped in 1 frame

Beams: \[ A = 3 \times 12 \times 16.5 = 594 \text{ in}^2 \]
\[ I = 3 \times \frac{12(6.5)^2}{12} = 13,476 \text{ in}^4 \]

Columns: \[ A = 2(12 \times 24) + 12 \times 12 = 720 \text{ in}^2 \]
\[ I = 2 \left[ \frac{24(12)^2}{12} \right] \times \frac{12(12)^3}{12} = 8640 \text{ in}^4 \]

Max. moment = 974 k. in

Analysis Results:

Lateral drift: top floor \[ \Delta = 2 \times .24 = 0.56^\circ \]
1st floor \[ \Delta = 2 \times .139 = 0.278^\circ \]

Moment/ exterior col. = \[ \frac{24(12)^{3/2}}{8640} \times 9.74 = 390 \text{ k. in.} \]

Moment/ interior col. = \[ \frac{12(12)^{3/2}}{8640} \times 9.74 = 195 \text{ k. in.} \]
* Interior Column:

\[ \frac{P_n}{f'_c \cdot A_g} = 0.444 \]

\[ M_n = 195 \text{ k.in.} \]

\[ (M_n)_{\text{max}} = 970 \text{ k.in.} \]

Safe

* Exterior Column:

\[ \frac{P_n}{f'_c \cdot A_g} = 0.07 \]

\[ \frac{(M_n)_{\text{max}}}{f'_c \cdot A_g \cdot h} = 0.08 \]

\[ M_n = 390 \text{ k.in.} \]

\[ (M_n)_{\text{max}} = 0.08 \times 4 \times (12 \times 24) \times 12 = 1106 \text{ k.in.} \]

Safe
Building Designation: "0"

Location: Emmitsburg, MD

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1829  Year(s) remodelled: 1970's
Date of Evaluation: 6/23/88
Area, (sq. ft.) 13270  Length 124'  Width 68'  Photo Roll No. ___

CONSTRUCTION DATA

Roof framing: Timber Trusses
Intermediate/floor framing: Timber members
Ground floor: Timber  Basement: Concrete
Exterior walls: Stone Masonry  Openings: Large windows
Columns: Brick  Foundations: Stone Masonry
General condition of structure: Fair
Evidence of settling: Not Noticeable

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model building type: MB15</td>
<td>MB15</td>
</tr>
<tr>
<td>Building period, T:</td>
<td></td>
</tr>
<tr>
<td>Unreduced base shear, ( V = \left(0.804 \times S\right)/(R \times T^{2/3}) \times (H) ) or ( V = \left[2.12A_e/R\right] \times W )</td>
<td></td>
</tr>
<tr>
<td>Response Modification Coefficient, ( R ): 1.25</td>
<td></td>
</tr>
</tbody>
</table>

EVALUATION DATA

\( A_e = 0.05 \)  \( A_v = 0.05 \)

Site soil profile type: S

Site soil coefficient, \( S = 1.2 \)

REMARKS

Historic resistor.

Timber steeple needs a special attention.
EVALUATION STATEMENTS FOR BUILDING TYPE 15: UNREINFORCED MASONRY BEARING WALL BUILDINGS

These buildings include structural elements that vary depending on the age of the building and, to a lesser extent, the geographic location of the structure. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In buildings built after 1950, unreinforced masonry buildings with wood floors usually have plywood rather than board sheathing. More recently, in regions of lower seismicity, these buildings can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possibly some interior walls, are unreinforced masonry. The walls may or may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity (\( \alpha_s = 0.4 \)). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

\[ \text{T} \quad \text{F} \quad \text{LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NUIS): Write a brief description of this linkage for each principal direction.} \]  
(Sec. 3.1)

\[ \text{T} \quad \text{F} \quad \text{REDUNDANCY: The structure will remain laterally stable after the failure of any single element.} \]  
(Sec. 3.2)

\[ \text{T} \quad \text{F} \quad \text{WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above.} \]  
(Sec. 3.3.1)

\[ \text{T} \quad \text{F} \quad \text{SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above.} \]  
(Sec. 3.3.2)
GEOMETRY: There are no significant geometrical irregularities; there are no setbacks (i.e., no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to the adjacent stories). (Sec. 3.3.3)

MASS: There are no significant mass irregularities; there is no change of effective mass of more than 50 percent from one story to the next, excluding light roofs. (Sec. 3.3.4)

VERTICAL DISCONTINUITIES: All shear walls are continuous to the foundation (Sec. 3.3.5)

TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

ADJACENT BUILDINGS: There is no immediately adjacent structure that is less than half as tall or has floors/levels that do not match those of the building being evaluated. A neighboring structure is considered to be "immediately adjacent" if it is within 2 inches times the number of stories away from the building being evaluated. (Sec. 3.4)

MASONRY UNITS: There is no visible deterioration of large areas of masonry units. (Sec. 3.5.10)

MASONRY JOINTS: The mortar cannot be easily scraped away from the joints by hand with a metal tool, and there are no significant areas of eroded mortar. (Sec. 3.5.9)

For buildings with wood diaphragms and unreinforced masonry bearing and enclosure walls at the perimeter, complete the evaluation using the procedure given in Appendix C. For other buildings, continue with the following evaluation statements.

MASONRY WALLS

SHEARING STRESS CHECK: The building satisfies the Quick Check of the shearing stress in the unreinforced masonry shear walls. (Sec. 5.4.1)

PROPORTIONS: In areas of high seismicity (\(A_s\) greater than or equal to 0.2), the height-thickness ratio of the unreinforced masonry wall panels is as follows: (Sec. 5.5.1; also see Appendix C)

- One-story building: \(h_w/t < 14\)
- Multistory building:
  - Top story: \(h_w/t < 9\)
  - Other stories: \(h_w/t < 20\)

MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls have negligible voids. (Sec. 5.4.2)
DIAPHRAGMS

T F PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

T F REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

T F SPAN/DEPTH RATIO: If the span/depth ratios of wood diaphragms are greater than 3 to 1, there are nonstructural walls connected to all diaphragm levels at less than 40-foot spacing. (Sec. 7.2.4)

T F SHEATHING: None of the diaphragms consist of straight sheathing or have span/depth ratios greater than 2 to 1. (Sec. 7.2.1)

CONNECTIONS

T F MASONRY WALL ANCHORS: Wall anchorage connections are steel anchors or straps that are developed into the diaphragm. (Sec. 8.2.3) Not known

T F ANCHOR SPACING: The anchors from the floor and roof systems into exterior masonry walls are spaced at 4 feet or less. (Sec. 8.2.4) Not known
Building O - Emmitsburg, MD 7-27-98

AR = 0.1, AE = 0.1

Roof: Straight sheathing v = 300 #/ft.

Length of shear wall at 1st floor x 198'

\[
hw/t = \frac{26}{1.5} = 17.3 < 14 \quad \text{OK.} \quad A_u \leq 0.1.
\]

Brick weight

\(130 \#/ft^3\) for masonry

\[\text{vol} = 250' \times 250' \times 71' + 100' = 670' \text{ Perimeter}\]

\[W (\text{masonry}) = 130 \times 24,120 \\leq 31,300 \text{ K}\]

Roof: Timber, 2 x 45 #/ft.

\[45 \times 124 \times 68 = 380 \text{ K}\]

Ceiling: Wood lath + plaster 20 #/ft.

\[20 \times 124 \times 68 = 170 \text{ K}\]

\[W (2 \text{ dead weight}) = 3130 + 380 + 170 = 3680 \text{ K}\]

\[V = C_s W\]

\[C_s = \frac{2.12 A_v}{R}\]

for short period buildings.
\[ C_s = \frac{2.12 \times 0.1}{1.25} = 0.17 \]

\[ V = 0.17 \times 3680 = 626 \text{ kts} \]

\[ V = \frac{626 \times 3412.8}{3.4128} = 626 \text{ kts} \]

\[ V_{in} = 0.56 V_{iw} + \frac{0.75 P_v}{A} = 0.56 \times 40 + \frac{0.75 \times (3680 \text{ kts})}{3412.8} \]

\[ = 22.4 + 8.68 = 31.08 \text{ psi} > 22.5 \text{ psi} \]

\[ \frac{0.14}{2} \]
## OPTION 2 COST ESTIMATION FORM

### COST ESTIMATION OPTION 2

1. **GROUP MEAN COST**
   - Group:
     - ☑️ URM
     - ☑️ S1
     - ☐ W1, W2
     - ☐ S2, S5
     - ☐ PC1, RM1
     - ☐ S5
     - ☐ C1, C3
     - ☐ C2, PC2, RM2, S4

   - Cost Coefficient \( C_1 \) from Table 4.3.2.
     \[ C_1 = 15.29 \]

2. **AREA ADJUSTMENT FACTOR**
   - Area:
     - ☐ Less than 10K sq. ft.
     - ☑️ 10K - 50K sq. ft.
     - ☐ 50K - 100K sq. ft.
     - ☐ 10K - 50K sq. ft.

   - Cost Adjustment Factor \( C_2 \) from Table 4.3.3
     \[ C_2 = 1.00 \]

3. **SEISMICITY/PERFORMANCE OBJECTIVE FACTOR ADJUSTMENT**
   - SEISMICITY:
     - ☑️ Low (NEHRP 1 or 2)
     - ☐ Moderate (NEHRP 3 or 4)
     - ☐ High (NEHRP 5 or 6)
     - ☐ Very High (NEHRP 7)

   - PERFORMANCE OBJECTIVE:
     - ☑️ Life Safety
     - ☐ Damage Control
     - ☐ Immediate Occupancy

   - Cost Adjustment Factor \( C_3 \) from Table 4.4.2
     \[ C_3 = 0.61 \]

4. **LOCATION ADJUSTMENT FACTOR**
   - City / State:
     - ☑️ Ellicott City, MD

   - Cost Adjustment Factor \( C_4 \) from Table 4.3.4 or Table 4.3.5
     \[ C_4 = 0.98 \]

5. **TIME ADJUSTMENT FACTOR**
   - Year: 1998

   - Inflation Rate: 2%

   - Cost Adjustment Factor \( C_5 \) from Table 4.3.6
     \[ C_5 = 1.10 \]

### TYPICAL STRUCTURAL COST
\[ C = C_1 \times C_2 \times C_3 \times C_4 \times C_5 \]
\[ C = 10.05 \]

**Building Area (Square Foot):** \( A = 15370 \)

**Estimated Structural Cost (A x C):**
\[ C_s = \left( 154,500 \right) \times \frac{300}{463,500} \]
\[ C_s = 46,350 \]

**Non-Structural Cost (C_1 \times C_L \times C_T):**
\[ \$42.05/\psi \times 0.98 \times 1.1 = \$17.25/\psi \times 3 \]
\[ C_{NS} = 790,800 \]

**Finishing Cost**
\[ \$42.05/\psi \times 15370 \]
\[ C_F = 646,300 \]

**Total (Structural + Non-Struc + Finishing):**
\[ C_{ST} = 1,900,600 \]

**Project Cost (C_{ST} \times 0.3):**
\[ C_P = 570,180 \]

**Total Cost**
\[ \approx 2,471,000 \]
Building Designation: Maynard Federal Regional Center
Location: Maynard, MA

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1968  Year(s) remodelled: 
Date of Evaluation: 9/8/92
Area, (sq. ft.) 80,000  Length 140'  Width 120'  Photo Roll No.

CONSTRUCTION DATA

Roof framing: Concrete beams and slab
Intermediate floor framing: Concrete beams and slab
Ground floor: N/A  Basement: N/A
Exterior walls: N/A  Openings:
Columns: Concrete  Foundations: Concrete footing
General condition of structure: Very Good
Evidence of settling: None

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model building type: MB 16</td>
<td>MB 16</td>
</tr>
<tr>
<td>Building period, T:</td>
<td></td>
</tr>
<tr>
<td>Unreduced base shear,</td>
<td></td>
</tr>
<tr>
<td>$V = [(0.804 \times S)/(R \times T^{2/3})] \times (W)$ or $V = [2.124a/R] \times W$</td>
<td></td>
</tr>
<tr>
<td>Response Modification Coefficient, $R$: N/A</td>
<td></td>
</tr>
</tbody>
</table>

EVALUATION DATA

$A_o = 0.10$  $A_v = 0.10$
Site soil profile type: $S_2$  Site soil coefficient, $S = 1.2$

REMARKS

Underground structure designed for nuclear blast.
Building Designation: MAYNARD V0AB

Location: MAYNARD, MA

DATA SUMMARY SHEET

BUILDING DATA

Year built: 1988  Year(s) remodelled: 
Date of Evaluation: 9-8-98
Area, (sq. ft.) 40,000  Length 272'  Width 147'  Photo Roll No. 

CONSTRUCTION DATA

Roof framing: metal roof deck
Intermediate floor framing:
Ground floor: concrete  Basement: none
Exterior walls: metal  Openings:
Columns: steel  Foundations: spread footing
General condition of structure:
Evidence of settling:

LATERAL FORCE RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model building type: MB05</td>
<td>MB05</td>
</tr>
<tr>
<td>Building period, T:</td>
<td></td>
</tr>
<tr>
<td>Unreduced base shear, $V = [(0.804v \times S)/(R \times T^{2/3})] \times (W)$ or $V = [2.12A_o/R] \times W$</td>
<td></td>
</tr>
<tr>
<td>Response Modification Coefficient, $R$:</td>
<td>5.5</td>
</tr>
</tbody>
</table>

EVALUATION DATA

$A_o = 0.10$
$A_v = 0.10$
Site soil profile type: S2  Site soil coefficient, $S = 1.2$

REMARKS

Pre-engineered rigid frames
EVALUATION STATEMENTS FOR BUILDING TYPE 5:
STEEL LIGHT FRAME

These buildings are pre-engineered and pre-fabricated with transverse rigid frames. The roof and walls consist of light-weight panels. The frames are designed for maximum efficiency, often with tapered beam and column sections built up of light plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames, with loads distributed to them by shear elements. Loads in the longitudinal direction are resisted entirely by shear elements. The shear elements can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

Address the following evaluation statements, marking each either true (T) or false (F). Statements that are found to be true identify issues that are acceptable according to the criteria of this handbook; statements that are found to be false identify issues that need investigation. For guidance in the investigation, refer to the handbook section indicated in parentheses at the end of the statement.

Be advised that the numerical indices preceded by an asterisk (*) in these statements are based on high seismicity ($A_y = 0.4$). Adjustments are reasonable for lower seismicity. The appropriate adjustment is not necessarily a direct ratio of seismicity.

BUILDING SYSTEMS

T  F  LOAD PATH: The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation (NOTE: Write a brief description of this linkage for each principal direction.) (Sec. 3.1)

T  F  REDUNDANCY: The structure will remain laterally stable after the failure of any single element. (Sec. 3.2)

T  F  WEAK STORY: Visual observation or a Quick Check indicates that there are no significant strength discontinuities in any of the vertical elements in the lateral-force-resisting system; the story strength at any story is not less than 80 percent of the strength of the story above. (Sec. 3.3.1)

T  F  SOFT STORY: Visual observation or a Quick Check indicates that there are no significant stiffness discontinuities in any of the vertical elements in the lateral-force-resisting system; the lateral stiffness of a story is not less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above. (Sec. 3.3.2)

T  F  TORSION: The lateral force resisting elements form a well balanced system that is not subject to significant torsion. Significant torsion will be taken as any condition where the distance between the story center of rigidity and the story center of mass is greater than 20 percent of the width of the structure in either major plan dimension. (Sec. 3.3.6)

B-15 (Type 5)
DETERIORATION OF STEEL: There is no significant visible rusting, corrosion, or other deterioration in any of the steel elements in the vertical or lateral-force-resisting systems. (Sec. 3.5.3)

MOMENT FRAMES

STRESS CHECK: The building satisfies the Quick Check of the stress in the diagonals. (Sec. 6.1.1)

BEAM PENETRATIONS: All openings in frame beam webs have a depth less than 1/4 of the beam depth and are located in the center half of the beams. (Sec. 4.2.3)

DIAPHRAGMS

PLAN IRREGULARITIES: There is significant tensile capacity at re-entrant corners or other locations of plan irregularities. (Sec. 7.1.1)

REINFORCING AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. (Sec. 7.1.3)

CONNECTIONS

STEEL COLUMNS: The columns in the lateral-force-resisting system are substantially anchored to the building foundation. (Sec. 8.4.1)

WALL AND ROOF PANELS

LIGHT GAGE METAL, PLASTIC, OR CEMENTITIOUS ROOF PANELS: All light-gage metal, plastic, or cementitious roof panels are properly connected to the roof framing at not more than 12 inches on center. (Sec. 8.6.1)

WALL PANELS: All wall panels (metal, fiberglass, or cement asbestos) are properly connected to the framing. (Sec. 8.6.2)
Mars Garage | Maynard, MA

Original Design Loads

Wind = 90 mph
Snow = 35 psf
L.I. (office) = 80 psf.

Weight of Building

Roofing (metal deck + insulation) = 3.5 psf
Purlin = 1.0

Roof weight = 4.5 x 39600 = 178.2 kips
Snow = 35 x 39600 = 1386.0 kips

Suspended Ceiling in office area:
1 psf x 9000 = 9 kips per floor.

2nd fl slab (4" concre): 48.3 psf x 9000 = 435 kips.

Interior walls: 55 psf x 120' x 26.5' = 175 kips

Interior partitions:
1st fl: CMU 55 x 11' x 6' = 381 kips
Metal Stud 4.5 x 11' x 185' = 92 kips

2nd fl: CMU 45 x 15' x 350 = 2.89 kips
MSP 4.5 x 8' x 510 = 18.4 kips

2nd fl steel framing: 70.5 kips
**Exterior Walls**

<table>
<thead>
<tr>
<th>North</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Col 1 thru 7</td>
<td>CMU</td>
<td>21.8</td>
<td>kips</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doors</td>
<td>23.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Col 7 thru 10</td>
<td>CMU</td>
<td>16.7</td>
<td>kips</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>South</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Col 1 thru 5</td>
<td>CMU</td>
<td>14.5</td>
<td>kips</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>4.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doors</td>
<td>15.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Col 5 thru 8</td>
<td>CMU</td>
<td>10.9</td>
<td>kips</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doors</td>
<td>11.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Col 8 thru 10</td>
<td>CMU</td>
<td>12.4</td>
<td>kips</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>East</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Col A thru E</td>
<td>CMU</td>
<td>27.5</td>
<td>kips</td>
<td></td>
</tr>
<tr>
<td>Col E thru G</td>
<td>CMU</td>
<td>36.3</td>
<td>kips</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>7.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**West**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CMU</td>
<td>10.9</td>
<td>kips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>27.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pre-engineered steel frames: 143 kips
D.L.: Roof 178.2 kips

Interior Walls/Partitions ext. 1571
Exterior Walls 891.2
Frames 143
2783 kips

Snow: 1386 kips
L.C.: 720 kips

\[ W = D.L. + L.C. + Snow = 4900 \text{ kips} \]

**Base Shear**

\[ V = C_s W \times T \]

\[ C_s = \frac{0.80 \times 0.1 \times 1.2}{5.6 \times (2.5)^{0.75}} = \frac{0.096}{12.13} = 0.008 \]

\[ T = 0.2 \times (24)^{0.25} = 2.5 \text{ sec.} \]

\[ V = 0.0085 \times 4900 \times 1.25 = 58.7 \text{ kips} \]

Assume all shear is carried by Masonry Walls:

\[ f' = 3000 \text{ psi} \]
\[ E_s = 29,000 \text{ ksi} \]
\[ E_m = 2250 \]
\[ n = 12.9 \]
\[ #4 \ - 2\1/8'' \ @ C \]

\[ f = 0.2 \times 32 \times 8 = 0.00078 \text{ K} \]

\[ k = 0.132 \]
\[ i = 1 - \frac{0.132}{3} = 0.956 \]

\[ b = 8'' \quad d = 48'' \]

\[ f_v = \frac{V}{b\cdot d} \]

About 60% of the base shear is carried by the shorter wall on tributary area.

\[ V = 0.6 \times 58.2 \]

\[ f_v = \frac{0.16 \times 58.2}{8 (0.956)(48 \times 12)} = 7.9 \text{ psi} \]

\[ \text{FEMA 310} \quad 3.5 \times 3.3 \]

\[ \gamma = \frac{1}{w} \left( \frac{V}{A_w} \right) \]

\[ = \frac{1}{3.0} \left( \frac{58.2}{8 \times 60 \times 12 \times 75\%} \right) = 4.5 \text{ psi} \]

- **Check Shear Transfer to the West Direction**

  \[ \text{Roof} \quad 3.5 \times \left( 180 \times 120 + 60 \times 120 \right) = 100.8 \text{ kips} \]

  \[ \text{Snow} \quad 3.5 \times 28800 = 100.8 \text{ kips} \]

  \[ \text{Wall} \quad N \left( 21.8 + 24 + 23 \right) \frac{1}{2} = 34.9 \]

  \[ 6 \left( 14.6 + 4.9 + 15.4 \right) \frac{1}{2} = 17.4 \]

  \[ (19.9 \times 2) \frac{1}{2} = 19.9 \]

  \[ 1180.5 \text{ kip} \]

Total Cross section of Z's:

\[ 24 \times 0.706 = 16.94 \text{ in} \]

\[ f = \frac{1180.5}{16.94} = 69.7 \text{ ksi} > 36 \text{ ksi} \]

Not adequate to transfer tension due to lateral movement in the E-W direction.
OPTION 2 COST ESTIMATION FORM

COST ESTIMATION OPTION 2

1. GROUP MEAN COST
   • Group:
     - URM
     - W1, W2
     - PC1, RM1
     - C1, C9
     - S1, S2, S3, S4
     - S5
   • Cost Coefficient $c_1$ from Table 4.3.2.
     - $c_1 = 7.23$

2. AREA ADJUSTMENT FACTOR
   • Area
     - Less than 10K sq. ft.
     - 10K - 50K sq. ft.
     - 50K - 100K sq. ft.
     - 100K - 500K sq. ft.
   • Cost Adjustment Factor $c_2$ from Table 4.3.3
     - $c_2 = 1.12$

3. SEISMICITY/PERFORMANCE OBJECTIVE FACTOR ADJUSTMENT
   • SEISMICITY
     - Low (NEHRP 1 or 2)
     - Moderate (NEHRP 3 or 4)
     - High (NEHRP 5 or 6)
     - Very High (NEHRP 7)
   • PERFORMANCE OBJECTIVE
     - Life Safety
     - Damage Control
     - Immediate Occupancy
   • Cost Adjustment Factor $c_3$ from Table 4.4.2
     - $c_3 = 1.4$

4. LOCATION ADJUSTMENT FACTOR
   • City / State
     - Maynard, MA
   • Cost Adjustment Factor $c_4$ from Table 4.3.4 or Table 4.3.5
     - $c_4 = 1.10$

5. TIME ADJUSTMENT FACTOR
   • Year
     - 1998
   • Inflation Rate
     - 2%
   • Cost Adjustment Factor $c_5$ from Table 4.3.6
     - $c_5 = 1.10$

TYPICAL STRUCTURAL COST
\[ C = c_1 \times c_2 \times c_3 \times c_4 \times c_5 \]
\[ C = 13.72 \]

Building Area (Square Foot): \( A = 40,000 \)

Estimated Structural Cost (A x C)
\[ C_S = \frac{548,900}{40} \]  

Non-Structural Cost \( C_{NS} \)
\[ C_{NS} = 145,200 \]

Finishing Cost \( C_F \)
\[ C_F = 40,000 \]

Total (Structural + Non-Struct + Finishing)
\[ C_{ST} = 734,000 \]

Project Cost \( C_P \)
\[ C_P = 220,200 \]

Total Cost
\[ \approx 954,000 \]
Attachment C: Building Inventory and Rehabilitation Cost Database
<table>
<thead>
<tr>
<th>Age/Co</th>
<th>Name of Building</th>
<th>St/Co</th>
<th>By/Gd/Sub/Md</th>
<th>Arch/</th>
<th>No./ch/Bld</th>
<th>Extnt</th>
<th>Cmpct/Clas</th>
<th>Constr/Build</th>
<th>Flt/Blk</th>
<th>Yr/Of/Str</th>
<th>Med/Of/Bld</th>
<th>Yr/Of/Bld</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>Doathouse</td>
<td>24</td>
<td>021 L</td>
<td>40</td>
<td>1E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1961</td>
<td>MB13</td>
<td>1961</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Bothell VSAB</td>
<td>53</td>
<td>061 H</td>
<td>2,737</td>
<td>1E0</td>
<td>50</td>
<td>Z1</td>
<td>H2</td>
<td>1965</td>
<td>MB05</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 104</td>
<td>51</td>
<td>107 L</td>
<td>1,015</td>
<td>1E0</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB16</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 105</td>
<td>51</td>
<td>107 L</td>
<td>938</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB15</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 106</td>
<td>51</td>
<td>107 L</td>
<td>337</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB16</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 110</td>
<td>51</td>
<td>107 L</td>
<td>1,292</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1966</td>
<td>MB16</td>
<td>1966</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 114</td>
<td>51</td>
<td>107 L</td>
<td>1,398</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 123</td>
<td>51</td>
<td>107 L</td>
<td>22</td>
<td>1E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB15</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 127</td>
<td>51</td>
<td>107 L</td>
<td>22</td>
<td>1E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB16</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 140</td>
<td>51</td>
<td>107 L</td>
<td>75</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB13</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 146</td>
<td>51</td>
<td>107 L</td>
<td>25</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 201</td>
<td>51</td>
<td>107 L</td>
<td>691</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB05</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 205/211/230</td>
<td>51</td>
<td>107 L</td>
<td>2,464</td>
<td>3E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB15</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 217</td>
<td>51</td>
<td>107 L</td>
<td>821</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1986</td>
<td>MB13</td>
<td>1986</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 219</td>
<td>51</td>
<td>107 L</td>
<td>348</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB05</td>
<td>1989</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 219A</td>
<td>51</td>
<td>107 L</td>
<td>348</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1993</td>
<td>MB05</td>
<td>1993</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 310</td>
<td>51</td>
<td>107 L</td>
<td>440</td>
<td>1E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB15</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 311</td>
<td>51</td>
<td>107 L</td>
<td>33</td>
<td>1E0</td>
<td>50</td>
<td>Z1</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 312/313</td>
<td>51</td>
<td>107 L</td>
<td>35</td>
<td>2E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 315</td>
<td>51</td>
<td>107 L</td>
<td>344</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 317</td>
<td>51</td>
<td>107 L</td>
<td>42</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 320</td>
<td>51</td>
<td>107 L</td>
<td>458</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1965</td>
<td>MB15</td>
<td>1965</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 320A</td>
<td>51</td>
<td>107 L</td>
<td>302</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1968</td>
<td>MB05</td>
<td>1968</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 321</td>
<td>51</td>
<td>107 L</td>
<td>22</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB14</td>
<td>1995</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 327</td>
<td>51</td>
<td>107 L</td>
<td>190</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB01</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 329</td>
<td>51</td>
<td>107 L</td>
<td>347</td>
<td>1E0</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1966</td>
<td>MB05</td>
<td>1966</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 331</td>
<td>51</td>
<td>107 L</td>
<td>161</td>
<td>1E0</td>
<td>50</td>
<td>Z1</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 400</td>
<td>51</td>
<td>043 L</td>
<td>953</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 401</td>
<td>51</td>
<td>043 L</td>
<td>64</td>
<td>1E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1975</td>
<td>MB13</td>
<td>1975</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 403</td>
<td>51</td>
<td>043 L</td>
<td>358</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 404</td>
<td>51</td>
<td>049 L</td>
<td>11</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB15</td>
<td>1974</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 405</td>
<td>51</td>
<td>107 L</td>
<td>929</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1900</td>
<td>MB01</td>
<td>1900</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 406</td>
<td>51</td>
<td>107 L</td>
<td>394</td>
<td>1E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB01</td>
<td>1974</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 408</td>
<td>51</td>
<td>043 L</td>
<td>452</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB05</td>
<td>1955</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 409</td>
<td>51</td>
<td>107 L</td>
<td>779</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB05</td>
<td>1974</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 410</td>
<td>51</td>
<td>043 L</td>
<td>568</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1900</td>
<td>MB01</td>
<td>1900</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 411</td>
<td>51</td>
<td>107 L</td>
<td>819</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB05</td>
<td>1974</td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boathouse</td>
<td>Pre-engineered steel frame with reinforced masonry walls. Reinforced poured concrete.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Tower (Heliport)</td>
<td>Poured concrete walls.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security Gatehouse</td>
<td>Reinforced poured concrete and cinder block.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewage Treatment Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorpool</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Pumping Station</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Shop</td>
<td>Cinderblock construction.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Shop with mezzanine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guardhouse</td>
<td>Contains Health Unit. Electrical equipment - transformer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covered walkway between buildings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Shop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Shop</td>
<td>Struct. passed marginally. Rehab cost is for improved performance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Array no.</td>
<td>Name of Building</td>
<td>State/County/Suburb</td>
<td>Arch (Ch)</td>
<td>No. of Blk</td>
<td>Elevat</td>
<td>Occ'd Date</td>
<td>Eav. in High</td>
<td>HLV Block</td>
<td>Protection</td>
<td>Model Block</td>
<td>Vis. Height</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>------------------</td>
<td>---------------------</td>
<td>-----------</td>
<td>------------</td>
<td>--------</td>
<td>------------</td>
<td>-------------</td>
<td>-----------</td>
<td>------------</td>
<td>-------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 413</td>
<td>51 107 L</td>
<td>1,104</td>
<td>1 E0</td>
<td>10</td>
<td>77</td>
<td>H2</td>
<td>1900</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 415</td>
<td>51 107 L</td>
<td>132</td>
<td>1 E1</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 417/425</td>
<td>51 107 L</td>
<td>57</td>
<td>2 E1</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 418</td>
<td>51 107 L</td>
<td>4</td>
<td>1 E1</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 420</td>
<td>51 107 L</td>
<td>703</td>
<td>1 E0</td>
<td>60</td>
<td>Z1</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 426</td>
<td>51 107 L</td>
<td>202</td>
<td>1 E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 429</td>
<td>51 107 L</td>
<td>1,468</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 430</td>
<td>51 107 L</td>
<td>1,336</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 430A</td>
<td>51 107 L</td>
<td>1,778</td>
<td>1 E5</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 431</td>
<td>51 107 L</td>
<td>1,517</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 431A</td>
<td>51 107 L</td>
<td>90</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1974</td>
<td>MB04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 435</td>
<td>51 107 L</td>
<td>2,585</td>
<td>1 E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 444</td>
<td>51 107 L</td>
<td>3,826</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 500</td>
<td>51 043 L</td>
<td>39</td>
<td>1 E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1972</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 501</td>
<td>51 043 L</td>
<td>144</td>
<td>1 E1</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1992</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 505</td>
<td>51 043 L</td>
<td>347</td>
<td>1 E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1986</td>
<td>MB04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 506</td>
<td>51 043 L</td>
<td>392</td>
<td>1 E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 507</td>
<td>51 043 L</td>
<td>1,048</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 508</td>
<td>51 043 L</td>
<td>86</td>
<td>1 E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1987</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 509</td>
<td>51 043 L</td>
<td>114</td>
<td>1 E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 701</td>
<td>51 043 L</td>
<td>1,014</td>
<td>1 E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1966</td>
<td>MB16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 702</td>
<td>51 043 L</td>
<td>1,029</td>
<td>1 E1</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 703</td>
<td>51 043 L</td>
<td>2,585</td>
<td>1 E0</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 704</td>
<td>51 043 L</td>
<td>3,826</td>
<td>1 E0</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1972</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 705</td>
<td>51 043 L</td>
<td>749</td>
<td>1 E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 706</td>
<td>51 043 L</td>
<td>1,048</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 707</td>
<td>51 043 L</td>
<td>86</td>
<td>1 E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1987</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 708</td>
<td>51 043 L</td>
<td>114</td>
<td>1 E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 709</td>
<td>51 043 L</td>
<td>1,014</td>
<td>1 E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 710</td>
<td>51 043 L</td>
<td>2,585</td>
<td>1 E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1966</td>
<td>MB16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 713</td>
<td>51 043 L</td>
<td>3,826</td>
<td>1 E0</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1992</td>
<td>MB08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 713A</td>
<td>51 043 L</td>
<td>749</td>
<td>1 E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1993</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 710</td>
<td>51 043 L</td>
<td>1,048</td>
<td>1 E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 720</td>
<td>51 043 L</td>
<td>8,424</td>
<td>1 E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 721+</td>
<td>51 043 L</td>
<td>24</td>
<td>1 E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 752</td>
<td>51 043 L</td>
<td>103</td>
<td>1 E3</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1985</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building 754</td>
<td>51 043 L</td>
<td>103</td>
<td>1 E3</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1985</td>
<td>MB01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5900</td>
<td>Building 701</td>
<td>51 043 L</td>
<td>114</td>
<td>1 E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5900</td>
<td>Building 702</td>
<td>51 043 L</td>
<td>114</td>
<td>1 E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5900</td>
<td>Building 703</td>
<td>51 043 L</td>
<td>114</td>
<td>1 E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1989</td>
<td>MB15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Note/Notes</td>
<td>Exceptionally High Risk</td>
<td>Evaluation Procedure</td>
<td>Soil Type</td>
<td>Found Type of Evaluation</td>
<td>Success</td>
<td>Difficulty</td>
<td>Notes/Memo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>-----------</td>
<td>--------------------------</td>
<td>---------</td>
<td>-------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person</td>
<td>Affiliation</td>
<td>Income</td>
<td>Non-Resident</td>
<td>Filming</td>
<td>Resident</td>
<td>Spouse or Partner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td>--------------</td>
<td>---------</td>
<td>----------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$55200</td>
<td>$45200</td>
<td>$22600</td>
<td>$36900</td>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guardhouses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guardshack</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firestation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Struct. passed marginally. Recommended for rehabilitation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cafeteria - seats 250-300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heliport</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picnic Shelter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poured reinforced concrete walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poured reinforced concrete walls and roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firing Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poleham</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trash Collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generator Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security Gatehouse, Reinforced poured concrete and cinder block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picnic Shelter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumping Station - mostly underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River Intake Station - underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generator Building - underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Booster Pumping Station - underground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agency/Co</td>
<td>Name of Building</td>
<td>Site Code</td>
<td>City Code</td>
<td>Sub/Building</td>
<td>Area (sq. ft)</td>
<td>Neig Bldg</td>
<td>Erupt</td>
<td>Occl/Clk</td>
<td>Elev Bldg</td>
<td>Story</td>
<td>Year/Code (R每隔年/编号)</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>--------------</td>
<td>--------------</td>
<td>-----------</td>
<td>-------</td>
<td>----------</td>
<td>-----------</td>
<td>-------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building A</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3,091</td>
<td>1E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1985</td>
<td>MB10</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building B</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>541</td>
<td>1E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1956</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building C</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>2,492</td>
<td>1E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB10</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building C-West</td>
<td>24</td>
<td>021</td>
<td>I</td>
<td>4,923</td>
<td>1E7</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB14</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building D</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>2,665</td>
<td>1E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1924</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building E</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3,252</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1923</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building F</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1,875</td>
<td>1E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1926</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building G</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>649</td>
<td>1E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1948</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building H</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1,871</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1923</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building I</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3,344</td>
<td>1E7</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1998</td>
<td>MB07</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building J</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>4,243</td>
<td>1E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1985</td>
<td>MB10</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building K</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>3,786</td>
<td>1E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1980</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building L</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1,065</td>
<td>1E0</td>
<td>30</td>
<td>Z2</td>
<td>H2</td>
<td>1959</td>
<td>MB10</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building M</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>678</td>
<td>1E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB14</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building N</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>4,449</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H1</td>
<td>1870</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building O</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>1,428</td>
<td>1E0</td>
<td>80</td>
<td>Z2</td>
<td>H1</td>
<td>1839</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building P</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>280</td>
<td>1E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building Q</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>948</td>
<td>1E0</td>
<td>40</td>
<td>Z2</td>
<td>H1</td>
<td>1880</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building R</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>499</td>
<td>1E0</td>
<td>23</td>
<td>Z2</td>
<td>H2</td>
<td>1950</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building S</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>626</td>
<td>1E0</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1926</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building T</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>110</td>
<td>1E0</td>
<td>10</td>
<td>Z2</td>
<td>H2</td>
<td>1960</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building U</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>156</td>
<td>1E1</td>
<td>80</td>
<td>Z2</td>
<td>H2</td>
<td>1982</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Building V</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>90</td>
<td>1E7</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1992</td>
<td>MB13</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Denton Federal Regional</td>
<td>48</td>
<td>121</td>
<td>L</td>
<td>5,110</td>
<td>1E0</td>
<td>29</td>
<td>Z1</td>
<td>H2</td>
<td>1954</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Denton VSB #2 Station</td>
<td>48</td>
<td>121</td>
<td>L</td>
<td>220</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1993</td>
<td>MB04</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Denton VSB-Old Station</td>
<td>48</td>
<td>121</td>
<td>L</td>
<td>4,738</td>
<td>1E0</td>
<td>10</td>
<td>Z1</td>
<td>H2</td>
<td>1985</td>
<td>MB04</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Fire Pump Station</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>372</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1981</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Maynard Federal Region</td>
<td>25</td>
<td>017</td>
<td>M</td>
<td>7,432</td>
<td>1E0</td>
<td>29</td>
<td>Z1</td>
<td>H2</td>
<td>1968</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Maynard VSB Station</td>
<td>25</td>
<td>017</td>
<td>M</td>
<td>3,716</td>
<td>1E0</td>
<td>50</td>
<td>Z1</td>
<td>H2</td>
<td>1988</td>
<td>MB05</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Morton Buildings</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>316</td>
<td>2E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1980</td>
<td>MB02</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Olney Federal Support C</td>
<td>24</td>
<td>031</td>
<td>L</td>
<td>6,039</td>
<td>1E0</td>
<td>29</td>
<td>Z1</td>
<td>H2</td>
<td>1970</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Olney Storage</td>
<td>24</td>
<td>031</td>
<td>L</td>
<td>139</td>
<td>2E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1955</td>
<td>MB15</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Reception and Break Room</td>
<td>48</td>
<td>121</td>
<td>L</td>
<td>285</td>
<td>1E3</td>
<td>60</td>
<td>Z2</td>
<td>H2</td>
<td>1964</td>
<td>MB05</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Sewage Pumping Station</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>12</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1940</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Sewage Pumping Station</td>
<td>24</td>
<td>021</td>
<td>L</td>
<td>12</td>
<td>1E0</td>
<td>50</td>
<td>Z2</td>
<td>H2</td>
<td>1995</td>
<td>MB16</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Storage Building - East</td>
<td>48</td>
<td>121</td>
<td>L</td>
<td>223</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB04</td>
<td></td>
</tr>
<tr>
<td>5800</td>
<td>Storage Building - West</td>
<td>48</td>
<td>121</td>
<td>L</td>
<td>223</td>
<td>1E1</td>
<td>40</td>
<td>Z2</td>
<td>H2</td>
<td>1990</td>
<td>MB04</td>
<td></td>
</tr>
<tr>
<td>N03</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>-----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>OK</td>
<td>FS</td>
<td>FN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>NG</td>
<td>FS</td>
<td>FN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N00</td>
<td>R2</td>
<td>P1</td>
<td>S2</td>
<td>FT3</td>
<td>OK</td>
<td>PS</td>
<td>PN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td>R1</td>
<td>P1</td>
<td>S2</td>
<td>FT1</td>
<td>NG</td>
<td>FS</td>
<td>FN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>State</td>
<td>Agency</td>
<td>Structural Cost</td>
<td>Additional Cost</td>
<td>Final Cost</td>
<td>Project Cost</td>
<td>Source or Code</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>-------</td>
<td>--------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------</td>
<td>-------------</td>
<td>---------------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$463500</td>
<td>$790800</td>
<td>$646300</td>
<td>$570200</td>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PA</td>
<td>$548800</td>
<td>$145200</td>
<td>$40000</td>
<td>$220200</td>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Recreation Building**

- Eligible for historic registry but not registered
- Auditorium seats approx. 500; Eligible for historic registry but not registered
- Eligible for historic registry but not registered
- Contains recreation area (swimming pool, basketball court, weight room)
- Design looked at Map Area 1 in BOCA and NEHRP
- Contains an auditorium and offices
- Cafeteria seats about 350; eligible for historic registration but not registered

**Chapel: historical building**

- Log Cabin; Holds 150-200 people for recreational purposes.

- Eligible for historic registry but not registered; Planned renovations for compu

- 12x14 precast concrete buildings used as arson labs; Built from 1982-1996.

**Security Station**

- Underground reinforced concrete structure.
- Garage and Office
- Underground; Poured concrete
- Underground reinforced concrete structure designed for nuclear blast

**Underground Reinforced Bunker: Code 29 for office/communications**

- Former firehouse being used for storage

- Underground; Poured concrete
- Underground; Poured concrete