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CHARACTERIZING DEMOLITION DEBRIS FOR DIVERSION OPPORTUNITIES: WWII-ERA AND KOREAN WAR-ERA BUILDINGS

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Facilities Engineering
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CHARACTERIZING DEMOLITION DEBRIS DIVERSION OPPORTUNITIES: WWII-ERA AND KOREAN WAR-ERA BUILDINGS

1. Purpose. This Public Works Technical Bulletin (PWTB) provides guidance for recovering, reusing, and recycling building materials typically disposed of as demolition waste. It will assist Army installations and Installation Management Agency (IMA) and USACE Districts in implementing practices to reduce the amount of demolition debris generated by the removal of surplus buildings.

2. Applicability. This PWTB applies to installation Directorates of Public Works, Public Works Business Centers, Directorates of Engineering, and other U.S. Army facilities' engineering activities involving facility disposal.

3. References.

a. Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 21 February 1997.

b. Executive Order (EO) 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition," 14 September 1998.

c. Memorandum, Deputy Under Secretary of Defense (Environmental Security), 13 May 1998, subject: New DoD Pollution Prevention Measure of Merit.

d. PWTB 200-1-23, "Guidance for the Reduction of Demolition Waste through Reuse and Recycling," 10 March 2003.

e. PWTB 420-49-30, “Alternatives to Demolition for Facility Reduction,” 10 February 2000.

f. PWTB 420-49-32, “Selection of Methods for the Reduction, Reuse, and Recycling of Demolition Waste,” 16 July 2001.

g. Memorandum, Principal Deputy Secretary of the Army (Installations and Environment), 18 January 2001, subject: Deconstruction and Re-Use of Excess Army Buildings.

h. Memorandum, Assistant Chief of Staff for Installation Management (ACSIM), 26 May 2000, subject: Sustainable Design and Development (SDD) Policy.

i. Memorandum, ACSIM, 06 February 2006, subject: Sustainable Management of Waste in Military Construction, Renovation, and Demolition Activities.

j. Guidelines, ACSIM, 13 January 2006, subject: Sustainable Management of Waste in Military Construction, Renovation, and Demolition Activities.

k. Unified Federal Guide Specification (UFGS) 01572, “Construction and Demolition Waste Management.”

l. UFGS 02220, “Demolition.”

m. Headquarters, Air Force Center for Environmental Excellence (AFCEE), Brooks AFB, TX, “Construction and Demolition Waste Management Guide,” March 2000.

4. Discussion.

a. This PWTB outlines procedural guidance and supporting data for assessing the material content of buildings. This assessment should enable a relatively quick quantity take-off estimate in order to determine opportunities for debris reduction. It also addresses building descriptions and information pertaining to quantities of material to be expected per gross floor area of building. Additional alterations to construction, which are common to some but not all buildings, will be referenced to the respective building type. It is important to note that no single quantity for material content is applicable to all buildings, construction types, and locations. Therefore, several building categories are described to address a range of project-specific conditions.

b. Construction and demolition (C&D) debris accounts for up to 80 percent of some installations’ solid waste streams. This situation is most critical where an installation is removing large numbers of World War II-era wood buildings and where new construction programs require the demolition of existing facilities. Demolition is expensive in and of itself. However, the costs to permit, construct or expand, operate and maintain, close, and monitor a landfill throughout its life are expenses incurred from disposal of demolition debris as well. Where an installation’s landfill is closed, hauling costs and tipping fees will cost more than onsite landfilling. Alternatives to conventional demolition and landfilling have proven that diverting more than 75 percent of debris from the landfill is achievable.

c. The Principal Deputy Assistant Secretary of the Army (PDASA), Habitat for Humanity (HfH), and other Federal agencies have entered into discussions on inexpensive and less wasteful avenues to dispose of surplus buildings by moving them off installations, or deconstruction to salvage building materials for reuse. The PDASA has committed the Army to supporting initiatives whereby the Army and surrounding communities can benefit from the reuse of excess Army buildings.

d. The Army has adopted the concept of Sustainable Design and Development (SDD), as described in the Memorandum, Assistant Chief of Staff for Installation Management (ACSIM), 26 May 2001. The Memorandum, ACSIM, 31 August 2001, provides guidance on the relationship of C&D waste management to SDD, and requires installations to incorporate C&D waste management programs into their Integrated Solid Waste Management Plans.

e. The Army has adopted a requirement to divert a minimum of 50 percent of the C&D waste generated through all Military Construction, renovation, and demolition activities, as described by Memorandum, Assistant Chief of Staff for Installation Management (ACSIM), 06 February 2006. Guidance on implementing that Memorandum, dated 13 January 2006, supports the Memorandum, and describes requirements for implementing a C&D Waste Management Plan, and for reporting C&D disposal and recycling results into the Solid Waste Annual Reporting system.

f. Appendix A to this PWTB describes the PWTB’s general applicability, specifically pertaining to construction types and application of data discussed herein. Appendix B provides quantity figures and material component descriptions pertaining to WWII-era Wood Framed Buildings. Application of the modeled data to building types and special considerations are discussed. Appendix C provides quantity figures and material component descriptions pertaining to Korean War-era Reinforced Concrete Buildings. Application of the data to building types and special considerations are discussed.

5. Points of Contact. HQUSACE is the proponent for this document. The POC at HQUSACE is Mr. Malcolm E. McLeod, CEMP-II, 202-761-0632, or e-mail: malcolm.e.mcleod@usace.army.mil.

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Appendix A
General Applicability

General

Construction and Demolition (C&D) debris disposal has become problematic at Army installations in both economic and environmental terms. Installations with Facility Reduction Program (FRP) requirements, active Military Construction (MILCON) programs, and Residential Communities Initiatives (RCI) are facing a significant C&D debris burden. Some installations report C&D debris to be roughly 80% of their solid waste stream.

The major cost components of demolition are loading, hauling, and tipping the debris at landfills. Costs for landfilling debris off-post can be tens of thousands of dollars for a two-story WWII-era barracks, and could be over one hundred thousand dollars for a Korean War-era barracks building. The diminishing numbers of C&D landfills across the United States, and regulatory constraints being placed on C&D debris disposal indicate off-post landfilling will only become more expensive in the future. Installations with on-post C&D landfills typically allow tipping at no cost to the contractor. However, the landfill's operation, maintenance, closure, and long-term monitoring are still the installation's responsibility. While so-called "free" tipping reduces the initial cost of demolition, the life-cycle landfill cost is still borne by the installation. Solid waste managers have reported costs of up to $50 per ton of C&D debris over the life of their landfills. When on-post C&D landfills close, off-post landfilling will be the only option.

Landfilling C&D debris has environmental consequences. The U.S. Environmental Protection Agency (EPA) has identified C&D debris as a contributor to greenhouse gas emissions. A two-story WWII-era barracks building generates approximately 160 Metric Tons Carbon Dioxide Equivalent, according to EPA's Waste Reduction Model (WARM). Consider the life-cycle environmental effects of extracting materials, depleting resources, and manufacturing, transporting, and disposing of virgin materials in lieu of reusing or recycling materials that are already on-hand. The amount of lumber that can be recovered from a WWII-era barracks is more than enough, in equivalent board feet, to build a contemporary single-family house. The recycled concrete aggregate produced from one Korean War-era barracks building can provide compacted base for about a half-mile of residential street.

It is, therefore, imperative that installations, and U.S. Army Corps of Engineers Districts supporting those installations, adopt practices to reduce the quantities of demolition debris generated through building removal activities, and where possible utilize these materials as resources instead of waste. Executive Office, Department of Defense, Army, and Corps of Engineers policy and guidance all reinforce this requirement.

Problem

Knowing the content of buildings and structures to be removed is fundamental to assessing the feasibility of recovering or recycling components and materials. The content of Army buildings and structures, specifically with regard to their potential as resources and useable materials, is largely unknown within the PW and USACE. Without recognizing value and opportunity, the incentive for diversion is absent. Given sufficient value, some additional cost or schedule adjustment may be acceptable in order to recover or recycle materials, or some net cost savings may be achieved by virtue of the materials' value. Without sufficient value, any increase in cost or extension of schedule, compared to conventional demolition, will not be justifiable. Even advocates of debris diversion may be reluctant to initiate deconstruction or aggressive recycling if they feel uncertainty is high, and risk may be greater than the reward.

Availability of Data

In 1998, the USEPA published a report *"Characterization of Building Related Construction and Demolition Waste in the United States."* This report characterized the quantity and composition of building-related C&D debris generated in the United States, and summarized waste management practices for this waste stream (see http://www.epa.gov/epaoswer/hazwaste/sqg/c&d-rpt.pdf). The U.S. Air Force Center of Environmental Excellence (AFCEE) has included this study's data in its *Construction & Demolition Waste Management Guide* as the basis for estimating the amount of wood, drywall, metals, concrete, cardboard, and plastic debris generated from both residential and nonresidential demolition. See http://www.afcee.brooks.af.mil/eq/programs/summary.asp?rscID=870

Two issues are of note with regard to this EPA report. First, the sample of buildings upon which the demolition debris characterization was based was quite small; 4 residential and 17 nonresidential projects. No Army buildings were included in the sample. Then, the report describes all materials coming out of the buildings as *waste*. No distinction is made among items that may be reused or recycled and those that are of no further use and should be landfilled. While not implying any criticism of the EPA report, it is of limited use in characterizing the debris stream generated by Army buildings.

Applicability of this PWTB

It is impractical for installation PW or USACE personnel to perform surveys of every building to be removed in order to determine opportunities for debris reduction. This PWTB enables these personnel to quickly estimate the types and amounts of materials present in these buildings, and determine in general terms the opportunities for debris reduction through salvage, reuse, and recycling. Essentially, the characterizations should reveal whether (1) a significant opportunity for debris reduction exists, (2) little opportunity for debris reduction exists, or (3) further detailed evaluation of the building would be advisable. With this information, the appropriate method of building removal can be implemented.

The buildings described in this PWTB represent the bulk of buildings to be removed at Army installations, now and in the foreseeable future. Under the FRP, the remaining WWII-era buildings are being removed. Under MILCON, a large number of the Korean War-era barracks and accompanying administrative buildings are being removed and replaced with new barracks complexes. As redevelopment of existing Family Housing is typically the responsibility of the RCI Partner, not the Government, a separate PWTB will provide guidance on reducing demolition debris from RCI programs.

Appendix B, WWII-Era Wood Frame Buildings, and Appendix C, Korean War-Era Concrete and Masonry Buildings provide data on each type of construction. For each basic construction type, generic categories of buildings are defined. All building types within a category are of similar enough characteristics that they can be included within the same descriptions. For each category of building, components and materials are characterized by type and quantity.

The material types listed below are included in the characterization of WWII-era buildings. Appendix B gives further detail as to specific material type where it is useful in the feasibility determination.

- Concrete

- Reinforcing steel
- Lumber
- Exterior materials (roofing, siding materials, insulation doors & windows)
- Interior construction materials (framing, wall surfaces, doors, ceilings, and finishes)
- Plumbing fixtures, equipment, & materials
- Heat generating equipment
- Heating and ventilation equipment & materials
- Electrical components & materials

Quantities are modeled to the extent possible on the basis of per-square-foot of building. Quantities represent a typical building in its standing condition; that is the building as originally constructed and items that have most commonly been added to, or removed from, the building over its life. Materials are represented in their common units of measure, as well as weight. Unit measures for each material or component, and for the total building, are given. The total weight of the standing building would represent the potential debris burden, assuming no other diversion takes place. This figure can be used as the basis of comparison for diversion.

The quantities are further annotated as to whether the material or component is most commonly reusable, either reusable or recyclable, or most commonly recyclable. A reasonable recovery factor, considering deterioration and damage upon removal, is also provided.

The "typical" content of the basic building, therefore, can be estimated by multiplying the unit quantity for each material by the square foot floor area of the building. A reasonable yield of these materials can be determined by applying the appropriate recovery factors.

It is unlikely many WWII-era buildings remain in their original condition on an active Army installation. Typically, buildings that were originally constructed with little interior partitioning have been subdivided and refinished. Each building has been modified individually, so all possible interior configurations cannot be represented within a single square-foot quantity. Variations in interior configuration have been modeled (minimum, moderate, and extensive additional partitioning). Features (systems, components, or materials) are also included if they are frequently found in the subject buildings, but not universally so. These quantities also represent material unit of measure and weight.

Assumptions have been made about the quantities of materials, components, and finishes for each of these variations. While not precisely accurate for an individual building, quantity differences will be minor with respect to the total building mass, and will be appropriate for the purposes. The quantities of these additional materials must then be added to the basic building's reusable materials, recyclable materials, and debris quantities.

The condition of materials and components is critical to their potential for reuse or recycling. The effects of age (with regard to functionality or performance), physical condition (with regard to damage or deterioration), and the presence of contamination are described. These conditions will be unique to each building, and therefore cannot be generalized. Where they apply to building materials or components, effects on reuse, recycling, and debris generation are described in qualitative, usually "if … then," terms. For example, if a component is damaged or functionally obsolete and no longer reusable, the potential for recycling is described. Or, if a contaminate is present on otherwise recyclable material, the requirement for disposing as debris is described. Such conditions may affect all or part of a material's quantity in the standing building.

To summarize, a characterization of the content of a WWII-era building can be performed by using data in Appendix B as follows.

Multiply the unit weight for the building by the building's square foot floor area. The total weight represents the potential building debris burden.

Multiply the unit quantity for each component and material by the square foot floor area of the building to estimate material quantities. Identify what materials are reusable, recyclable, and debris. Apply the appropriate potential diversion factors and estimate a total weight of each reusable material and recyclable material; include lost materials in the debris total.

Identify the features present in the building that are not included in the basic per-square-foot data. Multiply the unit quantity of each material by the building's square foot floor area. Apply the appropriate recovery factors and add to each the reusable, recyclable, and debris totals.

Identify conditions that apply to the building or materials. Where the conditions would suggest all, or some portion, of the materials would not be reusable or recyclable, subtract that amount from the reusable and recyclable totals, and add it to the debris total.

Compare the total diversion potential (reusable and recyclable quantities) to the total potential debris burden.

The following material types are included in the characterization of Korean War-era reinforced concrete and masonry buildings. Appendix C gives further detail as to specific material types.

- Concrete
- Masonry
- Steel (concrete reinforcing, structural steel, & miscellaneous metals)
- Exterior materials (roofing, siding materials, insulation doors & windows)
- Interior construction materials (framing, wall surfaces, doors, ceilings, and finishes)
- Plumbing fixtures, equipment, & materials
- Heat generating equipment
- Heating and ventilation equipment & materials
- Electrical components & materials

Quantities are modeled on a per-square-foot of standing building basis, similar to the WWII-era wood framed building data. Annotations relative to the reuse or recycle potential and recovery factors are similar as well.

The “typical” content of the basic building, therefore, can be estimated by multiplying the unit quantity by the square foot floor area of the building. A reasonable yield of these materials can be determined by applying the appropriate potential diversion factors .

The Korean War-era buildings have also undergone reconfiguration over their lives. These modifications have very little effect on the overall building mass, considering the primary building material is concrete. Therefore, modifications to the buildings’ original designs are ignored in these models.

The condition of materials and components is critical to their potential for reuse or recycling. The effects of age (with regard to functionality or performance), physical condition (with regard to damage or deterioration) and the presence of contamination are described, similar to the WWII-era wood frame building data.

To summarize, a characterization of the content of a Korean War-era reinforced concrete and masonry building can be performed by using data in Appendix C as follows.

Multiply the unit weight for the building by the building's square foot floor area. The total weight represents the potential building debris burden. Multiply the unit quantity for each component and material by the square foot floor area of the building to estimate material quantities.

From the building totals, identify what materials are reusable, recyclable, and debris. Apply the appropriate potential diversion factors and estimate a total weight of each reusable material and recyclable material; include lost materials in the debris total.

Identify conditions that apply to the building or materials. Where the conditions would suggest all, or some portion, of the materials would not be reusable or recyclable, subtract that amount from the reusable and recyclable totals, and add it to the debris total.

Compare the total diversion potential (reusable and recyclable quantities) to the total potential debris burden.

Conversion Factors

Multiply	By	To Obtain
acres	0.40469	hectares
feet	0.3048	meters
inches	2.54	centimeters
square feet	0.09290304	square meters

Appendix B
WWII-era Wood Framed Buildings

Building Categories

The majority of WWII-era wood framed buildings can be represented by four basic categories: (1) light-frame one story, (2) light-frame two story, (3) light-frame wide, and (4) long span buildings. This categorization is based primarily on a building's width, which dictates roof and floor structures. These structures are the most significant features in modeling quantities on a unit basis (i.e., quantity per square foot of building).

Light-frame, one story buildings. These buildings are constructed with common dimensional lumber members (2x4 through 2x12 joists, studs, and rafters), and are typically 25 to 30 feet wide in nominal dimension. Their original occupancies were administrative, dining, training, recreational, medical or clinic-types, and other troop-oriented services. Depending on the original facility type, most are 60 to 120 feet or more in length. These buildings' contents are summarized as follows.

- Foundation: Three or four rows of concrete piers support the building. Some facility types were built half on piers, and half on a slab-on-grade. Brick chimneys are typically located within boiler rooms, or immediately adjacent to the boiler rooms outside the building; these are supported by reinforced concrete foundations.
- Floor framing: 2x8 or 2x10 floor joists are spaced at 24 inches, and span between the rows of piers. The subfloor is 1x8 board placed diagonally across the joists. Frequently, joist spacing was decreased to 12 inches depending on the occupancy or superimposed load. Beams were built-up using two or three 2x10s or 2x12s. Floors at boiler rooms are frequently built as elevated concrete slabs, or are slab-on-grade. A concrete topping was typically placed over the wood framed floor at spaces originally designed as latrines, kitchens, and other wet areas.

- Exterior walls: 2x6 studs are spaced at 24 inches, and framing is balloon style. Exterior sheathing is either one-half inch gypsum wall board (GWB) or 1x8 board. Siding is 8- or 12-inch wood lap siding. Vinyl, aluminum, or steel siding is typically applied over the original wood siding, and insulation board frequently accompanies the added siding. Aluminum soffits and gutters have typically been added.
- Doors and windows: Insulated hollow metal doors have typically replaced the original doors. The original wood frames typically remain. Windows are typically vinyl- or aluminum-framed double hung replacement type, which may be single or double glazed. Original five-panel wood doors and six-over-six double hung wood windows may still be present in some buildings.
- Roof: Trusses, field-fabricated from 2x8s, are spaced at 24 inches, with 1x8 board sheathing placed perpendicular to the trusses. Roofing is three-tab asphalt shingle on roofing felt. One layer of shingle is common, although up to three layers may be present.

Figure B1. Exterior of WWII-era light-frame one story building.

- Interior construction: Partitions are framed with 2x4 studs and finished with painted one-half inch GWB. Ceilings are painted one-half inch GWB. The original flooring is 3-inch tongue-and-groove (T&G) wood strip; multiple layers of vinyl composition tile (VCT) with particleboard or plywood underlayment added over the original wood strip flooring. Interior doors are typically hollow core wood veneer doors; some original five-panel wood doors may be present.
- Mechanical/Electrical/Plumbing: A forced air furnace typically replaces the original boiler with a main distribution duct added above the ceiling, running down the center of the building, with branches supplying ceiling diffusers. Surface-mounted fluorescent light fixtures are added to the ceiling; duplex receptacles are added within any enclosed spaces. Load centers and distribution have usually been upgraded over original materials. Original two-fixture washrooms (toilet and lavatory) are generally upgraded with new fixtures and accessories, and a second two-fixture washroom is typically added.

Light-frame, two story buildings. These buildings are similar to those described above, with the addition of a second story. Buildings originally built as barracks are typically rectangular in plan, sometimes joined by connecting latrine units or corridors. Buildings built as administrative facilities are frequently U-, L-, H-, or T-shaped in plan, although they are similar in section throughout. These buildings’ contents are summarized as follows.

- Foundations: Four rows of concrete piers support the building. Some facility types were built half on piers, and half on a slab-on-grade. Brick chimneys are typically located within boiler rooms, or immediately adjacent to the boiler rooms outside the building; these are supported by reinforced concrete foundations.
- Floor framing: 2x8 or 2x10 floor joists are spaced at 24 inches, and span between the rows of piers. The subfloor is 1x8 board placed diagonally across the joists. Frequently, joist spacing was decreased to 12 inches depending on the occupancy or loads at that location within the building. Beams were built-up using two or three 2x10s or 2x12s. A concrete topping was typically placed over the wood framed floor at spaces originally designed as showers, latrines, and other wet areas. Interior bearing walls and 6x6 columns support beams built up with 2x8s or 2x10s, which in turn support the second floor.

- Exterior walls: 2x4 studs are spaced at 24 inches, and framing is balloon style; each stud is continuous from the first floor deck to the second floor eave. Exterior sheathing is either one-half-inch GWB or 1x8 board. Siding is 8- or 12-inch wood lap siding. Vinyl, aluminum, or steel siding is typically applied over the original wood siding, and insulation board frequently accompanies the added siding. Aluminum soffits and gutters have typically been added.
- Doors & windows: Insulated hollow metal doors have typically replaced the original doors. The original wood frames typically remain. Windows are typically vinyl- or aluminum-framed double hung replacement type, which may be single or double glazed. Original five-panel wood doors and six-over-six double hung wood windows may still be present in some buildings.
- Roof: Two-by-eight rafters span from ridge to eave, and are supported mid-span. Rafter spacing is 24 inches. Mid-span support consists of beams built up from two 2x8s or 2x4 knee walls, the beams being supported by either 6x6 or 4x4 columns and the knee walls being supported by bearing walls below. The roof system is braced laterally, longitudinally, and in the plane of the ceiling by 1x8s deployed diagonally, or in an X, between primary framing members. Two-by-six ceiling joists span eave-to-eave, and are spaced at 24 inches. One-by-eight sheathing is placed perpendicular to the rafters. Roofing is three-tab asphalt shingle on roofing felt. One layer of shingle is common, although up to three layers may be present.

Figure B2. Exterior of WWII-era light-frame two story building.

Figure B3. Interior of WWII-era light-frame two story building.

- Interior construction: Partitions are framed with 2x4 studs and finished with painted one-half-inch GWB. Ceilings are painted one-half-inch GWB. The original flooring is 3-inch T&G wood strip; multiple layers of VCT with particleboard or plywood underlayment have been added over the original wood strip flooring. Interior doors are typically hollow core wood veneer doors; some original five-panel wood doors may be present.
- Mechanical/Electrical/Plumbing: A forced air furnace typically replaces the original boiler. Depending on the size of the building, air handling units may be located throughout the building. A main distribution duct typically is added to the first floor ceiling, and above the second floor ceiling, each running down the center of the building branches supplying ceiling diffusers. Surface-mounted fluorescent light fixtures are added to the ceilings; duplex receptacles are added within any enclosed spaces. Load centers and distribution are typically upgraded over original materials. Original washrooms are typically upgraded with new fixtures

and accessories. Gang shower and latrine facilities in barracks are typically partitioned into washroom facilities.

Light-frame, wide buildings. These buildings are typically constructed with common dimensional lumber, using similar construction details as described above. Building widths may be 60 to 72 feet and wider; interior columns and beams create multiple structural bays to achieve the overall width. Building lengths may be several hundred feet. Their original occupancies were warehouse and storage facilities or some shop-type facilities. These buildings' contents are summarized as follows.

- Foundations: Foundations for these buildings were either constructed as slab-on-grade, or support a framed floor system. Where the foundations support a framed floor, five or more continuous footing and wall foundations are placed along the longitudinal column lines of the building. Brick chimneys are typically located within boiler rooms, or immediately adjacent to the boiler rooms outside the building; these are supported by reinforced concrete foundations.

Figure B4. Exterior of WWII-era light-frame wide structure.

Figure B5. Interior of WWII-era light-frame wide structure.

- Floor framing: Where floors are framed above grade, 2x12 floor joists are spaced at 12 inches, and span between the foundation walls. The subfloor is 2x6 T&G board. Frequently, joists are doubled, depending on the occupancy or loads at that location within the building. Beams were built-up using two or three 2x12s. A concrete topping was typically placed over the wood framed floor at spaces originally designed as latrines, wash stands, and other wet areas. Otherwise, the slab-on-grade surface is the floor surface.
- Exterior walls: Two-by-six studs are spaced at 24 inches. Exterior sheathing is either ½" gypsum wall board (GWB) or 1x8 board. Siding is 8- or 12-inch wood lap siding. Vinyl, aluminum, or steel siding is typically applied over the original wood siding, and insulation board frequently accompanies the added siding. Aluminum soffits and gutters have typically been added.
- Doors & windows: Insulated hollow metal doors have typically replaced the original doors. Sliding barn-style doors at loading docks have been replaced, usually by metal coil doors. Typically, some of the overhead door openings have been closed by framing the openings and covering the exterior surface with siding to match the exterior wall. Windows are typically vinyl- or aluminum-framed double hung replacement type, which may be single or double glazed. Original five-panel wood doors and six-over-six double hung wood windows may still be present in some buildings.
- Roof: Two-by-eight rafters span the ridge to the eave, and are supported mid-span. Rafter spacing is 24 inches. Mid-span support consists of beams built up from two or three 2x8s, which in turn are supported by either 6x6 or 8x8 columns. The 6x6 columns are typically solid wood, while the 8x8 columns are typically built up from 2x8s. The roof system is braced laterally, longitudinally, and in the plane of the ceiling by 2x8s deployed diagonally, or in an X, between primary framing members. 1x8 sheathing is placed perpendicular to the rafters. Roofing is three-tab asphalt shingle on roofing felt. One layer of shingle is common, although up to three layers may be present.
- Interior construction: These buildings were constructed with minimal interior partitioning. There is typically no finished ceiling. The interior surfaces of exterior walls are most commonly 1x6 or 1x8 T&G boards. Original interior walls are also finished with the T&G board. Added partitions are typically framed with 2x4 studs and finished with painted one-half-inch GWB. Various finishes have been applied over the original subfloor. Three-inch T&G wood strip flooring is

common, although 4-inch strip oak flooring frequently was installed at high-traffic areas. Steel diamond-plate has also been applied more recently to high-wear areas. Multiple layers of VCT with particleboard or plywood underlayment have been added over the original flooring, usually in added rooms. Interior doors are typically hollow core wood veneer doors.

- Mechanical/Electrical/Plumbing: A forced-air furnace typically replaces the original boiler. Depending on the size of the building, air handling units may be located throughout the building. A main distribution duct is hung from the roof structure and runs the length of the building. Alternatively, gas-fired heaters are suspended from the roof structure. Surface-mounted fluorescent light fixtures are added to the ceilings and duplex receptacles are added within any enclosed spaces. Load centers and distribution are also updated over original materials. Sprinkler systems have frequently been added. Original washrooms are generally upgraded with new fixtures and accessories. Most two-fixture washrooms have been upgraded with new fixtures and accessories, and a second two-fixture washroom has also been added.

Long-span buildings. This description includes several diverse building designs, each responding to somewhat similar but not identical functional requirements. As there are relatively few of each building type on an installation, they are combined into one category. The common feature is the roof is constructed to span significantly longer dimensions that the previously described light-frame construction.

Note, however, that each specific design can vary considerably from others within this group. Material quantities described in this Appendix must be considered “average” or “reasonable” for the category as a whole and quantities for any one specific building are likely to vary.

These buildings differ from those described above because of their greater interior clear span dimensions. Several building types are constructed with roof trusses to span 40 to 90 feet without columns. Trusses are frequently fabricated with heavier members. Columns are either timbers or are built up with multiple lumber members. Original occupancies included vehicle maintenance shops, assembly building such as theaters, gymnasia, motor pool buildings, and other similar structures requiring a large open interior space.

Figure B6. Exterior of WW-II era heavy long-span structures.

Figure B7. Interior of WWII-era heavy long-span structure.

The following charts outline the expected material quantities present in WWII-era wood frame constructed buildings in standing condition. Data are grouped according to the four building categories described previously.

Potential contaminates. The presence or absence of contaminates will have a significant effect on the feasibility of reusing or recycling building materials. Intentions to minimize waste must be tempered with human health and safety considerations.

It is common practice within Army installations to remove all asbestos-containing materials (ACM) prior to building removal, regardless of whether the building is mechanically demolished or manually deconstructed. This may be accomplished through an independent abatement contract, or included within the demolition contract Scope of Work. In either case, the demolition (or deconstruction) contractor will be allowed to proceed only after abatement work is completed, and the building is certified to be safe. Therefore, there should be no ACM present if and when personnel salvage or recycle materials. The only time ACM becomes a problem with demolition or deconstruction is when undetected ACM is found, upon which either demolition or deconstruction activities would have to stop. While the presence of ACM is of concern, it is not problematic to the issue of salvage and recycling if it is abated as a standard practice.

Some states require removal of all friable ACM prior to demolition (or deconstruction), but allow non-friable ACM to remain in the building upon demolition, and commingled with the debris. In WWII-era wood buildings, floor tile is the most common of these materials. The presence of vinyl asbestos tiles (VAT) will generally prevent the disassembly of the floor framing and salvaging of floor joists, at lease from the top down. The VAT is typically sandwiched between layers of more recently installed flooring, and the original tongue-and-groove strip flooring. The installation must determine whether abating the VAT is justified given the potential value of the floor joists, or whether it is feasible to remove the multiple layers of finish floor as a unit, encapsulating the VAT layer.

Concern is frequently expressed about salvaging materials that have been coated by lead-based paint (LBP). Any building removal activities, whether demolition or deconstruction, must observe 29 CFR 1926, the OSHA Construction Safety Standards, specifically Section 62, Lead in Construction. All occupational protection requirements are described in these standards.

Consideration must be given to what materials have and have not been painted throughout the buildings’ life. Typically, roof and floor framing has never been painted, and these materials constitute the vast majority of lumber in WWII-era buildings.

The Resource Conservation and Recovery Act (RCRA) does not apply to materials until they have been deposited into the waste stream. Salvaging or recycling building materials is not covered under RCRA. Furthermore, no Federal regulation or standard prohibits the salvage, sale, or reuse of LBP'd materials.

If LBP is present, it may or may not be a hazard. 40 CFR PART 745.61; "Identification Of Dangerous Levels Of Lead; Final Rule" defines lead hazard in target housing and child-occupied facilities as damaged or deteriorated paint on an impact surface, any chewable LBP where there is evidence of teeth marks, or any other deteriorated paint on the interior or exterior of a residential dwelling or child-occupied facility. LBP that is intact and otherwise not subject to detaching from the underlying wood is not defined as an LBP hazard.

Prudent practice dictates, however, that the installation show due diligence when allowing LBP materials to be removed for possible resale. This practice would include disclosing the likely presence of LBP, requiring the contractor to disclose the likely presence of LBP to whomever they sell or donate these materials. HUD 24 CFR Part 35, EPA 40 CFR Part 745 "Lead; Requirements For Disclosure Of Known Lead-Based Paint And/Or Lead-Based Paint Hazards In Housing; Final Rule" may provide an appropriate model for this disclosure. This document also requires a reference to the EPA pamphlet "Protect Your Family From Lead In Your Home" as part of this disclosure. Adopting similar information and disclosure practices would be advisable.

(1) Light-Frame, One Story Buildings

WWII - Era Wood Framed Constructed Buildings

Quantities according to a per-square-foot basis

Standing Condition

				(1) Light-frame, One story buildings								
				Potential Diversion								
				Salvage for Reuse			**Recycle**			**Debris**		
Building Component Categories	Description	**Average Quantity per GSF of Building**	Units	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Dim. Lumber	Framing lumber greater than 6 ft in length	**4.0** **9.6**	bf/gsf lbs/gsf	75%	2.99 7.18	bf/gsf lbs/gsf	20%	0.80 1.92	bf/gsf lbs/gsf	5%	0.2 0.48	bf/gsf lbs/gsf
Scrap Lumber	Framing lumber less than 6 ft in length	**0.3** **0.7**	bf/gsf lbs/gsf	0%	0.00 0.00	bf/gsf lbs/gsf	90%	0.27 0.65	bf/gsf lbs/gsf	10%	0.0 0.07	bf/gsf lbs/gsf
Siding	1x6 or 1x8 siding (novelty)	**0.9** **2.0**	bf/gsf lbs/gsf	75%	0.64 1.53	bf/gsf lbs/gsf	20%	0.17 0.00	bf/gsf lbs/gsf	5%	0.0 0.10	bf/gsf lbs/gsf
Sheathing	1x6 or 1x8 diagonal	**1.9** **4.4**	bf/gsf lbs/gsf	75%	1.39 3.33	bf/gsf lbs/gsf	20%	0.37 0.00	bf/gsf lbs/gsf	5%	0.1 0.22	bf/gsf lbs/gsf
Plywood	1/4-in. plywood	**0.1** **0.2**	bf/gsf lbs/gsf	90%	0.08 0.19	bf/gsf lbs/gsf	5%	0.00 0.00	bf/gsf lbs/gsf	5%	0.0 0.01	bf/gsf lbs/gsf
T&G Flooring	1x T&G flooring	**0.8** **2.0**	bf/gsf lbs/gsf	90%	0.74 1.77	bf/gsf lbs/gsf	5%	0.04 0.00	bf/gsf lbs/gsf	5%	0.0 0.10	bf/gsf lbs/gsf
Drywall	1/2-in. GWB	**2.1** **3.1**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	100%	2.1 3.08	sf/gsf lbs/gsf
Asphalt Shingles & Felt Paper*	235 lb Shingles	**1.2** **2.8**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	99%	1.14 0.00	sf/gsf lbs/gsf	1%	0.01 0.03	sf/gsf lbs/gsf
Concrete	RC foundation slabs & piers	**25.6**	lbs/gsf	0%	0.00	lbs/gsf	99%	25.34	lbs/gsf	1%	0.26	lbs/gsf
Reinforcing Steel	Typical steel reinforcement	**0.5**	lbs/gsf	0%	0.00	lbs/gsf	99%	0.47	lbs/gsf	1%	0.00	lbs/gsf
Heavy Timber	Typical 3x8 to 3x12											
Masonry	Brick chimney	**2.2**	lbs/gsf	50%	1.08	lbs/gsf	50%	1.08	lbs/gsf	0%	0.00	lbs/gsf
Plumbing	Fixtures, Piping,	**0.2**	lbs/gsf	50%	0.08	lbs/gsf	50%	0.08	lbs/gsf	0%	0.00	lbs/gsf
HVAC*	Equipment, Ductwork, misc.	**0.6**	lbs/gsf	0%	0.00	lbs/gsf	90%	0.53	lbs/gsf	10%	0.06	lbs/gsf
Doors	Sizes Vary	**0.1**	lbs/gsf	85%	0.11	lbs/gsf	10%	0.01	lbs/gsf	5%	0.01	lbs/gsf
Windows	Sizes Vary	**0.4**	lbs/gsf	85%	0.33	lbs/gsf	10%	0.04	lbs/gsf	5%	0.02	lbs/gsf
Equipment	Typical kitchen equipment						75%					
Electrical	light fixtures,	**0.2**	lbs/gsf	50%	0.08	lbs/gsf	25%	0.04	lbs/gsf	25%	0.04	lbs/gsf
		54.3	lbs/gsf		15.69	lbs/gsf		30.16	lbs/gsf		4.47	lbs/gsf

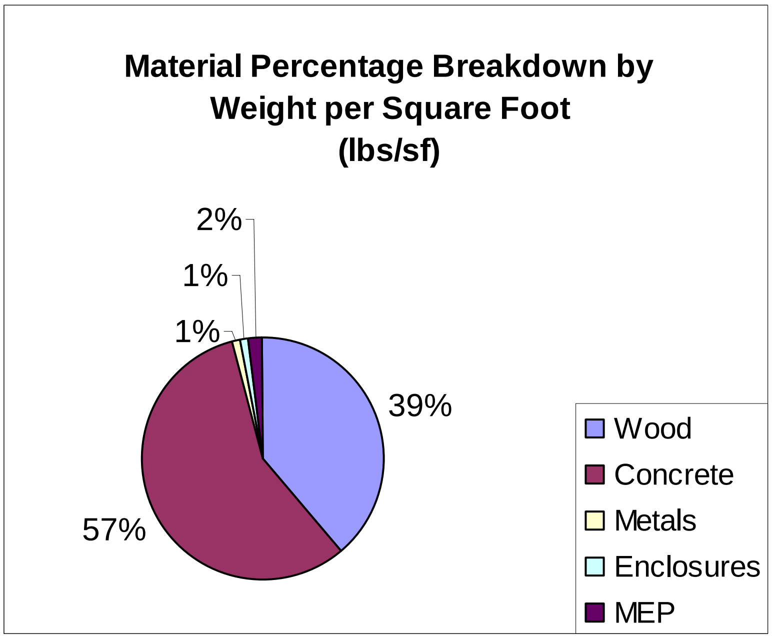
Potential Debris
54.3 lbs/gsf

Potential Diversion
45.85 lbs/gsf

* Asphalt Shingles may not have outlet for recycling, in this case they become debris.

* Newer components of HVAC systems may be reused.

lbs/sf	**General Summary**
19.0	Wood
27.8	Concrete
0.5	Metals
0.5	Enclosures
0.9	MEP



(2) Light-Frame, Two Story Buildings

WWII - Era Wood Framed Constructed Buildings

Quantities according to a per-square-foot basis

Standing Condition

				(2) Light-frame, Two story buildings								
				Potential Diversion								
				Salvage for Reuse			**Recycle**			**Debris**		
Building Component Categories	Description	**Average Quantity per GSF of Building**	Units	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Dim. Lumber	Framing lumber greater than 6 ft in length	**2.5** **6.1**	bf/gsf lbs/gsf	75%	1.90 4.58	bf/gsf lbs/gsf	20%	0.51 1.22	bf/gsf lbs/gsf	5%	0.1 0.31	bf/gsf lbs/gsf
Scrap Lumber	Framing lumber less than 6 ft in length	**0.2** **0.5**	bf/gsf lbs/gsf	0%	0.00 0.00	bf/gsf lbs/gsf	90%	0.19 0.45	bf/gsf lbs/gsf	10%	0.0 0.05	bf/gsf lbs/gsf
Siding	1x6 or 1x8 siding (novelty)	**0.8** **1.8**	bf/gsf lbs/gsf	75%	0.57 1.35	bf/gsf lbs/gsf	20%	0.15 0.00	bf/gsf lbs/gsf	5%	0.0 0.09	bf/gsf lbs/gsf
Sheathing	1x6 or 1x8 diagonal	**1.6** **3.8**	bf/gsf lbs/gsf	75%	1.20 2.85	bf/gsf lbs/gsf	20%	0.32 0.00	bf/gsf lbs/gsf	5%	0.1 0.19	bf/gsf lbs/gsf
Plywood	1/4-in. plywood	**0.4** **0.1**	bf/gsf lbs/gsf	90%	0.33 0.08	bf/gsf lbs/gsf	5%	0.02 0.00	bf/gsf lbs/gsf	5%	0.0 0.00	bf/gsf lbs/gsf
T&G Flooring	1x T&G flooring	**1.0** **2.3**	bf/gsf lbs/gsf	90%	0.87 2.07	bf/gsf lbs/gsf	5%	0.05 0.00	bf/gsf lbs/gsf	5%	0.0 0.12	bf/gsf lbs/gsf
Drywall	1/2-in. GWB	**3.0** **4.5**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	100%	3.0 4.46	sf/gsf lbs/gsf
Asphalt Shingles & Felt Paper*	235 lb Shingles	**0.7** **1.6**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	99%	0.65 0.00	sf/gsf lbs/gsf	1%	0.01 0.02	sf/gsf lbs/gsf
Concrete	RC foundation slabs & piers	**5.4**	lbs/gsf	0%	0.00	lbs/gsf	99%	5.36	lbs/gsf	1%	0.05	lbs/gsf
Reinforcing Steel	Typical steel reinforcement	**0.1**	lbs/gsf	0%	0.00	lbs/gsf	99%	0.09	lbs/gsf	1%	0.00	lbs/gsf
Heavy Timber	Typical 3x8 to 3x12	**0.2** **0.4**										
Masonry	Brick chimney	**3.3**	lbs/gsf	50%	1.67	lbs/gsf	50%	1.67	lbs/gsf	0%	0.00	lbs/gsf
Plumbing	Fixtures, Piping,	**0.3**	lbs/gsf	50%	0.16	lbs/gsf	50%	0.16	lbs/gsf	0%	0.00	lbs/gsf
HVAC	Equipment, Ductwork, misc.	**0.5**	lbs/gsf	0%	0.00	lbs/gsf	90%	0.43	lbs/gsf	10%	0.05	lbs/gsf
Doors	Sizes Vary	**0.2**	lbs/gsf	85%	0.18	lbs/gsf	10%	0.02	lbs/gsf	5%	0.01	lbs/gsf
Windows	Sizes Vary	**0.7**	lbs/gsf	85%	0.59	lbs/gsf	10%	0.07	lbs/gsf	5%	0.03	lbs/gsf
Equipment	Typical kitchen equipment						75%					
Electrical	light fixtures,	**0.1**	lbs/gsf	50%	0.05	lbs/gsf	25%	0.03	lbs/gsf	25%	0.03	lbs/gsf
		31.2	lbs/gsf		13.56	lbs/gsf		9.48	lbs/gsf		5.40	lbs/gsf

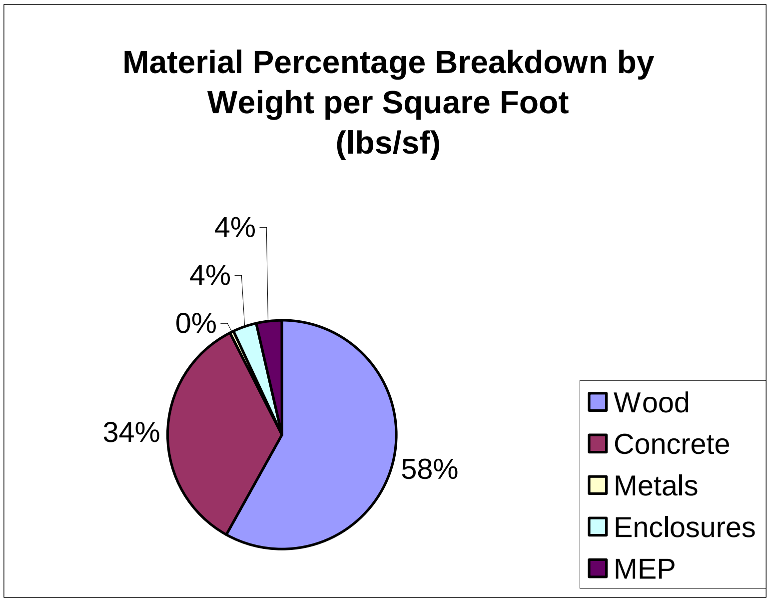
Potential Debris 31.2 lbs/gsf

Potential Diversion 23.04 lbs/gsf

* Asphalt Shingles may not have outlet for recycling, in this case they become debris.

* Newer components of HVAC systems may be reused.

lbs/sf	**General Summary**
14.7	Wood
8.7	Concrete
0.1	Metals
1.0	Enclosures
0.9	MEP



(3) Light-Frame, Wide Buildings

WWII - Era Wood Framed Constructed Buildings

Quantities according to a per-square-foot basis

Standing Condition

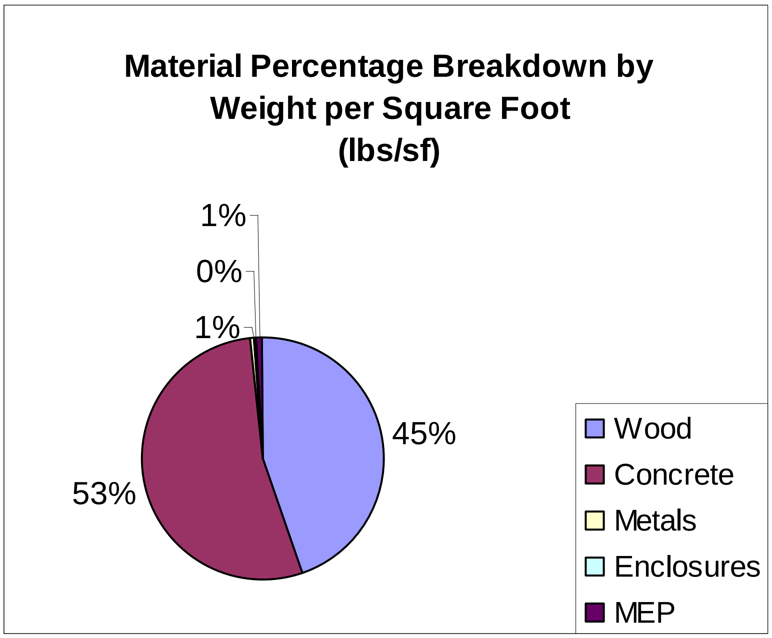
				(3) Light-frame, Wide Building								
				Potential Diversion								
				Salvage for Reuse			Recycle			Debris		
Building Component Categories	Description	Average Quantity per GSF of Building	Units	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Dim. Lumber	Framing lumber greater than 6 ft in length	**4.6** **10.9**	bf/gsf lbs/gsf	75%	3.45 8.18	bf/gsf lbs/gsf	20%	0.92 2.18	bf/gsf lbs/gsf	5%	0.2 0.55	bf/gsf lbs/gsf
Scrap Lumber	Framing lumber less than 6 ft in length	**0.5** **1.2**	bf/gsf lbs/gsf	0%	0.00 0.00	bf/gsf lbs/gsf	90%	0.45 1.08	bf/gsf lbs/gsf	10%	0.1 0.12	bf/gsf lbs/gsf
Siding	1x6 or 1x8 siding (novelty)	**0.4** **1.1**	bf/gsf lbs/gsf	75%	0.30 0.83	bf/gsf lbs/gsf	20%	0.08 0.00	bf/gsf lbs/gsf	5%	0.0 0.06	bf/gsf lbs/gsf
Sheathing	1x6 or 1x8 diagonal	**1.1** **2.5**	bf/gsf lbs/gsf	75%	0.83 1.88	bf/gsf lbs/gsf	20%	0.22 0.00	bf/gsf lbs/gsf	5%	0.1 0.13	bf/gsf lbs/gsf
Plywood	1/4" plywood	**0.5** **1.3**	bf/gsf lbs/gsf	90%	0.45 1.17	bf/gsf lbs/gsf	5%	0.03 0.00	bf/gsf lbs/gsf	5%	0.0 0.07	bf/gsf lbs/gsf
T&G Flooring	1x T&G flooring	**3.7** **9.0**	bf/gsf lbs/gsf	90%	3.33 8.10	bf/gsf lbs/gsf	5%	0.19 0.00	bf/gsf lbs/gsf	5%	0.2 0.45	bf/gsf lbs/gsf
Drywall	1/2" GWB	**0.7** **1.6**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	100%	0.7 1.60	sf/gsf lbs/gsf
Asphalt Shingles & Felt Paper*	235 lb Shingles	 **1.1**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	99%	0.00 0.00	sf/gsf lbs/gsf	1%	0.00 0.01	sf/gsf lbs/gsf
Concrete	RC foundation slabs & piers	**31.1**	lbs/gsf	0%	0.00	lbs/gsf	99%	30.79	lbs/gsf	1%	0.31	lbs/gsf
Reinforcing Steel	Typical steel reinforcement	**0.4**	lbs/gsf	0%	0.00	lbs/gsf	99%	0.40	lbs/gsf	1%	0.00	lbs/gsf
Heavy Timber	Typical 3x8 to 3x12											
Masonry	Brick chimney		lbs/gsf	50%	0.00	lbs/gsf	50%	0.00	lbs/gsf	0%	0.00	lbs/gsf
Plumbing	Fixtures, Piping,	**0.1**	lbs/gsf	50%	0.05	lbs/gsf	50%	0.05	lbs/gsf	0%	0.00	lbs/gsf
HVAC	Equipment, Ductwork, misc.	**0.3**	lbs/gsf	0%	0.00	lbs/gsf	90%	0.27	lbs/gsf	10%	0.03	lbs/gsf
Doors	Sizes Vary	**0.1**	lbs/gsf	85%	0.09	lbs/gsf	10%	0.01	lbs/gsf	5%	0.01	lbs/gsf
Windows	Sizes Vary	**0.0**	lbs/gsf	85%	0.00	lbs/gsf	10%	0.00	lbs/gsf	5%	0.00	lbs/gsf
Equipment	Typical kitchen equipment						75%					
Electrical	light fixtures,	**0.1**	lbs/gsf	50%	0.05	lbs/gsf	25%	0.03	lbs/gsf	25%	0.03	lbs/gsf
		60.7	lbs/gsf		20.33	lbs/gsf		34.80	lbs/gsf		3.35	lbs/gsf

Potential Debris	Potential Diversion
60.7 lbs/gsf	**55.13 lbs/gsf**

* Asphalt Shingles may not have outlet for recycling, in this case they become debris.

* Newer components of HVAC systems may be reused.

lbs/sf	**General Summary**
26.0	Wood
31.1	Concrete
0.4	Metals
0.1	Enclosures
0.5	MEP



(4) Heavy, Long Span Buildings

WWII - Era Wood Framed Constructed Buildings

Quantities according to a per-square-foot basis

Standing Condition

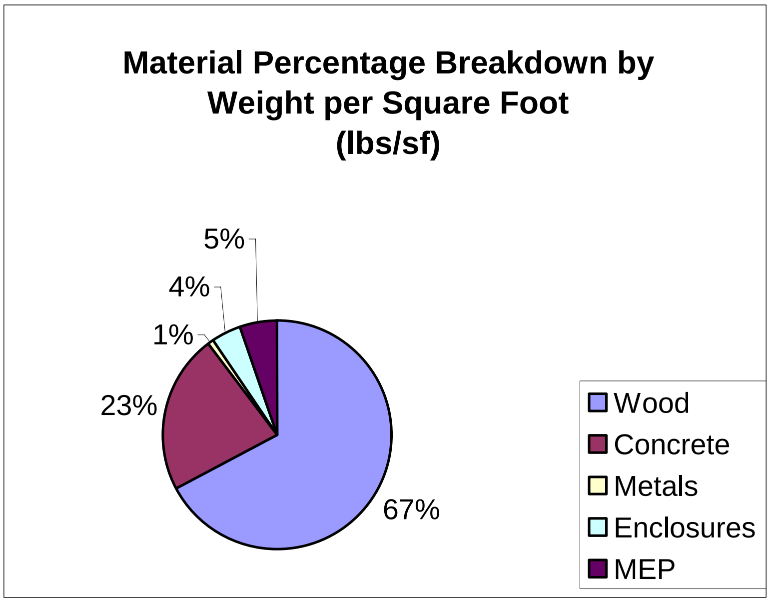
				(4) Heavy, Long Span								
				Potential Diversion								
				Salvage for Reuse			**Recycle**			**Debris**		
Building Component Categories	Description	**Average Quantity per GSF of Building**	Units	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Dim. Lumber	Framing lumber greater than 6 ft in length	**2.2** **5.4**	bf/gsf lbs/gsf	75%	1.65 4.05	bf/gsf lbs/gsf	20%	0.44 1.08	bf/gsf lbs/gsf	5%	0.1 0.27	bf/gsf lbs/gsf
Scrap Lumber	Framing lumber less than 6 ft in length	**0.0**	bf/gsf lbs/gsf	0%	0.00 0.00	bf/gsf lbs/gsf	90%	0.00 0.00	bf/gsf lbs/gsf	10%	0.0 0.00	bf/gsf lbs/gsf
Siding	1x6 or 1x8 siding (novelty)	**1.0** **2.4**	bf/gsf lbs/gsf	75%	0.75 1.80	bf/gsf lbs/gsf	20%	0.20 0.00	bf/gsf lbs/gsf	5%	0.1 0.12	bf/gsf lbs/gsf
Sheathing	1x6 or 1x8 diagonal	**1.1** **2.6**	bf/gsf lbs/gsf	75%	0.83 1.95	bf/gsf lbs/gsf	20%	0.22 0.00	bf/gsf lbs/gsf	5%	0.1 0.13	bf/gsf lbs/gsf
Plywood	1/4" plywood	**0.2** **0.6**	bf/gsf lbs/gsf	90%	0.18 0.54	bf/gsf lbs/gsf	5%	0.01 0.00	bf/gsf lbs/gsf	5%	0.0 0.03	bf/gsf lbs/gsf
T&G Flooring	1x T&G flooring	**0.9** **2.2**	bf/gsf lbs/gsf	90%	0.81 1.98	bf/gsf lbs/gsf	5%	0.05 0.00	bf/gsf lbs/gsf	5%	0.0 0.11	bf/gsf lbs/gsf
Drywall	1/2" GWB	**0.4** **1.1**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	100%	0.4 1.10	sf/gsf lbs/gsf
Asphalt Shingles & Felt Paper*	235 lb Shingles	**0.9**	sf/gsf lbs/gsf	0%	0.00 0.00	sf/gsf lbs/gsf	99%	0.89 0.00	sf/gsf lbs/gsf	1%	0.01 0.00	sf/gsf lbs/gsf
Concrete	RC foundation slabs & piers	**4.6**	lbs/gsf	0%	0.00	lbs/gsf	99%	4.55	lbs/gsf	1%	0.05	lbs/gsf
Reinforcing Steel	Typical steel reinforcement	**0.2**	lbs/gsf	0%	0.00	lbs/gsf	99%	0.20	lbs/gsf	1%	0.00	lbs/gsf
Heavy Timber	Typical 3x8 to 3x12	**0.5** **1.2**										
Masonry	Brick chimney		lbs/gsf	50%	0.00	lbs/gsf	50%	0.00	lbs/gsf	0%	0.00	lbs/gsf
Plumbing	Fixtures, Piping,	**0.1**	lbs/gsf	50%	0.05	lbs/gsf	50%	0.05	lbs/gsf	0%	0.00	lbs/gsf
HVAC	Equipment, Ductwork, misc.	**0.9**	lbs/gsf	0%	0.00	lbs/gsf	90%	0.81	lbs/gsf	10%	0.09	lbs/gsf
Doors	Sizes Vary	**0.6**	lbs/gsf	85%	0.51	lbs/gsf	10%	0.06	lbs/gsf	5%	0.03	lbs/gsf
Windows	Sizes Vary	**0.2**	lbs/gsf	85%	0.17	lbs/gsf	10%	0.02	lbs/gsf	5%	0.01	lbs/gsf
Equipment	Typical kitchen equipment						75%					
Electrical	light fixtures,	**0.1**	lbs/gsf	50%	0.05	lbs/gsf	25%	0.03	lbs/gsf	25%	0.03	lbs/gsf
		20.9	lbs/gsf		11.10	lbs/gsf		6.80	lbs/gsf		1.96	lbs/gsf

Potential Debris	**Potential Diversion**
20.9 lbs/gsf	**17.90 lbs/gsf**

* Asphalt Shingles may not have outlet for recycling, in this case they become debris.

* Newer components of HVAC systems may be reused.

lbs/sf	General Summary
13.7	Wood
4.6	Concrete
0.2	Metals
0.8	Enclosures
1.1	MEP



Alterations to Interior Partitioning

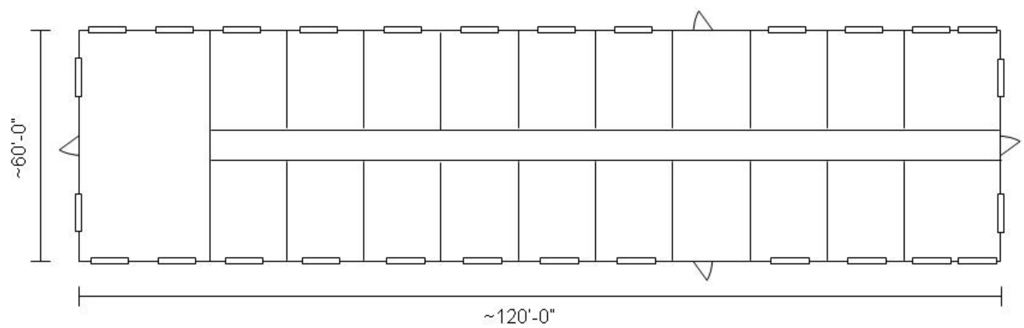
As a result of various renovations to wood frame constructed facilities many interior partitions original to the functional organization of the building have been altered. The following examples estimate the typical partitioning of a one and two story barracks type facility by assigning a maximum, moderate, and minimum value of interior partitions capable. For each building type dimensions were assumed to be 30 x 120 feet with a large room spanning the entire width of the building at one end.

- Maximum is used to describe the ultimate quantity of interior partitions able to be placed in order to achieve a reasonable division of area per room. Typical widths are assumed to be at least 10 feet in width.
- Moderate is used to describe the average quantity of interior partitions able to be placed in order to achieve a typical division of area per room. Rooms are typically twice the width than if the facility were to be partitioned to the its maximum potential.

- Minimum is used to describe the building if no partitioning exists in addition to the one room assumed to be in each building type.

Partition Layout for a Typical One Story Barrack

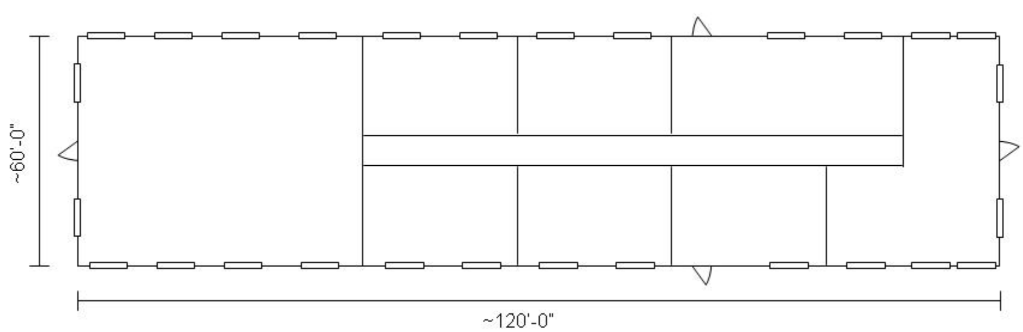
(30 ft x 120 ft)



Maximum Partitions Scale: 1 in. = ~15 ft

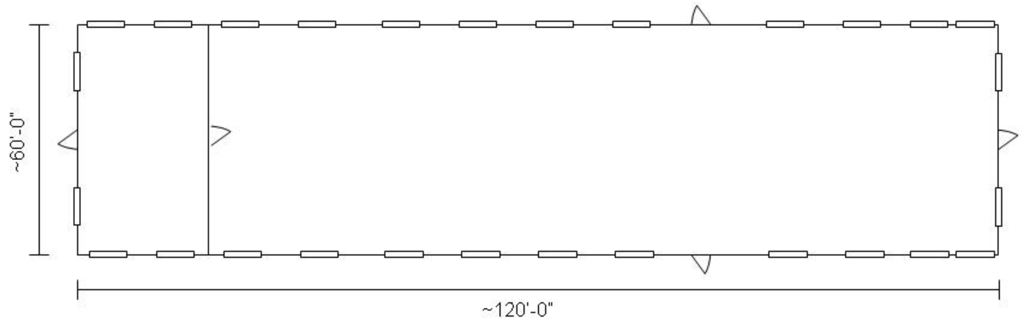
Partition Layout for a Typical One Story Barrack

(30 ft x 120ft)



Moderate Partitions Scale: 1 in. = ~15 ft

Partition Layout for a Typical One Story Barrack (30 x 120 ft)



Minimum Partitions Scale: 1 inch = ~15 feet

The following description is a suggested guide for applying additional quantity estimates derived from remodeled facilities. These general estimates are determined from assumptions made for a typical one story 3,600 sf wood frame constructed barracks facility and a two story 7,200 sf wood framed constructed barracks facility. The dimensions of the building are assumed to be 120 feet in length and 30 feet in width. It should be noted that these figures are estimates only and other factors may apply to the particular building in question.

After the general assessment of the facility type is determined, additional alterations to the standing condition of the building should be established.

If remodeling has occurred, assess the extent of partitioning using the guidelines provided above: Maximum, Moderate, or Minimum. Use the above plans as a general guideline to compare with the building in question.

Apply the estimates obtained from the partitioning general summary charts to the individual components determined previously from the total four building types.

For example if a 2,000 sf building falls into category (1) Light-Framed, One Story Building, the estimated amount of dimension lumber is 4.0 bf/sf, given an estimated 8,000 bf or 17,120 lb of existing dimension lumber. After determining that a moderate amount of alterations to interior partitions has occurred, an additional factor for dimension lumber should be applied to the original estimate. If the interior construction consists of 2x4 stud construction, the estimated amount of partitioning for a moderate alteration is 0.32 bf/sf. Thus, 640 bf or 1,370 lb should be added to the total amount of estimated dimension lumber. (8,000 bf + 640 bf = 8,640 bf or 17,120 lb + 1,370 lb = 18,490 lb) Additional quantity factors should be determined for other components associated with interior partitions such as drywall, doors, and windows where applicable.

After the amount of partitioning is accounted for, the Potential Diversion Factors can be applied to the combined total to determine the estimated debris diversion amount. Potential Diversion Factors and typical diversion methods can be found under the previous building categories component chart.

1) **Estimated Partitioning Capable in a Typical One Story Barracks Type Facility** 30 ft x 120 ft

General Summary of One Story Barracks Facility

Component	Maximum lb/sf of building	Moderate lb/sf of building	Minimum lb/sf of building
Framing Stud Size	2x4	2x4	2x4
Interior Framing	1.3	0.7	0.1
Exterior Framing	0.8	0.8	0.8
Drywall	6.8	4.6	2.5
Doors & Windows	0.8	0.6	0.5

*(sf) refers to the gross floor area

(2) **Estimated Partitioning Present in a Typical Two Story Barracks Type Facility** 30 ft x 120 ft

General Summary of One Story Barracks Facility

Summary	Maximum lb/sf of building	Moderate lb/sf of building	Minimum lb/sf of building
Framing Stud Size	**2x4**	**2x4**	**2x4**
Interior Framing	2.6	1.3	0.2
Exterior Framing	1.7	1.7	1.7
Drywall	13.7	9.1	2.8
Doors & Windows	1.6	1.1	0.9

*(sf) refers to gross floor area

* Wall surface of exterior wall is calculated separately from the wall surface of interior partitions.

Note: Windows range from a variety of sizes including the following: 2.58 ft x 4.5 ft double hung, 2.67 ft x 4.5 ft double hung, 3.33 ft x 5.33 ft double hung, and 3.67 ft x 4.5 ft double hung. An average of 14 SF was assumed for all window area values.

Appendix C
Korean War-era Reinforced Concrete and Masonry Buildings

Building Categories

The majority of Korean War-era reinforced concrete and masonry constructed buildings can be represented by two basic categories consisting of minor variations: (1a) Three Story Hammerhead Barracks with Dining Facilities, (1b) Three Story Hammerhead Barracks with Administrative Facilities, (2a) Motor Pool Facility with Interior Steel Columns, and (2b) Motor Pool Facility without Interior Steel Columns. Functionally the buildings can be represented by three categories: Barracks Quarters, Office Barracks, and Motor Pool. The unit weight of material contained in buildings which function as Living Quarters and Offices can be considered the same, thus can be grouped into the same building category of (1a or 1b) Three-Story Hammerhead Barracks with attached Facilities. The functions of the Motor Pool Facilities are the same, but vary slightly in construction types as type (2a) has interior steel columns with exterior perimeter concrete columns and type (2b) has no interior columns with exterior perimeter steel columns.

Three Story “Hammerhead” Barracks with Dining Facilities. These buildings are constructed with a concrete structural frame consisting of reinforced concrete columns, one-way joist floor system, and concrete masonry infilled walls. Typical dimensions of a three-story barrack are 265 feet in length by 38 feet, 10 inches in width for the main portion of the building, and the attached dining facility with rough dimensions of 55 feet, 6 inches in length by 119 feet, 9 inches in width. The building contents are summarized as follows:

- Foundation: Reinforced concrete foundation wall footing with an estimated thickness of 10 inches. Reinforce concrete pier footings support interior columns.
- Floor Framing: One way concrete joists system, with 6-inch wide joists spaced on average 20 inches O.C. Joist depth range from 10- to 12-inches deep with a 2.5-in. slab thickness. A typical span is 24 feet. Edge beams and girders

range in sizes from 1 to 2 feet in depth and 8 inches to 1 foot in width.

- Exterior walls: Concrete masonry units in filled between reinforced concrete columns with typical bay sizes of 24 inches O.C. Exterior finish upgrades consist of Dryvit applied over the existing C.M.U. and concrete structure.
- Doors and windows: Insulated hollow metal doors typically have replaced the original doors. The original wood frames typically remain. Windows are typically vinyl or aluminum-framed double hung replacements, which may be single or double glazed.
- Roof: Typically a built up roof system. Insulating fill varies between 2 to 6 inches.
- Interior Construction: Partitions are constructed of concrete masonry units (CMU). Some areas have acoustical ceiling plaster as well as GSU (Glazed Surface Unit), typically found in dining area functions. The original floorings consisted of Vinyl Asbestos Tile, which has typically already been abated and replaced with resilient tile laid over the concrete floor slab.
- Mechanical/Electrical/Plumbing: A forced-air furnace typically replaces the original boiler with a main distribution duct added above the ceiling, running down the center of the building, with branches supplying ceiling diffusers. Surface-mounted fluorescent lights fixtures are added to the ceiling; duplex receptacles are added within any enclosed spaces. Load centers and distribution have usually been upgraded over original materials. Original washroom facilities have generally been upgraded with new fixtures and accessories.
- Equipment: Various types of kitchen equipment are present where dining facilities are present. Equipment includes, but is not limited to: dishwashers, ranges, ovens, steam kettles, deep fryers, griddles, steam table, cold table, and industrial fridge.

Figure C1. Exterior façade of Korean War-era barracks facility.

Three Story Hammerhead Barracks with Administrative Facilities. These buildings are constructed with a concrete structural frame consisting of reinforced concrete columns, one-way joist floor system, and concrete masonry infilled walls. Typical dimensions are 265 feet in length by 38 feet, 10 inches in width for the main portion of the building, and the attached administrative facility with rough dimensions of 55 feet, 6 inches in length by 119 feet, 9 inches in width. The building contents are summarized as follows:

- Foundation: Reinforced concrete foundation wall footing with an estimated thickness of 10 inches. Reinforce concrete pier footings support interior columns.

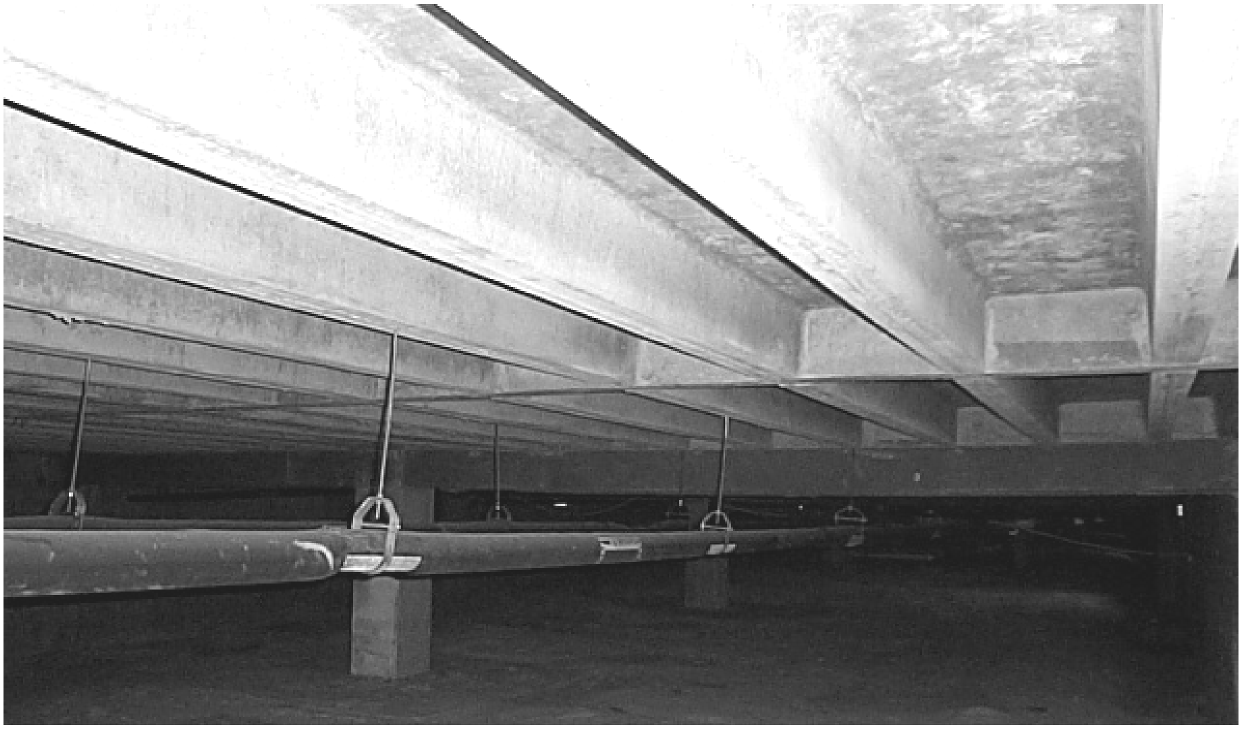


Figure C2. Concrete floor system.

- Floor Framing: One way concrete joists system, with 6-inch wide joists spaced on average 20 inches O.C. Joist depth range from 10 to 12 inches deep with a 2.5-inch slab thickness. A typical span is 24 feet. Edge beams and girders range in sizes from 1 to 2 feet in depth and 8 inches to 1 foot in width.
- Exterior walls: Concrete masonry units in filled between reinforced concrete columns with typical bay sizes of 24 feet O.C. Exterior finish upgrades consist of Dryvit applied over the existing CMU and concrete structure.
- Doors and windows: Insulated hollow metal doors typically have replaced the original doors. The original wood frames typically remain. Windows are typically vinyl or aluminum-framed double hung replacements, which may be single or double glazed.
- Roof: Typically a built up roof system. Insulating fill varies between 2 and 6 feet.
- Interior Construction: Partitions are constructed of concrete masonry units (CMU) (verify wall finish). Some areas have acoustical ceiling plaster as well as GSU (Glazed Surface Unit), typically found in dining area functions. The original floorings consisted of Vinyl Asbestos Tile, which has typically already been abated and replaced with resilient tile laid over the concrete floor slab.

- Mechanical/Electrical/Plumbing: A forced air furnace typically replaces the original boiler; a main distribution duct typically is added above the ceiling, running down the center of the building, with branches supplying to ceiling diffusers. Surface mounted fluorescent lights fixtures are added to the ceilings; duplex receptacles are added within any enclosed spaces. Load centers and distribution are typically upgraded over original materials. Original washroom facilities are typically upgraded with new fixtures and accessories.

Motor Pool Facility. These buildings are typically constructed with a concrete structural frame consisting of reinforced concrete columns on the exterior perimeter, with a row of interior steel columns. An alternate structural system consists of steel columns on the exterior perimeter without any interior steel columns. The difference in structural system will slightly affect the quantity of steel present. The Motor Pool Facility (2b) lacks interior steel columns, but has more steel due to the amount of steel columns used at the perimeter columns. Motor Pool Facility (2b) also has slightly more CMU infill. CMUs infill the walls where large openings are not required for overhead doors. This single story building has a steel framed roof structure with metal decking. The roofing system consists of a typical built-up system.

Figure C3. Motor pool facility.

Typical dimensions are 120 feet, 3 inches in length by 40 feet in width. The building contents are summarized as follows:

- Foundation: Reinforce concrete pier footings support exterior concrete or steel columns, as well as for interior W-shaped steel columns. Reinforced concrete foundation wall footings with an estimated thickness of 8-inch spans between each pier footing.
- Floor Framing: Six-inch concrete slab on grade with 6 x 6 x 10/10 welded wire mesh.
- Exterior walls: CMUs infilled between the exterior columns with typical bay sizes of 16 feet O.C. Large metal overhead doors exist in between six of the bays. Exterior finish upgrades consist of Dryvit applied over the existing CMU and concrete structure.
- Doors and windows: Metal overhead doors take the place of concrete masonry units in several bays. Insulated hollow metal doors typically have replaced the original doors were applicable. The original wood frames typically remain. Windows are typically vinyl or aluminum-framed double hung replacements, which may be single or double glazed. The sizes of the windows vary, but some can be up 8 feet, 1 inch in height and 11 feet, 9 inches in width.
- Roof: Steel roof system consisting of steel W-shapes. Girders are spaced at 16-foot O.C. with beams framing in about every 6 foot, 8 inches O.C. Two rows of 5/8-inch diameter sag rods run perpendicular between the beams. Horizontal lateral bracing can be found at the outside edges of the roof consisting of steel angles stemming out from the girder/column connection to the beams. Roofing material consists of a vapor barrier with 1 layer of 15-lb asphalt saturated felt, 30-lb asphalt per square over metal decking with metal gravel guard and fascia at the perimeters.
- Interior Construction: Partitions are constructed of concrete masonry units. A wire mesh partition also separates part of the floor space into office and parts storage. Most of the interior of this facility is open due to its function as a motor pool.
- Mechanical/Electrical/Plumbing: A forced-air furnace typically replaces the original boiler; a main distribution duct typically is added above the ceiling, running down the center of the building, with branches supplying to ceiling diffusers. Surface mounted fluorescent lights fixtures are added to the ceilings; duplex receptacles are added within any enclosed spaces. Load centers and distribution are typically upgraded over original materials. Original washroom facilities are typically upgraded with new fixtures and accessories.

The following tables outline the expected material quantities present in Korean War-era reinforced concrete and masonry constructed buildings in standing condition. Data are grouped according to the facility function associated to the Hammerhead Barrack building. Functions include dining facilities and or administrative type facilities.

Quantity estimates for exterior finishes upgrades are given. All exterior finish upgrades should be assumed to be classified as waste. It should be assumed that exterior finish upgrades will not affect the ability to recycle the concrete structural system it is adhered to, rather that the exterior finish material upgrade is to be removed completely.

The quantity estimate given for exterior finish upgrades should be multiplied by the gross exterior surface area of the building to obtain the total estimated weight of waste. This amount should be added to the total estimated amount of debris created from the original components of the building. This value should then be used as the total debris burden to be expected if all material was to be landfilled, as well as the value to be used to determine the potential diversion factor to be expected for the entire structure.

Potential contaminates. The presence or absence of contaminates will have a significant effect on the feasibility of reusing or recycling building materials. Intentions to minimize waste must be tempered with human health and safety considerations.

It is common practice within Army installations to remove all asbestos-containing materials (ACM) prior to building demolition. This may be accomplished through an independent abatement contract, or included within the demolition contract Scope of Work. In either case, the demolition contractor will be allowed to proceed only after abatement work is completed and the building is certified to be safe. Therefore, no ACM should be present if and when personnel salvage or recycle materials. The only time ACM becomes a problem with demolition or recycling is when previously undetected ACM is found, at which time either demolition activity would have to stop. While the presence of ACM is of concern, it is not problematic to the issue of salvage or recycling if it is abated as a standard practice.

Some states require removal of all friable ACM prior to demolition (or deconstruction), but allow nonfriable ACM to remain in the building upon demolition, to be commingled with the debris. In WWII-era wood buildings, floor tile is the most common of these materials. Presence of vinyl asbestos tiles (VAT) will prevent recycling of the concrete covered with the tile, which in turn will make it difficult to segregate and recycle clean concrete. The installation must determine whether abating the VAT is justified given the potential value of the recycled concrete.

Concern is frequently expressed about recycling materials which have been coated by lead-based paint (LBP). Any building removal activities, whether demolition or deconstruction, must observe 29 CFR 1926, the Occupational Safety and Health Administration (OSHA) Construction Safety Standards, specifically Section 62, Lead in Construction. All occupational protection requirements are described in these standards.

The presence of LBP on concrete structures does not necessarily constitute a hazard. Given the mass of the concrete, the concentration of lead in the rubble is likely to be quite small. ERDC/CERL has conducted limited analyses of concrete recycled from buildings coated with LBP, and determined the aggregate would not exceed the EPA limits for hazardous waste. During recycling operations, dust control must be implemented, which is a standard practice in the industry. The residual fines may contain enough LBP chips to warrant careful handling. Salvage and reuse of other LBP’d materials should follow the same precautions as given in Appendix B.

1a) Three Story Hammerhead Barracks with Dining Facilities

Korean War - Era Reinforced Concrete Construction

Quantities are on a per-square-foot basis

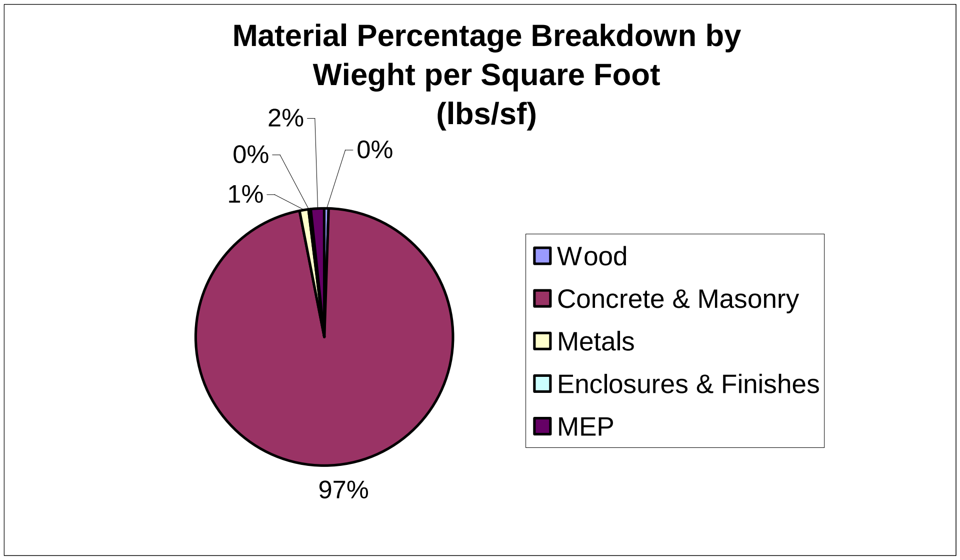
(1) 3 Story Hammerhead Barracks w/ Dining Facilities

Building Component Categories	Description	Average Quantity per GSF of Building	Units	Salvage for Reuse Percent	Salvage for Reuse Quantity	Salvage for Reuse Units	Recycle Percent	Recycle Quantity	Recycle Units	Debris Percent	Debris Quantity	Debris Units
Concrete	Reinforced Concrete	**185**	lbs/gsf	0%	0.00	lbs/gsf	99%	183.22	lbs/gsf	1%	1.85	lbs/gsf
Masonry	CMU Blocks, Glazed Structural Units	**23.0**	lbs/gsf	50%	11.48	lbs/gsf	50%	11.48	lbs/gsf	0%	0.00	lbs/gsf
Reinforcing Steel	Typical Steel Reinforcement	**2.5**	lbs/gsf	0%	0.00	lbs/gsf	99%	2.48	lbs/gsf	1%	0.03	lbs/gsf
Roofing	Typical build up roofing	**0.4**	sf/gsf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	0.42	lbs/gsf
Doors	Sizes vary	**1.0**	lbs/gsf	85%	0.85	lbs/gsf	10%	0.10	lbs/gsf	5%	0.05	lbs/gsf
Windows	Sizes vary	**1.0**	lbs/gsf	85%	0.85	lbs/gsf	10%	0.10	lbs/gsf	5%	0.05	lbs/gsf
Vinyl Tile		**1.0**	sf/gsf		0.00	lbs/gsf		0.00	lbs/gsf	100%	0.99	lbs/gsf
Acoustical Ceiling Plaster		**0.1**	sf/gsf		0.00	lbs/gsf		0.00	lbs/gsf	100%	0.08	lbs/gsf
Plumbing	Fixtures- toilets, urinals, porcelain sinks, toilet	**0.3**	lbs/gsf		0.00	lbs/gsf		0.00	lbs/gsf	100%	0.28	lbs/gsf
HVAC	Boiler/furnace, hot water heater, air condensing unit	**0.2**	lbs/gsf	0%	0.00	lbs/gsf	90%	0.22	lbs/gsf	10%	0.02	lbs/gsf
Equipment	Typical Kitchen Equipment	**0.1**	lbs/gsf		0.00	lbs/gsf	75%	0.05	lbs/gsf	25%	0.02	lbs/gsf
Electrical	Light Fixtures	**3.2**	lbs/gsf	50%	1.58	lbs/gsf	25%	0.79	lbs/gsf	25%	0.79	lbs/gsf
		217.8	lbs/gsf		**14.8**	lbs/gsf		**198.4**	lbs/gsf		**4.6**	lbs/gsf

Exterior Finish Upgrade	**Description**	**Average Quantity per SF**	**Units**	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Dryvit	2" thick, PB (polymerbased) attached with adhesive	17.6	lbs/sf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	17.60	lbs/gsf

General Summary	lbs/gsf	Percent of Total Weight
Wood	1	0.46%
Concrete & Masonry	208.02	96.44%
Metals	2.50	1.16%
Enclosures & Finishes	0.42	0.19%
MEP	3.75	1.74%

Gross Area	36000SF


Material Percentage Breakdown by
Wieght per Square Foot
(lbs/sf)
2%
0%
0%
1%
97%
Wood
Concrete & Masonry
Metals
Enclosures & Finishes
MEP

1b) Three Story Hammerhead Barracks with Administration Facilities

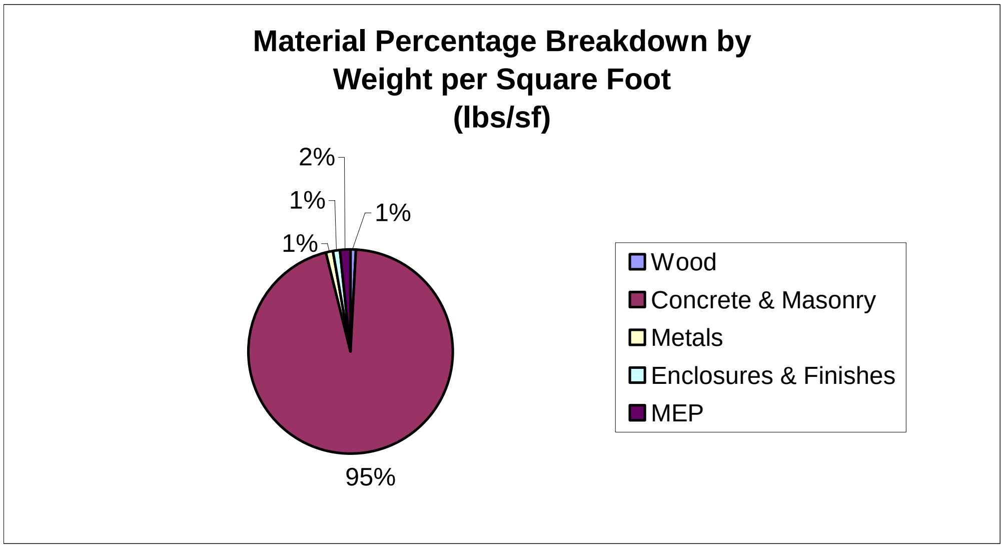
Korean War - Era Reinforced Concrete Construction

Quantities are on a per-square-foot basis

		(2) 3 Story Hammerhead Barracks w/ Administration Facilities		Salvage for Reuse			Recycle			Debris		
Building Component Categories	Description	**Average Quantity per GSF of Building**	Units	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Concrete	Reinforced Concrete	**185**	lbs/gsf	0%	0.00	lbs/gsf	99%	183.22	lbs/gsf	1%	1.85	lbs/gsf
Masonry	CMU Blocks, Glazed Structural Units	**26.7**	lbs/gsf	50%	13.36	lbs/gsf	50%	13.36	lbs/gsf	0%	0.00	lbs/gsf
Reinforcing Steel	Typical Steel Reinforcement	**2.5**	lbs/gsf	0%	0.00	lbs/gsf	99%	2.48	lbs/gsf	1%	0.03	lbs/gsf
Roofing	Typical build up roofing	**2.2**	sf/gsf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	2.17	lbs/gsf
Doors	Sizes vary	**2.6**	lbs/gsf	85%	2.21	lbs/gsf	10%	0.26	lbs/gsf	5%	0.13	lbs/gsf
Windows	Sizes vary	**1.7**	lbs/gsf	85%	1.45	lbs/gsf	10%	0.17	lbs/gsf	5%	0.09	lbs/gsf
Vinyl Tile		**1.0**	sf/gsf		0.00	lbs/gsf		0.00	lbs/gsf	100%	0.99	lbs/gsf
Acoustical Ceiling Plaster		**0.0**	sf/gsf		0.00	lbs/gsf		0.00	lbs/gsf	100%	0.00	lbs/gsf
Plumbing	Fixtures- toilets, urinals, porcelain sinks, toilet	**0.3**	lbs/gsf		0.00	lbs/gsf		0.00	lbs/gsf	100%	0.29	lbs/gsf
HVAC	Boiler/furnace, hot water heater, air condensing unit	**0.3**	lbs/gsf	0%	0.00	lbs/gsf	90%	0.23	lbs/gsf	10%	0.03	lbs/gsf
Equipment	Typical Kitchen Equipment	**0.0**	lbs/gsf		0.00	lbs/gsf	75%	0.02	lbs/gsf	25%	0.01	lbs/gsf
Electrical	Light Fixtures	**3.2**	lbs/gsf	50%	1.61	lbs/gsf	25%	0.80	lbs/gsf	25%	0.80	lbs/gsf
	Total	**225.5**	lbs/gsf		**18.6**	lbs/gsf		**200.5**	lbs/gsf		**6.4**	lbs/gsf

General Summary	**Tons**	**Percent of Total Weight**
Wood	2	0.90%
Concrete & Masonry	211.79	95.30%
Metals	2.50	1.12%
Enclosures & Finishes	2.17	0.98%
MEP	3.77	1.70%

Gross Area	36000SF


Material Percentage Breakdown by
Weight per Square Foot
(lbs/sf)
2%
1%
1%
1%
95%
Wood
Concrete & Masonry
Metals
Enclosures & Finishes
MEP

2a) Motor Pool Facility with Interior Steel Columns

Korean War - Era Reinforced Concrete Construction

Quantities are according to a per-square-foot basis

(1) Motor Pool with Interior Steel Columns & Concrete Exterior Columns

					Salvage for Reuse			Recycle			Debris		
Material Break Downs	Description	Weight (tons)	Average Quantity per SF	Units	Percent	Quantity	Units	Percent	Quantity	Units	Percent	Quantity	Units
Concrete	RC foundation, floor slab, columns, beams	303	126	lbs/sf	0%	0.00	lbs/gsf	99%	124.55	lbs/gsf	1%	1.26	lbs/gsf
Masonry	CMU Blocks, Glazed Structural Units	21	8.7	lbs/sf	50%	4.36	lbs/gsf	50%	4.36	lbs/gsf	0%	0.00	lbs/gsf
Steel	Steel Columns and Beams	9.1	3.8	lbs/sf		0.00	lbs/gsf		0.00	lbs/gsf	100%	3.77	lbs/gsf
Reinforcing Steel	Typical Steel Reinforcement	2.1	0.9	lbs/sf	0%	0.00	lbs/gsf	99%	0.85	lbs/gsf	1%	0.01	lbs/gsf
Metal Decking	1.5-in. thick, 18ga. Deck	7.9	3.3	lbs/sf		0.00	lbs/gsf		0.00	lbs/gsf	100%	3.30	lbs/gsf
Roofing	Typical build up roofing	7.1	3.0	lbs/sf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	2.95	lbs/gsf
Doors	Sizes vary	1.5	0.64	lbs/sf	85%	0.54	lbs/gsf	10%	0.06	lbs/gsf	5%	0.03	lbs/gsf
Windows	Sizes vary	0.6	0.2	lbs/sf	85%	0.20	lbs/gsf	10%	0.02	lbs/gsf	5%	0.01	lbs/gsf
Plumbing	Fixtures- toilets, urinals, porcelain sinks, toilet partitions	0.3	0.1	lbs/sf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	0.13	lbs/gsf
HVAC	Boiler/furnace, hot water heater, air condensing unit	0.6	0.3	lbs/sf	0%	0.00	lbs/gsf	90%	0.23	lbs/gsf	10%	0.03	lbs/gsf
Electrical	Light Fixtures, Wiring	1.1	0.4	lbs/sf	50%	0.22	lbs/gsf	25%	0.11	lbs/gsf	25%	0.11	lbs/gsf
	Total	**354**	**147.1**	lbs/sf		**5.3**	lbs/gsf		**130.2**	lbs/gsf		**11.6**	lbs/gsf

General Summary	Tons	Percent of Total Weight
Wood	0	0.0%
Concrete & Masonry	324	91.4%
Metals	19.1	5.4%
Enclosures & Finishes	9.2	2.6%
MEP	2.0	0.6%

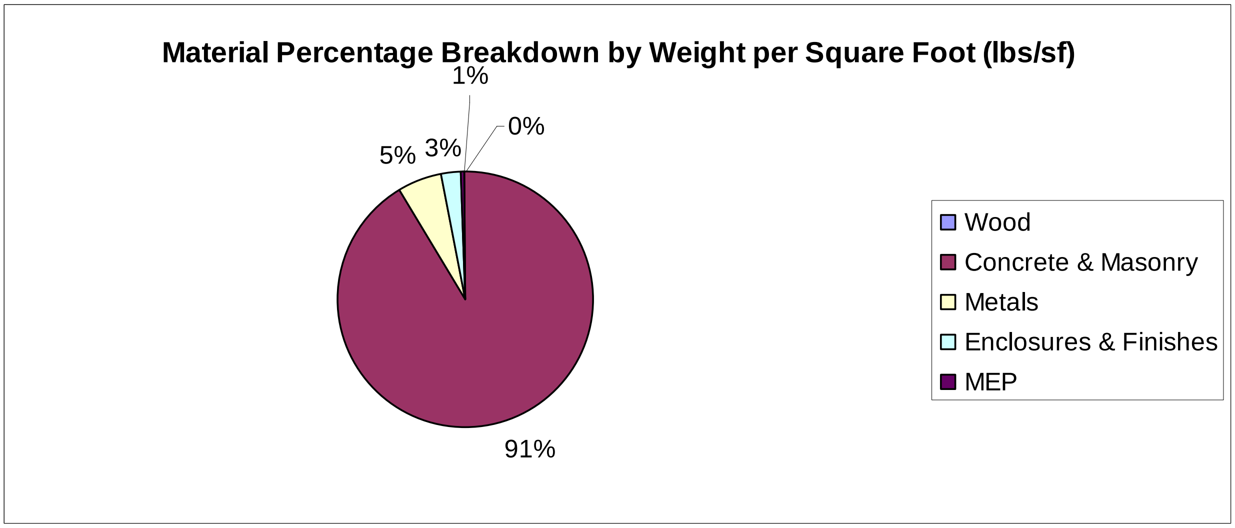

Material Percentage Breakdown by Weight per Square Foot (lbs/sf)
1%
0%
5%
3%
91%
Wood
Concrete & Masonry
Metals
Enclosures & Finishes
MEP

Figure C4. Motor pool facilities with interior steel columns.

2b) Motor Pool Facility without Interior Steel Columns

Korean War - Era Reinforced Concrete Construction

Quantities are on a per-square-foot basis

(2) Motor Pool without Interior Steel Columns & Steel Exterior Columns

Material Break Downs	Description	Weight (tons)	Average Quantity per SF	Units	Salvage for Reuse Percent	Salvage for Reuse Quantity	Salvage for Reuse Units	Recycle Percent	Recycle Quantity	Recycle Units	Debris Percent	Debris Quantity	Debris Units
Concrete	RC foundation, floor slab, columns, beams	281	117	lbs/sf	0%	0.00	lbs/gsf	99%	115.68	lbs/gsf	1%	1.17	lbs/gsf
Masonry	CMU Blocks, Glazed Structural Units	38	15.9	lbs/sf	50%	7.95	lbs/gsf	50%	7.95	lbs/gsf	0%	0.00	lbs/gsf
Steel	Steel Columns and Beams	12	5.0	lbs/sf		0.00	lbs/gsf		0.00	lbs/gsf	100%	4.96	lbs/gsf
Reinforcing Steel	Typical Steel Reinforcement	2.1	0.9	lbs/sf	0%	0.00	lbs/gsf	99%	0.85	lbs/gsf	1%	0.01	lbs/gsf
Metal Decking	1.5" thick, 18ga. Deck	7.9	3.3	lbs/sf		0.00	lbs/gsf		0.00	lbs/gsf	100%	3.30	lbs/gsf
Roofing	Typical build up roofing	7.1	3.0	lbs/sf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	2.95	lbs/gsf
Doors	Sizes vary	1.5	0.64	lbs/sf	85%	0.54	lbs/gsf	10%	0.06	lbs/gsf	5%	0.03	lbs/gsf
Windows	Sizes vary	0.7	0.3	lbs/sf	85%	0.26	lbs/gsf	10%	0.03	lbs/gsf	5%	0.02	lbs/gsf
Plumbing	Fixtures- toilets, urinals, porcelain sinks, toilet	0.3	0.1	lbs/sf	0%	0.00	lbs/gsf	0%	0.00	lbs/gsf	100%	0.13	lbs/gsf
HVAC	Boiler/furnace, hot water heater, air condensing unit	0.6	0.3	lbs/sf	0%	0.00	lbs/gsf	90%	0.23	lbs/gsf	10%	0.03	lbs/gsf
Electrical	Light Fixtures, Wiring	1.1	0.4	lbs/sf	50%	0.22	lbs/gsf	25%	0.11	lbs/gsf	25%	0.11	lbs/gsf
	Total	**353**	**146.6**	lbs/sf		**9.0**	lbs/gsf		**124.9**	lbs/gsf		**12.7**	lbs/gsf

General Summary	Tons	Percent of Total Weight
Wood	0	0.00%
Concrete & Masonry	319	90.6%
Metals	22	6.2%
Enclosures & Finishes	9.4	2.7%
MEP	2.0	0.6%

Gross Area	4810

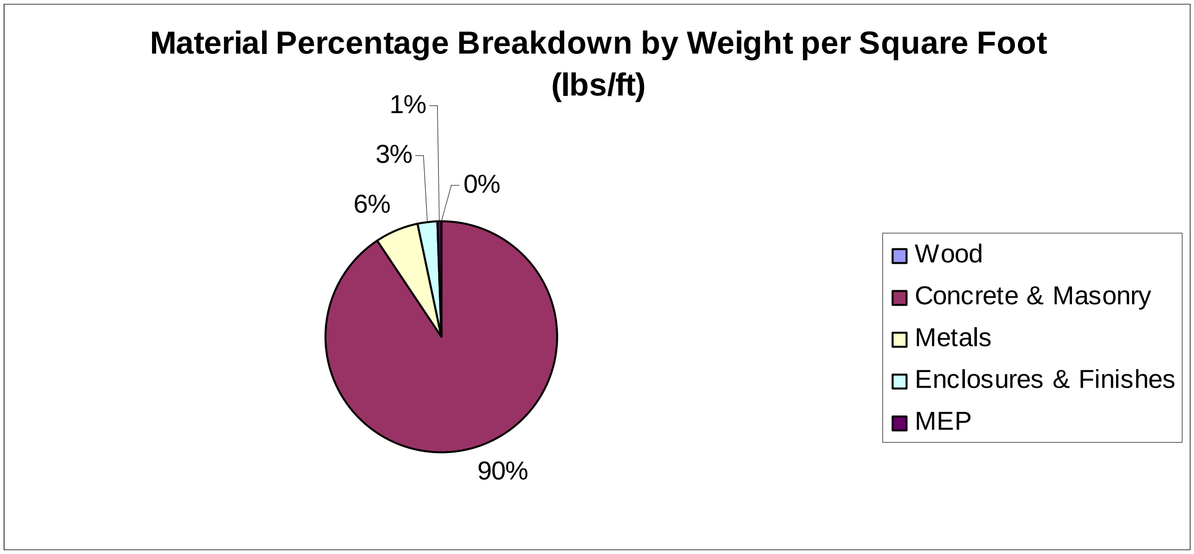

Material Percentage Breakdown by Weight per Square Foot (lbs/ft)
1%
3%
0%
6%
90%
Wood
Concrete & Masonry
Metals
Enclosures & Finishes
MEP

Figure C5. Motor pool facility with exterior perimeter concrete columns

Figure C6. Motor pool facility roof construction

It should be noted that, although Motor Pool Facility (2b) does not have interior steel columns, the quantity of steel present is larger than the quantity of steel in Motor Pool Facility (2a). This occurs as a result of additional steel columns used as exterior perimeter columns of the structural systems versus concrete columns used in Motor Pool Facility (2a).