FM 3-34.170/MCWP 3-17.4 (FM 5-170)

ENGINEER RECONNAISSANCE

March 2008

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HEADQUARTERS DEPARTMENT OF THE ARMY
UNITED STATES MARINE CORPS

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Field Manual
No. 3-34.170/MCWP 3-17.4 (5-170)

Headquarters
Department of the Army
Washington, DC, 25 March 2008

Engineer Reconnaissance

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***This publication supersedes FM 5-170, 5 May 1998.**

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Preface

Doctrine provides a military organization with unity of effort and a common philosophy, language, and purpose. This field manual provides doctrine for the application of engineer reconnaissance capabilities in support of the combined arms team conducting full spectrum operations.

Engineer reconnaissance, like chemical, biological, radiological, and nuclear (CBRN) and other technical applications, is not a form of reconnaissance (see chapter 3 for a discussion of the four forms of reconnaissance). Engineer reconnaissance is instead a focused application of special/unique capabilities supporting reconnaissance operations and is applicable over/pertinent to all four forms of reconnaissance. Field manual (FM) 3-34.170/Marine Corps Warfighting Publication (MCWP) 3-17.4 updates the FM that provides doctrinal guidance for engineer reconnaissance in support of full spectrum operations, including engineer reconnaissance in support of tactical operations as well as engineer technical reconnaissance support. This manual supersedes FM 5-170 and supports the doctrine found in FM 3-0, FM 3-34, and FM 6-0, and Field Manual Interim (FMI) 5-0.1. This manual will serve as a reference document for engineer commanders and staff, leaders, training developers, and doctrine developers throughout the Army and Marine Corps. It will also provide guidance to commanders for the employment of engineer reconnaissance capabilities in support of all operations. It is also the primary reference for engineer reconnaissance for Joint Publication (JP) 3-34.

This FM has an introduction and six chapters. It includes significant discussion on integrating the planning for engineer reconnaissance support within the planning doctrine in FM 5-0 and the command and control (C2) doctrine in FM 6-0. The introduction expands upon the manual’s purpose and summarizes the doctrinal changes it contains. Chapter 1 provides a doctrinal framework for the provision of engineer reconnaissance capabilities resident within engineer functions and supporting the warfighting functions, describes a range of tactical to technical engineer reconnaissance capabilities, and provides capabilities and limitations of the engineer reconnaissance team (ERT). Chapter 2 provides doctrine for integrating the planning for engineer reconnaissance within information management and planning processes of the combined arms team. It specifically addresses integration of geospatial support and provides specific C2 considerations for integration of engineer reconnaissance. Chapter 3 provides doctrine for integrating the application of engineer reconnaissance within tactical reconnaissance operations of the combined arms team. It also addresses considerations for the sustainment of engineer reconnaissance elements. Chapter 4 provides doctrine for the conduct of ERT operations providing engineer reconnaissance support at the tactical end of the range described in Chapter 1. ERTs conduct zone, area, and route reconnaissance with a specified additional focus on required technical information. Chapters 5 and 6 provide doctrine for the conduct of engineer assessments and surveys which provide engineer reconnaissance support at the technical end of the range described in Chapter 1. Assessment and survey teams conduct reconnaissance specifically focused on collecting detailed technical information. Appendix B illustrates the preparation of required engineer reconnaissance reports and forms. Appendix C incorporates the smartcard tools developed for infrastructure assessment. Appendix D provides the environmental baseline assessment tool. Appendix H includes a collection of other useful tools and resources.

The target audience for this manual is focused at the brigade and below maneuver commander and supporting staff. This also includes nonorganic unit commanders and staffs that will support brigade and below maneuver organizations. Additionally, it is pertinent to other commanders and staffs at all echelons. This doctrine will assist branch schools in teaching the integration of engineer capabilities. Engineer involvement is a virtual certainty for nearly every military operation. FM 3-34.170 is intended to inform all Service components of the types of engineer reconnaissance tasks and the variety of capabilities available to perform them.

This FM is built directly on the doctrine articulated in the following manuals:

- FM 3-0.
- FM 3-20.96.
- FM 3-34.
- FM 3-34.221.
- FM 3-90.
- FM 3-90.6.
- FM 5-0.
- FM 5-7-30.
- FM 5-71-2.
- FM 5-71-3.
- FM 6-0.
- FMI 5-0.1.

Given the magnitude of doctrinal changes in recent years, becoming familiar with these documents is essential to effectively using this manual. It also applies to selected portions of engineer support across echelons and throughout the area of operations (AO). Doctrine in FM 3-34.170 applies across the spectrum of conflict (from peace to general war) and the operational components of full spectrum operations (offense, defense, and stability, or civil support). However, it is focused at the tactical level of war and support of the tactical commander's engineer reconnaissance needs.

Terms that have joint or Army definitions are identified in both the glossary and the text. Glossary terms: The glossary lists most terms used in FM 3-34.170 that have joint or Army definitions. Terms with an asterisk in the glossary indicate that this FM is the proponent FM (the authority). Text references: Definitions printed in boldface in the text indicate that this FM is the proponent FM. These terms and their definitions will be incorporated into the next revision of FM 1-02/Marine Corps Reference Publication (MCRP) 5-12A. For other definitions in the text, the term is italicized, and the number of the proponent FM follows the definition. As a dual service manual, references made to the United States (U.S.) Army, Soldiers, and brigade combat team (BCT) are interchangeable with and/or include the United States Marine Corps (USMC), Marines, and regimental combat team (RCT) unless stated otherwise in the text. Additionally, unless this publication states otherwise, masculine nouns or pronouns do not refer exclusively to men.

This FM applies to the Active Army, the Army National Guard (ARNG)/Army National Guard of the United States (ARNGUS), the United States Army Reserve (USAR) unless otherwise stated and to the USMC.

Headquarters, United States Army Training and Doctrine Command (TRADOC) is the proponent for this publication. The preparing agency is the Doctrine Division (DD), United States Army Engineer School (USAES). Send written comments and recommendations on DA Form 2028, *Recommended Changes to Publications and Blank Forms*, directly to Commandant, United States Army Engineer School, ATTN: ATZT-TDD-E, 320 MANSCEN Loop, Suite 220, Fort Leonard Wood, Missouri 64573-8929. Send comments and recommendations by e-mail to <leon.mdottddengdoc@conus.army.mil>.

Introduction

The three engineer functions are combat (with the capabilities and activities of mobility, countermobility, and survivability [M/CM/S]), general, and geospatial engineering. All three of these functions include significant reconnaissance capabilities. This manual focuses on engineer support to combined arms commanders at all levels for engineer reconnaissance support during full spectrum operations. It includes extensive discussion on integrating the planning for and conduct of engineer reconnaissance support within the tactical operations of the combined arms team. This manual discusses capability resident within combat engineer units to form and employ ERTs. It also describes the capability resident within general engineer elements to form and employ ERTs, augment combat engineer ERTs, or provide assessment and survey teams. Finally, geospatial engineering is used to enable reconnaissance operations and may play a large role, especially during the planning process.

Engineer reconnaissance, like CBRN and other technical applications, is not a form of reconnaissance (see chapter 3 for a discussion of the four forms of reconnaissance). Engineer reconnaissance is instead a focused application of special/unique capabilities supporting reconnaissance operations and is applicable over/pertinent to all four forms of reconnaissance. Engineer reconnaissance generated from and organized by the engineer functions provides a range of technical reconnaissance capabilities. Each of the functions provides varying degrees of technical expertise and effort within the assigned mission and tasks. The tasks and levels of expertise provided overlap from function to function. For example, there is no clean dividing line from the technical effort required for the combat engineering task of classifying a route for combat vehicle traffic to the general engineering task of conducting a road reconnaissance to estimate the effort required for the upgrade of a main supply route (MSR). The combat engineering task will effectively address classification of the route but will also provide information useful in the general engineer's estimate. Similarly the general engineer's estimate will effectively address the effort required for an upgrade and will provide information useful in the classification of the route. Geospatial engineering is employed in support of both and in varying degrees as required by the task and situation.

The engineer functions provide a menu of reconnaissance capabilities varying in linkages to warfighting functions and varying in degree of technical expertise and effort applied to the assigned mission and tasks. The capabilities are generated from and organized by both combat and general engineer units with overarching support from geospatial means. With few exceptions (discussed in chapter 1), these units do not have organized and dedicated reconnaissance elements within their structure. Rather, combat and/or general engineers are task-organized as required by the situation—based on mission, enemy, terrain and weather, troops and support available, time available, civil considerations (METT-T[C])—and may be teamed separately or with other elements from across engineer (or even various warfighting) functions.

> ***Note.*** The Marine Corps and joint doctrine use METT-T without "civil considerations" being added.

FM 3-34.170 is a significant revision from FM 5-170, which it supersedes, and reflects considerable changes that have occurred over the 9 years since that manual was released. Many of the tactical tasks associated with engineer reconnaissance have remained essentially constant, but the operational environment (OE) has dramatically shifted. New requirements for technical information and new technologies available to the engineer have caused adjustments in reconnaissance challenges and capabilities. Another major change involves the Army's reorganization and restructuring to a modular force and the effects that this has on doctrine and operations. Changes that directly affect this manual include—

- The advent of the construct and term of assured mobility and its relationship to other doctrine (see FM 3-34).

- An acknowledgement of the importance of joint interdependence among the Services.
- The formalization of a planning tool that supports the engineer staff running estimate known as essential tasks for M/CM/S (see FM 3-34).
- The OE.
- The likelihood that the operations conducted will be joint, interagency, and multinational (see FM 3-0). The primary focus of joint engineer operations is to achieve the commander's intent by coordinating engineer support throughout the joint AO. All branches of Service possess organic engineer elements with varying degrees of technical and tactical capabilities. When available, units such as Navy construction battalion-engineers (Seabees), Air Force Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE), and Prime Base Engineer Emergency Force (Prime BEEF) organizations can augment the technical reconnaissance capability.
- The formalization of support requirements to homeland security. See JP 3-26 and FM 3-07.
- The frequency of contractors on the battlefield and their support for many of the tasks associated with general engineering. (See Army Regulation [AR] 715-9 and FM 3-100.21).
- Resulting changes in the basic design and organizational structures and equipment of engineer organizations to support the Army's ongoing transformation.
- The acknowledgement that nearly all operations will be conducted in the context of a joint, interagency, and multinational environment.

This FM includes the discussion of engineer reconnaissance in support of tactical operations as well as more technical engineer reconnaissance. It includes revised material from the current manual that guides engineer reconnaissance of roads, bridges, tunnels on routes, and other infrastructure components along a selected route and will discuss and integrate discussions of engineer reconnaissance in support of, M/CM/S operations. Changes in the structure of the force have not changed the basic principles of engineer employment, but they will adjust the C2 structure and force tailoring of engineer forces to support the BCT. Recent lessons learned include the need to define, develop, and provide a proponent manual for infrastructure reconnaissance and its memory aid for sewage, water, electricity, academics, trash, medical, safety, and other considerations (SWEAT-MSO) as well as reintegrate the discussion of clearing operations. Significant changes occur in this manual. This manual—

- Updates the discussion of the integration of engineer reconnaissance capabilities within the combined arms team.
- Describes a range of engineer reconnaissance capabilities from tactical to technical with overarching geospatial support.
- Establishes the ERT as an ad hoc, tactically focused reconnaissance capability.
- Establishes assessment and survey teams as an ad hoc, technically focused reconnaissance capability.
- Incorporates the capacity to augment with technical capabilities through field force engineering (FFE), multi-Service, interagency, contractor, and host nation (HN) capabilities.
- Changes "engineer recon" to an engineer resource assessment.
- Incorporates developing doctrine on infrastructure reconnaissance and environmental reconnaissance.
- Introduces or recaptures new doctrine on the reconnaissance of underground tunnels, as distinct from tunnels on routes as covered in the previous FM 5-170.

The engineer's contribution to operational success will always be highly desired/required by the commander. Demands for engineer reconnaissance support will often exceed capabilities as they are spread across and compete with the commander's needs for other engineer applications. The same engineer elements and capabilities are often required for each of these areas. Resolution of this competition is one of the goals of the planning process as the staff running estimate is created during mission analysis and the engineer coordinator (ENCOORD) identifies the specified and implied engineer tasks (may be more than M/CM/S) and their associated purposes. This results in the recommendation of essential tasks for M/CM/S to the supported commander.

Finally, this manual is written with the acknowledgement that the OE is much more variable than what doctrine was previously written against. Engineers must be prepared to go into any OE and perform its full range of reconnaissance tasks in support of the maneuver commander while dealing with a wide range of threats and other influences. It builds on the collective knowledge and wisdom gained through recent conduct of operations—combat as well as operations other than war—numerous exercises, and the deliberate process of informed reasoning throughout the Army. It is rooted in time-tested principles and fundamentals, while accommodating new technologies and diverse threats to national security.

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Chapter 1

Engineer Reconnaissance

Nothing is more worthy of attention of a good general than the endeavor to penetrate the designs of the enemy.

Niccolo Machiavelli

FM 1 and field manual interim (FMI) 5-0.1, describes "how Army forces fight" by describing an operational concept that is the core statement of Army doctrine. The Army's operational concept is full spectrum operations. The operational concept depends on the flexible combination of Army capabilities (combined arms) and joint capabilities (joint interdependence) integrated across the warfighting functions (WFFs) through mission command and the operations process. One of the fundamentals that underlie this concept and the basis for organization and operations of Army forces is combined arms. Combined arms is synchronized or simultaneous application of several arms—such as infantry, armor, field artillery, engineers, and aviation—to achieve an effect on the enemy that is greater than if each arm was used against the enemy separately or in sequence. Engineer support to the combined arms team adds key capabilities that ensure the team's freedom of maneuver and preserve the team's combat power. An important measure of effectiveness of the team's integration of lethal and nonlethal capabilities is the degree to which the commander can concentrate combat power at the critical place and time and the agility with which the commander can shift those concentrations to new situations. Engineer support also adds reconnaissance capabilities to improve the commander's situational understanding (SU) about the enemy and environment, enabling the concentration and agility needed. This chapter begins the discussion of engineer reconnaissance and the application of those capabilities integrated and synchronized with the other systems—warfighting functions—united by the combined arms commander toward the common purpose of accomplishing the mission.

ENGINEER FUNCTIONS

1-1. Engineer support capabilities are traditionally characterized as supporting the combined arms team with combat tasks (including mobility—breaching, clearing, and bridging; countermobility—emplacing and/or reinforcing obstacles; and survivability hardening and emplacement of fighting/protective positions), general tasks (including general construction and reinforcement of the combat tasks), and geospatial tasks (to include mapping and terrain analysis). The traditional engineer support capabilities are organized into three engineer functions: combat M/CM/S, general, and geospatial engineering. The engineer functions are useful in describing the various engineer support capabilities and associated linkages through the WFFs across the entire spectrum of operations. Engineer functions are similarly useful in organizing and describing a range of engineer reconnaissance capabilities that vary from a purely tactical focus to a purely technical focus linking through the warfighting functions to support the combined arms reconnaissance operation.

COMBAT ENGINEERING

1-2. Combat engineering is defined by JP 3-34 and JP 1-02 as those engineering capabilities and activities that support the maneuver of land combat forces and that require close support to those forces. Combat engineering consists of three types of capabilities and activities: M/CM/S.

1-3. Combat engineering includes those capabilities organic to and augmenting the BCTs/RCTs. Combat engineering provides tactical level engineer support to combat (offense and defense), stability, or civil support operations and is typically (although not always) focused on the support of close combat. It may be augmented at times with general engineering support but retains its focus on the integrated application of engineer capabilities to support the combined arms team's freedom of maneuver (mobility and countermobility) and protection (survivability). (See FM 3-34.2, FM 90-13, and FM 5-103 for more information on combat engineering.)

1-4. Combat engineer reconnaissance capabilities are similarly focused on supporting the WFFs of movement and maneuver and protection. These capabilities are typically fully integrated into the intelligence, surveillance, and reconnaissance (ISR) plan and targeted to improve the commander's understanding of the enemy's use of terrain and obstacles within the AO. Combat engineer reconnaissance can range from almost purely tactically focused to a fully integrated tactical reconnaissance focused on gathering technical information.

GENERAL ENGINEERING

1-5. General engineering is defined by JP 3-34 and JP 1-02 as those engineering capabilities and activities, other than combat engineering, that modify, maintain, or protect the physical environment. Examples include the construction, repair, maintenance, and operation of infrastructure, facilities, lines of communication and bases; terrain modification and repair; and selected explosive hazard activities. (See FM 5-104, FM 3-100.4; and FM 7-15 for additional information on general engineering.)

1-6. As mentioned in the definition, general engineering may be performed in direct support of combat operations which results in a gray area in distinguishing purely combat engineering from general engineering tasks at the tactical level. General engineering will typically not be associated with close combat. More distinguishable at the operational level, general engineering capabilities are applied to establish and maintain the infrastructure necessary for sustaining military operations in theater. At times, the military operation may extend general engineering support to restore facilities, power, and life-support systems within the infrastructure of the AO. This effort aids in the recovery and the transition to preconflict conditions or may be the objective of civil support operations. General engineering tasks—

- May include construction or repair of existing logistics-supported facilities, line of communications (LOC) and MSRs, airfields, ports, water wells, power plants, pipelines, and base camps/force bed down.
- May be performed by a combination of joint engineer units, civilian contractors, and host-nation (HN) forces.
- Usually require large amounts of construction materials, which must be planned and provided for in a timely manner.
- May include the production of construction materials.
- May include support to selecting real property for lease or operation and upgrading those facilities (to include hardening for protection).

1-7. General engineer reconnaissance capabilities are typically focused on technical requirements for the construction or repair of sustainment facilities. However; just as other general engineering capabilities may be applied in direct support of combat engineering, general engineer reconnaissance may similarly augment combat engineer capabilities at the tactical level. General engineer capabilities may be focused at the tactical or operational level but, in every case, introduce additional technical capabilities that are applied to improve the commander's understanding of the terrain, facilities, and infrastructure within the AO.

GEOSPATIAL ENGINEERING

1-8. Geospatial engineering is defined by JP 3-34 and JP 1-02 as those engineering capabilities and activities that contribute to a clear understanding of the physical environment by providing geospatial information and services to commanders and staffs. Examples include terrain analyses, terrain visualization, digitized terrain products, nonstandard tailored map products, precision survey, geospatial data management, baseline survey data, and force bed-down analysis. Engineer planners are charged to be terrain experts and to advise commanders on how to conceptualize the OE effectively. They must be supported by terrain analysts to fully assist others to use the terrain more effectively. (See FM 3-34.230 and JP 2-03 for more information on geospatial support to Army and Joint systems.)

1-9. Geospatial engineering provides commanders with information about the terrain and assists them in conceptualizing the OE more accurately to make knowledgeable decisions. It supports reconnaissance and other operations ranging from a tactical to a more technical focus. Geospatial engineering provides terrain analysis, digitized terrain products, nonstandard tailored map products, map production, precision survey, terrain data management, and baseline survey data—all of which contribute to improving SU. Creative and productive use of digital terrain data aids the commander's visualization of the physical environment by determining factors such as, but not limited to—

- Avenues and routes for friendly/enemy forces.
- Terrain limitations to enemy capabilities.
- Obstacle zone locations.
- Environmentally significant areas (water resources, hazards).
- Major engagement areas (EAs).
- Unit positions.
- Deep operation targets and their impact on future operations.
- Rescue operation parameters.
- Flood prediction models.
- Mission planning and rehearsal data.

ARMY WARFIGHTING FUNCTIONS

1-10. Engineer functions are the baseline functions performed by multi-Service engineers to support the maneuver force. These functions are each generally aligned in support of specific warfighting functions (see figure 1-1 on page 1-4) although they have impact in and across the others.

- Combat engineering is aligned primarily with the movement and maneuver and the protection functions.
- General engineering aligns to focus its support on the sustainment and protection functions, reinforcement of combat engineering outside of close combat, and support to operational mobility and countermobility.
- Geospatial engineering is primarily aligned with the C2 and intelligence functions.

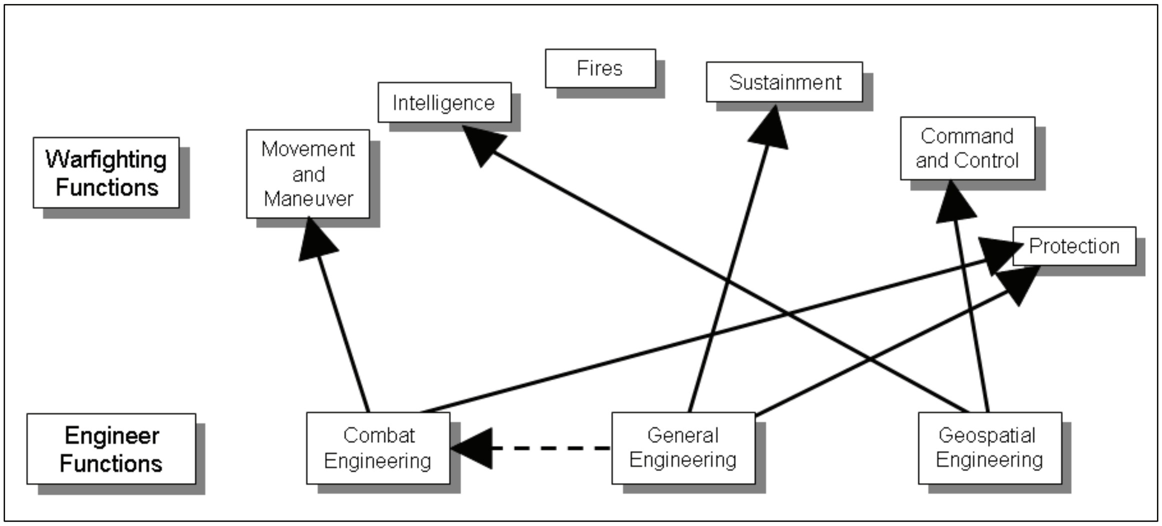


Figure 1-1. Engineer primary relationships to the warfighting functions

1-11. In describing the purpose of the warfighting functions, FMI 5-0.1 states that commanders generate and focus combat power by tying the warfighting functions together through leadership. To synchronize and execute operations, commanders must be able to visualize and direct operations through the warfighting functions. To effectively support the combined arms team, engineer reconnaissance capabilities retain their relationship through the warfighting functions. The combat engineer capability to rapidly assess the maneuverability of a selected route for heavy combat vehicle traffic is synchronized and then executed primarily through its relationship to the movement and maneuver function and is typically conducted as an enabler to the tactical route reconnaissance mission. The general engineer capability to classify and provide a design for the upgrade of a selected bridge along the MSR is similarly synchronized and executed through its relationship to the sustainment function and would typically be conducted as a stand-alone engineer mission. Engineer reconnaissance capabilities are generated from and organized within the framework of the engineer functions but are applied by the commander through their alignment or relationship to the warfighting functions.

ENGINEER RECONNAISSANCE

1-12. Reconnaissance operations are those operations undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy or to secure data concerning the meteorological, hydrographical, or geographical characteristics and the indigenous population of a particular area. Reconnaissance primarily relies on the human dynamic rather than technical means. Reconnaissance is a focused collection effort. It is performed before, during, and after other operations to provide information used in the intelligence preparation of the battlefield (IPB) process, as well as by the commander to formulate, confirm, or modify the course of action (COA).

1-13. The responsibility for conducting reconnaissance does not reside solely with specifically organized units. Every unit has an implied mission to report information about the terrain, civilian activities, and friendly and enemy dispositions; regardless of its physical location and primary function. Although all units conduct the implied reconnaissance mission, the commander typically focuses specifically organized reconnaissance units on the highest priority requirements. The BCT designs have more than doubled the reconnaissance capabilities organic to brigade commanders and given them new surveillance and target acquisition capabilities. This design permits the BCT to mix aggressive patrolling, reconnaissance in force, and a multilayered and integrated approach to their reconnaissance efforts. Their ability to develop the situation both in and out of contact and to act first with decisiveness is enhanced by this robust reconnaissance capability.

1-14. Even with the robust reconnaissance capability now available in support of the BCT, the commander must know the capabilities and limitations of reconnaissance assets to ensure that the employment of these assets is within their capabilities and on missions for which they have been trained and equipped. Although reconnaissance primarily relies on the human dynamic rather than technical means, the situation may require collecting a higher degree of technical information than nonspecialized units possess. An area with suspected contamination by chemicals or industrial toxins, for example, must be targeted for reconnaissance by assets equipped to determine the type and level of contamination present as well as protection from the contamination. Supporting units—such as engineers, CBRN, explosive ordnance disposal (EOD), military police (MP), and others—have specialized capabilities to collect technical information that complements the force's overall reconnaissance effort. It is this collection of technical information that defines a range of engineer reconnaissance capabilities.

RANGE OF ENGINEER RECONNAISSANCE

1-15. Engineer reconnaissance, like CBRN and other technical applications, is not a form of reconnaissance (see chapter 3 for a discussion of the four forms of reconnaissance). Engineer reconnaissance is instead a focused application of special/unique capabilities supporting reconnaissance operations and is applicable over/pertinent to all four forms of reconnaissance. Engineer reconnaissance generated from and organized by the engineer functions provides a range of technical reconnaissance capabilities. Each of the functions provides varying degrees of technical expertise and effort within the assigned mission and tasks. The tasks and levels of expertise provided overlap from function to function. For example, there is no clean dividing line from the technical effort required for the combat engineering task of classifying a route for combat vehicle traffic to the general engineering task of conducting a road reconnaissance to estimate the effort required for the upgrade of an MSR. The combat engineering task will effectively address classification of the route but will also provide information useful in the general engineer's estimate. Similarly the general engineer's estimate will effectively address the effort required for an upgrade but also provide information useful in the classification of the route. Geospatial engineering is employed in support of both and in varying degrees as required by the task and situation. Figure 1-2 on page 1-6 graphically describes the range of technical information provided by engineer reconnaissance capabilities. This graphic is not intended to define absolutes but rather general relationships and linkages between the engineer functions and the technical and tactical engineer reconnaissance capabilities.

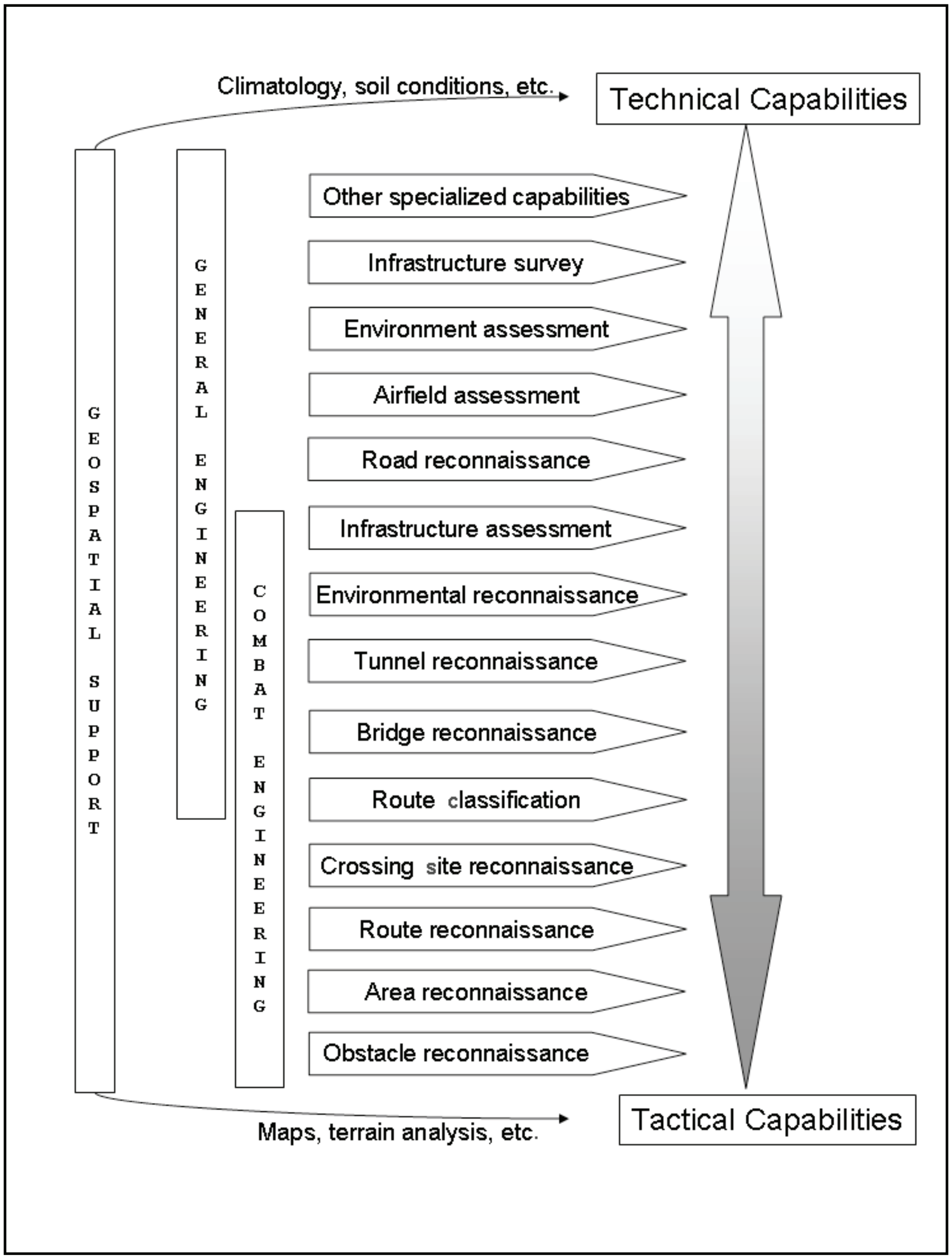


Figure 1-2. Range of engineer reconnaissance capabilities

1-16. As portrayed in figure 1-2, the engineer functions provide a menu of reconnaissance capabilities varying in linkages to warfighting functions and varying in degree of technical expertise and effort applied to the assigned mission and tasks. The capabilities are generated from and organized by both combat and general engineer units with overarching support from geospatial means. With few exceptions as discussed later in this chapter, these units do not have organized and dedicated reconnaissance elements within their structure. Rather, combat and/or general engineers are task-organized as required by the situation, based on METT-T[C], and may be teamed separately or with other elements from across engineer (or even warfighting) functions.

> ***Note.*** The Marine Corps and joint doctrine use METT-T without "civil considerations" being added.

ENABLING AND TEAMING WITH OTHER RECONNAISSANCE CAPABILITIES

1-17. Engineers teamed directly with dedicated reconnaissance assets, by adding some degree of technical skill to the team, can increase the tempo and effectiveness of the reconnaissance mission. Combat engineers are typically task-organized directly to maneuver battalion scouts or reconnaissance squadron troops to augment those units during tactical reconnaissance operations. The reconnaissance unit conducts the overall mission while the assigned engineer team focuses on the more technical information required, such as detailed information on a complex obstacle or a proposed crossing site. While various engineers are available to be task-organized directly to reconnaissance units, the teaming of engineers directly into the reconnaissance forces directly supporting the BCT/RCT is the most common application.

1-18. With the exception of the reorganized single engineer company supporting the Army heavy BCT (HBCT), engineer units organic to and augmenting the BCTs/RCTs have no dedicated reconnaissance assets; but with measured risk to other mission support, they have the capability to provide ERTs to augment the BCT/RCT reconnaissance squadron or maneuver battalion scout platoons. If required, the engineer company commander forms an ERT(s) ranging in size from a three-man team to a platoon. ERTs may operate independently; however, they normally augment one of the squadron troops or other maneuver units directly involved in reconnaissance operations. If an ERT augments a squadron element, the team should be task-organized with equipment that is compatible with mission requirements and the supported reconnaissance force. The final section of this chapter provides additional discussion on the formation of ERTs.

1-19. General engineer reconnaissance capabilities, when not in direct support of combat engineers, will typically be organized in the form of assessment or survey teams. These task-organized teams will have a specific focus for the collection of technical information and are less likely to be teamed directly with reconnaissance units in the BCT/RCT. (Additional discussion on engineer assessment and survey teams is provided later in this chapter as well as in chapter 6.)

TACTICAL CAPABILITIES

1-20. Combat engineers conduct tactical reconnaissance as described by Army tactical task (ART), Conduct Tactical Reconnaissance, in FM 7-15 and includes five subtasks—zone reconnaissance, area reconnaissance, reconnaissance-in-force, route reconnaissance, and conducting a reconnaissance patrol. These missions are fully integrated within the BCT/RCT tactical reconnaissance operations but, because they are conducted by engineers, will include some degree of focus on technical information as required by the commander's reconnaissance guidance. These missions may be conducted by ERTs, teamed with other forces or in a stand-alone fashion, if they are assigned to a combat engineer unit supporting the BCT/RCT.

1-21. The majority of tactical engineer reconnaissance capabilities enable the collection of technical information in support of the combat engineering function. Reconnaissance in support of M/CM/S operations is conducted primarily by ERTs (composed of combat engineers) and focuses on collecting tactical and technical information to support the BCT's/RCT's freedom of maneuver and protection. (Chapter 4 provides a detailed discussion of reconnaissance support of the five functions of mobility operations, support of obstacle integration and turnover in countermobility operations, support to fighting and other protective positions, and support to other tactical operations in the BCT/RCT.) The specific combat engineer reconnaissance tasks include, but are not limited to,—

- Obstacle reconnaissance focused on bypass or breach of obstacles.
- Route reconnaissance focused on route clearance operations.
- Area reconnaissance focused on explosive hazards (EHs), such as mines and unexploded explosive ordnance (UXO), requiring area clearance operations.
- Crossing site reconnaissance focused on determining requirements for a gap crossing.
- Route reconnaissance focused on establishing a combat road or trail.
- Reconnaissance of planned or existing sites and facilities supporting forward aviation operations.
- Obstacle, including demolition obstacles, reconnaissance focused on establishing friendly obstacles integrated with fires.

- Obstacle reconnaissance in preparation for target turnover.
- Area reconnaissance focused on establishing vehicle fighting positions and/or protective works.
- Area reconnaissance in support of urban combat operations.
- Reconnaissance of tunnels and underground structures.
- Reconnaissance to establish an initial assessment of environmental factors.
- Reconnaissance to establish an initial assessment of infrastructure factors.
- Reconnaissance in complex terrain.

1-22. General engineering capabilities are employed in direct support of combat engineer ERTs as required based on the factors of METT-T[C], providing additional technical capabilities as required for the mission. Additionally, general engineer capabilities are teamed with ERTs, other BCT/RCT units, or in stand-alone organizations to conduct tactical reconnaissance tasks that enable missions linked to BCT/RCT sustainment. These tasks are tactical missions that include the requirement to gather technical information needed for—

- MSR maintenance and upgrade.
- General engineering in support of airfields and heliports.
- Bridge construction or repair.
- General engineering in support of protection.
- Procurement and/or production of construction materials.
- General engineering in support of real estate activities.

TECHNICAL CAPABILITIES

1-23. General engineers provide a range of technical reconnaissance capabilities. These capabilities are similar in focus to the reconnaissance tasks that enable missions linked to BCT/RCT sustainment. Technical capabilities are distinguished from the support provided to combat engineer missions and from tactical sustainment missions by the level at which the requirements are identified and addressed. At the tactical level, the BCT/RCT may have a general engineer element in direct support to maintain or upgrade a specified MSR in the BCT/RCT AO. General engineers working at the operational level will conduct reconnaissance to identify requirements for major construction along a ground LOC. Technical reconnaissance capabilities are typically conducted by a general engineer assessment team or survey team to gather the technical information required for—

- Maintenance and upgrade of ground LOCs.
- Bridge construction or repair.
- General engineering in support of airfields and heliports.
- General engineering in support of seaports.
- General engineering in support of survivability.
- Real estate and real property maintenance activities.
- Procurement and/or production of construction materials.
- General engineering in support of base camps and support areas.
- Power generation and distribution.
- Petroleum pipeline and storage facilities.
- Water supply and well drilling.
- Underwater and other specialized construction support.
- Infrastructure survey.
- Environmental baseline assessment.
- Environmental remediation survey and assessment.

1-24. Technical capabilities include robust support from joint service, multiagency, contractor, HN, and reach-back element. Field force engineering (FFE) is the broad range of activities linked through the general engineer element on the ground to apply a high degree of technical expertise to the engineer mission. (FFE is discussed in chapter 6. Some of the reach-back resources available are discussed in appendix H. See also FM 3-34.)

ENGINEER RECONNAISSANCE TEAM CAPABILITIES AND LIMITATIONS

1-25. The Army is restructuring from a division-based to a brigade-based force—the modular force. Modular force brigades are strategically flexible, and the major combat and support capabilities a brigade needs for most operations are organic to its structure. The three types of BCTs are HBCT, infantry (IBCT), and Stryker (SBCT). The BCT contains organic elements from many different branches, including, MP, military intelligence (MI), infantry/armor, artillery, logistics, and engineers. When deployed, specialized units are added according to the needs of the mission. The BCT has a significant collection capability inherent in its organic reconnaissance squadron, maneuver battalion scout platoons, and MI company and may be augmented with ISR assets from echelons above the BCT. This section describes the capabilities and limitations of task-organized ERTs formed by engineers supporting the BCT. This includes the combat engineer companies organic to each of the BCT structures and augmenting engineer units. (Additional information on the structure of each of the BCTs can be found in FM 3-90.6. Additional information on the capabilities and structure of the combat engineers organic to each of the BCTs can be found in FM 3-34.221, FM 7-30, FM 7-71.2, and FM 5-71-3.)

1-26. The Marine Corps structure includes combat engineer capabilities task-organized in direct support of the RCT. While the combat engineer elements supporting the RCT do not include organic or dedicated reconnaissance formations, they do have the capability to conduct tactical reconnaissance as required by the situation. Combat engineers conducting tactical reconnaissance in support of the RCT provide the range of capabilities described in the section on tactical capabilities above and in chapter 4. The RCT will tend to rely more heavily than its BCT counterpart on joint Service support or other general engineer augmentation to provide the technical range of support.

1-27. With the exception of the HBCT engineer company, current engineer force structure does not provide for personnel or equipment dedicated to reconnaissance efforts. However, experience has shown that employment of engineers in a tactical reconnaissance role enhances the effectiveness of combat engineer support as well as the tempo and technical quality of the reconnaissance operation. Because an engineer unit has limited assets to draw from, the formation of ad hoc ERTs will subsequently degrade the capabilities of the organization from which they are drawn. The commander should be aware of the ERT capabilities but also understand the trade-offs between using engineer assets in a reconnaissance role versus using them in other roles.

FORMATION OF AN ENGINEER RECONNAISSANCE TEAM

1-28. An ERT is the baseline engineer reconnaissance element. Only the reorganized single engineer company in the HBCT provides dedicated personnel and equipment that can be quickly organized in a reconnaissance element. However, engineer units that identify and train personnel, establish standing operating procedures (SOPs), and provide necessary equipment for the formation of task-organized reconnaissance teams have effectively employed ERTs. The identified element may be a team, squad, platoon, or larger. Highly trained personnel are required for obstacle and other engineer tactical reconnaissance operations requiring not only the tactics, techniques, and procedures necessary for tactical reconnaissance operations but also knowledge and experience in the specific technical information requirements (IR). ERT training must include the skills sets necessary for tactical reconnaissance tasks with a focus on collecting technical information.

1-29. The ERT is normally task-organized for a specific mission, and its elements are drawn from the combat mobility platoons, the mobility support platoon, or the search team of the engineer company in the HBCT. The ERT—

- Increases the supporting unit reconnaissance capabilities concerning complex mine and wire obstacle systems, enemy engineer activities, and the details of mobility along a route.
- Provides detailed technical information on any encountered obstacle.
- Conducts an analysis of assets needed to reduce any encountered obstacle.
- Marks bypasses of obstacles based on guidance from the supported commander. This guidance includes whether to mark bypasses and the direction the force should maneuver when bypassing an obstacle.
- Assists in guiding the breach force to the obstacle for reduction.
- Assists in gathering basic enemy information.
- Provides detailed technical information on routes (including classification) and specific information on bridges, tunnels, fords, and ferries along the route.
- Provides the initial level technical information required for an airfield assessment.
- Assists in acquiring information on enemy engineer equipment on the battlefield.
- Conducts tactical reconnaissance with a specified focus on the initial technical information required for environmental or infrastructure assessments.

1-30. An ERT conducts operations as part of a larger combined arms force, directly augmenting the reconnaissance squadron or operating as a discrete element within the plan. The team normally performs reconnaissance of one named area of interest (NAI) or multiple NAIs within the same vicinity in the AO. More than one ERT may be employed if multiple NAIs need to be observed in dispersed locations. In most instances, the ERT will conduct its reconnaissance dismounted. However, the team may arrive in the vicinity of the reconnaissance objective in many ways—including dismounted, by air, or by ground transportation. If the team travels dismounted or is air inserted, it should consist of at least three personnel. If the team uses an organic vehicle to arrive in the vicinity of its reconnaissance objective, it should consist of at least five personnel—three with the dismounted element and two with the team's vehicle as the mounted element. Ideally it will travel in a vehicle that is similar to other reconnaissance vehicles so it will blend in and maintain comparable mobility, maneuverability, and vehicle protection.

1-31. A dismounted element should consist of three or more personnel and be commanded by a reconnaissance team leader. The dismounted element's mission is to locate and report all necessary information required by the supported commander according to the ISR plan. This information can be transmitted directly to the supported unit's headquarters on the appropriate net (according to the SOP or the ISR order) or relayed through the mounted element.

1-32. A mounted element consists of at least two personnel per vehicle—the vehicle operator and an assistant reconnaissance team leader. The mounted element's mission is to maintain communication with both the dismounted element and the supported unit. The mounted element is responsible for relaying any intelligence collected by the dismounted element to the appropriate C2 node and ensures that the team's vehicle is not discovered by the enemy. All obstacle intelligence (OBSTINTEL) collected by a reconnaissance team is also sent to its parent engineer headquarters, if possible. The mounted element's secondary mission is to be prepared to go forward and complete the reconnaissance if the dismounted element is unsuccessful.

1-33. Successful employment of engineers in a tactical reconnaissance role requires a trained engineer staff at the BCT/RCT as well as in the engineer unit providing the capability. The formation of ERTs will consequently degrade the capabilities of the organization from which the personnel and equipment is drawn. The brigade engineer and the unit commander must understand the trade-offs between using engineer assets in a reconnaissance role versus using them for other M/CM/S tasks when making recommendations to the BCT/RCT commander. The brigade engineer must work with the engineer unit commander to understand the specific unit's capabilities, their SOP, and any augmentation they will require, including integration within the security and evacuation plan for the overall reconnaissance effort.

The brigade engineer and unit commander coordinate with the supported maneuver unit to augment the ERT with necessary assets to accomplish the mission.

LIMITATIONS OF AN ENGINEER RECONNAISSANCE TEAM

1-34. One of the high-frequency tasks associated with reconnaissance missions is locating obstacles and restrictions that may affect the trafficability along a route or an axis. The purpose of this reconnaissance is to determine how best to overcome the effects of the obstacle: reduction or bypass. Tasks associated with this reconnaissance may be to estimate the reduction assets necessary to reduce the obstacle, to mark the best location to reduce, or to recommend a bypass of the obstacle. If the obstacle is to be bypassed, the reconnaissance team should be prepared to provide guides and markings. The reconnaissance should include the location of supporting enemy positions and possible reduction sites for the obstacle. Obstacles and restrictions are either existing or reinforcing. Manmade and natural obstacles and restrictions include the following:

- Minefields, improvised explosive devices (IEDs), and other EHs.
- Bridges and other terrain gaps.
- Log obstacles.
- Antitank (AT) ditches.
- Wire entanglements.
- Defiles.
- Persistent agent contamination.

1-35. Some ERTs (primarily Army ERTs) have the capability to clear or reduce small obstacles that are not covered by fire or observation; however, an ERT's primary task with regard to tactical and protective obstacles is the reconnaissance of those obstacles as well as locating and marking bypasses around obstacles and restrictions. ERTs have the following limitations:

- The engineer company does not have personnel and equipment listed on the table(s) of organization and equipment (TOE) and the modified TOE specifically dedicated for reconnaissance activities. Only the reorganized engineer company in the HBCT has a search team that can be quickly organized to function as an ERT.
- The team is extremely limited in its ability to destroy or repel enemy reconnaissance units and security forces.
- The distance the ERT can operate away from the main body is restricted by the range of communications, the range of supporting indirect fires, and the ability to perform sustainment operations.
- The team has limited communications capability. Based on the radio configuration of the vehicle used during the reconnaissance and whether the ERT is working under maneuver element control, dedicated monitoring of engineer nets may be difficult. However, with the single-channel ground and airborne radio system (SINCGARS), the ERT should be able to scan critical engineer nets or, at the very least, easily switch to the engineer net to report OBSTINTEL. Other communication means, including digital systems, may not be as capable of rapidly switching linkages to reflect task organization changes.
- The ERT has very limited obstacle creation and reduction ability because it normally carries a light basic load of demolitions according to the unit SOP. Obstacle reduction is normally limited to manually reducing obstacles not covered by enemy fires and observation.

1-36. Regardless of where personnel come from to create the ERT, units have to dedicate a large amount of training time toward developing an effective ERT. This training includes—

- Training events with the reconnaissance squadron to develop a strong working relationship.
- Fundamentals of reconnaissance operations (see chapter 3).
- Operation with brigade assets, the reconnaissance squadron, and maneuver battalion scouts in a nearly habitual relationship to develop the trust and familiarity necessary to succeed on the battlefield.

- Procedures for reporting, calling for fires, first aid, land navigation, demolitions, minefield indicators, foreign mine recognition, dismounted movement techniques, vehicle and equipment maintenance, helicopter insertion, resupply, extraction, relay, and retransmission.
- Operation of digital communications and automated reconnaissance systems to facilitate passing reconnaissance information.
- Noise, light, and litter discipline and the use of night vision devices and camouflage.
- Rigorous physical training to meet mission requirements.

TECHNICAL AUGMENTATION OF AN ENGINEER RECONNAISSANCE TEAM

1-37. General engineers can provide a range of additional technical reconnaissance capabilities in direct support of an ERT. Technical support can take the form of augmentation of the ERT or reach-back support. In some cases, the ERT's mission will provide the initial technical information to plan or focus the employment of follow-on assessment or survey elements from the general engineer force. General engineer capabilities available to add technical expertise include—

- Vertical or horizontal construction specialists.
- Port or pipeline construction expertise.
- Power generation and distribution specialists.
- Water well drilling and distribution specialists.
- Divers and underwater construction specialists.
- Real estate and facilities management expertise.
- Environmental engineering and specialist.
- Structural engineering and antiterrorism specialist.

1-38. ERTs may also be augmented with specialized capabilities from within the combat engineer function. In response to the proliferation of explosive and other hazards in the OE, selected combat engineers receive special training to provide additional capability to address the EH and other threats. Specialized training available includes a search advisor course and explosive ordnance clearance agent training.

1-39. Any person or organization that has received basic search training is a resource that may be able to provide specialized information to support the intelligence picture. Even relatively trivial information provided by a search aware individual may provide the necessary information from which to launch future search operations. (See FM 3-34.210 for additional information on search operations.)

1-40. The search advisor is usually an experienced company-level officer, warrant officer, or senior noncommissioned officer who has received intermediate or advanced search advisor training. A search advisor conducts detailed search planning, preparation, rehearsals, and mission execution. A unit commander may delegate authority to the search advisor as appropriate to accomplish the search mission. The specific authorities delegated depend upon the situation and the personalities involved. The search advisor can directly augment an ERT when the reconnaissance mission is planned in support of search operations. When unavailable to augment or accompany the ERT, the search advisor may provide specific IR for the reconnaissance focus in support of planned search operations.

1-41. The explosive ordnance clearance agent (EOCA) is not an engineer unit but rather a special engineer capability. EOCA personnel are combat engineers trained to perform limited identification and battlefield disposal of UXO as outlined in the EOCA identification guide and supplemental list of EOCA ordnance provided by the theater EOD commander (part of the ordnance order of battle). If the UXO is out of the scope of operations for the EOCA, EOD personnel must be called. EOCA personnel can assist EOD personnel in disposing of other EH as requested. Properly trained and certified EOCA personnel capabilities include—

- UXO reconnaissance. EOCA personnel are trained to perform detailed reconnaissance of a suspected UXO.
- UXO identification. EOCA personnel can perform limited identification of the items listed in the EOCA identification guide and supplemental EOCA ordnance list. Items that the EOCA cannot positively identify must be reported to EOD personnel.
- UXO area marking. EOCA personnel mark the UXO area according to the standard UXO marking system.
- Protective works. EOCA personnel can provide the blast and fragmentation danger area of identified UXO. EOCA may provide the estimated blast and fragmentation danger area for items similar to but not included in the EOCA identification guide and supplemental EOCA ordnance list. EOCAs will advise the on-scene commander with the recommended personnel and equipment protective measures. When the commander determines that certain personnel or equipment cannot be removed from the hazard area, protective works must be established to protect those personnel and assets from the effects of the UXO. EOCAs will recommend and supervise the appropriate protective works to be completed.
- UXO disposal. EOCA personnel are authorized to destroy by detonation individual UXOs identified in the EOCA identification guide and supplemental EOCA ordnance list.
- IED disposal. EOCA personnel are authorized to blow in place munition-based IEDs identified in the EOCA identification guide and supplemental EOCA ordnance list.

1-42. The following are the EOCA's limitations:

- Cannot move, combine, and/or destroy multiple UXOs (such as a cache).
- Cannot perform reconnaissance or handling of IED or vehicle-borne IED (VBIED) incidents.
- Can only perform captured enemy ammunition (CEA) operations under direct supervision of EOD personnel (includes EH teams [EHTs]).
- Are not to be used for EH response calls. However, if EOD is not readily available as determined by the maneuver commander, EOCA personnel can be used to conduct an initial reconnaissance of the UXO. If the UXO falls within their capability, then EOCA personnel may dispose of the UXO.

Note. The EOD battalion/group at corps/division or EOD personnel within the chemical, biological, radiological, nuclear, and high-yield explosives (CBRNE) cell at the brigade manages modification to the supplemental EOCA ordnance list provided by the theater EOD commander (part of the ordnance order of battle), based upon the published ordnance of battle. Requests to modify the supplemental list will be coordinated through the local EOD unit or the EHT for approval by the EOD battalion/group at corps/division or EOD personnel within the CBRNE cell at the brigade.

Chapter 2

Integrating Engineer Reconnaissance Capabilities

Make your plans fit the circumstances.

General George S. Patton, Jr.

As stated in FM 6-0, the essential task of commanders is applying the art and science of war to the command and control of Army forces. The commander's command and control system enables the commander to use his authority to accomplish the mission and see to the health and welfare of subordinates. Using the command and control system, the commander directs the actions of his forces and imposes his will on the enemy. Through command and control the commander initiates the actions of, influences, and synchronizes the elements of combat power [warfighting functions plus leadership] to impose his will on the situation and defeat the enemy. The supporting arms must be fully integrated throughout the command and control system to effectively support the combined arms team. Engineer support includes reconnaissance capabilities to improve the commander's SU about the enemy and environment but must fit fully within the C2 processes and functions that enable information superiority and facilitate the commander's SU.

ENABLING INFORMATION SUPERIORITY

2-1. Reconnaissance provides information. In the general sense, information is the meaning humans assign to data. As described in FM 6-0, information is the most important of three elements of control. Information gives structure and shape to military operations and the operational environment. Commanders and staffs can then give meaning to and gain understanding of the events and conditions in which they make decisions and conduct operations.

2-2. Relevant information is all information of importance to the commander and staff in the exercise of command and control (see FM 3-0). (Intelligence is a subset of relevant information). An operational picture is a single display of relevant information within a commander's area of interest (see FM 3-0). A common operational picture (COP) is an operational picture tailored to the user's requirements, based on common data and information shared by more than one command (see FM 3-0). Data and information from all echelons of command and shared among all users create the COP. Although ideally the COP is a single display, it may include more than one display and information in other forms. By applying judgment to the COP, commanders achieve SU, upon which they base decisions. However, maintaining an accurate COP is complex and difficult. Information management (IM) contributes to the information superiority necessary for an accurate COP.

2-3. IM is a component of all C2 systems. It is a contributor to information superiority. IM is the provision of relevant information to the right person at the right time in a usable form to facilitate SU and decision-making. It uses procedures and information systems to collect, process, store, display, and disseminate information (see FM 3-0). IM provides the structure to process and communicate information and to put decisions into action.

2-4. Commanders can neither make decisions nor act to implement them without information. The amount of information that is available today and in the future makes managing information and turning it into effective decisions and actions critical to success during operations. Since effective C2 depends on getting relevant information (RI) to the right person at the right time, IM is crucial to C2. IM narrows the gap between RI that commanders require and the RI that they have. C2 systems manage information for one overriding purpose—to enable commanders to make timely decisions in spite of the fog and friction of operations. All information given to commanders must be RI; that is, commanders should only receive information they need to exercise C2. Staffs ensure this RI is accurate, timely, usable, complete, precise, and reliable.

2-5. Information becomes RI if it supports exercising C2 for a mission and if it is accurate, timely, usable, complete, precise, and reliable. RI provides the basis for creating and maintaining the COP and the substance of execution information. It is the basis for achieving SU. Commanders state the RI that they need by establishing the commander's critical information requirements (CCIR). The commander alone decides what information is critical based on his experience, the mission, input from his staff, the higher commander's intent, and his estimate of the situation. CCIR consist of two primary components (see figure 2-1):

- *Priority intelligence requirements (PIR).* PIR are the intelligence requirements for which the commander has an anticipated and stated priority in his task of planning and decision-making (FM 2-0).
- *Friendly force information requirements (FFIRs).* FFIR cover information the commander needs about the forces available for an operation. This could include unit strength, disposition, capability, and readiness (FM 6-0).
- *Essential elements of friendly information (EEFI).* EEFI are not CCIR but become priorities on a level with CCIR when a commander designates them as such. They also generate CCIR (usually PIR to determine if the enemy is collecting against or has detected EEFI). EEFI are the critical aspects of a friendly operation that, if known by the enemy, would subsequently compromise, lead to failure, or limit success of the operation and, therefore, must be protected from enemy detection (FM 1-02/MCRP 5-12A).

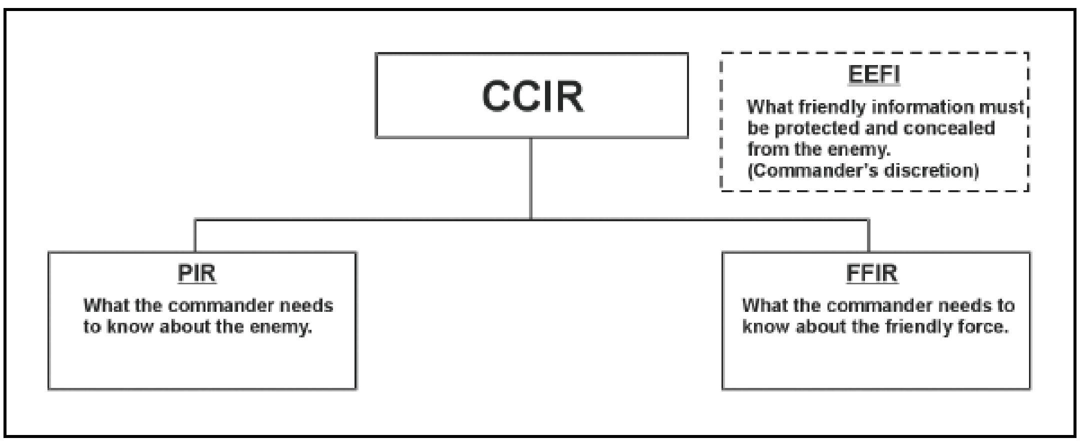


Figure 2-1. Commander's critical information requirements

2-6. IM, including priorities commanders set by establishing and continuously updating their CCIR, supports commanders' achieving and maintaining SU. SU and commander's visualization are based on RI provided by functional experts in the C2 system who process data into information. As commanders achieve SU, they use commander's visualization to determine the end state and the ways of getting from the present state to the end state. Figure 2-2 graphically depicts the commander's development of SU.

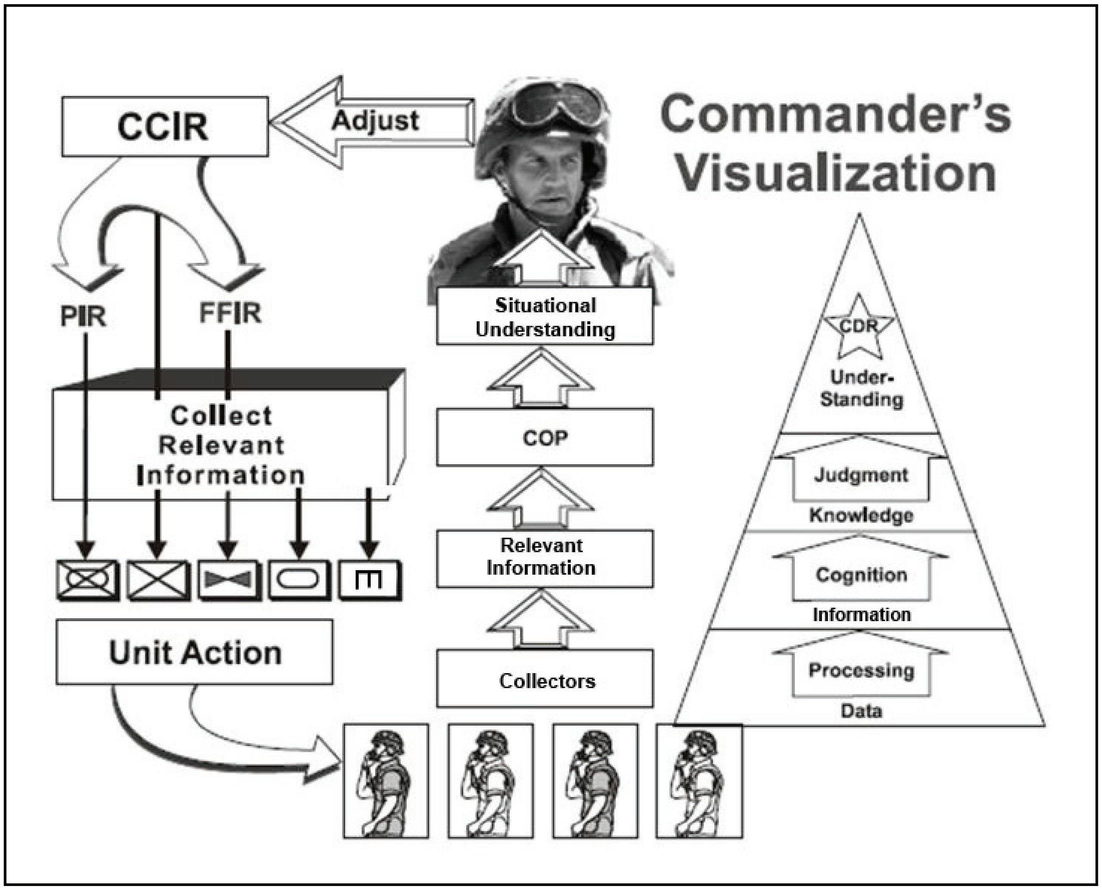


Figure 2-2. Developing situational understanding

2-7. At the start of the military decision-making process (MDMP), commanders expect to have gaps in information needed to accomplish the mission. Nevertheless, they make some initial decisions. One decision to make is which information, including intelligence, is needed to fill those gaps and attain a comprehensive SU. Commanders use CCIR to focus information collection on the RI they need to support their visualization and to make critical decisions. Staffs translate CCIR into execution information by tasking assets to collect the information required to answer them. Within the combined arms team, the ENCOORD acts as the translator of the CCIR into the technical information required from engineer reconnaissance.

INTEGRATING ASSURED MOBILITY

2-8. Assured mobility provides a planning framework to guide the commander and staff in the proactive application of engineer and other combat power to assure the freedom of movement and maneuver. As an integrating process, assured mobility provides linkage between the tasks associated with M/CM/S and their roles across the six WFFs. It applies in all operations and across the complete spectrum of conflict. Assured mobility is the framework of processes, actions, and capabilities that assure the ability of the joint force to deploy and maneuver where and when desired, without interruption or delay, to achieve the mission. It strives to ensure freedom of maneuver and preserve combat power throughout the AO as it seeks to exploit superior SU. This construct is one means of enabling a joint force to achieve the commander's intent. Assured mobility emphasizes proactive mobility and countermobility (and supporting survivability) and integrates all of the engineer functions in accomplishing this. Assured mobility is broader than the term mobility and should not be confused with the limited application of the mobility operations as described in FM 3-34.2. Its focus is on supporting the maneuver commander's ability to gain a position of advantage in relation to the enemy—by conducting mobility operations to negate the impact of enemy obstacles, conducting countermobility to impact and shape enemy maneuver, or a combination of both.

2-9. While focused primarily on the WFFs of movement and maneuver, intelligence, and protection, it has linkages to each of the WFFs and both enables and is enabled by those functions. While the engineer has a primary staff role in assured mobility, other staff members support its integration and have critical roles to play. The engineer plays an integrating role in assured mobility that is similar to the role played by the intelligence officer in the IPB integrating process. Other staff members also integrate M/CM/S tasks as a part of assured mobility. Examples would include—but are not limited to—the regulation of traffic in the maneuver space, the handling of displaced persons, and other M/CM/S tasks to support the maneuver plan. Assured mobility is the integrating planning process within which consideration of engineer, CBRN, and other reconnaissance capabilities will occur.

2-10. The framework of assured mobility follows the continuous cycle of the operations process. Achieving assured mobility rests on applying six fundamentals that both sustain friendly maneuver, preclude the enemy's ability to maneuver, and assist the protection of the force. The fundamentals of assured mobility are—

- **Predict:** Engineers and other planners must accurately predict potential enemy impediments to joint force mobility by analyzing the enemy's tactics, techniques, procedures, capability, and evolution. Prediction requires a constantly updated understanding of the OE.
- **Detect:** Using ISR assets, engineers and other planners identify early indicators for the location of natural and manmade obstacles, preparations to create/emplace obstacles, and potential means for obstacle creation. They identify both actual and potential obstacles and propose solutions and alternate courses of action to minimize or eliminate their potential effects.
- **Prevent:** Engineers and other planners apply this fundamental by denying the enemy's ability to influence mobility. This is accomplished by forces acting proactively before the obstacles are emplaced or activated. This may include aggressive action to destroy enemy assets/capabilities before they can be used to create obstacles. Political considerations and rules of engagement (ROE) may hinder the ability to apply the fundamental early in a contingency.
- **Avoid:** If prevention fails, the commander will maneuver forces to avoid impediments to mobility if this is viable within the scheme of maneuver.
- **Neutralize:** Engineers and other planners plan to neutralize, reduce, or overcome obstacles/impediments as soon as possible to allow unrestricted movement of forces. The breaching tenants and fundamentals apply to the fundamental of "neutralize."
- **Protect:** Engineers and other elements plan and implement survivability and other protection measures that will deny the enemy the ability to inflict damage as joint forces maneuver. This may include countermobility missions to deny the enemy maneuver and provide protection to friendly maneuvering forces.

2-11. Assured mobility provides the broad framework of fundamentals that serve to retain the focus and integrate M/CM/S within the combined arms team. Planners at all levels of the combined arms team rely on this framework to ensure that adequate support is provided to the commander's scheme of maneuver and intent. Within the combined arms team planning staff, it is the assured mobility section at the BCT level (and those same staff members at echelons above the BCT) that provides the input for engineer, CBRN, and similar specialized reconnaissance. The ENCOORD plans for the application of and coordinates the integration of engineer reconnaissance across the engineer functions and spanning the range from tactical to technical capabilities.

STAFF ENGINEER COORDINATION

2-12. Each maneuver force echelon down to brigade level has an organic engineer planner to integrate engineers into the combined arms fight. The task force and company levels may also have an engineer, but the engineer will seldom be organic to these echelons, except in the combined arms battalion of the HBCT. The engineer is a special staff member of the battle staff responsible for understanding the range of engineer capabilities/functions (combat, general, and geospatial engineering) available to the force and for synchronizing those capabilities to best meet the needs of the maneuver commander.

2-13. The ENCOORD is the planner responsible for coordinating engineer reconnaissance operations and is usually the senior engineer officer in the force. The ENCOORD may or may not command an engineer unit supporting the BCT/RCT. In the BCT/RCT, the brigade or regimental engineer is the ENCOORD. However, when an engineer battalion is task-organized in support of the BCT/RCT, the BCT/RCT commander determines if a change will occur in ENCOORD designation. This decision is based upon the type of unit, duration of the attachment, and focus of the mission being performed by the supporting engineer battalion. If the attached engineer battalion commander is designated as the ENCOORD, the BCT/RCT staff engineer becomes the assistant ENCOORD. The assistant represents the ENCOORD during planning and when the ENCOORD is not available. At the maneuver battalion level, the ENCOORD is the senior engineer supporting that battalion. The ENCOORD performs the following key tasks that directly or indirectly support planning for engineer reconnaissance operations:

- Integrates the engineer functions of combat (M/CM/S), general, and geospatial engineering into future brigade plans.
- Develops the necessary input to BCT/RCT orders, annexes, and engineer unit orders (as required).
- Makes time-sensitive engineer decisions on requests for immediate tactical support received from BCT/RCT engineers.
- Trains the brigade engineer cell located at the brigade main command post (CP).
- Formulates ideas for engineer support to meet the BCT/RCT commander's intent.
- Visualizes the future state of engineer operations in the BCT/RCT.
- Recommends the engineer priorities of effort and support, essential tasks for M/CM/S, and acceptable mission risks to the BCT/RCT commander.
- Determines and evaluates critical aspects of the engineer situation.
- Decides what engineer missions must be accomplished to support current and future fights.
- Develops a scheme of engineer operations concurrent with the BCT/RCT maneuver COAs.
- Integrates the necessary orders and instructions into higher headquarters plans and orders.
- Issues timely instructions and orders to subordinate engineer units through the BCT/RCT base order to simplify preparation and integration.
- Monitors the execution of engineer orders and instructions by tracking the current fight.
- Alters the engineer plan using the feedback received from maneuver battalions, the engineer company, and any augmenting engineer units as required.
- Identifies any BCT/RCT requirements for echelons above brigade engineer and other M/CM/S assets to support the brigade.
- Makes the BCT/RCT commander aware of the capabilities, limitations, and employment considerations of supporting engineers and other M/CM/S assets.
- Recommends the engineer organization for combat.
- Plans and coordinates with the FSCOORD on integrating obstacles and fires.
- Advise the commander on using organic and nonorganic engineer assets.
- Advises the commander on employing and reducing obstacles.
- Provides a terrain visualization mission folder to determine the terrain effect on friendly and enemy operations (see TC 5-230).
- Produces maps and terrain products and coordinates with the terrain section for planning and distribution.
- Assists the intelligence staff officer (S-2) with the IPB—including information from the preparation of the engineer estimate.
- Participates in the targeting process.
- Provides information on the status of engineer assets on hand.

- Tracks all templated and known obstacles, scatterable mines (SCATMINEs), the survivability status, the route status, engineer missions, and any other engineer-specific information.
- Recommends MSRs and logistics areas to the logistics staff officer (S-4) based on technical information.
- Recommends IR to the S-2 through the operations staff officer (S-3).
- Coordinates with BCT/RCT S-4 or maneuver battalion S-4 for additional resources to support the mobility effort (Class III, Class IV).
- Advises the commander on environmental issues, coordinates with other staff members to determine the impact of operations on the environment, and helps the commander integrate environmental considerations into decision making.
- Recommends when engineer diver support may facilitate specific engineer reconnaissance in support of the BCT/RCT.
- Coordinates with MI and MP resources to identify elements of the threat that are pertinent to survivability and ensures that BCT/RCT personnel incorporate this threat into engineering survivability support activities.

2-14. The ENCOORD plans for the application and coordination of engineer reconnaissance and its integration. In this role, the ENCOORD is a critical link in the commander’s IM processes that provide the translation from the gaps identified by the commander in CCIR to the technical information focus of engineer reconnaissance. The ENCOORD and other members of the staff also ensure that geospatial support is provided and integrated in the combined arms team.

GEOSPATIAL INTEGRATION

2-15. Geospatial support includes the standards, processes, Soldiers and Marines, and equipment required to generate, manage, analyze, and disseminate the geospatial information necessary to assemble the best view of the operational environment for the command. Geospatial engineers manage the enterprise geospatial database—compiled from all sources including National Geospatial-Intelligence Agency, Topographic Engineering Center (TEC), other Services, coalition allies, as well as exploiting new collection and production from deployed Soldiers and Marines and sensors. Geospatial engineers manage the geospatial foundation of the COP, synchronizing hard and soft copy products that are a necessary component of all source intelligence and battle command.

2-16. Terrain analysis is a key product of geospatial support. It is the study of the terrain’s properties and how they change over time, with use, and under varying weather conditions. Terrain analysis starts with the collection, verification, processing, revision, and construction of source data. It requires the analysis of climatology (current and forecasted weather conditions), soil conditions, and enemy or friendly vehicle performance metrics. Terrain analysis and geospatial information and services (GI&S) is necessary to support the warfighter’s mission planning and operational requirements and requires the management of an enterprise geospatial database at every echelon from combatant command to deployed BCT/RCT. Terrain analysis is a technical process and requires the expertise of terrain-analysis technicians and terrain data specialist.

2-17. Geospatial engineering is provided to the Army and other Services based on echelon. It is focused on data generation, data management, and quality control at the numbered Army and combatant command level. At the corps and division levels, the majority of the workload is required to support database management, mission planning, and the IPB process. Below division level, geospatial engineering is increasingly focused on current operations and updating the geospatial database (database management).

2-18. A topographic company is assigned to provide direct and general support to an active theater of operations. Topographic companies are the only unit with dedicated geospatial data generation capability within the Army force structure. The topographic company requires access to the Global Information Grid (GIG) and classified tactical local area network (LAN) SECRET Internet Protocol Router Network (SIPRNET) to update and disseminate geospatial information and products. Topographic companies are composed of collection management platoons, analysis platoons, finish print platoons, and a headquarters platoon. Two collection management platoons generate geospatial data from a variety of sources. Currently these platoons are designed to derive high-resolution elevation and feature data from existing and emerging sensors. Two analysis platoons provide direct support to separate numbered armies, coalition allies (that lack geospatial support), joint task force (JTF) commands, and deployed divisions. Two print finish platoons provide hard copy geospatial products to units in theater.

2-19. The geospatial engineer team organic to the corps/division collects and provides updated geospatial data and products to support corps/division operations. The team performs analysis and acquires, manages, and disseminates geospatial data and products to support corps/division planning and execution, maintains the corps/division common topographic operating picture (CTOP) on the corps'/division's server, and provides updates to the corps's/division's portion of the Theater Geospatial Database (TGD). The corps/division team provides direct support to the component intelligence staff (G-2) and operations staff (G-3) planners and provides general support to the staff and subordinate units. The geospatial engineer team requires access to the classified tactical LAN (SIPRNET) to update and disseminate geospatial information and products.

2-20. The geospatial engineer team organic to the brigade headquarters performs analysis, management, and dissemination of geospatial data and products to support brigade planning and execution and maintains the brigade's CTOP on the brigade's server and provides updates to the brigade's portion of the TGD. The team provides direct support to the S-2/S-3 with general support to the staff and subordinate units. The brigade level team is too small to provide continuous direct support to the S-2 but will form ad hoc geospatial intelligence (GEOINT) cells as necessary to support operations. The geospatial engineer team requires access to the classified tactical LAN (SIPRNET) to update and disseminate geospatial information and products.

PLANNING PROCESSES

2-21. The MDMP (and associated troop-leading procedures [TLPs]) is the doctrinal planning model that establishes procedures for analyzing a mission; developing, analyzing, and comparing COAs against criteria of success and each other; selecting the optimum COA; and producing a plan or order (see figure 2-3 on page 2-8). (Detailed references to the MDMP and the TLP are found in FM 5-0.)

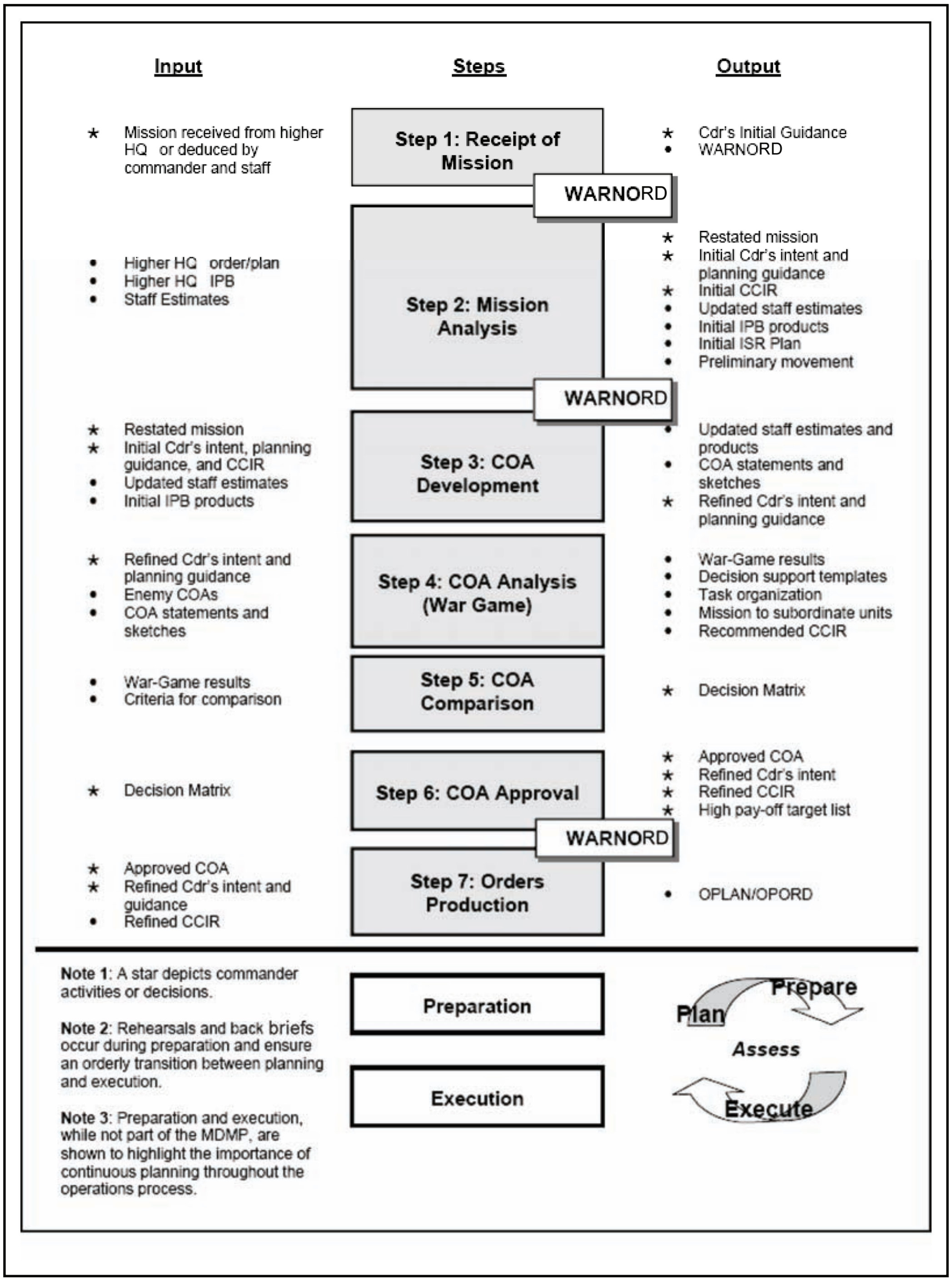


Figure 2-3. The military decision-making process

2-22. Commanders and staffs also use the rapid decision-making and synchronization process (RDSP) described in FMI 5-0.1 to make decisions and rapidly resynchronize forces and warfighting functions when presented opportunities or threats during execution. The RDSP includes five steps. Leaders perform them as shown in FMI 5-0.1. The first two steps may be performed in any order, including concurrently. The last three steps are performed interactively until an acceptable COA is found (see figure 2-4).

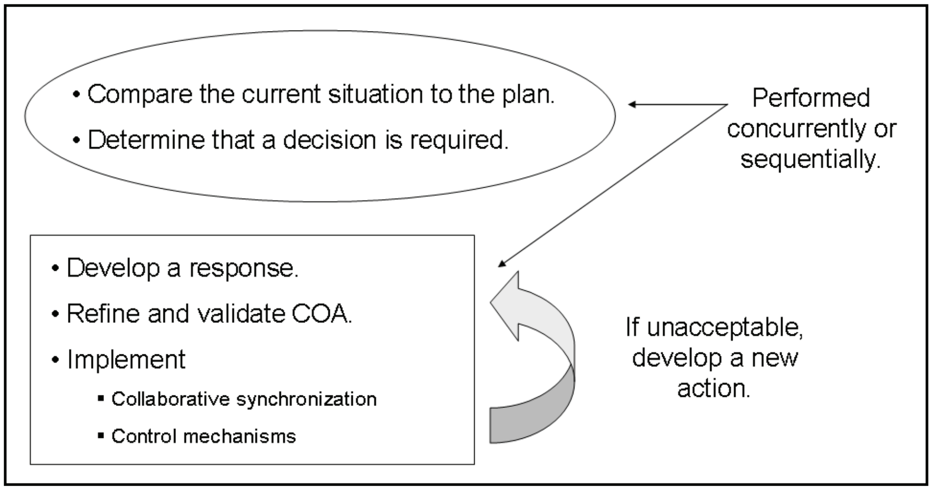


Figure 2-4. Rapid decision-making and synchronization process

2-23. As is the case with other reconnaissance capabilities, commanders must balance the application of engineer reconnaissance against the corresponding trade-off in primary capability. In the case of engineers, engineer units tasked to conduct a specified reconnaissance task may not be available for employment on other M/CM/S tasks.

2-24. Increased engineer requirements in the contemporary OE may limit engineer resources immediately available to support mobility operations. Combat engineering (M/CM/S) and general engineering requirements often compete for the same engineer assets. Combat engineering requirements are assessed and categorized as mobility, countermobility, or survivability. The maneuver commander sets the priorities to allow the force to perform the most critical tasks. The ENCOORD and other staff members assist the maneuver commander in his decision by identifying essential tasks for M/CM/S.

2-25. An essential task for M/CM/S is a specified or implied M/CM/S task that is critical to mission success. Essential tasks for M/CM/S support assured mobility in a similar fashion to how essential tasks for fire support targeting. Although ultimately executed by a combined arms element, the staff (typically elements such as engineer, CBRN, MP, or EOD) identifies and recommends the essential tasks for M/CM/S to the commander. A fully developed essential task for M/CM/S includes the task and purpose.

- Task. A task is one or more clearly defined and measurable activities accomplished by individuals and organizations required to achieve the desired effects (FM 7-0). These are the most important M/CM/S tasks which must be accomplished. Often the entire operation is dependant on completing these tasks, and without their successful completion, the operation is at risk.
- Purpose. The desired or intended result of the task stated in terms relating to the purpose of the supported unit. This portion of the essential task for M/CM/S explains why it must be accomplished. It also provides intent to the engineer commander so he can be reactive as the situation changes.

2-26. The maneuver commander uses essential tasks for M/CM/S to communicate to subordinate maneuver units what he wants accomplished with specific assets supporting M/CM/S. This provides the maneuver unit with clear priorities and unity of purpose in planning, preparation, and execution. Essential tasks for M/CM/S also provide CBRN, MP, psychological operations (PSYOPS)/civil affairs (CA), and other nonengineer elements clearly articulated tasks related to M/CM/S. Example engineer reconnaissance related essential tasks for M/CM/S might include the following:

Essential Task for M/CM/S, Example #1	
Task:	Conduct engineer reconnaissance of MSR Tigers from CP 1 to CP 2.
Purpose:	Classify route, identify impediments to maneuver, and facilitate planning of route clearance operations.

Essential Task for M/CM/S, Example #2	
Task:	Conduct engineer reconnaissance of Crossing Area WHITE.
Purpose:	Collect and confirm crossing site data and locate key BCT river crossing locations.

Essential Task for M/CM/S, Example #3	
Task:	Conduct an infrastructure reconnaissance of the power station at grid ST231546.
Purpose:	Assess the status of the power station to enhance the SU of critical infrastructure throughout the area of operation.

Essential Task for M/CM/S, Example #4	
Task:	Conduct engineer reconnaissance of buildings at grid ST234544.
Purpose:	Determine if buildings are adequate to house BCT headquarters from protection standpoint.

2-27. The development of essential tasks for M/CM/S development begins during the mission analysis phase of the MDMP. During this phase, planners identify specified and implied tasks and associated purpose. From these tasks, combined with the maneuver commander's guidance, the ENCOORD and other staff representatives recommend essential tasks for M/CM/S to maneuver commanders during the mission analysis brief. At the conclusion of the mission analysis brief, the commander approves those essential tasks for M/CM/S that he considers relevant.

2-28. After essential tasks for M/CM/S are approved, the ENCOORD and other planners integrate them into COA development. The ENCOORD and other planners identify the essential tasks for M/CM/S required to achieve the desired effects and achieve the designated purpose. These planners develop associated methods to complete the essential tasks for M/CM/S by assigning resources and recommending priorities. The ENCOORD and other planners, in coordination with the maneuver planner, then synchronize the methods to achieve the desired effects on enemy or friendly forces.

2-29. The engineer estimate is a logical thought process and extension of the MDMP. It is conducted by the ENCOORD, concurrently with the planning process of the supported maneuver force, and is continually refined. This estimate allows for early integration and synchronization of essential tasks for M/CM/S into combined arms planning processes (MDMP or RDSP). It drives the coordination between the engineer, the supported commander, and other staff officers in developing engineer plans, orders, and the supporting annexes. Additionally, allocating engineer assets and resources assists in determining command and support relationships that will be used. Table 2-1 on page 2-12, illustrates the relationship between the MDMP and the engineer estimate, including identification of essential tasks for M/CM/S.

Table 2-1. The military decision-making process and the engineer estimate

Military Decision-making Process Mission Analysis	***Engineer Staff Running Estimate***
Analyze higher headquarters order. Conduct IPB. Determine specified, implied, and essential tasks. Review available assets. Determine constraints. Identify critical facts and assumptions. Conduct risk assessment. Determine CCIR. Develop ISR plan. Plan use of available time. Write restated mission. Conduct mission-analysis briefing. Approve restated mission. Develop commander's intent. Issue commander's guidance. Issue warning order (WARNORD). Review facts and assumptions.	Analyze the higher headquarters orders. Commander's intent Mission Concept of operation Timeline AO Conduct IPB/develop engineer staff running estimate. Terrain and weather analysis Enemy mission and M/CM/S capabilities Friendly mission and M/CM/S capabilities Analyze the engineer mission. Specified M/CM/S tasks Implied M/CM/S tasks Assets available Limitations Risk as applied to engineer capabilities Time analysis Identify essential tasks for M/CM/S Restated mission Conduct risk assessment. Safety Environment Determine CCIR (terrain and mobility restraints, obstacle intelligence, threat engineer capabilities). Integrate reconnaissance effort.
COA Development	Develop scheme of engineer operations. Analyze relative combat power. Refine essential tasks for M/CM/S. Identify engineer missions and allocation of forces/assets Determine engineer priority of effort/support Refine commander's intent for M/CM/S operations Apply engineer employment considerations. Integrate engineer operations into the maneuver COA.
COA Analysis	Wargame and refine the engineer plan.
COA Comparison	Recommend a COA.
COA Approval	Finalize the engineer plan.
Order Production	Input to basic operation order (OPORD). Scheme of engineer operations essential tasks for M/CM/S Subunit instructions Coordinating instructions Engineer annex/appendixes

SPECIFIC COMMAND AND CONTROL CONSIDERATIONS

2-30. Engineers are task-organized in a variety of ways, depending on the mission and current requirements. This task organization drives an engineer reconnaissance team's command or support relationship. When attached, a reconnaissance team is temporarily placed in the unit it supports. The commander of the supported unit exercises the same degree of C2 as he does over his organic units. In this relationship, the reconnaissance team receives all of its missions and support from the supported unit, not its organic engineer unit. Additionally, the supported unit commander may task organize the reconnaissance team as he feels is appropriate.

- In an operational control (OPCON) relationship, a reconnaissance team receives all of its tasking and missions from the supported unit. The supported unit commander retains the same authority over the reconnaissance team as over his organic units and may task organize the reconnaissance team as he feels is appropriate. Logistical support comes from the parent engineer unit unless the engineer battalion has coordinated with the supported unit for certain classes of supply.
- In a direct support (DS) relationship, a reconnaissance team answers directly to the supported unit's requests for support. Logistical support is provided by the parent engineer unit, and the reconnaissance team is commanded by its parent engineer unit commander.
- In a general support (GS) relationship, a reconnaissance team receives missions and all support from its parent engineer unit.

2-31. An engineer reconnaissance team can be employed using several methods. Each method has advantages and disadvantages.

- Integrated as part of the brigade intelligence-collection effort. In this method, an ERT is integrated into a brigade's collection effort. This effort normally includes other assets and receives the same types of support and sustainment as the rest of the brigade's reconnaissance assets. It is imperative that the engineer unit providing the ERT understands all aspects of the plan to employ the ERT. As a minimum, the ERT leader should attend the brigade's ISR rehearsal. The providing unit continues to track the ERT through the operation. Resources (including maintenance and personnel status), verification of the team's position, and activation of no-fire areas) must be closely monitored. The efficient dissemination of the intelligence collected by the team is also a critical task of the providing unit staff.
- Assigned brigade NAIs in a TF's AO. Under this method, an ERT receives its reconnaissance objectives from brigade through an engineer unit supporting a maneuver battalion/TF. The ERT leader should link up with the appropriate TF scout platoon leader upon receiving the mission from the providing engineer unit. The engineer unit must ensure that the necessary instructions to the appropriate TFs are included in the brigade's OPORD, especially if the TFs are expected to provide logistical support to the ERT (including casualty evacuation and vehicle recovery support). The team leader should be present at the scout platoon leader's OPORD and rehearsals to ensure understanding of the scout platoon's plan. To reduce the risk of fratricide, the ERT leader must provide his plan to the scout platoon leader. The ERT should report all checkpoints/locations on the same net that the TF scouts are operating on (for example, the TF operations and intelligence [O/I] net). All intelligence reports should be sent to both the TF and the engineer unit. The unit should then pass the information to the brigade and its subordinate elements. This employment concept should be used anytime the ERT works close to the TF scouts.
- Working under a TF's control. In this method, ERTs are placed under the TF's control to look at NAIs that the brigade has tasked to the TF or expects the TF to develop requiring engineer expertise (possibly a TF breaching operation). This method involves the least amount of coordination and planning for the providing engineer unit. However, the responsibility to plan and monitor the ERT's activities now falls to the TF engineer. Although the TF decides how to use the ERT, the TF engineer must be involved in the planning details to ensure that the team is properly used, is integrated into a sound ISR plan, and receives all necessary support.

2-32. The BCT/RCT distributes its reconnaissance assets throughout its AO. To prevent fratricide and to synchronize the collection effort and logistic support, the BCT/RCT must organize the AO. When assigning boundaries and task organizing subordinate units, the terrain team or BCT/RCT engineer should be included in the decision process. This will help to ensure the boundaries and task organization in conjunction with the terrain complement rather than hinder the reconnaissance effort. The reconnaissance squadron operates in one of two battlefield organizations with respect to terrain and command relationships. First, it can operate independently inside of its own AO. Second, it can operate independently inside one or more of the battalion AOs. Each technique has advantages and disadvantages for C2 and fratricide reduction and specific planning and coordination requirements that are part of the ISR order.

2-33. In most cases, ISR assets will be attached to a subordinate command to ensure integration and C2. However, the brigade may keep some assets under brigade control and assign them their own AO or have them operated independently in someone else's. The brigade special troops battalion (BSTB) is responsible for command oversight of these independent operators (in the HBCT and the IBCT), while the asset has the requirement to ensure coordination with the terrain manager of the land the BSTB is operating on. Examples of ISR assets operating independent of subordinate units include—

- BCT/RCT retransmission section supporting the reconnaissance squadron but located in a maneuver battalion sector.
- Unmanned aircraft system (UAS) launch and recovery site.

Chapter 3

Engineer Support to Intelligence, Surveillance, and Reconnaissance Operations

No matter how enmeshed a commander becomes in the elaboration of his own thoughts, it is sometimes necessary to take the enemy into account.

Sir Winston Churchill

Commanders make decisions and direct actions based on their SU. They keep their SU current by continuously assessing the situation and stating the information they need in CCIR. Throughout a continuous operations process, the commander's directions take different forms during planning, preparation, and execution. Chapter 2 discussed integrating engineer reconnaissance capabilities in the commander's planning processes. During preparation, commanders take every opportunity to improve their SU about the enemy and environment. Commanders integrate reconnaissance missions and surveillance means to form an integrated ISR plan that capitalizes on their different capabilities. Engineer reconnaissance can be an important part of this activity, providing data that contribute to answering the CCIR. Commanders normally initiate reconnaissance operations before completing the overall plan. Again, engineer reconnaissance operations, integrated with the commander's ISR plan, can gather important information which impacts the final plan. This chapter discusses considerations for employing engineer reconnaissance within ISR operations. Reconnaissance is not a static, one-time effort that achieves a goal and stops. To sustain the engineer reconnaissance capability, consideration must be made for its support. This chapter includes a discussion of sustainment considerations for engineer reconnaissance.

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE PLANNING

3-1. BCTs/RCTs conduct ISR operations producing intelligence on the enemy, environment (to include weather and terrain), and civil considerations necessary to support the commander in developing SU and making decisions. ISR operations are a commander's function supported by the entire staff and subordinate units. ISR operations are multifaceted and develop, synchronize, and integrate intelligence from a multitude of collection sources to eliminate functional "stovepipes" for planning, reporting, and processing information and producing intelligence. ISR operations must be nested from division to battalion level to ensure integration of all available assets towards a single purpose that results in increased security and flexibility to gain and maintain the initiative at the tactical level—the focus of the BCT/RCT and its subordinate elements.

3-2. ISR operations are a continuing activity that allows units to produce a continuous feed of relevant intelligence on the enemy, environment, and civil considerations required for the commander to make critical decisions. This information answers requirements developed throughout the operations process. Timely and accurate intelligence developed by aggressive and continuous ISR encourages audacity and can facilitate actions that negate enemy symmetric or asymmetric strengths.

STAFF SUPPORT OF THE INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE PROCESS

3-3. The BCT/RCT commander and the executive officer (XO) must ensure an integrated staff process to conduct planning and disseminate ISR orders. In the past, while the S-3 was doctrinally responsible, developing the ISR plan habitually fell on the brigade S-2 since the S-2 normally coordinated ISR assets and was the primary user of ISR products. Given the complex nature of the OE, combined with the significantly enhanced ISR capabilities of the BCT/RCT, it is imperative that the S-3, S-2, the FSCOORD, the ENCOORD, and other required staff work together to develop the ISR plan. The engineer is especially critical in ensuring that the reconnaissance effort will facilitate and enable the mobility of the BCT/RCT. Further, the significance of ISR operations on unit success dictates involvement by the entire staff, not just the ISR section. This allows the S-2 to focus on fusing information from national through tactical intelligence sensors, better enabling the S-2 to provide the commander with timely and accurate intelligence assessments. The commander uses the fused intelligence provided by ISR to make decisions that allow him to place combat effects on the enemy to impede, harass, or attrite the enemy and then to employ maneuver forces to destroy it. The BCT/RCT XO integrates the staff actions of the S-2 and S-3, as well as the rest of the staff and reconnaissance squadron commander to identify collection requirements and implement the ISR plan.

3-4. With staff participation, the BCT/RCT S-2 supports the ISR effort by focusing the collection, processing, analysis, and intelligence products on the critical needs of the commander. The BCT/RCT S-3, in coordination with the S-2, tasks and directs the available ISR assets to answer the CCIRs. The required information is obtained through various detection methods and systematic observation, reconnaissance, and surveillance. A continuous process, this task has four subtasks: perform intelligence synchronization, perform ISR integration, conduct surveillance, and conduct reconnaissance.

INTELLIGENCE SYNCHRONIZATION

3-5. The S-2, with staff participation, synchronizes the entire collection effort to include all assets the commander controls, assets of lateral units and higher echelon units and organizations, and intelligence reach to answer the commander's PIRs and IRs. Intelligence synchronization activities include the following:

- Conducting requirements management: anticipate, develop, analyze, validate, and prioritize intelligence requirements. Recommend PIRs to the commander. Manage the commander's intelligence requirements, requests for information (RFIs) from subordinate and lateral organizations, and tasks from higher headquarters. Eliminate satisfied requirements and add new requirements as necessary.
- Developing indicators for each enemy COA.
- Developing specific information requirements (SIRs) that will answer the PIR and IR.
- Converting the SIRs into ISR tasks or RFIs that tailor the reporting criteria to the collection capabilities of tasked assets (See figure 3-1 for the ISR task development process). The S-2 assigns intelligence production and reach tasks to subordinate intelligence elements or personnel, submits RFIs to higher and lateral echelons, and coordinates with (or assists) the S-3 to develop and assign ISR tasks.
- Comparing the ISR tasks to the capabilities and limitations of the available ISR assets (in coordination with the S-3).
- Forwarding SIRs that cannot be answered by available assets to higher or lateral organizations as RFIs.
- Assessing collection asset reporting and intelligence production to evaluate the effectiveness of the ISR effort.
- Maintaining SU to identify gaps in coverage and to identify the need to cue or redirect ISR assets.
- Updating the intelligence synchronization plan. The S-2 manages and updates the intelligence synchronization plan as PIRs are answered and new requirements arise.

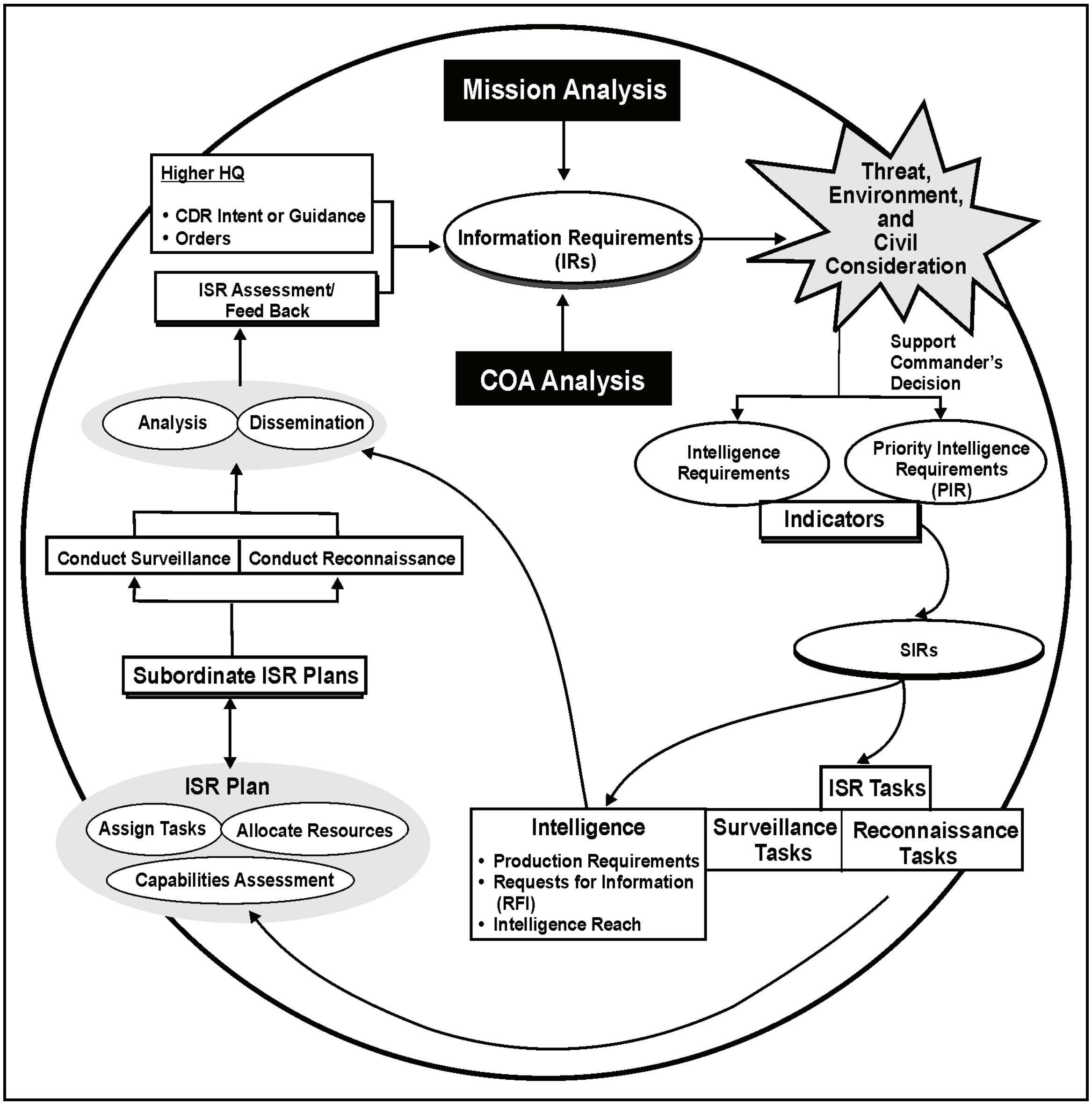


Figure 3-1. ISR task development process

Intelligence Synchronization Considerations

3-6. The S-2 generally follows six considerations in planning intelligence synchronization and ISR activities: anticipate, integrate, prioritize, balance, control, and reach. (Refer to FM 34-2 for more information regarding intelligence synchronization).

- Anticipate. The intelligence staff must recognize when and where to shift collection or identify new intelligence requirements. The overall intent of this principle is to identify a new, or adjust an existing requirement, and present it to the commander for approval before waiting for the commander or staff to identify it.

- Integrate. The intelligence staff must be fully integrated into the unit's orders production and planning activities to ensure early identification of intelligence requirements. Early and continuous consideration of collection factors enhances the unit's ability to direct collection assets in a timely manner, ensures thorough planning, and increases flexibility in selecting assets.
- Prioritize. Prioritize each intelligence requirement based on its importance in supporting the commander's intent and decisions. Prioritization, based on the commander's guidance and the current situation, ensures that limited ISR assets and resources are directed against the most critical requirements.
- Balance. ISR capabilities complement each other. The intelligence staff should resist favoring or becoming too reliant on a particular unit, discipline, or system. Balance is simply planning redundancy when required, eliminating redundancy when not desired, and ensuring an appropriate mix of ISR assets or types. The intelligence synchronization matrix (ISM) is useful in determining or evaluating balance.
- Control. To ensure timely and effective responses to intelligence requirements, a unit should first use the ISR assets it controls. These assets usually are more responsive to their respective commander and serve to lessen the burden on the ISR assets of other units, agencies, and organizations.
- Reach. Intelligence reach may be the only way to satisfy an intelligence requirement. If possible, one should not depend solely on intelligence to answer a PIR.

3-7. An effective discussion of ISR has to include an understanding of the CCIRs. The CCIRs are elements of information required by commanders that may affect decision making and dictate the successful execution of missions. The commander decides what information is critical based on experience, the mission, the higher commander's intent, the staff's input, initial IPB, information, intelligence, and recommendations. (Refer to FM 3-0 for more information regarding CCIRs.)

3-8. Based on the CCIRs, two types of supporting IRs are generated: PIRs and FFIRs. However, commanders may determine that they need to know whether one or more EEFI have been compromised or that the enemy is collecting against a designated EEFI. In those cases, commanders may designate that question as one of their CCIRs.

3-9. IRs are all of the information elements required by the commander and staff to successfully plan and execute operations; that is, all elements necessary to address the METT-T[C] factors. Vetting by the commander or his designated representative turns an IR into either a PIR or an intelligence requirement. IRs are developed during COA analysis based on METT-T[C] factors.

3-10. PIRs are those intelligence requirements for which a commander has an anticipated and stated priority in his task of planning and decision-making. PIRs are associated with a decision based on action or inaction or the OE that will affect the overall success of the commander's mission. The commander designates intelligence requirements as CCIR (PIR and FFIR). Answers to the PIRs help produce intelligence essential to the commander's SU and decision making.

3-11. The S-2 recommends to the commander those IRs produced during the MDMP that meet the criteria for PIR. They do not become CCIR until approved by the commander. Additionally, the commander may unilaterally designate PIRs. The IRs that are not designated by the commander as PIRs remain intelligence requirements. The intelligence requirement is a gap in the command's knowledge or understanding of the OE or threat that the intelligence Army warfighting function must fill.

3-12. The S-3 then tasks the unit's assets to answer both the PIR and intelligence requirements through the ISR plan. PIR should—

- Ask only one question.
- Support a decision.
- Identify a specific fact, event, activity (or absence thereof) that can be collected.
- If linked to an enemy course of action (ECOA), indicate an ECOA prior to, or as early as possible in, its implementation.
- Indicate the latest time the information is of value (LTIOV). The LTIOV is the absolute latest time the information can be used by the commander in making the decision the PIR supports. The LTIOV can be linked to time, an event, or a point in the battle or operation to friendly force IRs. The staff also develops FFIRs which, when answered, provide friendly force information that the commander and staff need to achieve SU and to make decisions.

Friendly Force Intelligence Requirements

3-13. The staff also develops FFIRs which, when answered, provide friendly force information that the commander and staff need to achieve SU and to make decisions.

Essential Elements of Friendly Information

3-14. EEFI establish information to protect—not information to obtain. Thus, EEFI are established to inform or direct BCT/RCT unit and element efforts to deny enemy efforts to collect against specific BCT/RCT actions, units, intentions, or capabilities. In some cases, EEFI may form the underlying basis for tasks to subordinate units, particularly during security operations. Further, commanders may determine that they need to know whether one or more EEFI have been compromised or that the enemy is collecting against a designated EEFI. In those cases, commanders may designate that question as one of their CCIRs, using the ISM which generates PIRs and/or FFIRs. For example, a commander may determine that if the enemy discovers the location and movement of the friendly reserve, the operation is at risk. In this case, the location and movement of the friendly reserve are EEFI. The commander designates determining whether the enemy has discovered the location and movement of the friendly reserve as one of his CCIR. That CCIR, in turn, generates PIR and FFIR to support staff actions in determining whether the EEFI have been compromised.

Development of the Intelligence Synchronization Plan

3-15. The entire unit staff develops its IRs and determines how best to satisfy them. The staff uses reconnaissance and surveillance assets to collect information. The ISR synchronization plan includes all assets that the operations officer can task or request and coordination mechanisms to ensure adequate coverage of the areas of interest.

3-16. The ISR synchronization plan, often presented in a matrix format, aids in synchronizing the entire ISR effort with the overall operation and the commander's decisions and/or decision points (DPs). The intelligence synchronization plan is often produced in conjunction with the ISR plan. However, before performing intelligence synchronization and finalizing the intelligence synchronization plan, the S-2 must have the following:

- The CCIR (PIR and FFIR).
- A prioritized list of the remaining intelligence requirements.
- Evaluated ISR assets and resources.
- All of the assigned ISR tasks.

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE INTEGRATION

3-17. As depicted in figure 3-2 on page 3-6, ISR integration is a continuing process. Engineer planners must be integrated throughout the cycle.

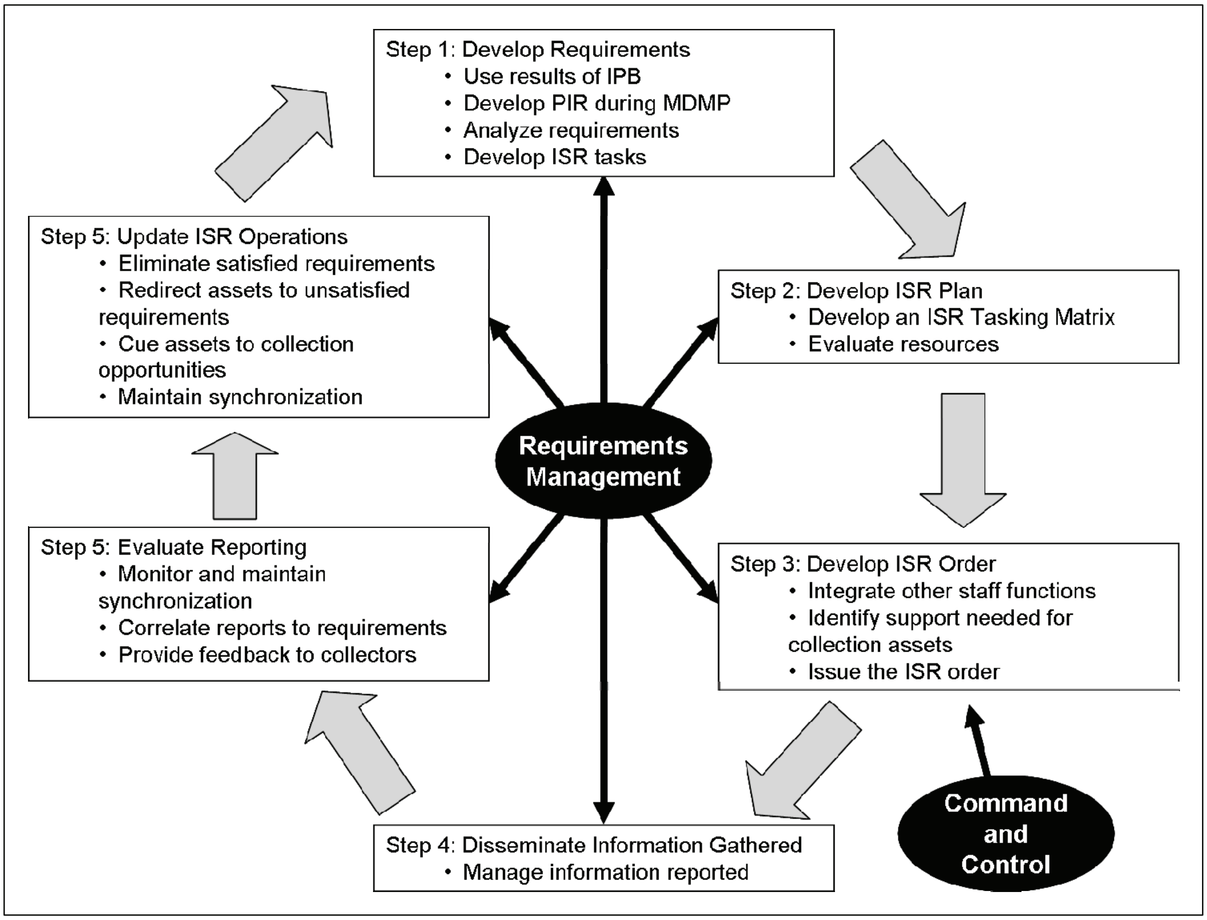


Figure 3-2. ISR integration

3-18. The S-3, in coordination with the S-2 and other staff members, orchestrates the tasking and directing of all available ISR assets to answer the PIRs, FFIRs, and IRs by matching requirements with specific collection assets using the following factors:

- Availability. Determine what assets are organic and readily available. When will attachments arrive? What systems are not fully mission capable and when will they be repaired? What are the maintenance and crew rest requirements? What systems are available in higher, adjacent, and subordinate units? How long will it take the asset to get into position?
- Capability. Can the asset answer the questions asked? Does it have sufficient range? Can it operate in the expected climate and visibility conditions? Will you need to maintain contact with the target when it is identified?
- Vulnerability. What is the threat’s ability to locate, identify, and destroy the collector both at the target area and on the route to and from the mission? Is the risk of loss greater than the potential gain of information? Will the asset be needed for other subsequent operations?
- Performance History. How reliable is the specific asset based on training, leadership, and past experience. Who are the “work horses” that can get the job done?

Formation of the Intelligence, Surveillance, and Reconnaissance Plan

3-19. The result of this process forms the ISR plan. The ISR plan provides a list of all the ISR tasks to be accomplished, both internal and external to the BCT/RCT. The S-2 and the S-3 develop tasks, orders, and requests from the SIRs. These tasks, orders, and requests are then assigned based on the capabilities and limitations of the available ISR assets and the LTIOV taking into account the concepts of—

- Cuing. Cuing involves the use of one or more sensor systems to provide data that directs collection by other systems. For example, sweeping the AO electronically with a wide area surveillance system may reveal activity that in turn triggers direct collection by a more accurate, pinpoint sensor system such as an UAS or scout team.
- Redundancy. Redundancy involves the application of several identical assets to cover the same target. Use redundant tasking against high-payoff targets when the probability of success by any one system is low (for example, several scout teams infiltrating over different routes when the risk of detection is high but no other systems are capable of collecting the required information).
- Mix. Mix refers to planning for complementary coverage by a combination of assets from multiple disciplines. Sensor mix increases the probability of collection, reduces the risk of successful enemy deception, facilitates cueing, and provides more complete reporting. For example, thermal imagery from a UAS may indicate several vehicle-like hot spots in a suspected enemy battle position (BP). A scout team observing the same NAI may reveal that half of those hot spots are actually decoys and not enemy armored vehicles.
- Integration. Integration is the resource management aspect of collection strategy development. Barring a decision to use redundant coverage of a critical target, attempt to integrate new requirements into planned or ongoing missions. Integration helps avoid the common problem of under tasking very capable collectors. During limited periods of time, collection capability may exceed that of the tasking. Brigades can resolve this by reevaluating each collection asset for excess capability, focusing excess collection capability on the most important of the remaining unfulfilled requirements, and finally redirecting assets to maximize support to the most important requirements—new or old.

Finalized Intelligence, Surveillance, and Reconnaissance ISR Plan

3-20. The finalized ISR plan is produced as an ISR order in the ISR annex to a BCT/RCT OPORD. (Refer to FM 5-0 for specific information on the ISR annex). However, an initial ISR order is usually prepared at the conclusion of mission analysis during the planning process and issued prior to the completed BCT/RCT operations order to start reconnaissance and surveillance operations required to achieve the intended ISR effect.

Execution of and Updating the Intelligence, Surveillance, and Reconnaissance Plan

3-21. The S-3 updates the ISR plan based on information received from the S-2. The S-3 is the integrator and manager of the ISR effort through an integrated staff process and procedures. As PIRs are answered and new IR arise, the S-2 updates intelligence synchronization requirements and provides the new input to the S-3 who updates the ISR plan. The S-2 works closely with all staff elements to ensure the unit's organic collectors receive appropriate tasking. The ISR plan reflects an integrated collection strategy and employment, production, and dissemination scheme that will effectively answer the commander's PIR.

RECONNAISSANCE OPERATIONS

3-22. Engineer reconnaissance occurs within the context of the maneuver commander's reconnaissance operations. Combat engineers may be assigned a tactical reconnaissance mission. For example, a sapper company augmenting the BCT/RCT may be tasked to conduct an area reconnaissance as part of the BCT/RCT reconnaissance operation. More likely, the engineer reconnaissance team will be tasked to conduct technical reconnaissance tasks in support of a broader tactical reconnaissance mission. In this case, for example, the sapper company is tasked with providing a team to conduct a crossing site reconnaissance as part of a supported element's area reconnaissance mission. In both situations, the engineer reconnaissance is one component of a broader combined arms reconnaissance operation. To ensure that the engineer component fits effectively within the combined arms operation, it is critical for the engineer reconnaissance planners and team leaders to understand the language of the maneuver commander's tactical reconnaissance operation. Similarly, the staff planners and team leader must describe their engineer reconnaissance capabilities and support requirements in terms of the tactical operation to ensure integration with the overall reconnaissance operation.

DEFINITIONS

3-23. *Reconnaissance* is defined as a mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy, or to secure data concerning the meteorological, hydrographical, or geographical characteristics and the indigenous population of a particular area (FM 3-0). Reconnaissance is the focused collection effort performed before, during, and after other combat operations to provide combat information and intelligence, which are then used by the BCT/RCT commander and staff to develop, confirm, or modify the commander's plan.

3-24. *Surveillance* is a task defined as the systematic observation of airspace, surface, or subsurface areas by visual, auditory, electronic, photographic, or other means (FM 1-02). Surveillance tasks are inherent in reconnaissance and security missions; they are also conducted during offensive, defensive, and stability operations.

3-25. A *reconnaissance objective* is a terrain feature, geographical area, enemy force, and/or infrastructure about which the commander wants to obtain additional information (FM 3-90). It clarifies the intent of the reconnaissance effort by specifying the most important result that the reconnaissance is to accomplish. When a reconnaissance team does not have enough time to complete all of the tasks associated with a specific form of reconnaissance, it uses the reconnaissance objective to guide it in setting priorities.

3-26. The reconnaissance focus defines the "what" on which the reconnaissance team must concentrate its efforts and assets (threat, society, infrastructure, or terrain). It is linked to answering the BCT/RCT commanders' CCIR, supporting lethal and nonlethal targeting, and filling any additional voids in RI. Reconnaissance focus, combined with one or more reconnaissance objectives, serves to efficiently concentrate the effort of the reconnaissance assets on a chaotic, changing battlefield (FM 3-90).

Note. The reconnaissance tempo defines the pace of the operation and as such specifies the depth of detail that the reconnaissance is required to yield (FM 3-90).

3-27. *Engagement criteria* (lethal and nonlethal) establish minimum thresholds for engagement. They clearly specify which targets the reconnaissance teams are expected to engage and which they will hand off to other assets. Nonlethal contact, for example, identifies engagement criteria for tactical questioning of civilians and/or factional leaders. This criterion allows team leaders to anticipate bypass criteria and to develop a plan to maintain visual contact with bypassed threats (FM 3-90).

METHODS

3-28. Two general reconnaissance methods may be employed by a commander to solve tactical dilemmas and conduct battles and engagements: reconnaissance push and reconnaissance pull. These are not rigidly established prescriptions that are followed in checklist sequence or with by-the-numbers precision; rather, they are descriptive generalizations explaining how and when reconnaissance elements are to be employed (in the MDMP chronology) and what the results of reconnaissance will yield or drive in terms of the MDMP.

3-29. The answers to the following questions help provide a basis for categorizing methods of reconnaissance employment:

- Are reconnaissance elements deployed early in the planning process before the BCT/RCT plan is even known, or later, after the plan is fairly fleshed out?

- Does reconnaissance confirm or deny specifics of an evolving plan or help generalize a plan from the very start?

Reconnaissance Push

3-30. Reconnaissance push emphasizes a detailed plan prior to deployment of reconnaissance assets. Initially, a detailed ISR plan is developed to focus the reconnaissance effort on an evolving maneuver COA—or on several COAs—prior to the deployment of reconnaissance. As reconnaissance is deployed, commanders and staff begin work on one or more plans or COAs with the intent of refining these evolving plans as reconnaissance yields relevant combat information. Results of the reconnaissance effort, which tends to be broader and more extensive over a longer period of time, continue to be fed back to the BCT/RCT. There, commanders and planners, already actively engaged in MDMP, continue to update the evolving plans or COAs. They make refinements until available planning time is exhausted. The plan is then disseminated and rehearsed by subordinates.

3-31. In reconnaissance push, the detailed plan often encompasses several viable, well-digested branches or COAs that will be triggered by DP. These branches are understood by leaders at all levels and are well rehearsed. As the BCT/RCT deploys, the reconnaissance effort shifts to two other purposes:

- Providing DP trigger criteria information to facilitate the commander's decisions to adopt planned branches.
- Finding previously undiscovered enemy strengths and weaknesses on which the BCT/RCT can capitalize with greater success outside of planned branches.

Reconnaissance Pull

3-32. Reconnaissance pull represents any of the various methods of reconnaissance in which the commander deliberately refrains from committing to a specific plan or COA prior to deploying reconnaissance elements. The commander and staff develop an integrated ISR plan designed to yield information on the most tactically advantageous way to maneuver the BCT/RCT. Reconnaissance is focused on collecting information on enemy strengths and weaknesses or information to update the terrain analysis (to include OBSTINTEL) that will be critical in formulating the future plan or COA.

3-33. Upon discovering enemy strengths and weaknesses, reconnaissance essentially "pulls" the BCT/RCT maneuver battalions along the path of least enemy resistance into positions of marked tactical advantage. Success is predicated on all maneuver units fully understanding the commander's intent—the "glue" that holds the BCT/RCT together in a decentralized, rapidly changing situation. Weaknesses are often discovered in the very midst of execution, necessitating an ability to rapidly shift and alter schemes of maneuver to exploit opportunities. These on-the-fly modifications, however, have to be executed according to the commander's intent. Reconnaissance pull knowingly emphasizes opportunity at the expense of a detailed, well-rehearsed plan and unity of effort.

TECHNIQUES

3-34. Reconnaissance can be conducted using four techniques—dismounted, mounted, aerial, and sensor. For the most effective reconnaissance, the commander should consider using a combination of all methods.

3-35. The BCT/RCT employs numerous sensor systems in executing reconnaissance and surveillance. Commanders and staffs need to know the capabilities and limitations of the various systems. They must also understand that these systems are susceptible to countermeasures and that they lack the ability to convey the human dimension of the OE in terms of assessing the threat's morale, taking prisoners, or making crucial on-the-spot decisions or judgment calls. The scout directly observing the target is still the commander's most valuable reconnaissance asset. Therefore, the commander needs to maximize the use of dismounted scout observer teams to accurately assess the threat and the effects of the terrain on both forces. Engineer reconnaissance support is especially valuable to the commander for reporting OBSTINTEL—providing information on gaps and physically confirmed terrain conditions.

3-36. Stealth is a primary consideration in reconnaissance operations. Given the engineer reconnaissance team's lighter organization, stealth is even more essential. The team can expect to operate over extended distances well before the BCT's/RCT's execution of combat operations and must use stealth to gain information without alerting the enemy to the BCT's/RCT's intentions. They may operate independently or as a part of a larger reconnaissance element.

3-37. Without organic direct-fire systems (such as the mobile gun system or tanks), the ERT will seldom employ aggressive reconnaissance techniques. Exceptions to this may include situations in which the establishment of a military presence is desired and those in which the commander has determined that the target meets his engagement criteria and it is necessary to fight for information. If fighting is required, it should be on a limited scale, precisely focused against a target that meets the engagement criteria established by the commander, and under conditions favorable to the ERT. Some ERTs may be mounted in the engineer squad vehicle, but many will not be. In situations where a Soldier and Marine/unit is compromised by a threat, self-defense will always override the need for stealth.

COMMANDER'S RECONNAISSANCE GUIDANCE

3-38. The BCT/RCT commander's reconnaissance guidance is developed early in the MDMP. The commander's reconnaissance guidance covers the following considerations:

- Focus of reconnaissance.
- Tempo of reconnaissance.
  - Stealthy or forceful.
  - Deliberate or rapid.
- Engagement criteria (if any), both lethal and nonlethal.
  - Aggressive.
  - Discreet.

Focus

3-39. Reconnaissance focus defines *where* and *on what* the reconnaissance team needs to concentrate its information-gathering activities and allows the commander to select which critical tasks must be accomplished and with what asset(s). Reconnaissance focus must be linked to the tasks of answering the commanders' CCIR, supporting targeting (lethal and nonlethal), and filling additional voids in IR. The reconnaissance objectives of the team must be focused, at a minimum, on one or more of the following:

- Threat. These may include conventional and known enemy forces, insurgents, paramilitary forces, guerrillas, criminal groups, and even civilian groups and individuals.
- Society (social/human demographics). Gaining an awareness of how the local society affects military operations, as well as the impact of military operations on the society, may be critical to the commander when making operational decisions.
- Infrastructure. Infrastructure covers those systems that support the inhabitants, economy, and government of an area. Destroying, controlling, or protecting vital parts of the infrastructure can isolate the enemy from potential sources of support. Because these systems are inextricably linked, destroying or disrupting any portion of the urban infrastructure can have a cascading effect (either intentional or unintentional) on the other elements of the infrastructure. See chapter 6 for an in-depth discussion of infrastructure reconnaissance.
- Terrain. Terrain-focused reconnaissance identifies voids in terrain-related IR that a map or digital analysis simply cannot satisfy to an acceptable degree. Terrain reconnaissance also includes the effect of weather on the military aspects of the terrain. Typical engineer focus includes OBSTINTEL, route classification, and gap crossing sites.

Tempo

3-40. The tempo of the reconnaissance allows the commander to correlate time requirements for the reconnaissance with such factors as planning time, movement formations, and operational methods (such as dismounted or mounted). The commander establishes the tempo by answering several questions: Given available time, will troops need to conduct stealthy or forceful reconnaissance? Is the reconnaissance mission deliberate or rapid? Figure 3-3 illustrates these terms used to describe reconnaissance tempo:

- Stealthy reconnaissance entails methodical, time-consuming operations that minimize chance enemy contact. It is conducted predominantly dismounted, although mounted reconnaissance may be involved as well.
- Forceful reconnaissance, the opposite of stealthy, involves predominantly mounted operations that are much faster paced and in which reconnaissance units are less concerned about being detected by the enemy.
- Deliberate reconnaissance entails slow, detailed, broad-based operations in which the troop accomplishes several tasks.
- A rapid tempo, the opposite of deliberate, focuses the troops on a few key pieces of information required by the squadron commander.

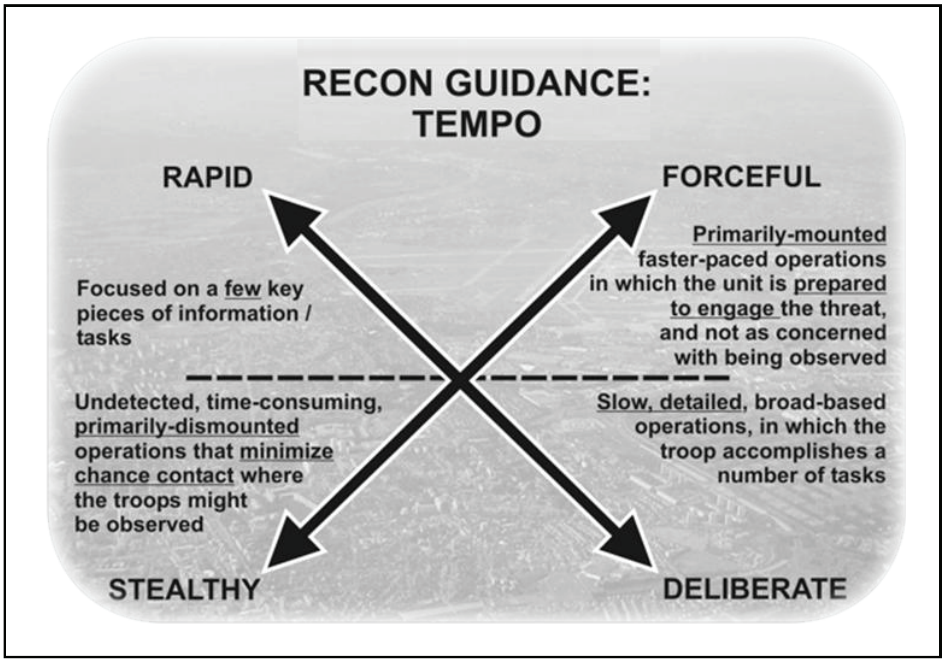


Figure 3-3. Reconnaissance guidance—tempo

3-41. Terminology describing the tempo of reconnaissance is not as important as the requirement that the commander and his subordinates talk the same language when it comes to determining what type of tempo is to be adopted and how that looks in the AO. Although the ERT may not receive specifically worded reconnaissance guidance from the commander, the ERT leader must analyze requirements for tempo based on collaborative huddles with the commander, WARNORDs, and his experience; the ERT leader can then articulate the requirements clearly to his subordinates in terms that have meaning.

Engagement Criteria

3-42. Engagement criteria establish which targets the reconnaissance squadron and its troops are expected to engage with direct or indirect fires and which ones they are expected to handover to the BCT's/RCT's maneuver battalions. In general, engagement criteria will apply only to ERTs directly augmenting reconnaissance elements. Criteria fall into the following categories:

- Aggressive reconnaissance implies liberal engagement criteria (weapons free/tight).
- Discreet reconnaissance is conducted with restrictive engagement criteria (weapons tight/hold).

3-43. Engagement criteria may be articulated in terms of the type and number of threat systems that a reconnaissance unit may be required to engage (or are prohibited from engaging). They may describe situations in which engagement will or will not occur. They may even address what types of friendly weapon systems may be employed or prohibited. Engagement criteria are linked closely with established ROE; however, they define important deviations from the ROE as opposed to being merely a reiteration of them.

3-44. Engagement criteria may also pertain to how the troop handles nonlethal contact, such as tactical questioning of civilians and/or factional leaders. Additionally, they allow troop commanders to anticipate bypass criteria and to develop a plan to maintain visual contact with bypassed or bypassing threat elements.

FORMS

3-45. There are four forms of reconnaissance—zone, area, route, and reconnaissance in force. As noted earlier in this chapter, these forms of reconnaissance will normally be conducted with a multidimensional focus that includes such factors as society and infrastructure as well as the threat and terrain. (Zone, area, and route reconnaissance are discussed further in this section. For information on reconnaissance in force, and additional information on the forms of reconnaissance, see FM 3-90.)

Note. A route reconnaissance is one of the three forms of tactical reconnaissance. It should not be confused with a route classification which can be included as part of the route reconnaissance (see chapter 5) or a road reconnaissance which is a technical component of the route classification.

Zone Reconnaissance

3-46. Zone reconnaissance is the directed effort to obtain detailed information concerning threat, terrain, society, and infrastructure according to the commander's reconnaissance focus within a location delineated by a line of departure (LD), lateral boundaries, and a limit of advance (LOA). A zone reconnaissance is assigned when the threat situation is vague or when information concerning cross-country trafficability is desired. It is appropriate when previous knowledge of the terrain is limited or when combat operations have altered the terrain. The reconnaissance may be threat-oriented, terrain-oriented, society-oriented, infrastructure-oriented, or a combination. Additionally, the commander may focus the reconnaissance effort on a specific force, such as the threat's reserve. A terrain-focused zone reconnaissance must include the identification of obstacles (OBSTINTEL), both existing and reinforcing, as well as areas of CBRN contamination or toxic industrial material (TIM). Focused reconnaissance capabilities (engineer, CBRN, and others) may augment one or more of the primary reconnaissance elements as required and available.

3-47. Zone reconnaissance takes more time to execute than many other reconnaissance missions because the target area is larger and the initial IPB usually generates many unanswered questions. If the time available is not adequate, the reconnaissance leader seeks additional time, reinforcements, or systems to assist in the reconnaissance effort. If necessary, the reconnaissance leader may accelerate the reconnaissance effort—and accept a degree of risk—by reducing the number of critical tasks to be accomplished.

3-48. A zone reconnaissance is organized with subordinate elements operating abreast of one another within a portion of the zone as designated by graphic control measures (see figure 3-4). If the BCT/RCT commander expects significant threat forces to be found within the zone, he considers attaching armored, mechanized, or aviation forces to the reconnaissance element to deal with the anticipated threat. If it is likely that the reconnaissance elements will encounter significant obstacles or other mobility impediments, the commander may provide combat engineer augmentation. If the zone reconnaissance will be outside the supporting range of the BCT/RCT, additional fire support elements may be task organized to move with the reconnaissance element.

3-49. As noted, a zone reconnaissance is controlled using lateral boundaries, an LD, and an LOA. Within the zone, the element conducting the reconnaissance further divides the AO with additional lateral boundaries to define subordinate unit zones. Subordinate zones may differ in size. Phase lines (PLs) and contact points are designated to coordinate the movement of elements operating abreast. Critical terrain features or points of interest are designated as checkpoints. Fire support coordinating measures (FSCMs) are included as needed. A route for the reconnaissance unit to enter the zone must be designated as well. All control measures should be on recognizable terrain when possible. Figure 3-4 illustrates graphic control measures for a zone reconnaissance.

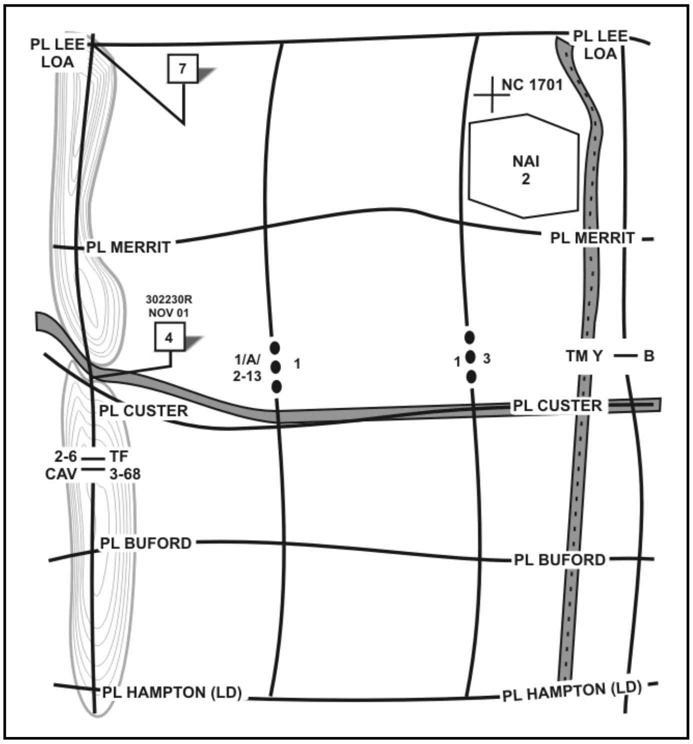


Figure 3-4. Zone reconnaissance graphic coordinating measures

3-50. Zone reconnaissance is a deliberate, time-consuming process; therefore, it must be focused. The reconnaissance force must accomplish certain critical tasks unless the BCT/RCT commander specifically directs otherwise. These tasks serve as a guide to indicate the actions associated with the zone reconnaissance, although they are not a set checklist and are not necessarily arranged sequentially. Not all critical tasks will be appropriate in all situations. The tasks to be accomplished as part of a zone reconnaissance are the following:

- Threat. Find and report threat forces within the zone.
- Society.
  - Determine the size, location, and composition of the populace within the zone, as well as applicable social demographics (such as race, sex, age, religion, language, national origin, tribe, clan, class, party affiliation, education, or any other significant social grouping).
  - Reconnoiter the society to determine local centers of gravity; the size, location, and composition of identifiable groups; and the interests and actions of these groups.
  - Establish and maintain contact with local civilian and military leadership.
  - Identify allegiances of the local populace to factions, religious groups, or other organizations.
- Infrastructure (see chapter 6 for more detailed discussion of infrastructure reconnaissance).
  - Identify key municipal infrastructure that can affect military operations (utilities, sewage, transportation [such as rail, bus, subway, or heliports and airfields], and communications).
  - Inspect and evaluate all bridges, overpasses, underpasses, and culverts within the zone.

- Terrain.
  - Locate all obstacles; create and mark lanes as specified in the execution orders.
  - Locate and determine the extent of contaminated areas within the zone, including CBRN and TIM.
  - Reconnoiter and determine the trafficability of all terrain within the zone, including urban areas.
  - Locate bypasses around urban areas, obstacles, and contaminated areas.
  - Provide OBSTINTEL and recommendations for breaching if necessary.
  - Locate fords or crossing sites near all bridges within the zone.

Area Reconnaissance

3-51. An area reconnaissance is a directed effort to obtain detailed information concerning threat, terrain, society, and infrastructure according to the commander's reconnaissance focus within a location often depicted as a reconnaissance objective. The objective in an area reconnaissance is substantially smaller than the terrain reconnoitered in a zone reconnaissance. These objectives may be a small village or town; facilities such as water treatment plants, weapon storage sites, or political headquarters; or other sites of tactical importance (such as a suspected assembly area, a cache site, or an airport). The reconnaissance squadron in the BCT can conduct decentralized reconnaissance in multiple areas simultaneously, either by maneuvering elements through the areas or by establishing stationary observation posts (OPs) within and/or external to them.

3-52. Forces conducting an area reconnaissance are organized according to the size, geography, physical infrastructure, and social dynamics of the area to be reconnoitered as well as the time available for conducting the reconnaissance. The forces may be required to reconnoiter one large area or several smaller ones. In many cases, areas to be reconnoitered are given to platoon-sized teams. A company-sized team may be committed to a larger area. Focused reconnaissance capabilities (engineer, CBRN, and others) may augment one or more of the primary reconnaissance elements as required and available. Area reconnaissance proceeds faster than zone reconnaissance because the effort is focused on a relatively smaller, specific piece of terrain or threat force.

3-53. The "area" for an area reconnaissance is delineated with a single continuous line enclosing the area to be reconnoitered and should be designated as an AO. If the AO is a large or complex urban area, it may also be delineated by marking lateral boundaries, an LD, and an LOA (similar to a zone reconnaissance). The graphic control measures for an area reconnaissance should always include the routes to and within the AO. See figure 3-5.

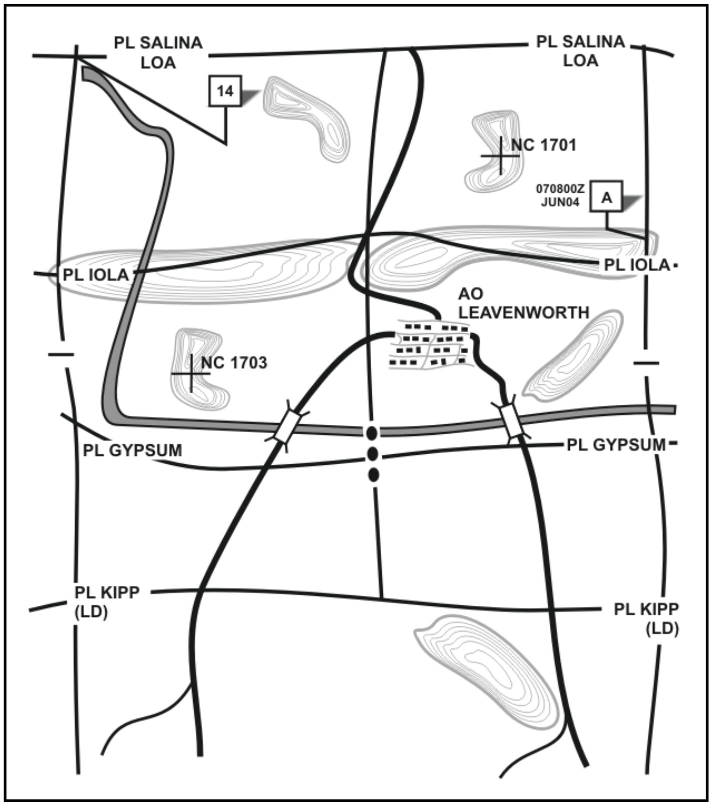


Figure 3-5. Area reconnaissance graphic control measures

3-54. The tasks accomplished as part of an area reconnaissance are the same as those for a zone reconnaissance—only the scale of the reconnaissance is different.

Route Reconnaissance

3-55. Route reconnaissance is the directed effort to obtain information (usually focused on threat and/or terrain) according to the commander's reconnaissance focus along a specified route and on all adjacent terrain (including lateral routes) from which movement along the route could be negatively influenced. The route is a prescribed course from a point of origin (start point [SP]) to a specific destination (release point [RP]); it could be a road or an axis of advance. Route reconnaissance is conducted to determine whether the route is clear of obstacles and/or threat forces and how well or poorly it will support the planned movement. Below the BCT/RCT level, route reconnaissance is often a task performed during zone or area reconnaissance.

3-56. A route reconnaissance may be assigned as a separate mission or as a specified task for a unit conducting a zone or area reconnaissance. Reconnaissance platoons can reconnoiter only one route at a time; therefore, the number of reconnaissance platoons available directly influences the number of routes that can be covered at one time. Integrating ground, air, and other technical assets assures a faster and more detailed route reconnaissance.

3-57. Reconnaissance elements will reconnoiter the route out to threat direct-fire range, focusing on key terrain that threat elements can use to influence the route. Determining trafficability of a route requires the reconnaissance element to determine the capability or extent to which the terrain will bear traffic or permit continued movement of a force. A thorough ground reconnaissance is required for developing detailed information on the route. Modern roadway features are often difficult to evaluate quickly in the process of route reconnaissance. Unless directed, the reconnaissance element does not conduct a deliberate engineer route classification. In some cases, the reconnaissance element may be reinforced with engineers to perform that mission; in others, the element may identify key features for follow-on engineers to classify or obstacles for engineers to clear. If enemy contact is expected, fire support from the fires battalion should be readily available. If CBRN or TIM contamination is expected, CBRN reconnaissance assets should accompany the force conducting ground reconnaissance because they can detect and determine the extent of contamination more quickly and accurately. When time is limited, air reconnaissance (manned and unmanned) can be used to determine which areas are clear of enemy forces and obstacles and to cue ground reconnaissance elements on where to focus their efforts.

3-58. Control measures for a route reconnaissance create an AO for the unit conducting the reconnaissance. (See figure 3-6 for an illustration.) The commander places lateral boundaries—on both sides of the route that are far enough out to allow reconnaissance of all terrain from which the threat could dominate the route. An LD perpendicular to the route is placed short of the SP. This allows adequate space for the unit conducting the reconnaissance to deploy into formation before reaching the SP. The LD creates one of the boundaries of the AO. An LOA is placed far enough beyond the route's RP to include any terrain from which the threat could dominate the route. Normally, coordination points or contact points are included to enable proper flank coordination. If air reconnaissance is employed, an air LOA is normally established to provide greater depth and to take advantage of the aircrafts' elevated observation platform and long-range acquisition capability. The SP and RP define that section of the route on which the unit collects detailed information. PLs and checkpoints are added to maintain coordinated reconnaissance, to control movement, or to designate critical points. Additional fire distribution measures and FSCMs are included to coordinate indirect and direct fires as necessary. All of these graphic control measures are placed along or on recognizable terrain features and, if possible, are identifiable from both the ground and the air to assist in air-ground coordination.

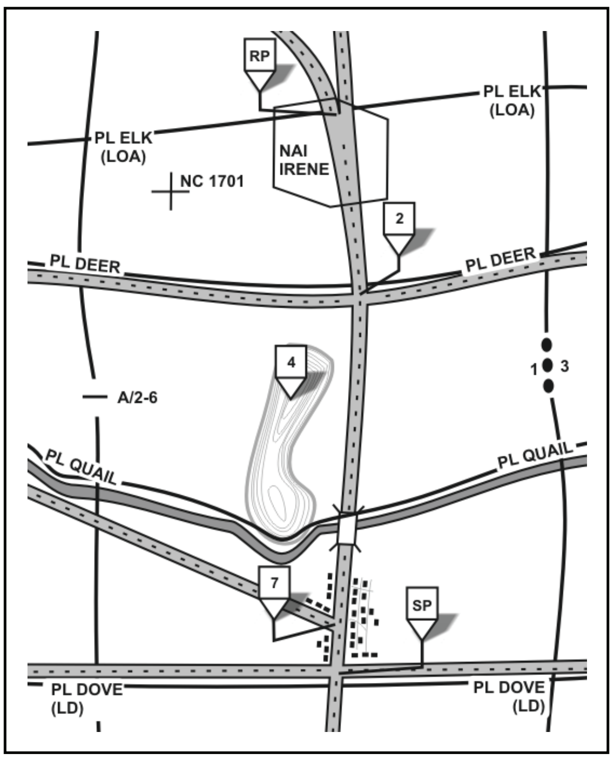


Figure 3-6. Route reconnaissance graphic control measures

3-59. Certain tasks are accomplished during route reconnaissance unless the commander specifically directs otherwise. IPB and CCIR often indicate exclusive critical information required by the higher commander that narrows the focus of the reconnaissance. The critical tasks are the following:

- Reconnoiter and determine trafficability of the route.
- Find and report any threat elements that can influence movement along the route.
- Reconnoiter routes approaching and inside urban areas.

- Reconnoiter lateral routes.
- Inspect and classify bridges along the route.
- Inspect and classify overpasses, underpasses, and culverts.
- Reconnoiter defiles along the route. Clear defiles of threat and obstacles within capability, or locate a bypass.
- Locate mines, obstacles, and barriers along the route. Within capabilities and according to the commander's intent, clear the route.
- Locate bypasses around built-up areas, obstacles, and contaminated areas.
- Update route information.

ENGINEER RECONNAISSANCE OPERATIONS

3-60. Within the combined arms reconnaissance operation, every unit has an implied mission to report information about the terrain, civilian activities, and friendly and enemy dispositions. The commander tasks reconnaissance elements to collect information that addresses his CCIR. When components of the CCIR include technical information, supporting arms with the appropriate specialty will be tasked to support the reconnaissance operation. As is also the case for CBRN, medical, EOD, and other supporting arms, engineer reconnaissance will typically occur within the context of tactical reconnaissance operations but include a focus on technical elements for which the supporting arms have been trained. As discussed in chapter 1, engineer reconnaissance generated from and organized by the engineer functions provides a range of technical as well as tactical reconnaissance capabilities. Specific considerations for engineer reconnaissance support will vary not only based on METT-T[C] but also based on the degree of technical expertise and effort required for the assigned mission and tasks.

3-61. Engineer reconnaissance operations support those operations undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy, or to secure data concerning the meteorological, hydrographical, or geographical characteristics and the indigenous population of a particular area. Engineer reconnaissance relies on the human dynamic but focuses on collecting technical information. It fits within the broader context of tactical reconnaissance operations but offers a range of capabilities based on the information required. Specific considerations for each engineer reconnaissance mission will vary as well.

ENGINEER RECONNAISSANCE TEAM OPERATIONS

3-62. ERTs are employed generally at the tactical level and in support of the combat engineer function. (ERT operations are discussed in detail in chapter 4 as tactical reconnaissance support.) The ERT will usually employ the same techniques and forms for their reconnaissance mission as the supported reconnaissance or maneuver element. The technical information collected by an ERT is an embedded part of a tactical reconnaissance mission, and the ERT is most effective as an integral part of (attached or OPCON to) a tactical reconnaissance element. Combat engineer units are more likely to provide the ERT, especially when it is attached or OPCON to a supported reconnaissance element. Combat engineer units organic to the BCTs/RCTs, as well as those typically augmenting the BCT/RCT, can more effectively integrate their ERT operations and coordinate for their required support.

3-63. ERTs conduct the basic tactical reconnaissance mission with an added focus on collecting the required technical information. The degree of technical focus required of the ERT will vary based on METT-T[C] but will generally highlight critical aspects of the combat engineer function: M/CM/S. ERTs will often conduct a zone, area, or route reconnaissance mission with added specified tasks to collect information on suspected obstacles, a possible crossing site or gap, or other aspects of mobility, countermobility, and/or survivability. While the ERT's technical focus is typically on the specified mobility, countermobility, and/or survivability mission, they have the capability to bring substantially increased technical expertise as required. With EOCA trained members or when augmented by EOCAs, the ERT can conduct limited UXO reconnaissance. The ERT can be augmented with general engineer capability if required to focus more specifically on detailed technical information required. The ERT can also use reach-back capability to apply substantial additional technical resources in support of IR.

3-64. General engineer units operate throughout the OE from the tactical level within BCTs/RCTs to the operational level supporting theaterwide requirements. General engineers have a limited capability to provide ERTs but are less effectively postured at the tactical level to integrate and coordinate the support of an ERT within BCT/RCT reconnaissance operations. General engineer units are more likely to provide expert augmentation to ERTs provided by combat engineers. A general engineer ERT may be employed to conduct reconnaissance to collect specific information supporting tactical sustainment missions (for example, a bridge reconnaissance along an MSR or a road reconnaissance in preparation for MSR upgrade missions). Although the ERT in this case is operating at the tactical level and within the BCT/RCT AO, the reconnaissance task is conducted more in support of a general engineer mission than as an integrated part of the BCT's/RCT's reconnaissance operations.

3-65. In every case, ERTs operating within the BCT/RCT AO must coordinate their activities and address the terrain management considerations as discussed at the end of chapter 2. The ENCOORD on the BCT/RCT staff is best postured to assist the engineer unit providing the ERT with the necessary coordination. The ENCOORD is also postured to assist with coordinating operational level reconnaissance missions—missions identified and/or assigned at echelons above the BCT/RCT—when those missions must occur within the BCT/RCT AO.

ASSESSMENTS AND SURVEYS

3-66. Engineer assessments and surveys are typically conducted at the operational level and in support of the general engineer function. (Assessments and surveys are discussed in detail in chapter 6 as technical reconnaissance support.) The assessment or survey teams are generally not employed when direct contact with the enemy is likely. Rather, engineer assessment or survey is typically conducted in a relatively secure area and is focused on specific and detailed technical information required for a future-engineered, or at least heavily engineered, mission. When operating within an assigned maneuver AO (BCT/RCT, division, corps, JTF, and so forth) the assessment or survey team must fully coordinate its activity with the maneuver unit. But, the engineer team's mission may or may not be an integrated part of the maneuver unit's reconnaissance operation. While combat engineer units will in some situations conduct an assessment (see figure 1-2 on page 1-6), general engineer units are more likely to provide the required assessment or survey team. Additional specialized assistance may also be provided from assets not typically organized into tactical units (United States Army Corps of Engineers [USACE], other government agency [OGA], contractors, HN, and so forth).

3-67. **An *assessment* is a judgment about something based on a technical understanding of the situation.** (See the complete definition in the glossary.) An assessment may follow the same format as a survey, but in the case of the assessment, time and/or specific technical expertise are not adequate to call it a survey. The assessment requires less time but provides less technical detail. Other, nonspecialized reconnaissance elements may also do assessments, but surveys require specialized technical expertise.

3-68. **A *survey* looks at or considers something closely, especially to form a technical opinion.** (See the complete definition in the glossary.) Examples include an environmental baseline survey (EBS) (see FM 3-100.4), an infrastructure survey (see chapter 6), and the more technical components of route classification.

3-69. Assessment and survey teams are specifically tailored to collect the detailed technical information required. Horizontal construction specialists are employed if the mission includes information required for road or airfield construction. Pipeline specialists are added if the mission will include petroleum distribution requirements. Structural engineers and antiterrorism specialists are added if the mission will include evaluations of buildings. The teams include the variety of specialties necessary for the supported mission. Substantial additional technical capabilities are added as necessary from joint Service, multiagency, contractor, HN, and reach-back elements. FFE is the broad range of activities linked through the general engineer element on the ground to apply a high degree of technical expertise to the engineer mission. (FFE is discussed in detail in chapter 6. Some of the reach-back resources available are discussed in appendix H. See FM 3-34 for additional information.)

3-70. FM 5-170, superseded by this manual, used the term "engineer recon" (and DA Form 1711, *Engineer Reconnaissance Report*,) to describe a general engineer reconnaissance to gather engineer information of a broad nature within the AO. It considers material, resources, and terrain features having engineer applications. This manual changes the designation of this task to an engineer resource assessment to avoid confusion with using engineer reconnaissance in a broader sense. The engineer resource assessment remains a valid, relevant task and is included in the discussion in chapter 6.

3-71. The ENCOORD on the appropriate maneuver unit staff is best postured to assist the engineer unit providing the assessment or survey team with the necessary coordination. The ENCOORD is also postured to assist with coordination for any required sustainment or other support of the team. In the HBCT or the IBCT, this organic support is likely to come from coordination with the BSTB.

SUSTAINMENT CONSIDERATIONS

3-72. An engineer unit providing an ERT capability will likely be able to provide only a limited amount of logistical support, especially after the ERT crosses the LD. For this reason, it is essential that the supported unit understands the ERT's requirements and embraces the support of the element. The engineer unit must coordinate closely with the brigade or battalion/TF for support that they cannot provide or that can be provided more effectively by the maneuver units. Examples include casualty evacuation, vehicle recovery, and maintenance support (including vehicle, communications, and weapon repair). Security considerations may also require assistance from the supported unit.

3-73. The sustainment concepts and organizational structures in the modular BCT reflect a paradigm shift from the supply-based sustaining system of the Army of Excellence to a technology-enhanced, distribution-based sustaining system. A distribution-based logistics system combines information capabilities with efficient delivery systems to form an efficient distribution pipeline. Direct throughput of supplies from the division and BCT to the battalion or company team is the rule rather than the exception with distribution-based logistics. For the BCT's organic engineer companies, the burden of sustainment operations is removed from the company commander and placed under the control of the combined arms or BSTB. The engineer company commander concentrates on fighting his unit to accomplish the tactical mission. The sustainment responsibility at company level is primarily to report status, supervise operator-level maintenance, request support, and ensure that sustaining operations are properly executed in the company's area.

3-74. For engineer units augmenting the BCT/RCT, staff coordination must be made at the appropriate battalion or brigade level so that the supporting unit's requirements are included in sustainment planning. Within the BCT/RCT, the maneuver and BSTB commanders ensure that support is provided not only for organic and attached elements but for any supporting units as well. The attached unit leader must coordinate with the battalion personnel staff officer (S-1) and furnish the S-1 with a copy of his unit battle roster as well as provide the battalion S-4 with the status of all key elements of equipment. The battalion S-4 coordinates support for the attachments and verifies who is to provide this sustainment and how support for attachments is to be requested. When a large unit attachment joins the BCT/RCT, the attachment should bring an appropriate slice of support assets from its parent unit. These sustainment assets are controlled by the BSB commander like the rest of the BCT/RCT sustainment elements.

3-75. Sustainment planning at the battalion level is the primary responsibility of the battalion S-4. In coordination with all company XOs and first sergeants, the process is integrated into operations planning with the concept of logistics support synchronized with operations. The unit SOP should be the basis for battalion level sustainment operations with planning to determine specific requirements and contingency preparation. The battalion and company orders should address only specific support matters for the operation and any deviations from the SOP.

EFFECTIVE SUSTAINMENT PLANNING

3-76. To provide effective support, sustainment planners and operators must understand the mission statement, commander's intent, and concept of the operation. The S-4 produces the service support paragraph and annexes of the OPORD, which include the following:

- Commander's priorities.
- Class III/Class V resupply during the mission (if necessary).
- Movement criteria.
- Type and quantities of support required.
- Priority of support, by type and unit.
- Sustainment overlay.
- Supply routes.
- Casualty evacuation (CASEVAC) points.
- Maintenance collection points.

SUPPORTING OPERATIONS

3-77. There are certain general considerations that guide planning and preparation of supporting operations. The following considerations are key to successful sustainment operations planning.

Reports

3-78. BCT/RCT SOPs establish report formats, reporting times, and voice brevity codes to keep logistics nets manageable. Digital communications provide sustainment functionality by providing accurate logistics situation and personnel situation reports, logistical call for support and logistics task order messaging, and task management capabilities. This functionality affects the synchronization of all logistics support in the AO between the supported and the supporter.

Logistics Package Resupply

3-79. The most efficient resupply of dispersed units is accomplished by logistics packages (LOGPACs). The support platoon at each forward support company organizes LOGPACs based on the S-4's guidance. LOGPACs are normally organized once a day for routine resupply. A habitual LOGPAC organization facilitates operations and allows direct coordination by the supply sergeant as necessary. LOGPACs normally consist of the following:

- A supply truck controlled by the food service sergeant. The supply truck contains the Class I rations for the unit (normally for the next 24-hour period) and the unit water trailer. The truck also brings requested Class II, V, and IX supplies.
- A petroleum, oil, and lubricants (POL) truck brings bulk fuel while packaged POL products are transported on cargo trucks.
- Additional trucks as necessary to carry supplies or replacement Soldiers and Marines.
- Escort vehicles.

Sustainment for Attachments

3-80. When a company, team, or detachment is attached to the maneuver battalion or special battalion, the S-4 should ensure the adequacy of medical, maintenance/recovery, and Classes III, V, and IX supply support. Basic support information sustainment planners should be obtained from the sending unit's S-4 when the receiving attachments includes—

- Number and type of vehicles, personnel by specialty, and weapon systems.
- Current status/strength.
- When the attachment is effective and for how long.
- What support assets are coming with the attachment.
- When and where the linkup will occur, and who is responsible for the linkup.

Chapter 4

Tactical Reconnaissance Support

Tactics are the cutting edge of strategy, the edge which chisels out the plan into action; consequently, the sharper this edge, the clearer cut will be the result.

Major General J.F. C. Fuller

Engineers are active participants in tactical reconnaissance operations: collecting information about the terrain, enemy engineer activity, obstacles, and weather effects within an AO. The ERT is the baseline engineer reconnaissance element for tactical reconnaissance support, and their operations share many of the characteristics that define the tactical reconnaissance operation. Tactical reconnaissance support is normally guided by the same objective, receives the same commander's guidance, and is conducted at the same tempo as the overall reconnaissance operation. ERT operations take the basic form of a route, area, or zone reconnaissance and use techniques compatible with the supported force. ERTs conduct zone, area, and route reconnaissance with a reconnaissance focus linked directly to answering the CCIR but with a specified additional focus on the required technical information. ERT operations share the characteristics of tactical reconnaissance while employing some of the same capabilities from the technical range of support as discussed in chapters 5 and 6. The majority of tactical engineer reconnaissance support enables the collection of information in support of M/CM/S operations and is conducted primarily by ERTs composed of combat engineers. General engineer capabilities—either teamed with ERTs or in stand-alone organizations—conduct reconnaissance that enables engineer support to tactical sustainment, but these operations typically resemble the technical range of support described in chapters 5 and 6 more than tactical reconnaissance. This chapter focuses on a discussion of reconnaissance support of the five functions of mobility operations, support of obstacle integration and turnover in countermobility operations, support to fighting and other protective positions, and support to other tactical operations performed by the BCT/RCT.

SUPPORT TO MOBILITY OPERATIONS

4-1. The ART, *Conduct Mobility Operations*, is defined in FM 7-15 as "Maintain freedom of movement for personnel and equipment within an AO without delays due to terrain or barriers, obstacles and mines." The following five functional areas of mobility operations (see FM 3-34.2) are intended to meet the challenges of mobility and maintain freedom of tactical maneuver and operational movement:

- Conduct Combined Arms Breaching Operations: detect, neutralize (by combined arms breach or bypass), mark, and proof mined areas and obstacles. Countermine and counterobstacle activities are typically performed in a close combat environment.
- Conduct Clearing Operations: employ tactics and equipment to detect and eliminate obstacles, mines, and other EHs. While this is not always part of a combined arms breaching operation and is typically not performed in a close combat environment, it will still generally include the task of breach.
- Conduct Gap Crossing Operations: fill gaps in the terrain to allow personnel and equipment to pass.

- Construct/Maintain Combat Roads and Trails: expediently prepare or repair routes of travel for personnel and equipment. This includes temporary bypasses of damaged roads and bridges.
- Perform Forward Aviation Combat Engineering (FACE): Construct/maintain forward airfields and landing zones (LZs), forward arming and refueling points (FARPs), landing strips, or other aviation support sites in the forward combat area.

4-2. The primary focus of the ERT collecting technical information in support of the functional areas of mobility operations is obstacles. The task is to conduct route, zone, or area reconnaissance to determine terrain trafficability and the location and boundaries of barriers, obstacles, and minefields. An obstacle is any obstruction designed or employed to disrupt, fix, turn, or block the movement of an enemy force. They are also employed to impose additional losses in personnel, time, and equipment on the enemy. Obstacles can exist naturally or be manmade or can be a combination of both. The effectiveness of obstacles is enhanced considerably when covered by observation and fire. Obstacles include abatis, antitank ditches, blown bridges, built-up areas, minefields, rivers, road craters, terrain, and wire. As mentioned above, mines are employed in combination with other obstacles to create complex obstacles.

OBSTACLE RECONNAISSANCE

4-3. In any operation where enemy obstacles can interfere with friendly maneuver, OBSTINTEL is one of the IR and should become PIR. Finding enemy obstacles or seeing enemy obstacle activity validates and refines the S-2's picture of the AO/OE. OBSTINTEL helps the S-2 determine the enemy's intentions, plans, and defense strength. The force engineer is the unit's expert on enemy countermobility capabilities and assists the S-2 in templating enemy obstacles, analyzing OBSTINTEL, and analyzing the effects of terrain. The S-3, S-2, and engineer establish effective OBSTINTEL collection by determining specific obstacle IR. Obtaining OBSTINTEL requires dedicated collection assets. Reconnaissance assets are tasked to collect specific information that is needed to fulfill obstacle IR.

4-4. Obstacle reconnaissance is one of the high frequency tasks conducted by ERTs. The task is to conduct reconnaissance of obstacles focused on answering obstacle intelligence IR—obstacle location, length, width, and depth; obstacle composition (wire, mines by type, and so forth.); soil conditions; locations of lanes and bypasses; and the location of enemy direct-fire systems. An ERT moves with scouts or a patrol and conducts dismounted reconnaissance of templated or confirmed obstacles. The purpose of the reconnaissance is not only to locate the obstacle but also to determine how best to overcome the effects of the obstacle—reduction or bypass. The following tasks may be associated with the reconnaissance:

- Locating and marking a bypass.

Note. If the obstacle is to be bypassed, the ERT can be employed to provide guides as well as mark the bypass.

- Locating and marking the best location to reduce.
- Estimating the reduction assets necessary to reduce the obstacle.

4-5. Although an ERT may have limited capability to clear or reduce small obstacles that are not covered by fire or observation, ERTs engaged in a reconnaissance mission for OBSTINTEL should rarely be used to reduce obstacles during the reconnaissance mission. Inadvertent detonation during reduction may compromise engineers and scouts, defeating the reconnaissance mission. It may also compromise the entire attack. If a decision is made to breach an obstacle, the ERT can typically provide guides to the breach forces for subsequent breaching operations.

4-6. The ERT approaches a known or suspected obstacle location with caution. Security is established, with support from the tactical reconnaissance element if possible, and selected engineers move dismounted to the obstacle. Trip wires and other wires may indicate that the enemy is using booby traps or command-detonated mines to prevent friendly forces from collecting information on the obstacle. The ERT prepares an obstacle report with the relevant information. Examples of OBSTINTEL collected through obstacle reconnaissance include—

- The location of existing and reinforcing obstacles.

- The orientation and depth of obstacles.
- Conditions of the soil (in the case of a minefield) to determine the ability to use tank plows.
- The presence, location, and type of wire.
- Lanes and bypasses.
- The composition of the minefield (buried or surface-laid AT and antipersonnel (AP) mines, antihandling devices [AHDs], and the depth of the mines).
- Types of mines and fuses; composition of the minefield.
- The location of enemy indirect-fire systems that can fire into the breach area.
- The composition of complex obstacles.
- Areas between successive obstacle belts.

4-7. The ERT forwards an obstacle report to both the supported unit tactical operations center (TOC) and its parent unit whenever possible. In the digital environment, information required remains the same; however, the means by which the ERT collects data and retransmits it back to the maneuver TOC has changed. Information obtained about the terrain, terrain features, and obstacles can now be digitally transmitted to the maneuver TOC to facilitate BCT/RCT force mobility. Information collected can be digitally transmitted in near real or real time via the digital reconnaissance system (DRS). The ERT employs DRS to record and report breached lanes, route critical points, bypasses, logistics resources, and the locations of wounded personnel or damaged equipment.

4-8. After collecting the information, the scout platoon or ERT leader analyzes the situation and the METT-T[C] factors to select a COA. Once the scouts and ERTs have determined the best COA for a situation, they execute it or recommend it to higher headquarters for approval. Generally, the reconnaissance team executes a particular COA without specific approval if it is addressed in the OPORD received from higher headquarters or if it is in the unit SOP. If the situation discovered is not covered by previous guidance, the reconnaissance team determines the best COA and recommends it to the commander before execution. The four COAs are—

- Use a bypass.
- Reduce the obstacle.
- Support a breaching operation.
- Continue the mission.

4-9. Using a bypass is the preferred method when it offers a quick, easy, and tactically sound means of avoiding the obstacle. A good bypass must allow an entire force to avoid the primary obstacle without risking further exposure to enemy fire and without diverting the force from its objective. Bypassing conserves reduction assets and maintains the momentum. If a reconnaissance team locates a bypass and the commander approves its use, scouts and engineers must mark it according to the supported unit tactical SOP and report it to their commander. At a minimum, this report should include the grid location to the far recognition marker and information on how the obstacle is marked, even if it is just to confirm that the bypass is marked according to the SOP. If the reconnaissance team is tasked to mark a bypass, the team must emplace markers so that they are not visible to the enemy. Engineers and scouts may be required to provide guides for the main body, especially if the bypass is difficult to locate or if visibility conditions are poor.

4-10. Bypassing is not always possible, and breaching may be the best or only solution, as in the following situations:

- The obstacle is integrated into a prepared defensive position, and the only available bypass moves friendly forces into the fire sack or an ambush.
- The reconnaissance mission specifically tasks the reconnaissance team to clear the original route for follow-on forces.
- The best available bypass route does not allow follow-on forces to maintain their desired rate of movement, or it diverts the force from the objective.
- Improvements to the bypass may require more time and assets than breaching the primary obstacles.

4-11. Reducing an obstacle significantly degrades the ability to maintain the momentum of the reconnaissance or follow-on forces. Obstacles that the scout and engineer are able to reduce include small minefields, simple wire obstacles, small roadblocks, and similar obstacles. The supported commander should make the decision to have the reconnaissance team reduce an obstacle while considering the risk to the reconnaissance team and the potential for prematurely identifying the route. Obstacle reduction should not be attempted if the obstacle is part of an integrated defensive position.

4-12. When a large obstacle is located and cannot be bypassed easily, the alternative is to support a breaching operation. Scouts and engineers perform additional reconnaissance tasks in support of the breaching operation. These tasks include determining the assets and time needed to reduce the obstacle and determining the best location for the reduction site. Scout and engineer reconnaissance efforts focus on the following:

- Trafficable routes to the reduction site and routes from the far side leading to the objective.
- Proposed locations for positioning the support force.
- Dispersed, covered, and concealed areas near the reduction site.
- The best location for the reduction effort at the obstacle. It is imperative that the reduction plan be sent to the reconnaissance teams once the scheme of maneuver is finalized. Information (such as the number of lanes required and the distance between lanes) is needed for the reconnaissance forces to conduct the necessary reconnaissance.
- Positions on both sides of the obstacle that could provide enemy observation of the reduction site.
- Trafficability and soil conditions near the reduction site. This is especially important for minefield reduction because mine-clearing blades will not work properly in all soil conditions.
- Soil type (loamy, rocky, sandy, and so forth).
- The width, depth, and bottom conditions of wet and dry gaps and fords.
- The bank height and slope and the soil stability of wet and dry gaps.
- The water velocity and the direction of flow of wet gaps and fords.
- The wind direction for using smoke to obscure enemy vision.
- The location of the forward edge of the minefield to support mine-clearing line charge use.

4-13. The ERT must provide timely, valuable information when large obstacles are encountered during a mission. The information is used by all elements of the breaching operation to finalize the suppression, obscuration, security, reduction, and assault plans for the breaching operation.

Clearing Operations

4-14. Clearing operations are designed to clear or neutralize all explosive hazards and other obstacles from a route or area. As with most mobility operations, clearing operations are often conducted by a combined arms force built around an engineer-based clearing force. Clearing operations include route clearance and area clearance. The reconnaissance focus in clearing operations is again on OBSTINTEL—but in support of clearing operations. The OBSTINTEL must be comprehensive and detailed to enable the neutralization of all obstacles along the route or in the area. The task is to conduct detailed reconnaissance of obstacles focused on answering obstacle intelligence IR—obstacle location, length, width, and depth; obstacle composition (wire, mines by type, and so forth); and soil conditions. The location of lanes and bypasses as well as information on enemy positions is also collected, but the focus is on detailed OBSTINTEL.

Route Clearance

4-15. Maneuver units or scouts (augmented by engineers) conduct a route reconnaissance to gain detailed information about a specific route and the terrain on both sides of the route that the enemy could use to influence movement. When the commander wants to perform reconnaissance of a specific route, a maneuver unit or scout platoon with an ERT conducts a route reconnaissance to gain information on obstacles obstructing trafficability of the route. This information provides the basis for the planning process of the clearance mission. Since the clearing operation is designed to ensure that the route is clear of obstacles and enemy forces and will support vehicle movement, detailed OBSTINTEL is required for every obstacle along the route. (See FMI 3-34.119/MCIP 3-17.01 and FM 3-34.210 for specifics about the considerations of IEDs in route clearance.)

4-16. Chapter 3 included a discussion of route reconnaissance as a form of tactical reconnaissance. A route reconnaissance element must accomplish a specified number of tasks unless directed to do otherwise. In the route reconnaissance specifically in support of a route clearance, the focus narrows to those obstacles and enemy forces obstructing trafficability along the route. The situation may require varying the reconnaissance tempo and engagement criteria, but the reconnaissance focus in support of route clearance must remain the detailed information required for the complete neutralization of all explosive hazards and other obstacles from the route.

4-17. Based on the time available and the commander's intent, the reconnaissance element may be directed to conduct clearance of some identified obstacles. The reconnaissance element may be organized as part of the clearance element or be directed to assist in planning the follow-on clearance mission. The reconnaissance leader must clearly understand the engagement criteria and focus on the OBSTINTEL required for the clearance mission. A route reconnaissance supporting a follow-on clearance mission focuses on—

- Locating obstacles along the route. In some situations, reconnaissance units may be required to clear routes, or portions or a route, of obstacles. Although using digital cameras during route reconnaissance is becoming more popular, the reconnaissance element must still capture all of the critical OBSTINTEL for obstacles along the route and not rely solely on the images relayed via the digital camera.
- Reconnoitering to the limit of the direct-fire range and terrain that dominate the route.
- Reconnoitering all built-up areas along the route (identify bypass routes, construction supplies and equipment, ambush sites, evidence of booby traps, and suitable sites for C2 and sustainment facilities).
- Locating bypasses around built-up areas, obstacles, and contaminated areas.
- Reporting route information (see reports discussed in appendix B).
- Finding and reporting all enemy forces that can influence movement along the route.

Area Clearance

4-18. Area clearance is the detection and if found, the identification, marking, neutralization, destruction, or removal of mines or other explosive ordnance, IEDs, and booby traps in a defined area to allow a military operation to continue with reduced risk. It is a combined arms operation. Clearing land mine hazards is primarily the responsibility of combat engineer units; the clearing of all other EHs is primarily the responsibility of EOD units within the Army or from EOD elements in other supporting Services.

4-19. ERTs conduct area reconnaissance to support the information gathering phase of an area clearance mission. The area reconnaissance enables detailed planning for the area clearance and provides the initial information needed to enable the technical survey described in FM 3-34.210. As with a route reconnaissance in support of clearance operations, the focus of the area reconnaissance narrows to those obstacles and enemy forces obstructing freedom of movement in the targeted area. The situation may require varying the reconnaissance tempo and engagement criteria, but the reconnaissance focus in support of area clearance must remain the detailed information required for the complete neutralization of all explosive hazards and other obstacles from the area.

4-20. Area reconnaissance provides the initial information needed to enable area clearance operations. The gathering of detailed technical and topographical information of known or suspected hazardous areas is conducted through a technical survey. (A technical survey is similar to intelligence preparation of the battlefield.) The primary aim of a technical survey is to collect sufficient information to enable the clearance requirement to be more accurately defined. The results of the survey drive the entire area clearance process from planning, task organization, and equipment and resource allocation to completion. Planners use all available intelligence assets to gather historical and existing EH information. Assets include—

- Coalition, joint, and Service fire support and air planners can provide information on possible friendly UXO locations and types.
- Human intelligence (HUMINT), minefield records from former warring factions, coalition intelligence, and nongovernmental agencies are all potential assets.
- Aerial reconnaissance must be used to analyze and determine the EH threat during the technical survey.

4-21. An on-site briefing by the technical survey team to the clearing team is the capstone of the technical survey. This ensures that the clearing team fully understands the templated and verified threat assessment with specific locations of threats. The technical survey is the first phase of area clearance and consists of three tasks:

- Information gathering.
- Reconnaissance.
- EHs survey.

4-22. Consider the following in gathering information:

- Coordinate hazard areas. Use a map or imagery to draw the hazard area for the operation. Identify units, security forces, observation towers, and roads. Identify those personnel or indigenous peoples who will need to be evacuated or controlled during the operation. The base operations center shift change is the best place to coordinate operations and resolve issues. Conduct coordination meetings to ensure success. Announce the operation during all concerned or appropriate daily update briefings.
- Employ HUMINT. Local commanders have some value in showing their own and enemy positions. This will help you see the no-man's-land in between and enable you to template obstacle reinforcement of the terrain. Local commanders can also tell you generally what types of EHs are in the area and where they are located.
- Integrate CA. CA personnel can help in understanding the impacts of clearing operations to local civilians. They are trained to gain and maintain contact with the locals to avoid confrontations, gain explosive hazard (mine/UXO) HUMINT, get local force's security help, and resolve any land rights issues in a timely fashion.
- Confirm recent incident/accident reports.
- Brief survey team prior to deploying to site.

4-23. Consider the following in conducting the reconnaissance:

- Terrain. If the terrain is rough or full of battle positions and debris instead of flat, this adds difficulty.
- Equipment or resources available.
  - Detection. Soldiers and Marines with hand-held detectors, sniffers, probes, trip-wire feelers, and mine detection dog teams.
  - Clearance. Flails, rollers, and mine-protected clearance vehicles.
  - Marking. The design of EH marking systems should take account of materials available and the period for which the marking system will be in place. The amount of materials needed change from the technical survey phase through the clearing phase.
- Weather. The effects of adverse weather on enemy and friendly systems must be factored into the plan.
- Using aerial reconnaissance. This is the next best source to imagery. It allows the commander and his key leaders to see the ground and to take high-resolution photographs for future magnification and printing. As many of the area clearance leaders as possible should take part in the aerial reconnaissance.
- Using visual reconnaissance. Key leaders should conduct a reconnaissance on the ground. Using the top of a mine-protected vehicle to stand on or a security observation tower, they should spend time viewing through binoculars. Coordinate and ensure EOD personnel are present. Their knowledge of UXOs will greatly assist in planning, clearing, and proofing the area.

- Using imagery. Use both recent and older imagery to support change detection methods and know what the colors or shading levels mean. Recent imagery is the single most useful tool to describe the threats. Be cautious when printing the area of operations, and overlay the threats in as much detail as possible because possible threats may be over templated. This may cause the recognition and assessment to be unnecessarily cautious or over resourced.
- Observing local nationals. Local nationals typically use trails and paths in the area. Observe and/or talk to those in the area that use these trails and paths on a daily basis. Show these trails on the technical survey. These are low risk start paths for the recognition phase to begin its cross-hatching network.

4-24. Consider the following when conducting the EH survey (see FM 3-34.210 for a more detailed discussion on completing DA Form 7602 (EH Survey Report Form):

- Confirmation of the presence of EH.
- Confirmation of any data that has been initially collected.
- Assessment of the ground in terms of the soil, metal contamination, vegetation, and slope.
- A definition of the area in terms of its size, described through measurements and azimuths.
- The required depth per area to which clearance will be conducted (may require adjustment from the depth specified in the tasking order).
- The resources required to carry out clearance activities in the identified area and the estimated time for manual teams, mechanically assisted teams, mine detection dog teams, and EOD teams, as appropriate.
- Boundary lane around the hazard area.
- Location of known safe areas and known or suspected hazard areas adjoining the area to be cleared.
- Survey marking. Use and record physical survey markers and indicators to assist subsequent area clearing operations.
  - Reference point. A reference point, or landmark, is a fixed point of reference some distance outside the hazardous area. It should be an easily recognizable and permanent feature (such as a crossroads or the abutment of a bridge) which can be used to assist in navigating to one or more benchmarks. The coordinates of a reference point should be surveyed by global positioning system (GPS).
  - Benchmark. A benchmark is a fixed point of reference that is used to locate a marked and recorded EH area. It should normally be located a short distance outside the suspected hazardous area. A benchmark may not be necessary if the reference point is sufficiently close to the perimeter of the hazardous area. The coordinates of a reference point should be surveyed by GPS.
  - Start point. An SP can be the same point as the benchmark or the first turning point.
  - Turn point (TP). A TP is a fixed point on the ground which indicates a change in direction of the perimeter of the hazardous area. It must be clearly marked and recorded. TP survey markers will be made of permanent or semipermanent material and will be buried or driven into the ground. Buried metal objects may be used to reinforce the marking of all TPs for permanent future reference.
  - Intermediate point (IP). The distance between survey markers on the perimeter of a hazardous area must not exceed 50 meters. IP survey markers will be used between TPs that are more than 50 meters apart. IP survey markers will be made of permanent or semipermanent material and will be buried or driven into the ground. Buried metal objects will be used to reinforce the marking of all IPs for permanent future reference.
  - Detailed site sketch. In addition to the information mentioned above, a detailed site sketch (drawn to scale) is prepared and provided to the unit that will eventually carry out the clearance task. This process must be completed to ensure gaining units fully understand the area and the EH threat. The technical survey should describe the threats, likeliness of each threat, imagery showing the locations of the threats, and where any change in threat occurs.

- Marking the perimeter. Mark the perimeter of the area to be cleared with red and white markers spaced no more than five meters apart. The red markers represent the hazard side and the white markers represent the safe side. The marking is done to provide a clear warning of danger to personnel and, where possible, to install a physical barrier to reduce the risk of unintentional entry into hazardous areas.
- Marking left and right edges. For boundary and safe lanes, left and right edges of the lanes should also be marked with red and white markers. The red markers are spaced five meters apart on the inside edge of the cleared lanes. White markers should be placed two to three inches inside the red markers on both sides of the cleared lane. Looking down a cleared lane, troops will see two rows of red markers on the outer edge of the lane and two rows of white markers inside the rows of red markers.

Note. If clearance does not immediately follow a technical survey, then survey markers should be left securely in place. Such markers will enable the hazardous area to be located accurately and safely at a later date.

GAP CROSSING

4-25. Military traffic engaged in rapid decisive maneuvers must be able to cross wet or dry gaps in existing road networks or natural high-speed avenues of approach. Very few LOCs will exist without some form of bridge, bypass, or detour. Maneuver forces and logistical support depend on three types of bridging: tactical, support, and LOC (and existing or permanent bridges). Tactical operations of combined arms forces within the BCT/RCT are primarily focused on the first two of these forms of bridging or the seizure of existing or permanent bridges. Tactical bridging is typically linked to combat engineers and immediate support of combined arms ground maneuver. (See FM 90-13 for a more in-depth discussion of bridging as a component of combined arms gap crossing operations.)

4-26. Engineers support gap crossing through construction, repair, and reinforcement of bridges; by providing bridge reconnaissance and classification; and in the construction of bypasses and detours. The specific mission undertaken is planned in a manner that maintains the momentum of the force. Bypasses and fording sites can be used to overcome obstacles when it is more feasible or when bridges are not available. Existing bridges may need to be repaired or reinforced to keep MSRs and LOCs open. As the tactical situation changes, MSRs are moved or adjusted to support the force. Forward elements may demand that expedient, standard, and nonstandard structures be emplaced to replace tactical bridging and support bridging and those assets returned for their use by the combat maneuver elements of the force. These types of bridges are also not designed for the multiple passes that are typical for MSRs and will need to ultimately be replaced by other bridging. Requirements for engineer units to employ tactical, support, and LOC bridging continue throughout the fight.

4-27. Engineers use products and support from geospatial engineering to greatly improve SU (to include terrain) and select optimal bridging sites. High-resolution satellite imagery or UAS video are precise pictures of terrain. The requirement for the engineer is to have the appropriate software. Engineer terrain teams assist in determining conditions in areas at or around potential gap crossing sites. Terrain teams have software that can assist in mission planning by determining soil conditions, hydrology, vegetation types, general weather patterns, and other useful aspects of the terrain.

4-28. ERTs conduct route or area reconnaissance with a focus on existing structures to gather information on trafficability of existing bridges. Chapter 6 provides a discussion on technical assessment of bridges. ERTs inspect the bridge to determine its load-carrying capacity (classification) and its structural integrity (see appendix F for classification instructions). The ERT determines whether the situation warrants emplacing a tactical, support, or LOC bridge. When a damaged bridge is to be replaced, reconnaissance information includes a report on the serviceability of the in-place structural members and other local materials that might be reused in other construction (see appendix B for reporting instructions). Maximum use should be made of existing bridge sites to take advantage of the existing roads, abutments, piers, and spans that are serviceable.

4-29. Bridge reconnaissance is classified as either hasty or deliberate, depending on the amount of detail required, time available, and security in the AO. ERTs typically conduct the hasty reconnaissance while augmented ERTs, assessment, or survey teams are tasked to conduct the deliberate reconnaissance. A deliberate reconnaissance is usually conducted in support of MSR and LOC bridging operations since greater traffic requirements dictate that time and qualified personnel be made available to support the task. An engineer light dive team can assist with the deliberate reconnaissance by providing near shore and far shore crossing site data. Additionally, they can mark and prepare landing sites, riverbanks, and exit routes for the crossing force. A deliberate reconnaissance includes a thorough structural analysis; a report on approaches to the bridge site; a report on the nature of the crossing site, abutments, intermediate supports; and bridge structure; repair and demolition information; and the possibility of alternate crossing sites.

4-30. When existing structures are not present or adequate to the crossing requirement, ERTs conduct area reconnaissance to collect data to determine acceptable terrain and conditions for new construction. ERTs use the assessment tools and procedures discussed in chapter 6 to provide the required technical focus for other gap crossing sites. Using the results of reconnaissance, planners can determine which type of bridge or bridge combinations are right for the mission based on available resources. The location ultimately chosen for the bridge is determined by numerous factors which are reflected in its structural design. Primary screening considerations include—

- Access and approach roads. Determine if the preexisting roads are adequate. The time to construct approaches can be a controlling factor in determining if a crossing site is feasible. Approaches should be straight, with two lanes, and less than a 6-percent slope.
- Width. Determine the width of the gap to be spanned at both normal and flood stage for wet gaps.
- Banks. Estimate the character and shape of the banks accurately enough to establish abutment positions. The banks should be firm and level to limit the need for extensive grading. Select straight reaches to avoid scour.
- Flow characteristics. Determine the stream velocity and erosion data, taking into consideration the rise and fall of the water. A good site has steady current that runs parallel to the bank at less than 3 feet per second.
- Stream bottom. Record the characteristics of the bottom. This will help in determining the type of supports and footings required. An actual soil sample is useful in the planning process, particularly in wide gaps that may require an intermediate pier.
- Elevation. Determine and record accurate cross-section dimensions of the site for determining the bridge's height. Planners must also know of any existing structures that the bridge must cross over.
- Materials. Determine the accessibility of material for improving bank conditions such as rock, gravel, or other expedient construction materials.

COMBAT ROADS AND TRAILS

4-31. The maneuver commander may require that a new or upgraded route be constructed to facilitate the mobility of his forces and support a scheme of maneuver or movement within an AO. An entirely new section of road may need to be constructed, for example, to bypass a known obstacle (natural or manmade). This may include the bypass of a densely populated location. The maneuver commander may also order an unusable road upgraded or a trail created to permit the passage of his forces. This combat construction could be a stand-alone mission to open or reopen a necessary route, or it may be part of a larger mobility operation; for example, a river crossing operation that may require access and egress roads. Construction and maintenance of combat roads and trails is a tactical task to enhance maneuver but is not the road construction mission performed by horizontal construction units within the general engineering function. Combat roads and trails include a requirement for a combination of route and area reconnaissance to gather the required technical information.

4-32. Thorough reconnaissance is essential in the selection of combat roads or trails. It normally starts with a study of available maps and aerial photos. Aerial reconnaissance provides much valuable information.

Detailed information, however, is obtained only by ground reconnaissance. The types of reconnaissance and their applicability to combat roads and trails include—

- Route reconnaissance. A route reconnaissance (chapter 3) is one of the three forms of tactical reconnaissance. It should not be confused with a route classification which can be included as part of the route reconnaissance (below and in chapter 5) or a road reconnaissance which is a technical component of the route classification.
- ***Route classification*. A route classification is assigned to a route using factors of minimum width and worst route type; least bridge, raft, or culvert military load classification; and obstructions to traffic flow.** Reconnaissance collects information about roads, bridges, tunnels, fords, waterways, and other natural terrain features that may affect the desired traffic flow. Information obtained in a hasty route classification may be adequately recorded on a simple sketch or overlay. Because of the greater detail obtained in a deliberate route classification, the overlays discussed in Chapter 5 along with specifically designed report formats (appendix B) are used.
- Road reconnaissance. ERTs conduct road reconnaissance as a component of route classification while assessment teams conduct road reconnaissance as the primary focus of technical reconnaissance support. The ERTs are primarily interested in the road as it impacts a route's trafficability. The assessment team is interested in the engineering details of the road to support its upgrade or repair. (Road reconnaissance is described in detail in chapter 5, and DA Form 1248 is included in appendix B.)
- Area reconnaissance. New road construction is avoided whenever possible to save time and labor. When a new road is necessary, however, the first step is area reconnaissance. This requires a specific type of area reconnaissance in which all possible route layouts are included to ensure selection of the best route. Its main objective is to locate a new road or trail in an area that will hold up under anticipated traffic and meets mission requirements.

4-33. ERTs conduct route reconnaissance to determine trafficability of the selected route and its components. Typically a route classification is included as a specified task for the ERT as part of an assigned route reconnaissance. The route classification describes the traffic-bearing capabilities and condition of selected route and supports decisions on improvements needed before a route can carry the proposed traffic. Route classification is classified as either hasty or deliberate. The way in which route reconnaissance is performed depends upon the amount of detail required, the time available, the terrain problems encountered, and the tactical situation. Hasty route classification determines the immediate military trafficability of a specified route. It is limited to critical terrain data necessary for route classification. The results are part of the mobility input to the COP. Information concerning the route is updated with additional reports as required by the situation and/or the commander's guidance. A deliberate route classification (including road, bridge, tunnel, and other technical components**)** is conducted when sufficient time and qualified technical personnel are available. Deliberate route classification is usually conducted when operational requirements are anticipated to cause heavy, protracted use of the road and may follow the conduct of a hasty route reconnaissance. An overlay is made as described in chapter 5 and, along with attachments, describes the route, its components, and pertinent terrain features in detail.

4-34. The ERT is briefed as to the anticipated traffic (wheeled, tracked, or a combination) and the anticipated traffic flow. Single flow traffic allows a column of vehicles to proceed while individual oncoming or overtaking vehicles pass at predetermined points. Double flow traffic allows two columns of vehicles to proceed simultaneously in the same or in opposite directions. The reconnaissance team may also be asked to determine the grade and alignment, horizontal and vertical curve characteristics, and the nature and location of obstructions. Obstructions are defined as anything that reduces the road classification below what is required to support the proposed traffic efficiently. Obstructions include—

- Restricted lateral clearance, including traveled way width such as bridges, built-up areas, rock falls or slide areas, tunnels, and wooded areas.
- Restricted overhead clearance, including overpasses, bridges, tunnels, wooded areas, built-up areas.
- Sharp curves.

- Excessive gradients.
- Poor drainage.
- Snow blockage.
- Unstable foundation.
- Rough surface conditions.

4-35. Other obstacles include CBRN contamination, roadblocks, craters, explosive hazards (to include mines and other UXOs and IEDs), cultural sites, and environmental restrictions. Existing bridging may require special attention, as it is often a weak link. It may be necessary to conduct a bridge reconnaissance and classification computations.

4-36. Information collected can be digitally transmitted in near real or real time via the DRS. When available, an automated route reconnaissance kit (ARRK) can provide engineer units with an automated reconnaissance package that allows the reconnaissance element to collect and process reconnaissance information. Use of the ARRK assists the ERT by tracking location, speed, curve, and slope of roads and obstacles encountered along the route. (The ARRK is described in detail in appendix H.)

4-37. ERTs conduct area reconnaissance when shortfalls are identified and the need to move or maneuver cannot be supported by the existing road or trail network. With their understanding of force mobility requirements in the forward area, the ERT can quickly evaluate the terrain for possible cross-country movement. The ERT can also evaluate and collect preliminary information on the potential for combat road or trail construction creation. Typically, the decision to construct combat roads or trails can be made with the technical information collected in the area reconnaissance. For more permanent new construction, an assessment or survey team will typically conduct specific site investigations to collect the detailed technical information required for planning a road network. Site investigation requires a thorough knowledge of soils engineering, hydrology, and technical design requirements. A detailed site investigation will serve as the foundation behind the design of a new road and/or the upgrade, repair, and maintenance of an existing road.

4-38. Periodic reconnaissance is especially important during frozen, wet, or unusually dry weather to determine the effects of these conditions on the roads and trails. During winter months in cold environments, this will include the feasibility of snow roads for off-route traffic or ice roads across lakes and streams. Maintenance requirements based on periodic reconnaissance (to include basic snow removal) must be coordinated with the units using the roads. This ensures that engineer effort will not be spent on roads that are no longer needed and that engineer crews will not interfere with the movement of critical convoys.

Forward Aviation Combat Engineering

4-39. Airfields and heliports are built, upgraded, repaired, and maintained to meet mission and operational requirements. FACE prepares or repairs LZs, FARPs, landing strips, or other aviation support sites in the forward combat area and is considered combat engineering tasks focused on providing support to tactical combat maneuver forces. (See FM 3-34.2.) All other airfield and heliport construction is considered general engineering tasks.

4-40. Airfields and heliports are classified by their degree of permanence and type of aircraft they are designed to support. They are essential for controlling aircraft, either fixed wing and/or rotary wing. These controlling aircraft, or aircraft combination, are identified for each kind of facility to establish limiting airfield and/or heliport geometric and surface strength requirements. Army airfields and heliports are divided into six classes (see Unified Facilities Criteria [UFC] 3-260-01):

- Class I. Helipads-heliports with aircraft 25,000 pounds (11,340 kilograms) or less. The controlling aircraft is a UH-60 aircraft at a 16,300-pound (7,395 kilograms) operational weight.
- Class II. Helipads-heliports with aircraft over 25,000 pounds (11,340 kilograms). The controlling aircraft is a CH-47 aircraft at a 50,000-pound (22,680 kilograms) operational weight.
- Class III. Airfields with Class A runways. The controlling aircraft combination is a C-23 aircraft at a 24,600-pound (11,158 kilograms) operational weight and a CH-47 aircraft at a

50,000-pound (22,680 kilogram) operational weight. Class A runways are primarily intended for small aircraft such as C-12s and C-23s.

- Class IV. Airfields with Class B runways. The controlling aircraft is a C-130 aircraft at a 155,000-pound (70,307 kilograms) operational weight or a C-17 aircraft at a 580,000-pound (263,084 kilograms) operational weight. Class B runways are primarily intended for high performance and for large, heavy aircraft such as C-130s, C-17s, and C-141s.
- Class V. Contingency operations heliport or helipads supporting Army assault training missions. The controlling aircraft is a CH-47 aircraft at a 50,000-pound (22,680 kilograms) operational weight.
- Class VI. Assault landing zones for contingency operations airfields supporting Army training missions that have semiprepared or paved surfaces (also known as forward landing strips). The controlling aircraft is a C-130 aircraft at a 155,000-pound (70,307 kilograms) operational weight or a C-17 aircraft at a 580,000-pound (263,084 kilograms) operational weight.

4-41. Air Force airfields are classified into six mission categories. A controlling aircraft or combination of controlling aircraft has been designated for each category to establish limiting airfield, geometric, and surface strength requirements. These airfield categories include (see UFC 3-260-01)—

- Light – F15, C-17.
- Medium – F-15, C-17, B-52.
- Heavy – F-15, C-5, B-52.
- Modified Heavy – F-15, C-17, B-1.
- Auxiliary – F-15.
- Assault Landing Zone – C-130, C-17.

4-42. A bare base airfield is a site with a usable runway, taxiway, parking areas, and a source of water that can be made potable. It must be capable of supporting assigned aircraft and providing other mission-essential resources, such as a logistical support and services infrastructure composed of people, facilities, equipment, and supplies. This concept requires modular, mobile facilities, utilities, and support equipment packages that can be rapidly deployed and installed. A bare base airfield forms the baseline for contingency operations airfield planning.

4-43. On normal operational airfields, pavements are grouped into the following four traffic areas based on the intended use and design load:

- Type A. Those traffic areas that receive concentrated traffic and the full design weight of the aircraft. These traffic areas require a greater pavement thickness than other areas on the airfield and include all airfield runways and, in some cases, taxiways as well. All airfield pavement structures on contingency operations airfields are considered type A traffic areas.
- Type B. Those traffic areas that receive a more even traffic flow and the full design weight of the aircraft. These traffic areas include parking aprons, pads, and hardstands.
- Type C. Those traffic areas with a low volume of traffic or the applied weight of the operating aircraft is generally less than the design weight. These traffic areas include secondary taxiways and washrack pavements.
- Type D. Those traffic areas with an extremely low volume of traffic and/or the applied weight of the operating aircraft is considerably lower than the design weight.

4-44. An airfield can also be described based on its location within the AO:

- Forward airfields intended to provide focused logistics support and/or support combat missions of short-range aircraft such as attack helicopter and UASs during contingency operations. These airfields are designed to initial or temporary contingency operations standards depending on the mission and operational requirements and may be paved or semiprepared. These may be initially prepared or repaired as FACE tasks.
- Intermediate airfields intended to provide general logistics support, support combat missions of longer-range aircraft during contingency operations, and/or training. These airfields are designed to temporary or semipermanent standards depending on mission and operational

requirements. Normally these airfields are paved. These airfields provide a link between forward tactical airfields and sustainment level airfields.

- Airfields intended to provide logistics support forward from fixed, secure bases to support combat operations of long-range aircraft and/or training. These airfields are designed to be semipermanent or permanent facilities.

4-45. ERTs conduct area reconnaissance to collect technical information required to support FACE. This information can also provide the base level information for planning follow-on assessments and/or general engineering airfield support and a survey if necessary. The ERT focuses on collecting the minimum information required for the intended use of the facility. The ERT employs the appropriate components of the full airfield assessment as discussed in chapter 6 to understand the information required by the FACE mission. Additional technical expertise can augment the ERT when the information required exceeds the ERT resident capability. The focus of reconnaissance in support of FACE may include any or all of the following:

- Site drainage system structure.
- Design and condition of runways, taxiways, and hardstands.
- Availability of soils and other materials and their usefulness for improving subgrade.
- Type and thickness of the base course.
- Type and thickness of the surface course.
- Information on related facilities, including access and service roads, ammunition and POL storage areas, navigation aids, maintenance aprons, warm-up aprons, corrosion control facilities, control towers, airfield lighting, and other facilities.
- Environmental considerations to include applicable force health protection intelligence.

SUPPORT TO COUNTERMOBILITY OPERATIONS

4-46. Countermobility operations involve constructing reinforcing obstacles integrated with fires to inhibit the maneuver of an enemy force, increase the time for target acquisition, and increase weapon effectiveness. Commanders integrate obstacle planning into the MDMP, integrate obstacles into the concept of operations (primarily through proper siting), and maintain integration through obstacle turnover, protection, and tracking. The force constructs, emplaces, or detonates tactical and protective obstacles to reinforce existing obstacles. Tactical obstacles are designed and integrated with fires to achieve a tactical effect—disrupt, fix, turn, or block. The three types of tactical obstacles are directed obstacles, situational obstacles, and reserve obstacles. They are distinguished by the differences in execution criteria. Protective obstacles are a key component of survivability operations. ERTs are employed to conduct area reconnaissance of proposed locations of obstacle complexes.

OBSTACLE PLACEMENT

4-47. Terrain analysis is used to identify areas suitable for obstacles. Reconnaissance is used to determine the exact location of individual obstacles based on the enemy force (target), desired location of massed fires, tentative weapon system positions, and the intended effect (disrupt, fix, turn, or block). An area reconnaissance is conducted to verify that individual obstacles are covered by fires, note locations of fire control measures and obstacles, and record the appropriate data on range cards. (For a detailed discussion on obstacle integration and siting of obstacles, see FM 90-7.)

4-48. Terrain analysis is also used to identify areas suitable for situational obstacles. Reconnaissance is used to determine the best location on the ground for a situational obstacle based on the enemy force (target), desired location of integrated fires, tentative DP, and the intended effect (disrupt, fix, turn, or block). Area reconnaissance is conducted to verify that selected locations are suitable for SCATMINE or other situational obstacles.

4-49. The integrated obstacle plan may include the use of demolition obstacles in conjunction with other types of obstacles. Demolition obstacle planning requires detailed technical information to design the demolition attack and estimate the resources necessary. ERTs conduct area reconnaissance to collect specific technical information for planning the demolition of selected targets. The ERT is given any information available on the selected target and must understand the demolition objective. This information helps the ERT to determine the best method of destroying the target and to estimate the preparation time required. For example, if the reconnaissance party knows that manpower and time are limited but explosives are plentiful, they may design demolitions requiring few men and little time but large quantities of explosives. With the information provided below, the ERT conducts reconnaissance of the target collecting and reporting the information on DA Form 2203 (*Demolition Reconnaissance Record*). (See appendix B):

- Location and nature of the target.
- Proposed classification of the demolition (reserved or preliminary).
- Type of firing system desired (dual or single).
- Economy of effort (whether the demolition must be completed in one stage or multiple stages).
- Utility of the target during demolition operations (whether the target must remain open to traffic during demolition preparations).
- Amount of time allowed or expected between preparation and execution of the demolition operation.
- Amount of time allowed for changing the state of readiness (safe to armed).
- Labor and equipment available for preparing the demolitions.
- Types and quantities of explosives.

MAINTAIN OBSTACLE INTEGRATION

4-50. ERTs conduct area reconnaissance periodically to ensure emplaced obstacles remain integrated into the scheme of maneuver. The task includes turnover and transfer, protection, repair, and tracking of obstacles. Obstacle protection includes counterreconnaissance to prevent the enemy from gathering obstacle intelligence and enemy mobility asset destruction to ensure maximum effectiveness of obstacles. Obstacle tracking includes supervising achievement of key milestones as part of the unit's timeline (Classes IV/V forward, EA development initiated, siting completed), collation and dissemination of obstacle information, and maintenance of records.

SUPPORT TO SURVIVABILITY OPERATIONS

4-51. Survivability provides cover and mitigates the effects of enemy weapons on personnel, equipment, and supplies while simultaneously deceiving the enemy regarding the intentions of the force. Survivability operations range from employing camouflage, concealment, and deception (CCD) to the hardening of facilities, C2 nodes, and critical infrastructure. Engineers may be called on to mass their skills and equipment to augment combat units in developing defensive positions into fortifications or strong points and improving defensive positions (see FM 5-103). More often, however, engineers participate in and provide staff advice on CCD (see FM 20-3) measures and the hardening of facilities to resist the destruction of C2 facilities (as part of integrated plans), air and missile defense weapons systems, and support structures within the communications zone. Within a missile threat environment, engineers provide field fortification support to harden key assets against missile attacks. Protection includes survivability engineering applications to HN facilities and United States (U.S.)-operated facilities as protective measures against terrorist or extremist groups that threaten U.S. forces or national interests. Survivability also includes providing concealment and protective shelter from the effects of enemy weapons. ERTs conduct area reconnaissance to collect the technical information required to plan survivability operations.

FIGHTING POSITIONS

4-52. The creation of company- and battalion-sized BPs involves constructing numerous fighting and protective positions to meet the commander's intent for those particular sites. Although engineers assist with design and prioritization within the commander's guidance, the maneuver unit is responsible for siting each position and developing the BP. The maneuver unit representative (typically the unit first sergeant or

XO) and the ERT conduct an area reconnaissance to design primary, alternate, and supplementary fighting positions and decide correct placement to maximize terrain effectiveness. The ERT also collects information necessary to estimate the survivability effort required.

4-53. Within the battle position, protective obstacles provide friendly forces with close-in protection and are part of their protection plan. During the area reconnaissance to design the BP, the ERT assists with design of close-in protection by identifying appropriate locations to employ protective obstacles.

PROTECTIVE POSITIONS

4-54. A protective position is one that has been specifically modified and enhanced to repel or minimize enemy weapons effects against personnel, equipment, facilities, or battle functions. The supported force uses protective positions (natural or artificial), measures, or equipment to reduce the effects of enemy weapons systems. These positions may require the construction of checkpoints and entry control points, especially if constructed in support of stability operations. Protective positions provide cover and concealment for personnel, systems, equipment, supplies, and other materiel not directly involved in fighting, including medical patients. These positions reduce the risks associated with all forms of enemy contact, such as direct and indirect fires, enemy observations, employment of CBRN weapons, and so forth.

4-55. ERTs conduct area reconnaissance—

- To design protective positions for personnel, systems, equipment, supplies, and other materiel not directly involved in fighting and to decide correct placement to maximize terrain effectiveness.
- To design protective earth walls, berms, and revetments for personnel, systems, equipment, supplies, and other materiel not directly involved in fighting and to decide correct placement to maximize terrain effectiveness.
- To identify vulnerabilities to buildings that could leave personnel, operations, and equipment unprotected based on identified threats. Existing and/or temporary buildings may be used to house troops, operations, and equipment. Protecting conventionally constructed and temporary buildings from threats, which can include large explosives and indirect- and direct-fire threats, is an engineering challenge. The buildings may have to be strengthened, hardened, or shielded. They should be located away from perimeters, roadways, and vantage points.
- To plan or revise the plan to employ bridge protective systems of river approaches to selected bridges. Protective systems for an existing floating bridge or river crossing site protect the bridge/site from waterborne demolition teams, floating mines, or floating debris. The three types of floating protective systems are antimine booms, impact booms, and antiswimmer nets.

SUPPORT TO OTHER COMBAT OPERATIONS

4-56. ERTs conduct zone, area, and route reconnaissance with a reconnaissance focus linked directly to answering the CCIR but with a specified additional focus on the required technical information. While the basic principles associated with engineer reconnaissance support is similar in support of M/CM/S operations, there are specific considerations that apply only to certain other types of combat operations. This section provides considerations for tactical engineer reconnaissance support to urban operations, search operations, tunnels and subsurface operations, as well as operations in complex terrain. This section also includes brief discussions on both environmental and infrastructure reconnaissance in support of tactical operations.

URBAN OPERATIONS

4-57. ERTs support tactical reconnaissance operations in urban terrain with route, area, and zone reconnaissance integrated closely with tactical reconnaissance elements. In urban operations, the preferred means of employment is to task organize ERTs directly to maneuver battalion scouts or reconnaissance squadron troops to augment those units during tactical reconnaissance operations. Engineers teamed directly with dedicated reconnaissance assets add required technical skills to the team which can increase the tempo and effectiveness of the reconnaissance mission. But in urban operations, the ERT must be familiar with planning considerations unique to the urban environment. This discussion focuses on the following elements of planning for urban reconnaissance operations:

- Collect and analyze existing intelligence.
- Determine reconnaissance and surveillance objectives.
- Plan infiltration and exfiltration routes.
- Synchronize aerial and ground reconnaissance plans.
- Develop communications and sustainment plans.
- Coordinate for support.
- Continue to improve the urban operations sketch.

Collect and Analyze Existing Intelligence

4-58. The reconnaissance squadron conducts collaborative planning with the BCT/RCT. Tactical reconnaissance elements collect information to allow the BCT/RCT commander to gain an understanding of the AO and select the most advantageous COA. Because of their complex nature, urban operations (UO) require time for development of SU. HUMINT and signal intelligence (SIGINT) will be major contributors of the required information; however, time requirements for locating sources and corroborating information must be taken into consideration.

4-59. Crucial in the planning of urban reconnaissance operations is urban IPB (see FM 3-06 for detailed information). Urban IPB will involve numerous agencies, some of which are not only external to the Department of Defense (DOD) but also to the U.S. government as well—including nongovernmental organizations (NGO) and international agencies. The MI company has the technical capability and operational expertise to use multisource information and to conduct fusion, rapid analysis, and dissemination of intelligence down to the lowest possible level in the chain of command. The staff identifies all relevant forces, their strengths and critical vulnerabilities, and the critical nodes of the urban areas that, if controlled, may provide leverage. The IPB process must also take into account special considerations of urban infrastructure components, such as cultural mapping in the social component and the location of industrial or other sites that may have implications in terms of hazardous materials (HAZMAT) or weapons of mass destruction. Aerial sensors will prove vital in this effort; however, there will be extensive requirements for ground reconnaissance and HUMINT efforts to collect and/or corroborate information.

4-60. Urban IPB must consider the impact of noncombatants, whose presence in the urban area may be substantial and dynamic. Determining the ethnic and religious composition of the populace and, if possible, their intent—to flee or remain in the urban areas—may prove crucial.

4-61. Tactical reconnaissance operations focus efforts on collecting information about the urban area that supports the BCT/RCT commander's designated COA. This information may be directly linked to the CCIR or may support triggers established in the COA (targeting lethal and nonlethal effects).

4-62. The development and dissemination of standardized urban mapping products can enhance the success of urban reconnaissance operations. Most commonly, these products are based on aerial photographic products from UAS reconnaissance overflights or satellite imagery. Using digital systems, these products can be enhanced with graphic overlays showing unit/element sectors, building numbering systems, and key buildings, sites, and terrain features. They can then be distributed through hard copy reproduction or digital broadcasting. When tactically and technically feasible, units should gain access to city planner or civil engineer maps, which will provide detailed information on the urban area.

4-63. The UO sketches will include a reference system to identify buildings and streets. Naming conventions should be simple, allowing for ease of navigation and orientation in the urban environment (for example, odd-numbered buildings on the left side of streets, even numbers on the right). Street names should not be used as references because signs can be missing or can be changed to confuse friendly forces.

4-64. Units conduct initial map and/or aerial photograph reconnaissance to pinpoint key terrain and other important locations that can be identified in the AO. These areas include the following:

- Safe havens, including—
  - Hospitals.
  - Police stations.
  - Embassies.
  - Other (friendly) facilities.
- Hazardous areas, including—
  - Construction sites.
  - Industrial areas.
  - Dangerous intersections.
  - Bridges.
  - Criminal areas.
- Major terrain features, including—
  - Historical, cultural, or religious sites.
  - Parks.
  - Airports and train stations.

Determine Reconnaissance and Surveillance Objectives

4-65. From the understanding gained through analysis of existing intelligence, the staff begins to identify reconnaissance objectives based on the mission assigned by the BCT/RCT commander.

4-66. The IR identified by the staff may be complex, detailed, and extensive. The ability of the BCT/RCT commander to understand the AO/OE and accurately assess information regarding the terrain and the presence of friendly, threat, and noncombatant personnel is vital in developing reconnaissance objectives.

Note. Tactical reconnaissance elements not only answer the IR of the BCT/RCT but also those of higher level commanders (such as for a JTF or Army forces) as well.

4-67. The considerations for IR development in the urban environment are unique, placing greater demand on HUMINT and imagery intelligence (IMINT) sources. In developing objectives, the staff must weigh the assigned IR against the time available to accomplish the mission. The following are samples of IR that can help define reconnaissance objectives:

- What is the threat's most likely/most dangerous COA?
- Where are the threat's critical C2 nodes located?
- What is the status of the key LOCs leading into and within the urban area?
- What are the likely threat withdrawal routes and choke points?
- Are there obstacles impeding movement along the routes to and from assembly areas?
- Would isolation cause the threat to withdraw from the urban area?
- Has the deployed threat force had any training in UO?
- What are the potential vulnerabilities to the infrastructure facilities?
- Where are cross-mobility corridors located within the urban area?
- Where are cultural, political, or symbolic facilities located?
- How do locals (by faction) view friendly forces and U.S. efforts in general?
- What are the locations of diplomatic embassies and missions in the urban area?
- What are the locations of U.S. citizens (if any) within the urban area?
- Is the threat indigenous to the urban area or from the outside the area?

4-68. These IR examples demonstrate the need for detailed information collection planning. The key to successful urban reconnaissance is gathering information from outside the urban area and refining objectives as reconnaissance elements approach the area. Though time-consuming, this layered reconnaissance approach—"peeling back the onion"—will significantly increase the commander's and staff's ability to gain SU while reducing potential threats to Soldiers and Marines and assets.

Plan Infiltration and Exfiltration Routes

4-69. When tactically feasible, tactical reconnaissance elements enter the urban area using infiltration techniques that allow orientation on the reconnaissance objective without having to engage the threat or fight through prepared defenses. Elements will infiltrate to establish urban OPs and conduct surveillance or target acquisition on NAIs or targeted areas of interest (TAIs). Because reconnaissance teams may be required to remain during BCT/RCT operations, these elements must carefully select positions for them—as well as exfiltration routes if they are to leave the area during the conduct of the operation. A general rule of thumb is to exfiltrate on routes different from those used for infiltration. Parent and/or controlling units must also develop a plan to support the infiltrated teams.

Synchronize Aerial and Ground Reconnaissance Plans

4-70. During UO, it is most effective to task organize UAS assets to the lowest possible level. This will allow the company and troop commanders on the scene to control the employment of UAS and keep its use synchronized with reconnaissance operations. If the BCT/RCT chooses to maintain control of the UAS assets, it must ensure that the employment of the UAS supports the actions of the tactical reconnaissance elements and that these elements have direct access to the information being collected.

Develop Communication and Sustainment Plans

4-71. Communications in the urban environment require detailed planning that will allow units freedom of movement while maintaining C2 with elements dispersed within the urban environment. To communicate effectively and continuously, leaders must minimize limitations imposed by the urban environment and maximize the advantages of existing civil communications. Tactical reconnaissance elements must plan for redundant communications because of the limiting effects of urban terrain.

4-72. To ensure effective communications, the staff must identify terrain along the approach route and in the urban AO that supports line-of-sight communications. They then coordinate to establish retransmission sites on supporting terrain or structures to facilitate C2 during the units' initial entry into the urban area.

4-73. In developing a sustainment plan to support the urban reconnaissance, the staff should identify potential logistics release points (LRP) that can be secured by limited forces. Stadiums, warehouse facilities in industrial transportation areas, and schools in dispersed residential areas are examples of possible LRPs. If the reconnaissance elements are tasked to conduct sustained operations or transition to stability operations, LRPs can be expanded into logistical sites or operating bases. Because of security considerations and the limited support vehicles and supplies available, casualty evacuation and vehicle recovery are the main logistical functions that should occur within the urban area.

Coordinate for Fire Support

4-74. The staff must consider numerous factors when coordinating and planning targets that will support operations in an urban environment. The most likely mission that must be planned entails identifying targets to support disengagement from unexpected contact. Examples of fire support considerations for UO include the following:

- Do the ROE support the use of lethal fires within the urban area?
- Who controls each fire support asset?
- Has the fire plan been exchanged with adjacent units?
- Has the observer plan been developed, including OPs in buildings, location of laser designators, and overwatch of trigger points?

- Have locations of hazardous sites been identified? This includes both above- and below-ground sites (such as fuel and industrial storage tanks and gas distribution lines) and any other areas where incendiary effects of detonating artillery and mortar rounds could start structure fires.
- Has the general construction or composition of buildings and road surfaces been identified? This may affect the type of munitions used.
- Where do buildings, overhead power lines, or towers mask or degrade GPS devices and compasses?
- Will obscurants and illumination favor friendly or threat units?
- Will buildings or structures require fire support personnel to carry/use equipment not normally on hand (for example, field expedient antennas, climbing ropes, wire gloves, axes, or sledgehammers)?
- What are the requirements for radar coverage? Should radar zones be established? If so, where? For how long?

4-75. In addition to conventional munitions, the use of precision guided munitions (PGM) must also be carefully considered. The biggest consideration for using PGMs is that some sort of laser or infrared designator equipment must be available. In the event these assets are not available, augmentation may be required from the BCT/RCT.

4-76. Reconnaissance elements may be supported by a variety of attack helicopters. The increased risk of small arms, rocket propelled grenade, and man-portable air defense system engagements means aviation forces normally support UO by operating away from built-up areas. If the risk analysis determines that the payoff is higher than the risk, however, aviation forces can be employed in and around the urban area. The most common missions assigned to attack helicopters in UO are the following:

- Reconnaissance.
- Security of friendly locations.
- Isolation of urban objectives.
- Precision engagement of hardened point targets.
- Interdiction and destruction of threat armored vehicles moving against friendly forces.

4-77. In addition to these missions, aviation assets may be called on to perform additional, more nontraditional roles during UO. This is particularly true during stability operations in urban areas. Additional missions may include the following:

- Providing limited relay of radio messages from isolated ground units.
- Videotaping and/or photographing routes or objectives for later analysis by ground commanders.
- Assisting, for limited periods, in the control and coordination of fires with the maneuver of ground forces.
- Marking or identifying specific buildings and areas by smoke, fires, or targeting lasers.
- Providing navigational and directional assistance to ground units.
- Providing countersniper and countermortar armed reconnaissance patrols around friendly unit locations.

4-78. Reconnaissance elements may be supported by a variety of assault or lift helicopters. These assets can be crucial for the flexible and responsive movement of troops and supplies and for C2. The most common missions assigned to assault/lift helicopters in the urban environment are the following:

- Air assault.
- CASEVAC and medical evacuation.
- Air movement of troops and supplies.
- Emplacement of LRPs.
- C2 operations.
- Noncombatant evacuation operations.

- Electronic warfare operations.
- Combat search and rescue. (Marines perform tactical recovery of aircraft and personnel vice combat search and rescue.)
- Emplacement of volcano mines.

4-79. The need to deliver hovering fires from temporary BP may require the aircraft to carry less than a full load of munitions or fuel. This is especially true in hot climates and high altitudes. Reduced loads mean more frequent trips to FARP and less time on station. Long route distances during air movements may require the establishment of FARPs along the route prior to operations. Climate will also affect the number of troops or amount of supplies the aircraft can transport.

4-80. From the ground unit perspective, helicopters are most effective when they operate under the OPCON of the ground unit commander closest to the threat; therefore, company commanders and platoon leaders must be proficient in directing attack helicopter fires. At the same time, because ground reconnaissance leaders can direct the efforts of only a few aircraft at a time, it may be more effective for the aviation unit to retain control of its individual aircraft. They then operate by continuously rotating attack helicopter elements into the battle area where they then coordinate their attacks with the ground commander's maneuver.

Improving the Urban Operations Sketch

4-81. Because individual vehicles and sections execute urban reconnaissance operations, every Soldier and Marine must have an understanding of the sketch and reference system. In addition, sketches are critical to C2; they facilitate control in tracking units with greater detail and in obtaining precise location updates throughout operations.

4-82. The staff confirms and updates urban sketches during planning and execution of UO and continues to add more detail throughout the operation. Specifically, reconnaissance elements assess entry routes that the BCT/RCT could use in support of operations. Because most maps do not provide the necessary level of detail to meet these important operational considerations, selected reconnaissance elements will usually have to create overlays to enhance SU. Included with the sketches are overlays that categorize sections of the urban area by ethnicity, religious affiliation, and other prevailing characteristics that could affect operations. The consolidated sketches and overlays are used to create an urban map with overlays for the BCT/RCT.

SEARCH OPERATIONS

4-83. ERTs support military search operations by collecting technical information on the potential target of the search. The information collected through route, zone, or area reconnaissance supports the planning and targeting for subsequent search operations. While the ERT and search team are distinct and mission specific organizations, the ERT can be augmented by a military search advisor to ensure that the information collected is relevant to planned search operations. Each team has the potential to enable the other team.

4-84. Military search is the application of systematic procedures at every level of command to locate specified targets in support of military or civil police operations. Specified targets include people, information, and material resources employed by an adversary. (Military search operations are discussed in detail in FM 3-34.210.) They include six standard search procedures:

- Person searches.
- Vehicle searches, incorporating deliberate vehicle checkpoints.
- Area searches.
- Route searches.
- Nondisruptive building searches (occupied).
- Disruptive building searches (unoccupied).

4-85. The reconnaissance conducted in support of planned search operations will include collection of information on terrain and likely hazard locations. For example, a route reconnaissance in support of a planned route search could focus on collecting information on the cover and concealment potential and vulnerable points along the route (such as the location of culverts and drainage ditches that may be employed to conceal hazards) and the amount of debris found along the route that could be employed to conceal hazards. Similarly, a reconnaissance in support of a force/venue protection would allow the identification of locations such as mortar base plates and attack routes into and away from fixed sites. For planned search operations, a search advisor must provide specific focus for the tactical engineer reconnaissance support required.

TUNNELS AND SUBSURFACE OPERATIONS

4-86. This section discusses reconnaissance to collect information on the use of tunnels, natural caves, or underground facilities by enemy forces. Caves and underground facilities can be used for command and control centers, logistics staging areas, hospitals, or fortifications. The larger underground facilities can be quite complex. They can be wired for electricity and communications and can have pumping stations for supplying air to lower levels. Caves can have many large chambers connected by passageways. Also, tunnel systems can have many large rooms joined by interconnecting tunnels. Search operations include a specified target, whereas the reconnaissance objective is to collect specified information. Search team organization and the reconnaissance team organization may differ significantly as well.

Note. This section should not be confused with the discussion on reconnaissance of tunnels on routes which is included in chapter 5. Reconnaissance support involving tunnels and subsurface operations should not be confused with engineer support for military search operations (see FM 34.210).

Tunnel Uses

4-87. Tunnels can be dug with zigzags and sumps to reduce the effects inside them of small-arms fire, explosives, and gas. Some tunnels, rooms, passageways, or chambers can contain concealed exits to allow an enemy to hide or escape if the complex or cave is penetrated. Other tunnels can be booby-trapped to kill intruders. Tunnels and caves are hard to detect from the air or ground. Their construction can make them impossible to destroy with conventional ammunition. Tunnels can also be dug in the basement of safe houses for use as escape routes if a house is compromised. Tunnel entrances are normally covered by fire from another point on the complex.

4-88. An enemy can use tunnels in penetration operations to gain access to restricted areas. In built-up areas, they can infiltrate through sewers, or they can tunnel to their target from the basement of a nearby building, subway tunnel, or sewer. When insurgents are below the target, they can either build an exit and penetrate the target from below or fill the tunnel with explosives and destroy the target.

4-89. Tunnels are used for approach and escape and for access to caves and underground bunkers for firing positions and for protection against indirect fires. They are also used as a common method for storing food and materials in underground caches. If large enough, some tunnel complexes can house underground hospitals and base camps.

Tunnel Detection

4-90. The first step in detecting or locating tunnels is to reduce a large geographical area of interest to a smaller area of interest, to a smaller area of probable locations. This can be accomplished by studying indications of probable tunnel locations. Some indicators that tunnels are being employed by insurgent forces include—

- Movement of insurgents in a specific direction after being spotted by aircraft.
- Sniper fire occurring from areas where there are no obvious avenues of withdrawal.
- Vegetable gardens far from places of habitation.

- Operations where insurgents inflict casualties at relatively long range and disappear without making close contact or being detected by friendly forces.
- The smell of burning wood or food cooking in an area lacking habitation.

4-91. Conventional aerial photography produces results if the appearance of the surface and vegetation is changed from the normal. This requires skilled personnel to interpret photographs. In a jungle environment, aerial photography may be prohibited since dense vegetation, such as double or triple canopy jungle, obscures the ground.

4-92. Once determined that a certain area may contain a tunnel system, several indicators can be helpful in detecting tunnels. Visual inspections often disclose the general area of a tunnel but not its precise location. The key to finding a tunnel system is applying common sense to the situation. A platoon or company should be assigned a small search area (never larger than a 1,000-meter grid square). These small areas are chosen based on intelligence reports or on past actions of the insurgent force. The unit searches every square meter of the area. Some visual indicators usually found include—

- Worn places on trees that the insurgent uses as handholds.
- A small trail, much like a game trail, through brush into a clump of small trees.
- Cut trees—not a sure indicator.
- Limbs tied near the treetop to conceal the use of a tunnel from aircraft.
- Slight depression in or around a group of small trees.
- Air holes—sure indicators.
- A lone individual, mainly a female, in the area.
- Freshly cooked food with no one attending the site.
- Fresh human feces in the area.

4-93. These are all good indicators. However, they can vary depending on the area. The places to look for indicators are in the corners of hedgerows and trails and streams. The enemy often hides in these places in order to see without being seen. Also, hiding in these places allows those who finished the camouflage to escape undetected. The insurgents are aware of the danger of setting a pattern. However, they must have a location that provides observation as well as concealment. Soldiers and Marines should look for OPs that allow the insurgent to move into or out of an area undetected.

4-94. Sometimes, the exact location of a tunnel can be obtained by questioning the local populace or prisoners, who may have occupied or helped dig the system. Due to compartmentalization, they may not be able to locate an entrance or exit unless they have seen or used the completed tunnel.

Tunnel Reconnaissance

4-95. Entering an area where a tunnel complex is located requires a methodical approach. Security to the flanks and rear is imperative. The size of the objective area of operations determines the strength of the unit assigned the search mission. The unit, company, or platoon is task organized for tunnel operations.

- Security element—plus headquarters element to cordon search area.
- Search element—to search the immediate area for tunnels. The search element is subdivided into search and security teams.
- Reserve element—to assist in cordon and reinforce as needed.

4-96. The techniques of deliberate search are centered on the rifle squad. Each squad is divided into a security and a search team. A slow methodical search is conducted in the area of operations. Once assigned a search area, the squad systematically searches every square meter. The security element moves toward the limits of the search area. Once a hole (tunnel) is discovered, the security element surrounds the area while the search team prepares to destroy or neutralize the hole (tunnel).

4-97. The reconnaissance element may require the following special items to perform tunnel operations:

- Mine detector— used to detect ammunition and weapon caches.
- Grenades—fragmentary, smoke, white phosphorus, and concussion types. Grenades should not be used after friendly forces have entered a tunnel.

- Demolitions—used to destroy tunnel systems. Due to the complexity of charges needed to destroy some tunnel complexes, an engineer team should support the search unit. Also, the large amount of demolitions required for some operations can present unique logistics problems, mainly in a jungle environment. (See FM 3-06.11 for information on the urban environment).
- Air generator—used to force smoke into tunnel complex.
- Flashlights—to search tunnels.
- Weapons—Pistols should be used inside tunnels. The pistol has good stopping power and is effective at close range.
- Loudspeaker—used to call the enemy from tunnels.

Tunnel Destruction

4-98. The destruction of a tunnel is a four-step process:

- Step 1. A Soldier and Marine fires one or two magazines from a rifle into the tunnel entrance. This discourages the enemy from staying close to the entrance. After gaining the attention of the insurgents, the insurgents are told to vacate the hole or tunnel or be killed. They may surrender without a fight, saving not only the efforts of killing but also of excavating the hole or tunnel for weapons and documents.
- Step 2. If step 1 fails, breaching operations are used. A grenade is placed on the entrance cover to gain access. The entrance cover is removed in this manner to reduce the effects of any attached booby traps.
- Step 3. Once the entrance cover has been destroyed, the following measures are used (depending on the situation):
  - Insert grenades (fragmentary or concussion) to kill or incapacitate the enemy.
  - Insert smoke grenades to reveal the locations of other entrances or exits.
- Step 4. Soldiers and Marines then enter to ensure that all weapons and documents are recovered and all enemy (dead or wounded) are removed. The hole or tunnel is searched for small compartments built to hide weapons and ammunition. If a tunnel complex proves to be extensive with bunkers and large rooms, it is cleared systematically. Bunkers are destroyed or occupied to prevent the enemy from reoccupying them through another tunnel. Do not clear more bunkers than friendly forces can hold.

4-99. Deliberate search techniques emphasize where to look for the enemy (locations that provide the enemy with observation, cover, concealment, and an escape route). When the Soldier and Marine learns what to look for, any of these indicators are likely to trigger a mental alert that the enemy is not far away. After searching the tunnel destroy it with explosives.

4-100. Neutralization and clearing of tunnels are slow and deliberate procedures, which can be costly in terms of casualties. Since each tunnel system differs in size and construction, different quantities and placements of explosives are needed for each type.

- Block explosives. Using block explosives to destroy a tunnel system has a disadvantage and advantages:
  - Disadvantage: All the explosive power is concentrated at one point. Thus, the destruction is localized, and often portions of the tunnel are unaffected. However, a large (10- to 12-pound) block of explosive tamped against the ceiling may cause an entire tunnel to collapse.
  - Advantages: The ease of emplacement, ease of procurement, and feasibility of aerial resupply. Also, block or satchel charges are effective in destroying bunkers, sunken living quarters, underground rooms, and short tunnels. Cratering charges are also effective for underground rooms.
- Shaped charge. The shaped charge in tunnel destruction is effective in certain circumstances. A shaped charge placed underground in the middle of a tunnel complex and aimed downward destroys the area around and above the charge. Also, a shaped charge placed in a deep complex and aimed upward results in extensive destruction.

- Bangalore torpedoes. Another effective method of tunnel destruction uses bangalore torpedoes placed throughout the tunnel length (regardless of depth). The constant length of explosives throughout the tunnel ensures complete destruction. The bangalore (5 feet long) adapts to the twists and turns in tunnels. A disadvantage of a bangalore torpedo is the logistics problems arising from its size and weight. Resupply may be a problem if large quantities are used to destroy a tunnel system.

COMPLEX TERRAIN

4-101. Tactical reconnaissance will require engineer support in all types of terrain and climate. Each environment's advantages and disadvantages are considered in the planning and conduct of ERT operations. ERTs conduct route, zone, and area reconnaissance in jungles, mountainous areas, deserts, cold regions, and employ specialized knowledge, skills, techniques, and equipment for each of these areas. This section presents characteristics of four environments which impact tactical engineer reconnaissance support and their associated considerations.

Jungles

4-102. Jungles are humid, tropic areas with a dense growth of trees and vegetation. Visibility is typically less than 100 feet, and areas are sparsely populated. Mounted infantry and armor operations are limited in jungle areas, and jungle vegetation provides excellent concealment from air and ground observation. Vegetation does not provide adequate cover from small caliber direct-fire and artillery indirect-fire fragments. Adequate cover is available using the natural ravines and gullies produced by erosion from the area's high annual rainfall. Few natural or locally procurable materials are available in jungle areas. Other considerations are high water tables, dense undergrowth, and tree roots (often requiring aboveground level protective construction).

4-103. The focus of engineer reconnaissance support in jungle terrain is influenced by the engineer tasks typically conducted. The following discussion highlights common M/CM/S tasks requiring engineer reconnaissance in jungle terrain.

4-104. The construction and maintenance of roads/tracks/trails are the initial means of improving mobility. Heavy rainfall, the clearance of vegetation, drainage, and the movement of equipment and materials all combine to make this a long and painstaking task. Once constructed, routes will need regular maintenance. Landing sites and drop zones will also need to be constructed to enhance the ability to move troops and stores by air transport and helicopters. However, with training and advice, other nonengineer troops should also be able to take on some of these tasks. Crossing obstacles, such as large rivers, may require engineer advice, support and, possibly, equipment; but once suitable material for the construction of boats, rafts, and small bridges has been provided, other troops will often be able to complete the task. Bridging of obstacles to allow vehicle passage normally requires special equipment and should remain an engineer task. Minefields in the jungle are likely to be of the nuisance or protective variety and will remain an engineer task for clearance. Engineers may also be required to breach enemy defensive positions and to clear booby traps and other EHs.

4-105. The main countermobility tasks for engineers will be to block roads/tracks/trails, lay mines and booby traps (where ROE permit), and to carry out demolitions. Blocking roads/tracks/trails is always particularly effective to provide opportunities for counteraction, such as ambush or air strike. Countermobility tasks may also assist in developing a deception plan—provided it is coordinated at the highest appropriate level.

4-106. Engineers may be required to construct defensive positions, field fortification (including artillery gun positions), and protective locations for combat supplies.

4-107. Engineers will have a large variety of other tasks and commitments which will demand their advice and attention. In the early states of a deployment, the engineers are more likely to be concerned with establishing a secure base.

Mountainous Areas

4-108. Characteristics of mountain ranges include rugged and poorly trafficable terrain, steep slopes, and altitudes greater than 1,600 feet. Irregular mountain terrain provides numerous places for cover and concealment. Because of rocky ground, it is difficult and often impossible to dig below ground positions; therefore, boulders and loose rocks are used in aboveground construction. Construction materials used for both structural and shielding components are most often indigenous rocks, boulders, and rocky soil. Often, rock formations are used as structural wall components without modification. Conventional tools are inadequate for preparing individual and crew-served weapons fighting positions in rocky terrain. Engineers assist with light equipment and tools (such as pneumatic jackhammers) delivered to mountain areas by helicopter. Explosives and demolitions are used extensively for positions requiring rock and boulder removal. (FM 3-97.6 provides detailed information on mountain operations.)

4-109. The focus of engineer reconnaissance support in mountainous terrain is influenced by the engineer tasks typically conducted. The following discussion highlights common M/CM/S tasks in mountainous terrain.

4-110. Mobility support is likely to be the major task, particularly the construction, improvement, and maintenance of routes. Main supply routes may be vulnerable particularly where they run through defiles. The provision of drainage and bridging is likely to be required because of the large number of mountain streams and their susceptibility to flash flooding. New bridges may be required to cross streams, replace weak bridges, and cross gorges. Constructing new routes is likely to involve major engineering work especially excavation and fill. Because of the shortage of routes and restricted access, the following mobility tasks will also assume particular significance:

- Obstacle clearance.
- Construction of passing and parking areas.
- Snow clearance.
- Helicopter landing sites.
- Tasks related to resupply by air.

4-111. As routes are restricted, the effect of obstacles will be greatly enhanced. Blocking roads and passes, destroying tunnels, and laying mines are particularly effective in rugged terrain. Care must be taken not to restrict the movement of your own forces. All obstacles may have to be coordinated at a higher formation level than for normal operations.

4-112. Digging in may be difficult even when using explosive means. It is likely that defensive positions will largely be based on raised fortifications and sangars. The construction of defensive positions remains an all arms/branches responsibility but engineers may be called upon to provide advice and enhanced engineer capabilities to support their efforts. Some measure of tunneling may even be required. Irregular mountain terrain provides many opportunities for cover and concealment. Light engineer equipment transported by helicopters can provide valuable assistance in protecting maneuver units. There may also be the need to construct support bases for indirect-fire weapons.

4-113. Other common engineer tasks may include—

- Construction and operation of aerial ropeways.
- Construction of logistic facilities.
- Antihelicopter measures.
- Support to remote signals sites.
- Geographic and survey support.

Deserts and Extremely Hot Conditions

4-114. Deserts are extensive, arid, treeless, suffer from a severe lack of rainfall, and possess extreme daily temperature fluctuations. The terrain is sandy with boulder-strewn areas, mountains, dunes, deeply eroded valleys, areas of rock and shale, and salt marshes. Effective natural barriers are found in steep slope rock formations. Wadis and other dried up drainage features are used extensively for protective position placement. Camouflage and concealment, as well as light and noise discipline, are important considerations in desert terrain. Target acquisition and observation are relatively easy in desert terrain. (FM 90-3 provides detailed information on the considerations associated with desert operations.)

4-115. The focus of engineer reconnaissance support in desert terrain is influenced by the engineer tasks typically conducted. The following discussion highlights common M/CM/S tasks in desert terrain.

4-116. The vastness of the desert makes mobility a prime concern. Cross-country mobility may be poor in soft sand, rocky areas, and salt flats. Greater engineer reconnaissance effort will be needed to identify routes, existing obstacles, and minefield locations. Engineer tasks may include—

- Assisting maneuvers by reducing slopes, smoothing rock steps, and maintaining routes.
- Providing dry-gap crossings including those required to traverse oil pipelines.
- Increasing weight-bearing capacity through soil stabilization to provide good roads or sites for aircraft landing strips or helicopter landing zones.
- Suppressing dust using, for example, diesel fuel or oil mixtures.
- Obscuring enemy lines of sight during breaching operations.

4-117. A minefield, to be of any tactical value in the desert, must usually cover a relatively large area, so mechanical means are best suited for employment. SCATMINEs may also be widely used. Since there are often too many avenues of approach to be covered with mines, it is usually best to employ tactical minefields to cover any gaps between units, especially for night defense. Target-oriented obstacles may often be the best choice to reduce the enemy's mobility. Terrain dependent obstacles may be extensive and must be used in conjunction with each other and with any natural obstacles. All should support EAs.

4-118. Sand is effective in covering mines. However, shifting sand creates potential problems such as exposing the mines (causing them to malfunction) or accumulating excessive sand (degrading performance). Shifting sand can also cause mines to drift. Antitank ditches require extensive preparation time and may require extensive maintenance. Caution must be exercised to prevent the ditch from identifying a defensive front or flank and to deny their use as protection for enemy infantry.

4-119. Deserts provide little cover and concealment from ground-based observers and even less from aircraft. Because of the lack of concealment, camouflage must often be used. Hull and turret defilade positions for tactical vehicles may be important. Dispersion and frequent moves are other survivability techniques. Preparation of fortifications in the desert is difficult. Sandy soil requires revetments, while rocky plains or plateaus may be impossible to dig in. To counter this problem, emplacements are built up with rocks and depressions are used whenever possible. Hardening of logistics facilities, C2 nodes, and upgrades to or construction of forward landing strips and main supply routes are important in desert operations. A safety inspection of construction works is likely to be required daily, after any heavy rain, and after receiving direct or indirect fire.

4-120. Other engineer tasks that may be applicable in these conditions include analyzing terrain, providing water and fuel, and erecting sun shelters for equipment and personnel. Bridging may also be required for wadis or other gaps.

Arctic and Cold Regions

4-121. Cold regions of the world are characterized by deep snow, permafrost, seasonally frozen ground, frozen lakes and rivers, glaciers, and long periods of extremely cold temperatures. Digging in frozen or semifrozen ground is difficult with equipment and virtually impossible for the Soldier and Marine with an entrenching tool. Fighting and protective position construction in snow or frozen ground takes up to twice as long as positions in unfrozen ground. Operations in cold regions are affected by wind and the possibility of thaw during warming periods. An unexpected thaw causes a severe drop in the soil strength which creates mud and drainage problems. Positions near bodies of water, such as lakes or rivers, are carefully located to prevent flooding damage during the spring melting season. Wind protection greatly decreases the effects of cold on both Soldiers and Marines and equipment. (FM 3-97.11 provides detailed information on the considerations associated with arctic and cold region operations.)

4-122. The focus of engineer reconnaissance support in cold regions is influenced by the engineer tasks typically conducted. The following discussion highlights common M/CM/S tasks in cold regions.

4-123. Mobility will be impeded by snow, ice-covered terrain, weather, and long hours of darkness.

- Increased engineer effort will be necessary for the construction, improvement, and maintenance of forward airstrips, helicopter landing sites and roads, especially LOC roads, which are likely to be high priority targets.
- Roads and tracks may quickly become impassable to wheeled and tracked vehicles in heavy snowfalls. Snow clearance and route maintenance equipment must always be available.
- The LOC will often follow river valleys and cross many bridges which may make the gaps they cross become impossible to bypass if they are destroyed. There may be a major requirement for new bridges, overbridging, rafting, and/or ferrying. Improvisation is possible using ice and snow. (Technical Manual [TM] 5-349 provides a detailed discussion on the improvised use of ice in bridge operations.) Equipment bridging can be used but the following should be considered:
  - It must be used with care as light alloy and cast metal can become brittle at low temperatures.
  - Construction times are increased (normally doubled).
  - An adequate reserve of spare parts is required.
- Heating equipment and warming/drying facilities should be readily available.

4-124. Countermobility tasks are likely to concentrate on the limited routes available. Route denial, demolitions, and off-route mines will be particularly important. Minefields may also be used but the following must be considered in planning and laying:

- The effect of cold on materials.
- The reduced work rates in arctic and cold weather conditions.
- The variable performance of equipment and systems in deep snow conditions, especially SCATMINEs.
- The need for subsequent adjustment to be made after a fresh fall of snow or a sudden thaw.

4-125. Shelter is essential to survival. Preserving your own shelters and destroying the enemy's become important ends in themselves, which can influence the outcome of the battle. Measures to increase chances of survival from enemy action and from the hostile environment will include—

- Constructing field defenses—snow and ice fortifications with overhead protection using either improvised or equipment shelters and snow/ice concrete.
- Providing advice and assistance with countersurveillance plans and works.

4-126. Other engineer support includes increased resources for water supply and facilities for shelter with heating and lighting.

OTHER TYPES OF RECONNAISSANCE

4-127. Other types of engineer reconnaissance are generally intended to support a survey by more technical elements. Both the environmental assessment and infrastructure assessments tend to be linked to urban operations although not exclusively.

ENVIRONMENTAL ASSESSMENT

4-128. If the tactical situation permits, commanders conduct or direct an EBS before occupying the AO in conjunction with an environmental health site assessment (EHSA). An EBS is typically performed by or with support from and centered on general engineer elements supported by other technical specialties. An EHSA is performed by a team centered on preventive medicine personnel and supported by other technical specialties. ERTs may need to perform an initial site assessment to gather information for an EBS and/or the engineer portion of the EHSA with or without assistance from general engineers. (Chapter 6 discusses environmental reconnaissance in detail while appendix D provides detailed EBS guidance and an example.)

INFRASTRUCTURE ASSESSMENT

4-129. Infrastructure reconnaissance is accomplished in stages; the infrastructure assessment and the infrastructure survey. (The assessment and survey are in detail in chapter 6.) Since it is most likely that combat engineer units will be on site first, an ERT can be expected to conduct the initial assessment along with whatever other technical expertise is available in the unit it is supporting. The ERT uses a series of smartcards (see appendix C) to provide the initial infrastructure rating and assessment to be forwarded to more qualified personnel who follow in later stages of the mission. As operations continue, general engineer and other supporting technical support elements will be available to provide teams that are more qualified to perform an infrastructure survey. The infrastructure survey teams use the infrastructure assessments from the ERTs to prioritize categories and parts of the infrastructure to be reassessed in more detail via an infrastructure survey. (See appendix C and FM 5-104 for more information.)

Chapter 5

Technical Reconnaissance – Route Classification

The art of war is, in the last result, the art of keeping one's freedom of action.

Xenophon, Greek Historian (c. 430-355 BC)

ERTs and engineer assessment and survey teams collect technical information to determine a route classification for specified routes. **The *route classification* is assigned to a route using factors of minimum width and worst route type; least bridge, raft, or culvert military load classification; and obstructions to traffic flow.** The classification is displayed using a classification formula and route symbols on an overlay. The information collected is assembled and retained as supporting data for the formula and graphical representation. This data is also useful in planning and designing repairs and upgrades along the route. While ERTs provide a degree of technical expertise in many if not all of the route classification components, they operate as an integrated part of an overall tactical reconnaissance operation at the BCT/RCT level and below. The ERT would typically conduct a route reconnaissance, the tactical task, with a specified additional focus on collecting information required to assign the classification. Technical augmentation to ERTs adds to the degree of technical expertise available to collect more detailed information on specific route components: roads, bridges, tunnels, and so forth. Assessment and survey teams employ a routinely high degree of technical expertise and are focused nearly exclusively on detailed technical information required for design of repairs or upgrades along the route. The capabilities in both cases overlap substantially and could be conducted in phases. An ERT could conduct an initial route reconnaissance collecting only the technical information necessary to assign an overall classification. An augmented ERT could then be tasked to conduct an area reconnaissance to collect more detailed information on limiting factors along the route. Finally, using both the initial classification information and the subsequent information on limiting factors, an assessment or survey could be conducted to gather details necessary to design an upgrade. This chapter discusses the technical information required for a route classification, with the exception of bridges and other gap crossings discussed in chapter 6.

ROUTE CLASSIFICATION

5-1. Route classification results from collecting detailed technical information on various components of a designated route—such as the road network, the bridges along a selected route, any underpasses and/or overpasses, and so forth. Route classification provides a graphical display of both the load-carrying capacity and rate of travel capacity of the selected route. In a route classification, the designated route components are reconnoitered and a classification formula is determined. The resulting formula along with graphical information from the classification components are displayed as a route classification overlay, which may be included directly on the COP, and is supplemented by the components reports that were generated to determine the classification.

5-2. In a general sense, route classification is based on technical information collected on the various components of the selected route. In application, a route classification may include only the most critical details—such as if the route includes bridges with limited crossing capacity, underpasses with low overhead clearance, or critical sections of poorly maintained road. These components would be the determining components and possible sole components of a route classification. A route classification may also include alternate roads on which movement can be made and what type of vehicle and traffic load the alternate or bypass can handle. The route classification as discussed in this section includes a full menu of components that may be based on each situation critical to determining a route classification.

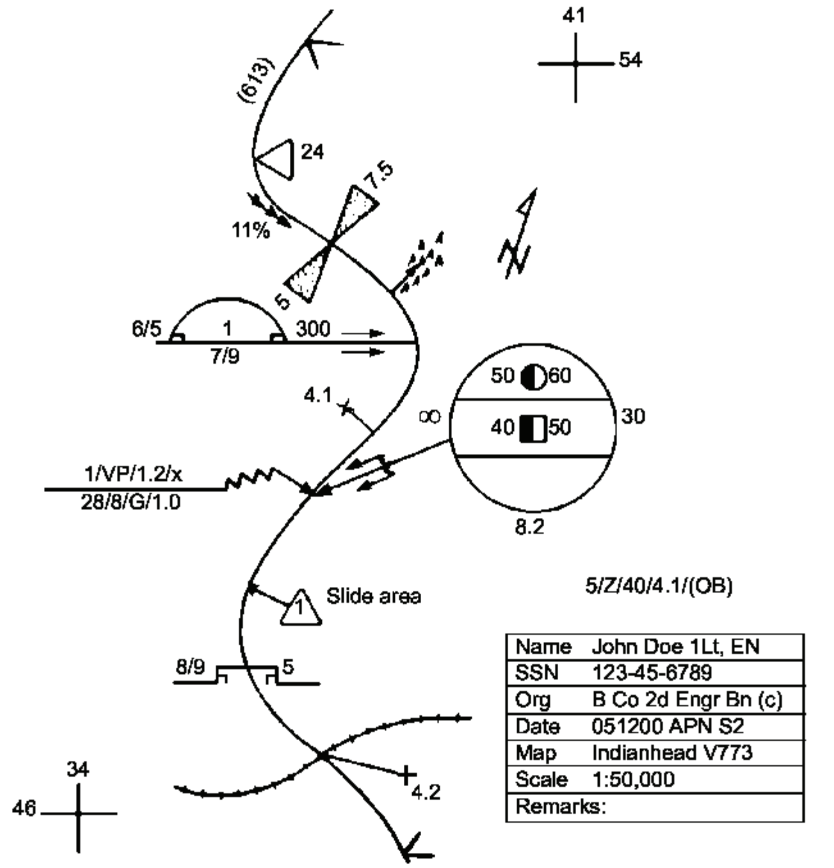
5-3. During combat operations, only the necessary and essential facts about a route are gathered as quickly and safely as possible from a route reconnaissance. ERTs are most likely employed to collect the required technical information, and the results of the ERT's route reconnaissance may or may not provide the detailed information necessary to determine a full route classification. Their tempo of operations will generally be dictated by the tempo of the reconnaissance element with which they are traveling. As the primary concern along a route shifts to tactical sustainment, the reconnaissance focus may shift to collecting information necessary to assess improvements along the route. ERTs may again be employed, but more likely a supporting general engineer element will be tasked to conduct the necessary assessment. During stability operations or as the primary concern along a route again shifts to operational sustainment, detailed route classification missions including a broader selection of the route components are performed to obtain in-depth information for upgrade or maintenance missions of, or along, the route.

5-4. Routes are classified by obtaining the most pertinent information concerning trafficability and applying it to the route classification formula as described in this chapter. DA Form 1248, *Road Reconnaissance Report*; DA Form 1249, *Bridge Reconnaissance Report*; DA Form 1250, *Tunnel Reconnaissance Report*; DA Form 1251, Ford Reconnaissance Report; and DA Form 1252, *Ferry Reconnaissance Repor*t, help organize the collected reconnaissance information. (These forms are covered in detail in appendix B.)

ROUTE CLASSIFICATION OVERLAY

5-5. A route classification overlay graphically depicts a route's network of roads, bridge sites, and other components. The route components are reconnoitered and the data recorded as support documentation for the complete route. A route classification overlay gives specific details on what obstructions will slow down a convoy or maneuver force along a route. The following information is included on the route classification overlay (see figure 5-1):

- The route classification formula.
- The name, rank, and Social Security number (SSN) of the person in charge of performing the classification.
- The unit conducting the classification.
- The date-time group (DTG) that the classification was conducted.
- The map name, edition, and scale. Ensure that a North arrow and grid reference marks are indicated on the overlay.
- Any remarks necessary to ensure complete understanding of the information on the overlay. Include a route name in this section when applicable. Include a legend for any nonstandard symbols used on the overlay.



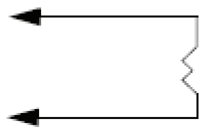
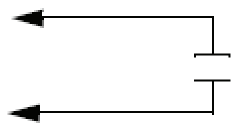
Name	John Doe 1Lt, EN
SSN	123-45-6789
Org	B Co 2d Engr Bn (c)
Date	051200 APN S2
Map	Indianhead V773
Scale	1:50,000
Remarks:	

Figure 5-1. Route classification overlay

BYPASSES

5-6. Bypasses are detours along a route allowing traffic to avoid an obstruction. Bypasses limited to specific vehicle types, such as those capable of swimming or deep-water fording, are noted on the reconnaissance report. Bypasses are classified as easy, difficult, or impossible. Each type of bypass is represented symbolically on the arrow extending from the tunnel, ford (see chapter 6), bridge (see chapter 6), or overpass symbol to the map location (see table 5-1 on page 5-4).

Table 5-1. Bypass symbols

	Bypass easy. Use when the obstacle can be crossed in the immediate vicinity by a U.S. 5-ton truck without work to improve the bypass.
	Bypass difficult. Use when the obstacle can be crossed in the immediate vicinity, but some work to improve the bypass is necessary (the estimation of time, troops, and equipment necessary to prepare the bypass is included on the reconnaissance report).
	Bypass impossible. Use when the obstacle can be crossed only by repairing the existing or constructing a new bridge or tunnel or by constructing a detour.

ROUTE CLASSIFICATION FORMULA

5-7. The route classification formula is derived from information gathered during the route reconnaissance and/or reconnaissance of key components of the route. The formula is recorded on the route classification overlay (see figure 5-1 on page 5-5) and consists of the following:

- (1) Route width, in meters.
- (2) Route type (based on ability to withstand weather).
- (3) Lowest military load classification (MLC).
- (4) Lowest overhead clearance, in meters.
- (5) Obstructions to traffic flow (OB), if applicable.
- (6) Special conditions, such as snow blockage (T) or flooding (W).

Example
in (1) / (2) / (3) / (4) (5) (6) format
5.5 / Y / 30 / 4.6 (OB) (T or W)

(1) ROUTE WIDTH

5-8. The route width is the narrowest width of traveled way on a route (see figure 5-2). This narrow width may be the width of a bridge, a tunnel, a road, an underpass, or other constriction that limits the traveled-way width. The number of lanes is determined by the traveled-way width. The lane width normally required for—

- Wheeled vehicles is 3.5 meters.
- Tracked vehicles is 4.0 meters.

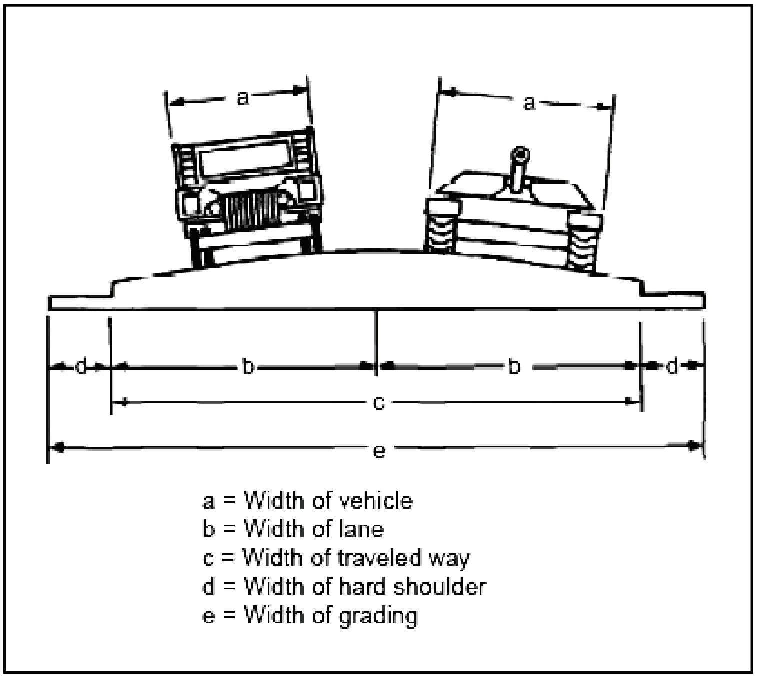


Figure 5-2. Route widths

5-9. According to the number of lanes, a road or route can be classified as follows:

- Limited access—Permits passage of isolated vehicles of appropriate width in one direction only.
- Single lane—Permits use in only one direction at any one time. Passing or movement in the opposite direction is impossible.
- Single flow—Permits the passage of a column of vehicles and allows isolated vehicles to pass or travel in the opposite direction at predetermined points. It is preferable that such a route be at least 1.5 lanes wide.
- Double flow—Permits two columns of vehicles to proceed simultaneously. Such a route must be at least two lanes wide.

(2) ROUTE TYPE

5-10. The route type is determined by its ability to withstand weather. It is determined by the worst section of road on the entire route and is categorized as follows:

- Type X—An all-weather route that, with reasonable maintenance, is passable throughout the year to a volume of traffic never appreciably less than its maximum capacity. This type of route is normally formed of roads having waterproof surfaces and being only slightly affected by rain, frost, thaw, or heat. This type of route is never closed because of weather effects other than snow or flood blockage.
- Type Y—A limited, all-weather route that, with reasonable maintenance, is passable throughout the year but at times having a volume of traffic considerably less than maximum capacity. This type of route is normally formed of roads that do not have waterproof surfaces and are considerably affected by rain, frost, thaw, or heat. This type of route is closed for short periods (up to one day at a time) by adverse weather conditions during which heavy use of the road would probably lead to complete collapse.
- Type Z—A fair-weather route passable only in fair weather. This type of route is so seriously affected by adverse weather conditions that it may remain closed for long periods. Improvement of such a route can only be achieved by construction or realignment.

(3) MILITARY LOAD CLASSIFICATION

5-11. A route's MLC is a class number representing the safe load-carrying capacity and indicating the maximum vehicle class that can be accepted under normal conditions. Usually, the lowest bridge MLC (regardless of the vehicle type or conditions of traffic flow) determines the route's MLC. If there is not a bridge on the route, the worst section of road will determine the route's overall classification. (Appendix E provides additional discussion of the MLC.)

5-12. In cases where vehicles have a higher MLC than the route, an alternate route may be sought or an additional reconnaissance of the roads within the route may be necessary to determine whether a change in traffic flow (such as single-flow crossing of a weak point) will permit heavier vehicles on the route. When possible, ensure that the route network includes a number of heavy-traffic roads, as well as average-traffic roads. This helps staff planners manage heavy-traffic loads to decrease the bottleneck effect.

5-13. The entire network's class is determined by the minimum load classification of a road or a bridge within the network. The broad categories are—

- Class 50—average-traffic route.
- Class 80—heavy-traffic route.
- Class 120—very heavy-traffic route.

(4) OVERHEAD CLEARANCE

5-14. The lowest overhead clearance is the vertical distance between the road surface and any overhead obstacle (power lines, overpasses, tunnels, and so forth) that denies the use of the road to some vehicles. Use the infinity symbol (∞) for unlimited clearance in the route classification formula. (Points along the route where the minimum overhead clearance is less than 4.3 meters are considered an obstruction).

(5) ROUTE OBSTRUCTIONS

5-15. Route obstructions restrict the type, amount, or speed of traffic flow. They are indicated in the route classification formula by the abbreviation "OB." If an obstruction is encountered, its exact nature must be depicted on the route classification overlay. Obstructions include—

- Overhead obstructions such as tunnels, underpasses, overhead wires, and overhanging buildings with a clearance of less than 4.3 meters.
- Reductions in traveled-way widths that are below the standard minimums prescribed for the type of traffic flow (see table 5-2). This includes reductions caused by bridges, tunnels, craters, lanes through mined areas, projecting buildings, or rubble.
- Slopes (gradients) of 7 percent or greater.
- Curves with a radius of 25 meters and less. Curves with a radius of 25.1 to 45 meters are not considered an obstruction; however, they must be recorded on the route classification overlay.
- Ferries.
- Fords.

Table 5-2. Traffic flow capability based on route width

	Limited Access	*Single Lane*	*Single Flow*	*Double Flow*
Wheeled	At least 3.5 m	3.5 to 5.5 m	5.5 to 7.3 m	Over 7.3 m
Tracked and combination vehicles	At least 4.0 m	4.0 to 6.0 m	6.0 to 8.0 m	Over 8 m

(6) SNOW BLOCKAGE AND FLOODING

5-16. In cases where snow blockage is serious and blocks traffic on a regular and recurrent basis, the symbol following the route classification formula is "T." In cases where flooding is serious and blocks traffic on a regular and recurrent basis, the symbol following the route classification formula is "W."

5-17. The following are examples depicting the use of the route classification formula:

- 6.1m/Z/40/∞—A fair-weather route (Z) with a minimum traveled way of 6.1 meters and an MLC of 40. Overhead clearance is unlimited (∞) and there are no obstructions to traffic flow. This route, based on its minimum traveled-way width, accommodates both wheeled and tracked, single-flow traffic without obstruction.
- 6.1m/Z/40/∞ (OB)—A fair-weather route (Z) similar to the previous example, except there is an obstruction. This obstruction could consist of overhead clearances of less than 4.3 meters, grades of 7 percent or greater, curves with a radius of 25 meters and less, or fords and ferries. A traveled way of 6.1 meters limits this route to one-way traffic without a width obstruction. If the route is used for double-flow traffic, then 6.1 meters of traveled way is considered an obstruction and is indicated in the formula as an obstruction.
- 7m/Y/50/4.6 (OB)—A limited, all-weather route (Y) with a minimum traveled way of 7 meters, an MLC of 50, an overhead clearance of 4.6 meters, and an obstruction. This route width is not suitable for double-flow traffic (wheeled or tracked). This width constriction is indicated as OB in the route classification formula if the route is used for double-flow traffic.
- 10.5m/X/120/∞ (OB) (W)—An all-weather route (X) with a minimum traveled-way width of 10.5 meters, which is suitable for two-way traffic of both wheeled and tracked vehicles; an MLC of 120; unlimited overhead clearance; an obstruction; and regular, recurrent flooding.

CURVE CALCULATIONS

5-18. The speed at which vehicles move along a route is affected by sharp curves. Curves with a radius of 25 meters or less are obstructions to traffic and are indicated by the abbreviation "OB" in the route classification formula and identified on DA Form 1248 (see appendix B). Curves with a radius between 25.1 and 45 meters are recorded on the overlay but are not considered obstructions.

Measuring Methods

5-19. Several methods are used to measure curves: the tape-measure, triangulation, and formula methods.

Tape-Measure Method

5-20. A quick way to estimate the radius of a sharp curve is by using a tape measure to find the radius (see figure 5-3, page 5-8). Imagine the outer edge of the curve as the outer edge of a circle. Find (estimate) the center of this imaginary circle and then measure the radius using a tape measure. Start from the center of the circle and measure to the outside edge of the curve. The length of the tape measure from the center of the imaginary circle to its outer edge is the curve's radius. This method is practical for curves located on relatively flat ground and having a radius up to 15 meters.

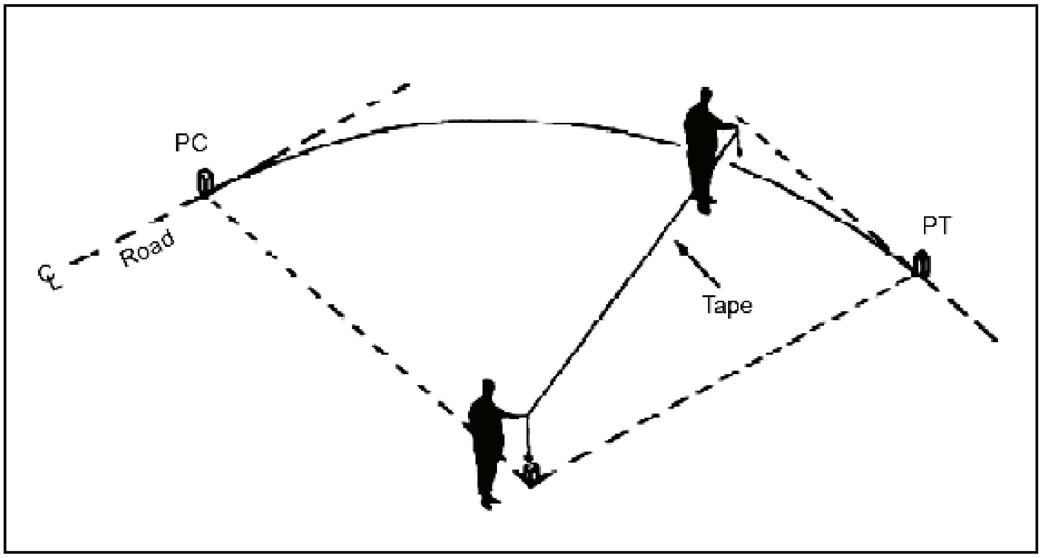


Figure 5-3. Tape-measure method

Triangulation Method

5-21. You can determine a curve's approximate radius by "laying out" right triangles (3:4:5 proportion) at the point of curvature (PC) and point of tangency (PT) locations (see figure 5-4). The intersection (o), which is formed by extending the legs of each triangle, represents the center of the circle. The distance (R) from point o to either point PC or PT represents the curve's radius.

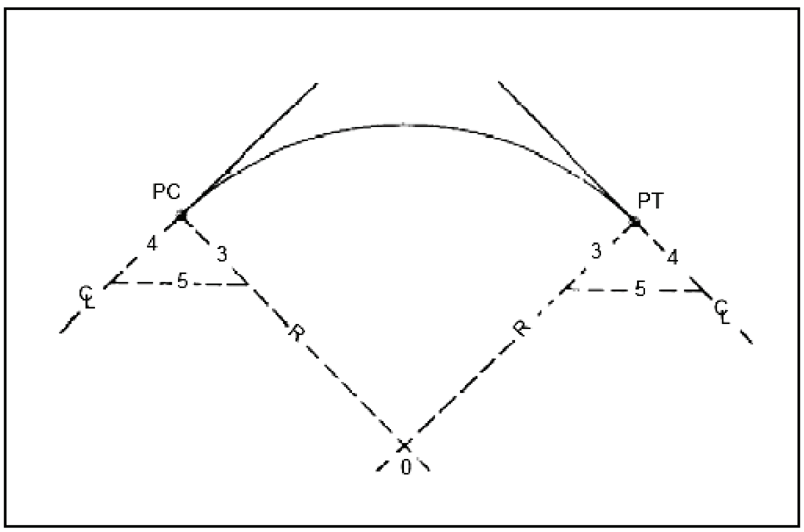


Figure 5-4. Triangulation method

Formula Method

5-22. Another method of determining the curve's radius (see figure 5-5) is based on the following formula (all measurements are in meters):

$$R = (C^2/8M) + (M/2)$$

R = radius of curve

C = distance from the centerline of the road to the centerline of the road at the outer extremities of the curve

M = perpendicular distance from the center of the tape to the centerline of the road

Note. When conditions warrant, set M at 2 meters from the centerline and then measure C^2 meters from the centerline. Use this method when there is a time limitation or because natural or manmade restrictions prevent proper measurements.

Example

If C is 15 meters and M is fixed at 2 meters, the formula becomes: $R = (15^2/16) + 2/2$

The result of this calculation R = (225/16) + 1 solve as R = 15.06 would be an obstruction to traffic flow, and “OB” would be placed in the route classification formula.

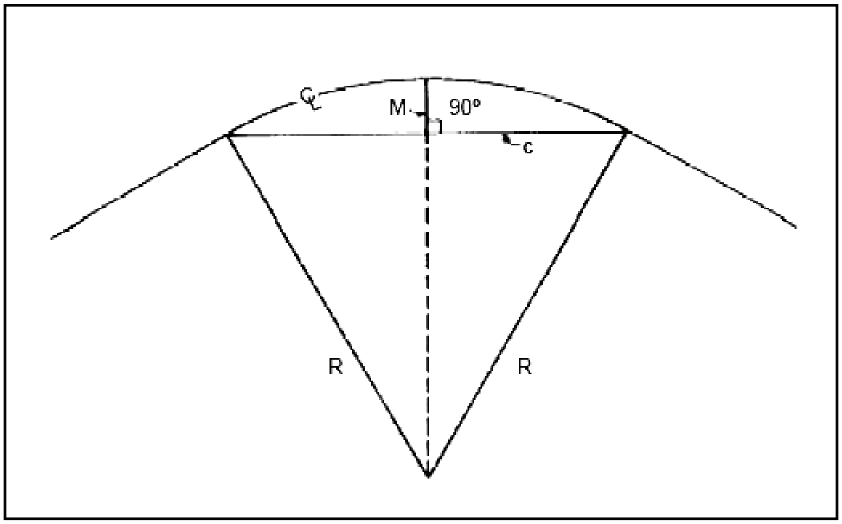


Figure 5-5. Formula method

Curve Symbol

5-23. Sharp curves with a radius of 45 meters or less are symbolically represented on maps or overlays by a triangle that points to the curve’s exact map location. In addition, the measured value (in meters) for the radius of curvature is written outside the triangle (see figure 5-6, page 5-10). All curves with a radius of 45 meters are reportable and need to be noted on DA Form 1248 (see appendix B).

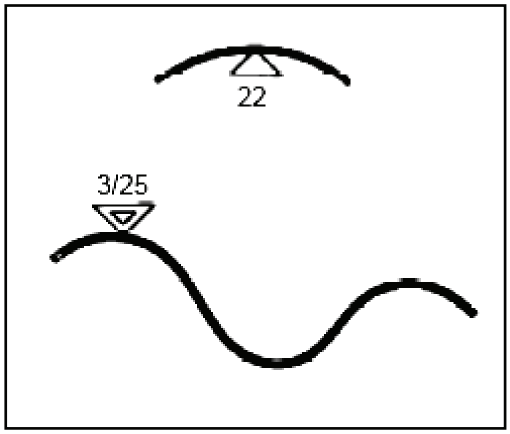


Figure 5-6. Curve symbols

Series of Sharp Curves

5-24. A series of sharp curves is represented by two triangles, one drawn inside the other. The outer triangle points to the location of the first curve. The number of curves and the radius of curvature for the sharpest curve of the series are written to the outside of the triangle (see figure 5-6).

SLOPE ESTIMATION

5-25. The rise and fall of the ground is known as the slope or gradient (grade). Slopes of 7 percent or greater affect the movement speed along a route and are considered an obstruction. The percent of slope is used to describe the effect that inclines have on movement rates. It is the ratio of the change in elevation (the vertical distance to the horizontal ground distance) multiplied by 100 (see figure 5-7). It is important to express the vertical distance and the horizontal in the same unit of measure. Report all slopes greater then 5 percent on the route classification overlay.

Percent of Slope

5-26. The following paragraphs discuss the methods used to determine the percent of slope.

Clinometer Method

5-27. A clinometer is an instrument that directly measures the percent of slope. It can be found in engineer survey units, as part of an artillery compass, and as part of an engineer platoon sketch set. (In some kits, the clinometer has been replaced by a surveying level. Follow the instructions included with the instrument.)

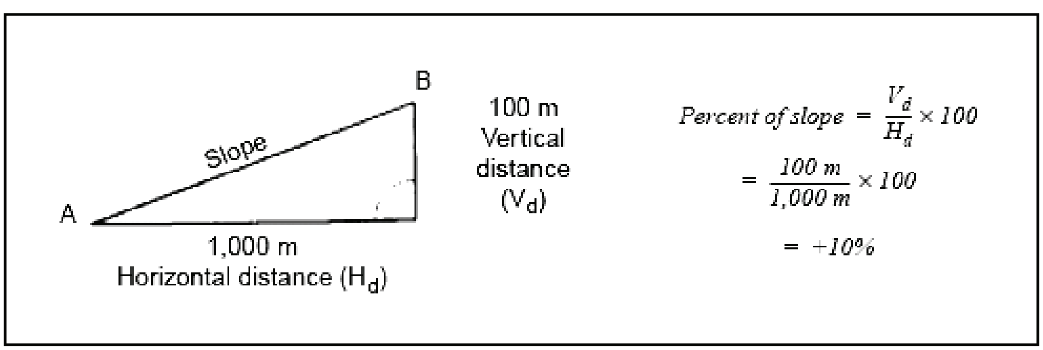
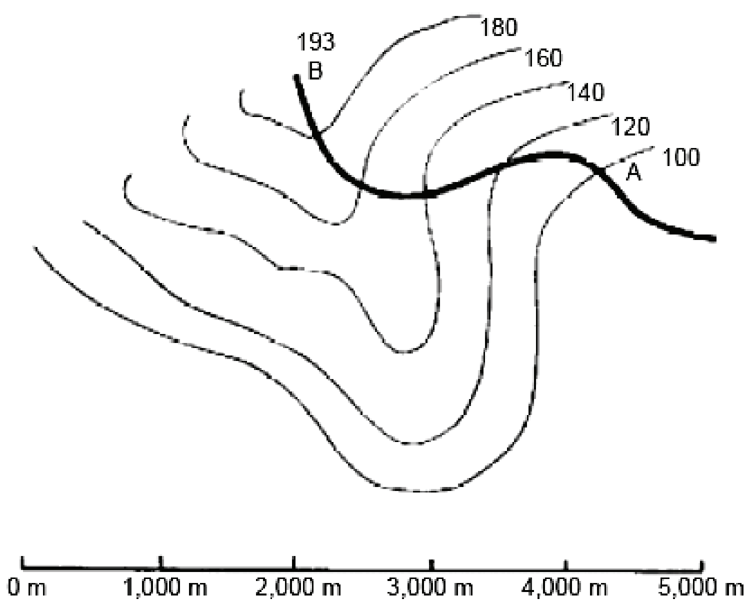


Figure 5-7. Percent-of-slope formula

Map Method

5-28. Use a large-scale map (such as 1:50,000) to estimate the percent of slope quickly. After identifying the slope on the map, find the difference in elevations between the top and bottom of the slope by reading the elevation contours or spot elevation. Then, measure and convert the horizontal distance (usually road distance) to the same unit of measurement as the elevation difference. Substitute the vertical and horizontal distances in the percent-of-slope formula and compute the percent of slope. (See figure 5-8.)



Find the difference in elevation (V_d)

Spot elevation B	=	193 m
Spot elevation A	=	100 m
Difference in elevation (V_d)	=	93 m

Find the horizontal distance (H_d)

Road distance A to B (use a piece of paper and graphic scale as shown in FM 21-26) = 3,720 m

Use the percent-of-slope formula.

$$\frac{V_d}{H_d} \times 100$$

$$= \frac{93}{3,720} \times 100$$

$$= +2.5\%$$

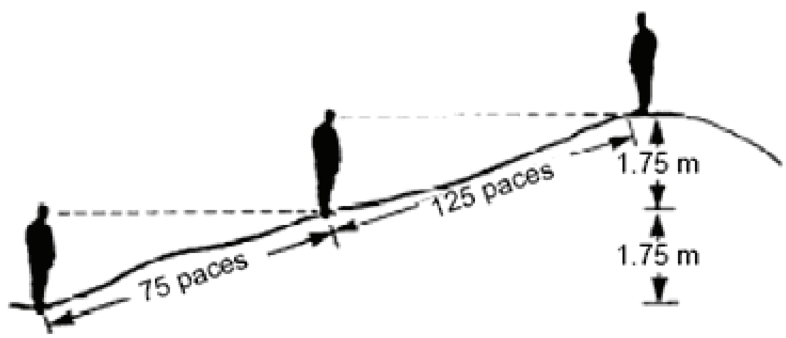
Figure 5-8. Map method to determine percent of slope

Pace Method

5-29. The pace method is a quick way to estimate percent of slope. Determine, accurately, the height and pace of each Soldier and Marine for each member of a reconnaissance team before using this method. As a rule of thumb, the eye level of the average Soldier and Marine is 1.75 meters above the ground. The pace of the average Soldier and Marine is 0.75 meter.

5-30. Perform the following procedures for the pace method:

- Stand at the bottom of the slope with head and eyes level.
- Sight a spot on the slope. This spot should be easily identifiable. If it is not, another member of the team should go forward to mark the location.
- Walk forward and stand on the marked spot. Record the number of paces. Repeat this procedure until you reach the top of the slope (estimate fractions of an eye level).
- Compute the vertical distance by multiplying the number of sightings by the eye-level height (1.75 meters). Compute the horizontal distance by totaling the number of paces and converting them to meters by multiplying by 0.75 (or the known pace-to-meter conversion factor).
- Calculate the percent of slope by substituting the values into the percent-of-slope formula (see figure 5-9). Because this method considers horizontal ground distance and incline distance as equal, you can obtain reasonable accuracy only for slopes less than 30 percent. This method requires practice to achieve acceptable accuracy. A line level and string can be used to train this method.



Find:	Percent of slope	=	
Given:	Eye-level height	=	1.75 m
	Pace	=	.75 m
Answer:	Vertical distance	=	2 x 1.75 m
		=	3.5 m
	Horizontal distance	=	(75 paces + 125 paces x .75
		=	150 m

$$Percent\ of\ slope = \frac{V_d}{H_d} \times 100$$

$$= \frac{3.50}{150} \times 100$$

Figure 5-9. Pace method to determine percent of slope

Angle-of-Slope Method

5-31. The angle-of-slope method is a quick way to estimate the percent of slope. The angle of slope is first measured by using an elevation quadrant, an aiming circle, an M2 compass, or binoculars with a standard reticle. If the instrument used to take the angle of measurement is mounted above ground level, the height difference must be compensated for by sighting above the slope a corresponding, equal distance. (The corresponding distance is the distance the instrument is above the ground). You must conduct the angle of measurement at the base of the slope. Once you obtain the angle of measurement, refer to table 5-3 and enter the column corresponding to the measured angle of slope. You can read the percent of slope directly from table 5-3 (see figure 5-10).

Table 5-3. Conversion of degrees and mils to percent of slope

Degrees of Slope	*Mils of Slope*	*Percent of Slope*
1	18	1.7
2	36	3.5
3	53	5.2
4	71	7.0
5	89	8.7
10	175	17.6
15	267	26.7
20	356	36.4
25	444	46.6
30	533	57.7
35	622	70.0
40	711	83.9
45	800	100.0
50	889	108.7
55	978	117.6
60	1,067	126.7

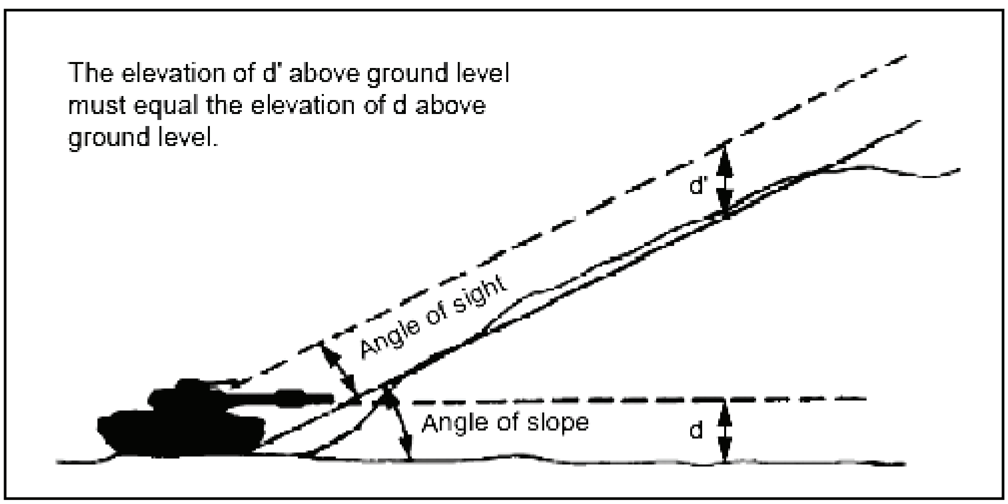


Figure 5-10. Angle-of-slope method to determine percent of slope

Slope Symbol

5-32. Most vehicles negotiating slopes of 7 percent or greater for a significant distance will be slowed. Such slope characteristics must be accurately reported. The symbols illustrated in figure 5-11, page 5-14, are used to represent various slopes.

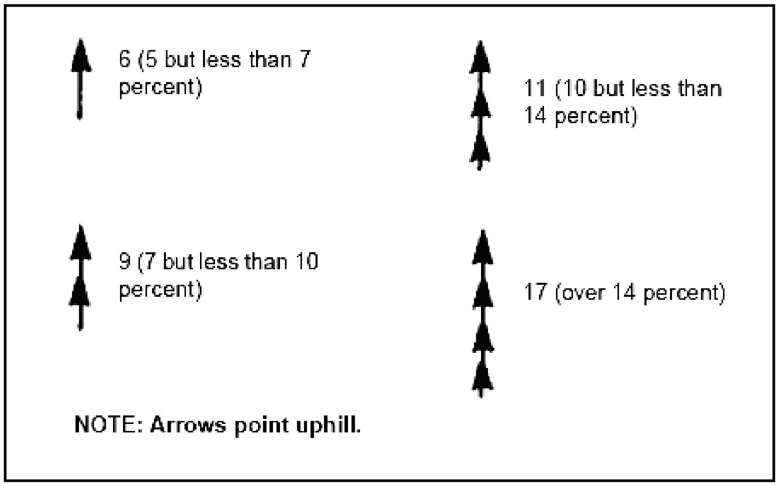


Figure 5-11. Percent-of-slope symbols

Description of Slope Symbols

5-33. A single arrowhead along the trace of a route pointing in the uphill direction indicates a grade of at least 5 but less than 7 percent. Two arrowheads represent a grade of at least 7 but less than 10 percent. Three arrowheads represent a grade of at least 10 but less than 14 percent. Four arrowheads represent a grade of 14 percent or more. A symbol is not required for slopes less than 5 percent.

5-34. The percent of slope is written to the right of the arrow (see figure 5-11). When the map scale permits, the length of the arrow shaft will be drawn to map scale to represent the approximate length of the grade.

> ***Note***. Slopes of 7 percent or greater are obstructions to traffic flow and are indicated by the abbreviation "OB" in the route classification formula.

CONSTRICTIONS

5-35. Reductions traveled-way widths (constrictions) include narrow streets in built-up areas, drainage ditches, embankments, and war damage. These constrictions may limit vehicle movement; therefore, the physical dimensions of the vehicles that will be using the route must be known and considered when conducting the route classification.

5-36. Constrictions in the traveled-way width below minimum requirements are depicted on maps and overlays by two opposing shaded triangles. The width of the usable traveled way (in meters) is written next to the left triangle. The length of the constriction (in meters) is written next to the right triangle (see figure 5-12).

> ***Note.*** Constrictions of traveled-way widths below the minimum standard for the type and flow of traffic are obstructions and are indicated by the symbol "OB" in the route classification formula.

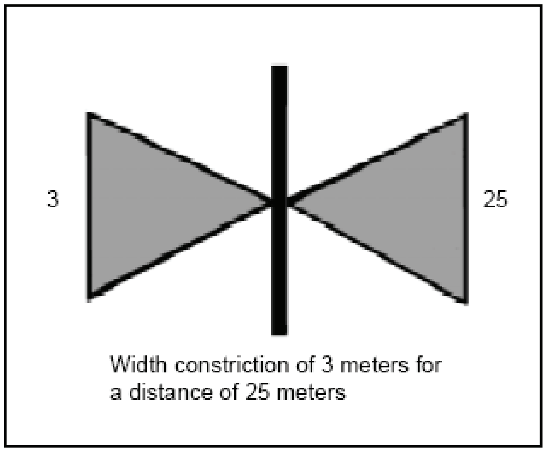


Figure 5-12. Route constriction symbol

UNDERPASSES

5-37. An underpass is depicted on a map or overlay by a symbol that shows the structure's ceiling. It is drawn over the route at the map location. The width (in meters) is written to the left of the underpass symbol, and the overhead clearance (in meters) is written to the right of the underpass symbol (see figure 5-13).

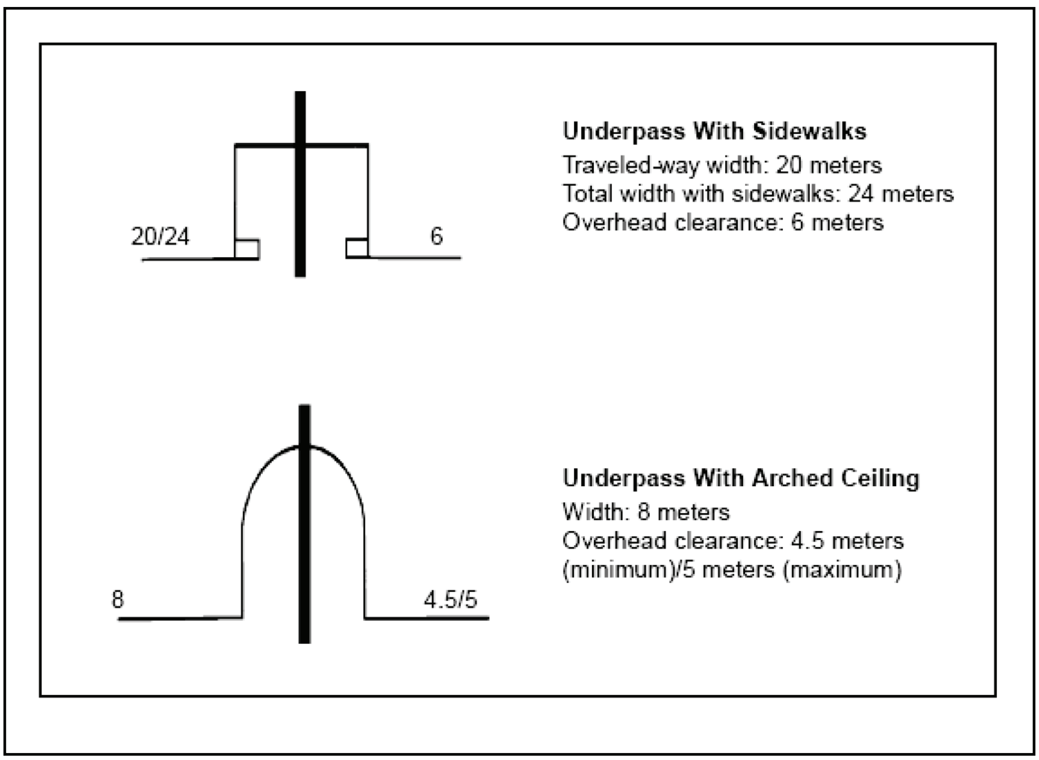


Figure 5-13. Underpass symbols

5-38. If sidewalks permit emergency passage of wider vehicles, the sidewalks are symbolically represented. This information should be noted on DA Form 1250 (see appendix B). The traveled-way width is recorded first, followed by a slash, and then the structure's total width, including sidewalks.

CAUTION

Items such as arched ceilings or irregularities in ceilings that result in a decrease in overhead clearance must be noted. In such cases, an extension of width may not mean that the structure will accommodate wider vehicles.

5-39. Both minimum and maximum overhead clearances, if different, will be recorded. The minimum will be recorded first, followed by a slash, and then the maximum overhead clearance.

TUNNELS ON ROUTES

5-40. A tunnel on a route is an artificially covered (such as a covered bridge or a snowshed) or an underground section of road along a route. A tunnels reconnaissance determines essential information such as the serial number, location, type, length, width (including sidewalks), bypasses, alignment, gradient, and cross section. Tunnel reconnaissance is reported on DA Form 1250 (see appendix B). A tunnel consists of a bore, a tunnel liner, and a portal. Common shapes of tunnel bores (see figure 5-14) are semicircular, elliptical, horseshoe, and square with an arched ceiling.

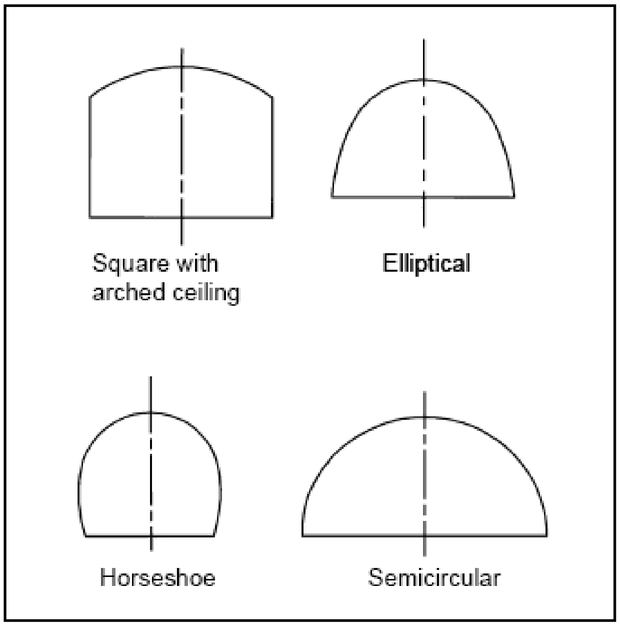
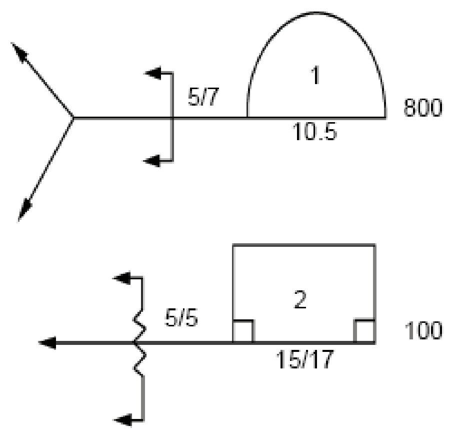


Figure 5-14. Types of tunnel bores

5-41. Basic tunnel information is recorded on maps or overlays using symbols (see figure 5-15). The location of the tunnel entrance is shown on a map or overlay by an arrow from the symbol to the location of the entrance. For long tunnels (greater than 30.5 meters), both tunnel entrance locations are indicated.



Tunnel Number 1
Minimum overhead clearance: 5 meters
Maximum overhead clearance: 7 meters
Traveled way: 10.5 meters wide; 800 meters long; easy bypass available

Tunnel Number 2
Minimum overhead clearance: 5 meters
Maximum overhead clearance: 5 meters
Traveled way: 15 meters wide (17 meters total including sidewalks); 100 meters long; difficult bypass available

Figure 5-15. Tunnel symbols

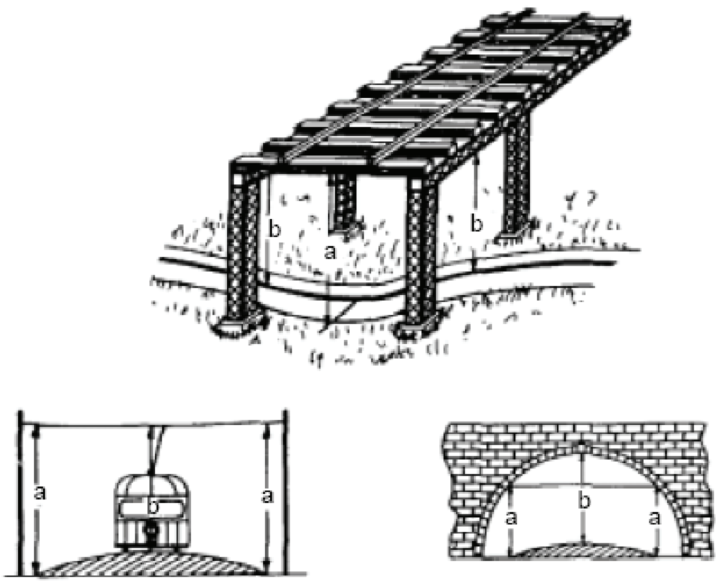
5-42. For later reference, a serial number is assigned to each tunnel. (Check for an existing fixed serial number on the actual tunnel or map sheet; if it does not have a serial number, assign a number based on the unit's SOP.) Serial numbers are not duplicated on any one map sheet, overlay, or document. The number is recorded inside the symbol. The traveled-way width is shown in meters and is placed below the symbol.

5-43. If sidewalks permit the emergency passage of wider vehicles, then the sidewalks are symbolically represented and the traveled-way width is written first, followed by a slash, and then the total width including the sidewalks.

CAUTION

Structures with arched or irregular ceilings will decrease overhead clearance. An extension of width does not always mean that the structure will accommodate wider vehicles.

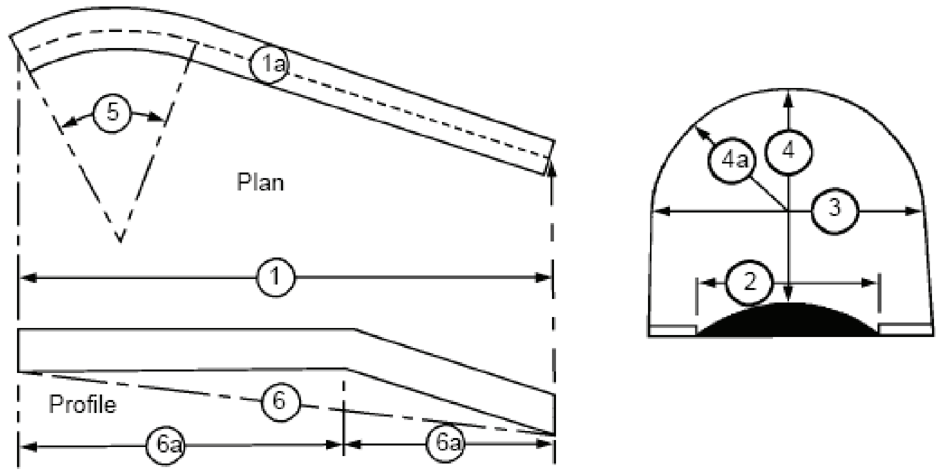
5-44. Overhead clearance is the shortest distance between the surface of a traveled way and any obstruction vertically above it. The measurement of overhead clearance must be accurate. Obtain the measurements shown in figure 5-16 (page 5-18) and figure 5-17 (page 5-19) and record them on DA Form 1250 (see appendix B).



a - Minimum measurement (always taken at the outside edge of the traveled way)
b - Maximum measurement (always taken at the center of the road)

Figure 5-16. Overhead clearance measurements

5-45. The reconnaissance element records a general description and sketch of what the tunnel entrances (portals) look like and the composition. The portal view information and sketch are recorded (see figure 5-18 on page 5-20) on DA Form 1250 (see appendix B).



1 - Portal-to-portal length of tunnel
1a - Centerline distance of tunnel
2 - Effective width of the traveled way, curb to curb
3 - Horizontal clearance (minimum width of the tunnel bore measured at least 4 feet above the traveled way
4 - Overhead clearance (minimum distance between the top of the traveled way and the lower edge of the tunnel ceiling or any obstruction below the ceiling, such as trolley wires or electric light wires)
4a - Rise of tunnel arch (radius of curved portion)
5 - Radius of curvature of the traveled way, either measured or estimated
6 - Gradient (percentage of rise of the traveled way between portals)
6a - Change in gradient within the tunnel (percentage of rise each way from break of grade)

Figure 5-17. Dimensions required for tunnels

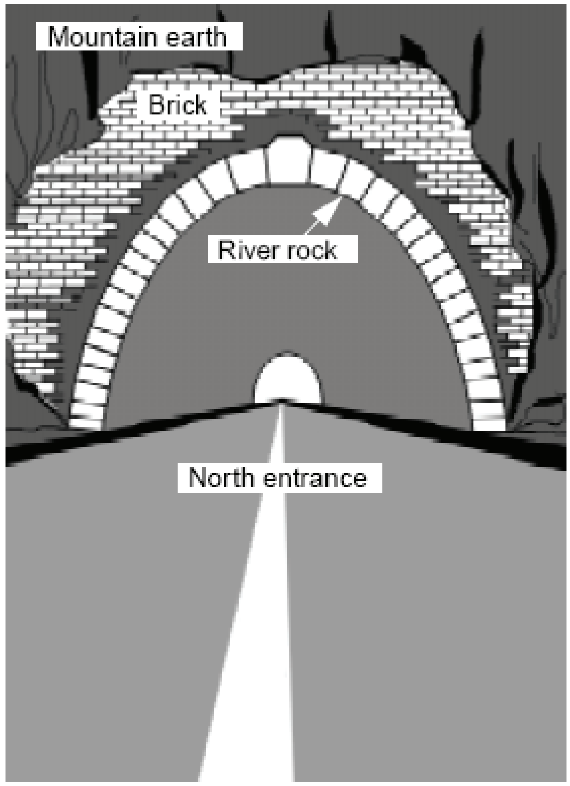


Figure 5-18. Portal view of tunnel

ROAD RECONNAISSANCE PROCEDURE

5-46. A road reconnaissance collects detailed technical information on the engineering characteristics and trafficability of a road or road section within a route. Report results of a road reconnaissance on DA Form 1248 (see appendix B).

5-47. In general, a road consists of a road surface, base course, and subgrade (see figure 5-19).

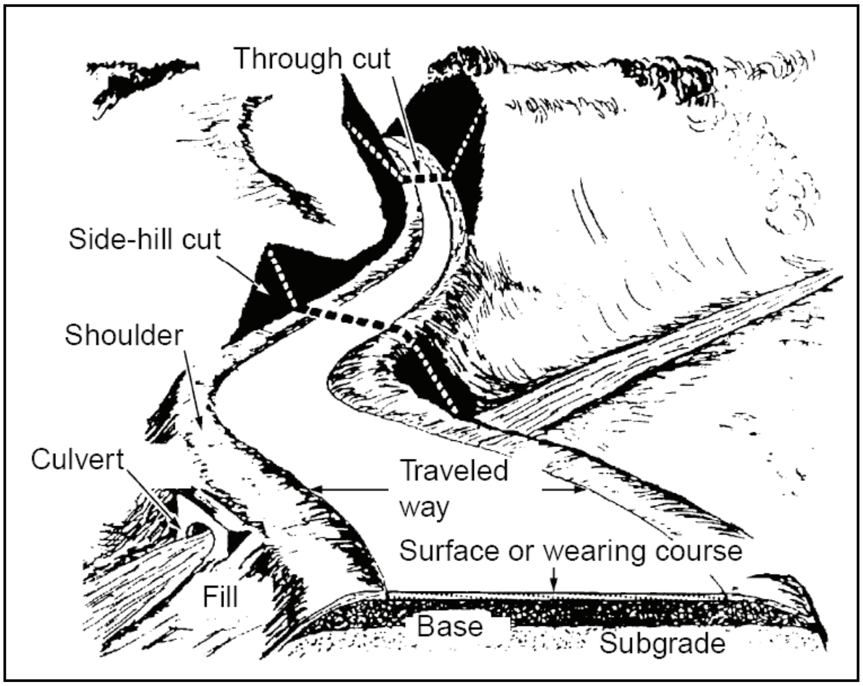


Figure 5-19. Parts of a road

SOIL TYPES AND CHARACTERISTICS

5-48. Identifying the soil type used in road construction is a critical component of the road reconnaissance. Soils, stabilized when necessary, form the subgrade and base course for the vast majority of roads. Soils are considered according to type, characteristics, and allowable foundation bearing pressure. See table 5-4 (page 5-22) and table 5-5 (page 5-23). Soil types (table 5-4) range from gravel and sandy soils to clay and silty soils. The principal soil type described in table 5-4 is further analyzed in table 5-5 including an allowable bearing pressure. The allowable bearing pressure is expressed as a California Bearing Ratio (CBR) and which is then used in determining the load-bearing capacity of a flexible road surface.

Note. The CBR is a measure of the shearing resistance of soil under controlled density and moisture conditions (figure 5-20, page 5-26). It is expressed as a ratio of the unit load required to force a piston into the soil to the unit load required to force the same piston the same depth into standard crushed stone.

Table 5-4. Principal soil types

Name	***Description***
Gravel	A mass of detached rock particles, generally water worn, which passes a 3-inch sieve and is retained on a No. 4 sieve (0.187 inches).
Sand	Granular material composed of rock particles which pass a No. 4 sieve (0.187 inches) and are retained on a No. 200 sieve (0.0029 inches). It is difficult to distinguish sand from silt when the particles are uniformly small. Dried sand, however, differs from silt in that it has no cohesion and feels grittier.
Silt	A fine, granular material composed of particles which pass the No. 200 sieve (0.0029 inches). It lacks plasticity and has little dry strength. To identify, prepare a pat of wet soil and shake it horizontally in the palm of the hand. With typical inorganic silt, the shaking action causes water to come to the surface of the sample, making it appear glossy and soft. Repeat tests with varying moisture contents. Squeezing the sample between the fingers causes the water to disappear from the surface and the sample quickly stiffens and finally cracks or crumbles. Allow sample to dry, test its cohesion, and feel by crumbling with the fingers. Typical silt shows little or no dry strength and feels only slightly gritty in contrast to the rough grittiness of fine sand.
Clay	Extremely fine-grained material composed of particles which pass the No. 200 sieve (0.0029 inches). To identify, work a sample with the fingers, adding water when stiffness requires. Moist sample is plastic enough to be kneaded like dough. Test further by rolling ball of kneaded soil between palm of hand and a flat surface. Clay can be rolled to a slender thread, about 1/4 inch in diameter, without crumbling; silt crumbles, without forming a thread. Measure hardness of dry clay by finger pressure required to break a sample. It requires much greater force to break dry clay than dry silt. Clay feels smooth in contrast to the slight grittiness of silt.
Organic	Soil composed of decayed or decaying vegetation, sometimes mixed with fine-grained mineral sediments such as peat or muskeg. It is identified by coarse and fibrous appearance and odor. Odor may be intensified by heating. Plastic soils containing organic material can be rolled into soft, spongy threads.

Table 5-5. Soil characteristics of roads and airfields

Major Divisions		***Letter***		***Name***	***Field CBR***
Coarse-grained soils	Gravel and gravelly soils	GW		Well-graded gravels or gravel-sand mixtures, little or no fines	60-80
		GP		Poorly graded gravels or gravel-sand mixtures, little or no fines	25-60
		GM	d[1]	Silty gravels, gravel-sand-silt mixtures	40-80
			u[2]		20-40
		GC		Clayey gravels, gravel-sand-clay mixtures	20-40
	Sand and sandy soils	SW		Well-graded sands or gravelly sands, little or no fines	20-40
		SP		Poorly graded sands or gravelly sands, little or no fines	10-25
		SM	d[1]	Silty sands, sand-silt mixtures	20-40
			u[2]		10-20
		SC		Clayey sands, sand-clay mixtures	10-20
Fine-grained soils	Silts and clays (liquid limits <50)	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	5-15
		CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	5-15
		OL		Organic silts and organic silt-clays of low plasticity	4-8
	Silts and clays (liquid limits >50)	MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	4-8
		CH		Inorganic clays of high plasticity, fat clays	3-5
		OH		Organic clays of medium to high plasticity, organic silts	3-5
Highly organic soils		Pt		Peat and other highly organic soils	

Note. Division of GM and SM groups into suddivisions of d and u are for roads and airfields only; subdivision is basis of Atterberg limits.

[1] Indicates liquid limit is 28 or less, and plasticity index is 6 or less.

[2] Indicates liquid limit is 28 or greater.

BASE COURSE AND SUBGRADE

5-49. The base course and subgrade are the intermediate fill under the traveled surface of the roadway. Base courses are usually composed of gravel or crushed rock. Subgrade soils are typically more silts and clay soils. Table 5-6, page 5-24, cross-references various engineering properties of soils to the soil letter designator.

Table 5-6. Engineering properties of soil types

Letter		Value as Foundation when Not Subject to Frost Action[3]	Value as Base Directly Under Bituminous Pavement	Potential Frost Action[4]	Compressibility and Expansion	Drainage Characteristics
GW		Excellent	Good	None to very slight	Almost none	Excellent
GP		Good to excellent	Poor to fair	None to very slight	Almost none	Excellent
GM	d[1]	Good to excellent	Fair to good	Slight to medium	Very slight	Fair to poor
	u[2]	Good	Poor	Slight to medium	Slight	Poor to practically impervious
GC		Good	Poor	Slight to medium	Slight	Poor to practically impervious
SW		Good	Poor	None to very slight	Almost none	Excellent
SP		Fair to good	Poor to not suitable	None to very slight	Almost none	Excellent
SM	d[1]	Good	Poor	Slight to high	Very slight	Fair to poor
	u[2]	Fair to good	Not suitable	Slight to high	Slight to medium	Poor to practically impervious
SC		Fair to good	Not suitable	Slight to high	Slight to medium	Poor to practically impervious
CL		Fair to poor	Not suitable	Medium to high	Medium	Practically impervious
OL		Poor	Not suitable	Medium to high	Medium to high	Poor
MH		Poor	Not suitable	Medium to high	High	Fair to poor
CH		Poor to very poor	Not suitable	Medium	High	Practically impervious
OH		Poor to very poor	Not suitable	Medium	High	Practically impervious
Pt		Not suitable	Not suitable	Slight	Very high	Fair to poor

[1] Indicates liquid limit is 28 or less, and plasticity index is 6 or less.
[2] Indicates liquid limit is 28 or greater.
[3] Values are for subgrades and base courses except for base courses directly under bituminous pavement.
[4] Indicates whether these soils are susceptible to frost.

ROAD CAPACITY AND COMPUTATIONS

5-50. The load-bearing capacity of a road is its ability to support traffic and is expressed by a military load classification (MLC). The load-bearing capacity of a road with a flexible surface describes its ability to support traffic and is expressed initially as a maximum allowable wheel load and then converted to an equivalent MLC. After determining the type of subgrade material using tables 5-4, 5-5, and 5-6 (pages 5-21 through 5-24), an accurate estimation of the load-bearing capacity of a road for wheeled vehicles can be made by measuring the combined thickness of the surface and base course and using figure 5-20, page 5-5-26, to obtain the corresponding load bearing capacity in pounds. Note that some pavement sections may include a SP (sand) subbase material between the base course and a silt or clay subgrade, the thickness of SP can be included in the calculations for combined thickness in inches of pavement and base in Figure 5-20. The load-bearing determined in Figure 5-20 is expressed as a maximum allowable wheel load in pounds. See Table 5-7 to convert the bearing capacity in pounds to an equivalent MLC.

Note. That road classification for tracked vehicles is not normally assigned. Other factors such as wear and tear on the roads surface by track action usually determines the road's capacity to support track vehicles.

Table 5-7. Wheeled vehicle classification related to single wheel load

Classification number	*Maximum single wheel load (pounds)*
4	2,500
8	5,500
12	8,000
16	10,000
20	11,000
24	12,000
30	13,500
40	17,000
50 - 150	20,000

5-51. If the MLC of the road is greater than the classification of the weakest bridge on the route, the bridge classification determines the capacity of the route.

5-52. After determining the type of subgrade material, an accurate estimation of the load-bearing capacity of a road for wheeled vehicles can be made by measuring the combined thickness of the surface and base course and using figure 5-20 to obtain the corresponding load-bearing capacity in pounds. Note that some pavement sections may include a sand (depicted as SP) subbase material between the base course and a silt or clay subgrade. The thickness of SP can be included in the calculations for combined thickness in inches of pavement and base in figure 5-20. (See appendix E to convert the bearing capacity in pounds to an equivalent MLC).

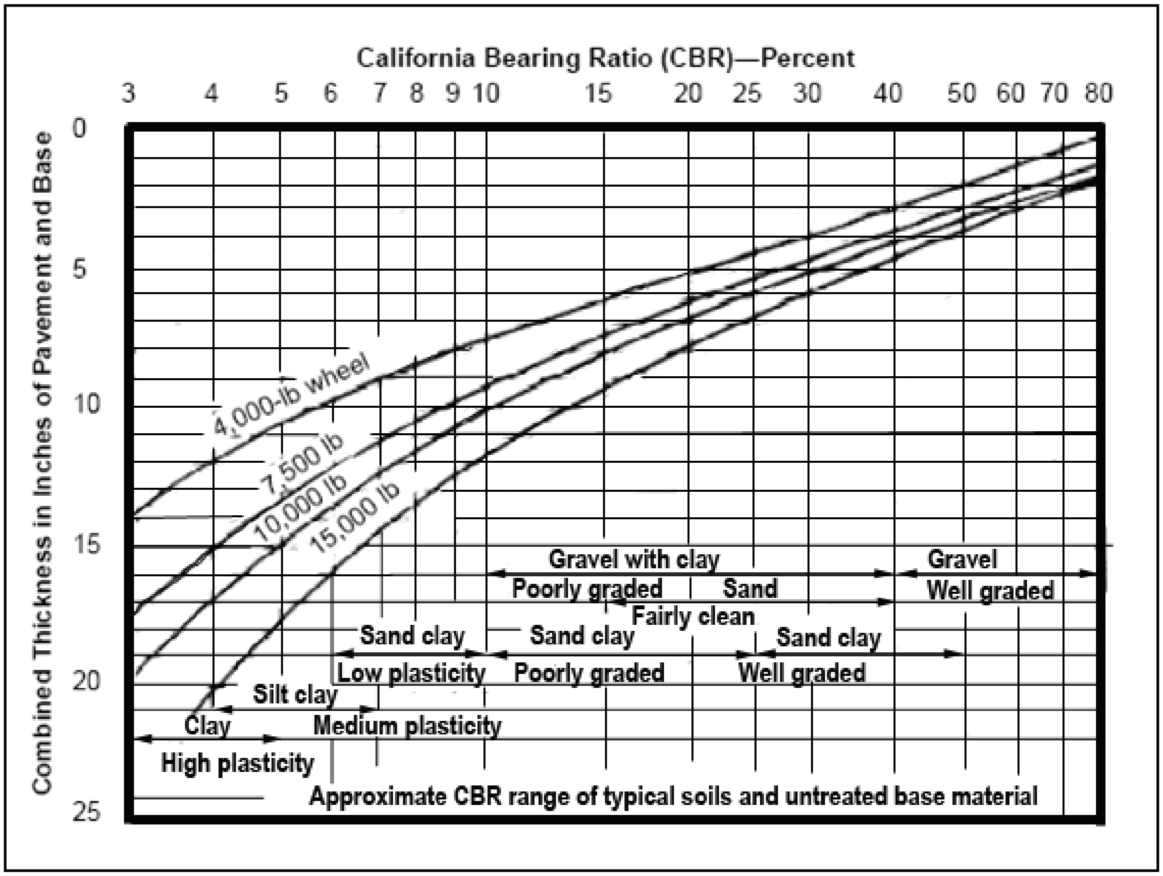


Figure 5-20. Load bearing capacity of roads with a flexible surface

ROAD CLASSIFICATION FORMULA

5-53. The road classification formula is a systematic description of the limiting section of a road. Do not confuse it with the route classification formula. Recorded information from the road classification formula is included in the route classification formula. The following paragraphs describe each portion of the formula shown below:

B g s 4 / 5 r (8 km) (OB) (T)
(1) (2) (3) (4) (5) (6)

- (1) Limiting characteristics. Prefix the formula with "A" if there are no limiting characteristics and "B" if there are one or more limiting characteristics. Represent an unknown or undetermined characteristic by a question mark, together with the feature to which it refers. In the example above, the letter *g* indicates steep gradients and the letter *s* indicates a rough surface (see table 5-8).
- (2) Minimum traveled-way width. Express this width in meters followed by a slash and the combined width of the traveled way and the shoulders. In the example above, the minimum traveled way is 4 meters and the combined width is 5 meters.

- (3) Road surface material. Express this with a letter symbol. The formula above describes the surface material as r, meaning water-bound macadam. Use the symbols listed in table 5-9 (page 5-28); they are further related to the X, Y, and Z route types of the route classification described earlier in route reconnaissance procedures.
- (4) Road length. Express the road length in kilometers and place in parentheses.
- (5) Obstructions. Indicate any obstructions along a road by placing the symbol "OB" after the road length, as shown in the example above. Details of the obstructions are not shown in the formula; they are reported separately by appropriate symbols on accompanying maps or overlays or on DA Form 1248 (see appendix B). Report the following obstructions:
  - Overhead obstructions (less than 4.3 meters over the route).
  - Constrictions in traveled-way widths less than 6 meters for single-flow traffic or less than 8 meters for double-flow traffic (tracked or combination vehicles [see table 5-2, page 5-6]).
  - Slopes of 7 percent or greater.
  - Curves with a radius of less than 25 meters (report curves of 25.1 to 45 meters).
- (6) Blockage. If blockage is regular, recurrent, and serious, the effects of snow blockage and flooding are indicated in the road classification formula. The symbol for snow blockage is "T" and the symbol for frequent flooding is "W."

Table 5-8. Symbols for limiting characteristics

Limiting Characteristics	*Criteria*	*Symbol*
Sharp curves	Sharp curves with a radius of 25 meters or less (82 feet) are reported as obstructions.	c
Steep gradients	Steep gradients, 7 percent or steeper; such gradients are reported as obstructions.	g
Poor drainage	Inadequate ditches, crown or camber, or culverts; culverts and ditches blocked or otherwise in poor condition.	d
Weak foundation	Unstable, loose, or easily displaced material.	f
Rough surface	Bumpy, rutted, or potholed to an extent likely to reduce convoy speeds.	s
Excessive camber or superelevation	Falling away so sharply as to cause heavy vehicles to skid or drag toward shoulders.	j

Table 5-9. Symbols for type of surface materials

Symbol	*Material*	*Route Type*
K	Concrete	Type X; generally heavy duty
kb	Bituminous (asphaltic) concrete (bituminous plant mix)	Type X; generally heavy duty
P	Paving brick or stone	Type X or Y; generally heavy duty
Pb	Bituminous surface on paving brick or stone	Type X or Y; generally heavy duty
rb	Bitumen-penetrated macadam, water-bound macadam with superficial asphalt or tar cover	Type X or Y; generally medium duty
r	Water-bound macadam, crushed rock or coral or stabilized gravel	Type Y; generally light duty
L	Gravel or lightly metaled surface	Type Y; generally light duty
nb	Bituminous surface treatment on natural earth, stabilized soil, sand-clay, or other select material	Type Y or Z; generally light duty
b	Used when type of bituminous construction cannot be determined	Type Y or Z; generally light duty
n	Natural earth stabilized soil, sand-clay, shell, cinders, disintegrated granite, or other select material	Type Z; generally light duty
V	Various other types not mentioned above	Classify X, Y, or Z depending on the type of material used (indicate length when this symbol is used).

EXAMPLES OF THE ROAD CLASSIFICATION FORMULA

5-54. A sample DA Form 1248 is shown in appendix B. The following are examples of the road classification formula:

- A 5.0/6.2k—road with no limiting characteristics or obstructions, a minimum traveled way of 5.0 meters, a combined width of traveled way and shoulders of 6.2 meters, and a concrete surface.
- B g s 4/5 1 (OB)—road with limiting characteristics of steep gradients and a rough surface, a minimum traveled way of 4 meters, a combined width of 5 meters, gravel or lightly metaled surfaces, and obstructions.
- B c (f?) 3.2/4.8 p (4.3km) (OB) (T)—road with limiting characteristics of sharp curves and unknown foundation, a minimum traveled way of 3.2 meters, a combined width of 4.8 meters, paving brick or stone surface, obstructions, and 4.3 kilometers long subject to snow blockage.

***Notes*.**

1. Where rockslides are a hazard or poor drainage is a problem, include information on a written enclosure or legend.

2. Ensure that a new classification formula is entered on the DA Form 1248 each time the road changes significantly.

Chapter 6

Technical Reconnaissance – Assessments and Surveys

Bring war material with you from home, but forage on the enemy…use the conquered foe to augment one's own strength.

Sun Tzu, The Art of War

Engineer assessments span the overlap area from tactical to technical on the range of engineer reconnaissance capabilities. ERTs conduct tactical reconnaissance but may include all or key portions of an assessment as part of the specified focus of technical information. General engineers may augment the ERT, form an ERT, or form an assessment team as the situation requires. Assessments may be conducted as an integrated requirement in the tactical reconnaissance operation or may be in support of IR at the operational level. Engineer surveys are typically conducted at the operational level and in support of the general engineer function. While ERTs may provide the degree of technical expertise required for an assessment, they operate as an integrated part of an overall tactical reconnaissance operation at the BCT/RCT level and below. Even when conducting an assessment, the ERT retains a significant tactical reconnaissance focus. Operational level assessments and survey teams employ a routinely high degree of technical expertise and are focused nearly exclusively on the technical requirements of the reconnaissance support mission. The capabilities in both cases overlap substantially, but the overall nature of the engineer reconnaissance support is distinct. This chapter discusses the assessment and/or survey capabilities typically provided by general engineer elements, and those assessment capabilities available as necessary from ERTs. Technical capabilities included in this chapter are often augmented with robust support from other Services, OGAs, contractors, host-nation support (HNS), and reach-back support through FFE and similar capabilities found in other Services. Regardless of the level of reconnaissance support integration, when operating within assigned maneuver AOs, the assessment or survey team must fully coordinate their activity with the maneuver unit.

BRIDGE RECONNAISSANCE

6-1. A bridge reconnaissance is conducted to collect detailed technical information on selected bridges. The bridge reconnaissance is conducted as part of a route or road classification or as separate mission focused on the selected bridge. Based on the situation, the reconnaissance may be conducted by an ERT, an augmented ERT, an assessment team, or a survey team. The level of detail of the information collected will increase in the progression from ERT to survey team. In every case, the information collected can be used to determine the bridge load-carrying capacity (see appendix F for a detailed discussion on bridge classification) and to estimate resources for repair or upgrade of the bridge. ERTs also conduct bridge reconnaissance to collect information to enable the planning and estimation of the materials required for a bridge demolition. (See FM 3-34.214 for additional information on bridge demolition requirements). DA Form 1249 (see appendix B) is used to report the information collected from a bridge reconnaissance.

6-2. Appendix F of this manual provides the procedure for applying the information collected in the bridge reconnaissance to determine the hasty bridge load classification. This assessment provides the basic

MLC information necessary for the commander to plan for the use of the bridge. Refer to FM 3-34.343 for a complete discussion of bridge classification procedures. The method of bridge load classification covered in appendix F is adequate for most applications.)

6-3. Large, multilane highway bridges are common in the common operational environment (COE). These bridges with steel girders or prestressed concrete beams may be difficult to classify using the procedure in appendix F. Damaged bridges will also present a challenge for classification resulting from the damage as well as for repair options to mitigate the damage. The USACE has developed specific expertise to assist in assessing bridges that present a challenge to reconnaissance elements in the field. The assistance is available through reach-back support as discussed under FFE in this chapter and in appendix H.

BRIDGE SPAN TYPES AND COMPONENTS

6-4. The most common span types for nonstandard bridges include—

- Timber or steel trestle bridge with timber deck (including steel truss type highway bridges).
- Steel-stringer bridge with concrete deck (including steel multigirder and two-girder highway bridges).
- Concrete steel-stringer bridge.
- Concrete T-beam bridge with asphalt surface (including reinforced concrete and prestressed highway bridges).
- Masonry arch bridge.

6-5. Ice bridging is a type of nonstandard bridge that may be encountered where appropriate climate conditions exist. Ice bridges typically reinforce an already present ice cover on large bodies of water, streams, and rivers allowing the passage of heavier load classifications that would otherwise be supported by the existing ice. Reconnaissance should focus on determining whether the initial ice span is stable and not simply a floating ice mass (see TM 5-349 and TM 5-852-1).

6-6. Based on the type of span, basic components including the following:

- Approaches (the portions of a route leading to a bridge). Approaches may be mined or booby-trapped, requiring thorough investigation during a reconnaissance.
- Substructure (lower part of a bridge). The substructure consists of the abutments and intermediate supports that transfer the bridge’s load to the ground. It is important to measure all aspects of an abutment, including its height, width, and length; the abutment wings; and the intermediate support.
- Superstructure (the upper part of a bridge). The superstructure consists of the following components (see figure 6-1):
  - Stringers rest on and span the distance between the intermediate supports or abutments. Stringers are the superstructure’s main load-carrying members. They receive the load from the flooring and the vehicles and transfer it to the substructure.
  - The flooring system often consists of both decking and tread. The decking is laid directly over the stringers at right angles to the centerline of the bridge. The tread is laid parallel to the centerline of the bridge and between the curbs.
  - Curbs are placed at both edges of the flooring to guide the vehicles. A vehicle with an axle that is wider than the traveled-way width (between the curbs) cannot cross the bridge. Most bridges, however, allow for vehicular overhang beyond the normal traveled area. This allowance is called horizontal clearance above the curbs and is a safety factor.
  - Railings along the bridge are built to guide drivers and to protect vehicular and foot traffic.
  - Trusses are used in some bridge superstructures, either above or below the traveled way, to increase the load-carrying capacity. A truss is a structural element made of several members joined together to form a series of triangles.

- The number of members in each span is noted where applicable (for example, stringer bridges and concrete T-beam bridges). Exact dimensions of specific bridge members are taken as outlined later in this chapter.
- The span length is measured from center to center of the supports. The bridge's classification is usually based on the weakest span. If the weakest span is apparent, no other spans need to be examined. However, if the weakest span is difficult or impossible to locate, all spans must be classified. Even if several spans look identical, actual measurements should be taken to prevent error.
- The traveled-way width is measured between the inside faces of the curbs. However, the horizontal clearance on a truss bridge is measured from a point 1.21 meters above the roadway.

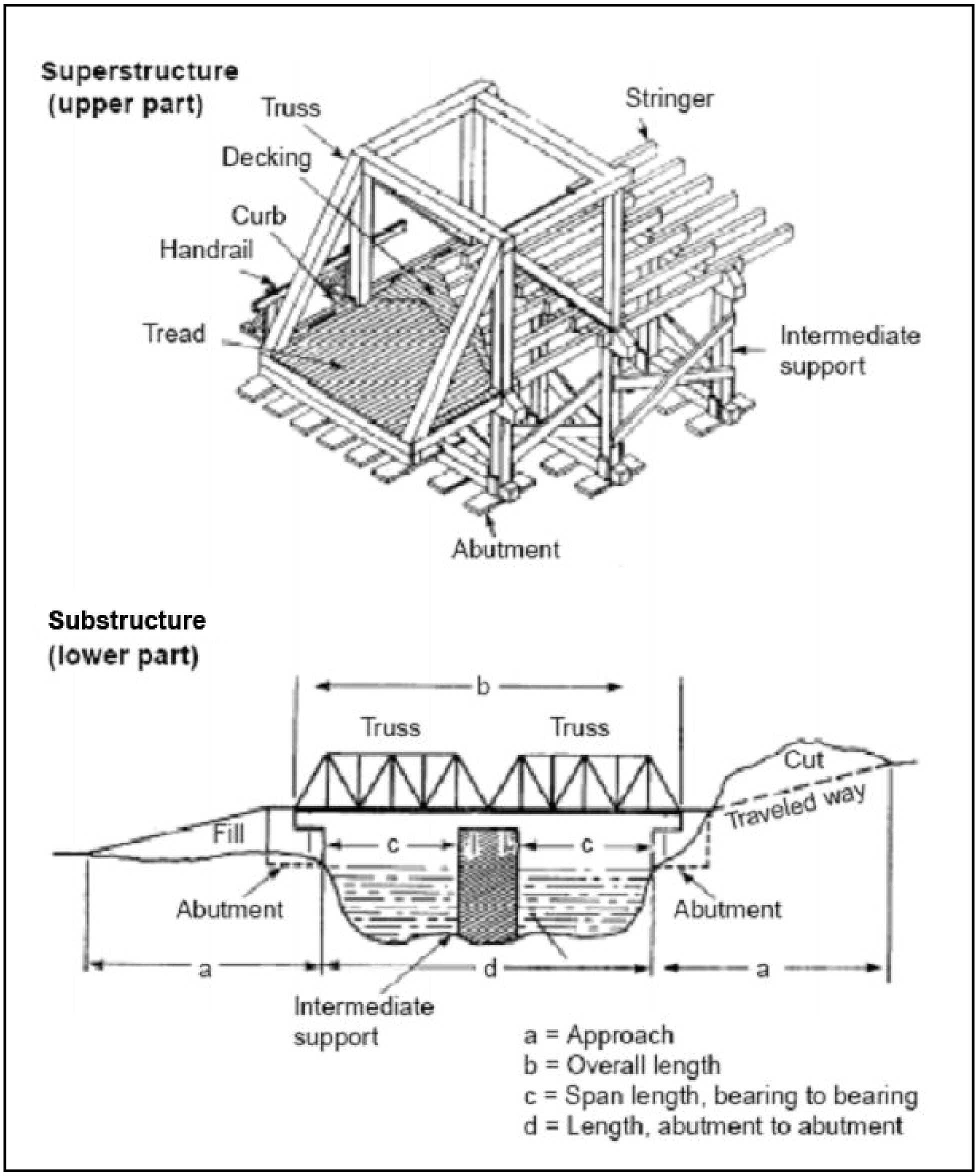


Figure 6-1. Bridge components

BRIDGE CONDITION

6-7. The reconnaissance team collects general information and assesses the bridge's general condition, paying particular attention to evidence of damage from natural causes (rot, rust, and deterioration) or combat action. Classification procedures presume that a bridge is in good condition. If the bridge is in poor condition, the classification obtained from mathematical computations must be reduced according to the classifier's judgment.

BRIDGE SYMBOL

6-8. The reconnaissance team collects the specific bridge information necessary to fill out the full North Atlantic Treaty Organization (NATO) bridge symbol (see figure 6-2) on a map or overlay. This symbol is different from an on-site bridge classification sign as shown in appendix G; do not confuse the two. The information necessary for the full bridge symbol includes the—

- Bridge serial number.
- Geographic location.
- Bridge's MLC.
- Overall length.
- Traveled-way width.
- Overhead clearance.
- Available bypasses.

6-9. A bridge serial number is assigned for future reference and is recorded in the symbol's lower portion (assign a number according to the unit's SOP). For proper identification, do not duplicate serial numbers within any one map sheet, overlay, or document.

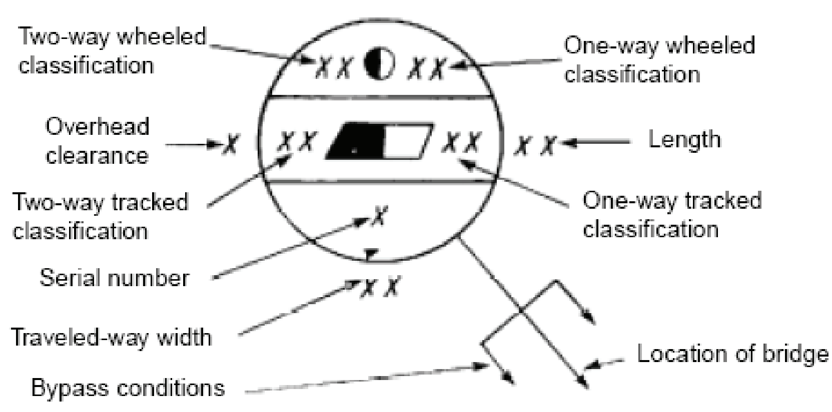


Figure 6-2. Full NATO bridge symbol

6-10. The bridge's geographic location is shown by an arrow extending from the symbol to the exact map location. The bridge's MLC number is shown in the symbol's top portion. This number indicates the bridge's carrying capacity; classifications for both single- and double-flow traffic are included. In those instances where dual classifications for wheeled and tracked vehicles exist, both classifications are shown.

6-11. The bridge's overall length is the distance between abutments, measured along the bridge's centerline. This figure is placed to the right of the circle and is expressed in meters.

6-12. The minimum lane width is the clear distance between curbs. Place this figure below the symbol and express it in meters. Bridges may be obstructions to traffic flow because the traveled-way width of the overall route may be reduced on the bridge to below the minimum standards prescribed in table 6-1.

6-13. The overhead clearance is the minimum distance between the bridge's surface and any obstruction above it. This figure is shown (in meters) to the left of the symbol. Underline any overhead clearance less than the minimum required by the bridge classification number (see table 6-1). Unlimited overhead clearance is indicated by the symbol ∞. Often a telltale or other warning device is placed before the bridge to indicate overhead-clearance limitations (see figure 6-3). Report any overhead clearance less than 4.3 meters as an obstruction in the route classification formula. A question mark is used to indicate information that is unknown or undetermined and is included as part of the bridge reconnaissance symbol. (See appendix G for signs used to mark roads and bridges.)

Table 6-1. Minimum overhead clearance for bridges

Bridge Classification	***Minimum Overhead Clearance***
Up to 70	4.3 meters
Above 70	4.7 meters

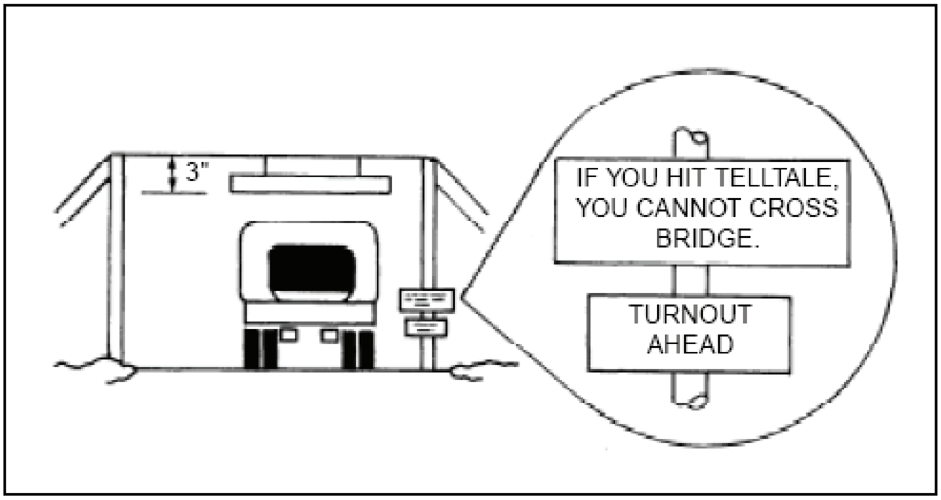


Figure 6-3. Telltale

6-14. The reconnaissance team may be interested in railway bridges which could be used by road vehicles in an emergency. The team conducts a bridge reconnaissance and makes an overall assessment of the adaptability of the railway bridge for road traffic indicating "use easy" or "use difficult" on the bridge symbol. (A sample of the full NATO bridge symbol used to indicate a railway bridge can be found in appendix B.)

> ***Note.*** A railroad bridge is considered easy to adapt for use if it can be adapted in less than 4 hours with 35 Soldiers and Marines and the appropriate resources.

BRIDGE DIMENSIONS

6-15. The reconnaissance team collects specific bridge dimensions if the information will be necessary to determine the hasty bridge load classification (see appendix F). The dimensions required vary for each of the seven basic bridge types. (Table F-1 on page F-2 F-2 summarizes the dimensions that the reconnaissance team must collect if the information will be used to classify the bridge. Entries in the table correspond to figures F-1 through F-6 on pages F-4 through F-9 as indicated in parenthesis under the span type.)

OTHER GAP CROSSING SITES

6-16. Like bridges, the range of engineer reconnaissance capabilities is employed to collect detailed technical information on gap crossing sites where bridges are not present. Also like bridge reconnaissance, these missions are typically conducted as part of a route or road classification, or as a separate mission focused on the selected site. Based on the situation, the reconnaissance may be conducted by an ERT, an augmented ERT, an assessment team, or a survey team. The level of detail of the information collected increases in the progression from ERT to survey team. The information collected is used to determine the route classification and to estimate resources for repair or upgrade of the site or for construction of a bridge at the site. The various gap crossing reconnaissance capabilities and their corresponding report forms (instruction for reporting for each are included in appendix B) are—

- Ford Reconnaissance (use DA Form 1251).
- Ferry Reconnaissance (use DA Form 1252).
- River Reconnaissance (use DA Form 7398, *River Reconnaissance Report*).
- Underwater Reconnaissance (also uses DA Form 7398).

FORDS

6-17. A ford is a location in a water barrier where the current, bottom, and approaches allow personnel and vehicles and other equipment to cross and remain in contact with the bottom during crossing. Fords are obstructions to traffic flow and are shown by the abbreviation "OB" in the route classification formula for ford information on DA Form 1251 (see appendix B).

6-18. During high-water periods, low-water bridges are easily confused with paved fords because both are completely submerged. It is important to know the difference between this type of bridge and a paved ford because of corresponding military load limitations.

6-19. Fords are classified according to the crossing potential (or trafficability) for pedestrians or vehicles. Fordable depths for vehicular traffic can be increased by suitable waterproofing and adding deepwater fording kits. These kits permit fording depths up to an average of 4.3 meters. Check vehicle TMs for further fording information.

6-20. Record the composition of the approaches. They may be paved or covered with mat or trackway, but they are usually unimproved. The composition and the slope of the approaches to a ford should be carefully noted to determine the trafficability after fording vehicles saturate the surface material of the approaches. Identify the ford's left and right approaches when looking downstream.

6-21. Record the current velocity and the presence of debris to determine the effect, if any, on the ford's condition and passability. Estimate the current as—

- Swift (more than 1.5 meters per second).
- Moderate (1 to 1.5 meters per second).
- Slow (less than 1 meter per second).

6-22. The ford's stream-bottom composition largely determines its trafficability. It is important to determine whether the bottom is composed of sand, gravel, silt, clay, or rock and in what proportions. Record whether the ford's natural river bottom has been improved to increase the load-bearing capacity or to reduce the water depth. Improved fords may have gravel, macadam, or concrete surfacing; layers of sandbags; metal screening or matting; or timber (corduroy) planking. Note if there is material nearby that may be used to improve the ford. Record limited ford information (such as the following) on maps or overlays using a symbol as shown in figure 6-4.

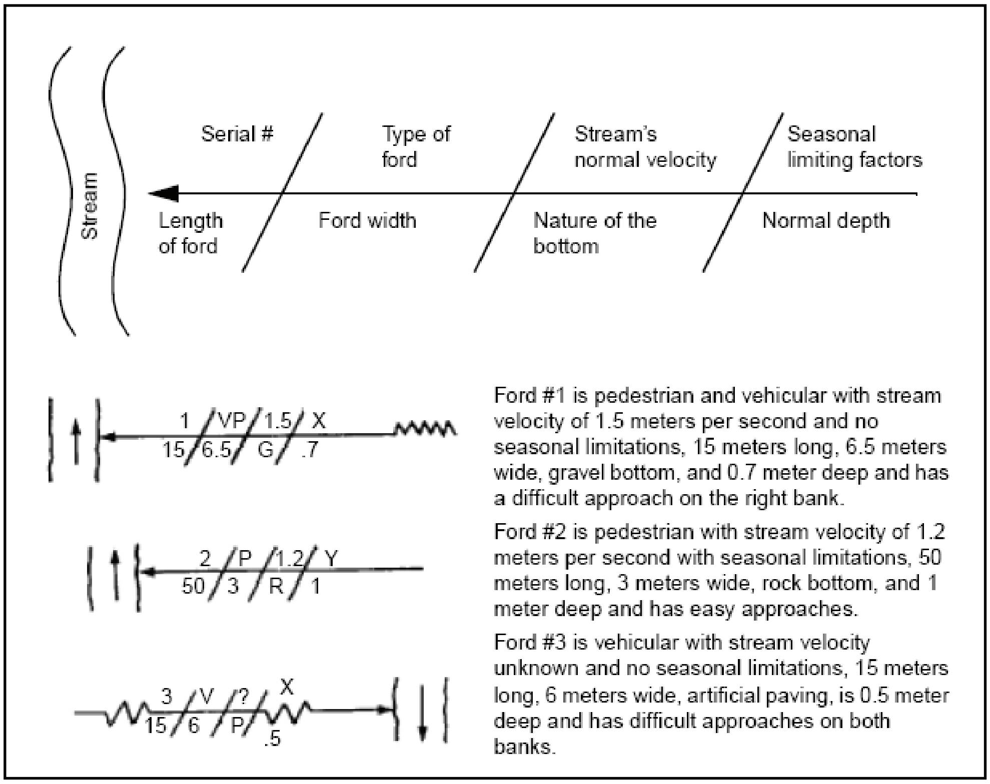


Figure 6-4. Ford symbols

- The ford's geographic location is shown by an arrow from the symbol to the ford location on a map or overlay. The symbol is drawn on either side of the stream.
- A serial number is assigned to each ford for reference (if the map sheet has a preassigned serial number, use it). Follow the unit's SOP in assigning serial numbers. They must not be duplicated within any one map sheet, overlay, or document.
- The type of ford is determined by bottom conditions, width, and water depth. Use the letters "V" for vehicular or "P" for pedestrian to show the ford type. Approaches are not considered in determining the ford type.
- The stream's normal velocity is expressed in meters per second. Seasonal limiting factors follow the stream velocity notation and are shown by the following letters:
  - X = no seasonal limitations except for sudden flooding of limited duration (such as flash floods).
  - Y = serious, regular, or recurrent flooding or snow blockage.

Note. If the Y symbol is used, the route type in the route classification formula automatically becomes type Z.

- The length of the ford, expressed in meters, is the distance from the near to far shores. The width of the ford is the traveled-way width of the ford's bottom.

- The nature of the bottom is indicated by the most appropriate letter symbol:
  - M = mud.
  - C = clay.
  - S = sand.
  - G = gravel.
  - R = rock.
  - P = artificial paving.
- The normal depth is the depth of water at the deepest point, expressed in meters. During a hasty reconnaissance, the actual water depth is used.
- A stream's left and right banks are found by looking downstream. Imagine yourself in the middle of the stream and looking downstream. Your left arm would indicate the left bank and the right arm the right bank. In drawing this portion of the symbol, pay attention to the direction of the stream flow. A difficult approach is shown by irregular lines placed on the corresponding side of the basic symbol.

6-23. All elements of the ford symbol are separated by slashes. If you do not know or cannot determine any item of the ford symbol, substitute a question mark for the required information.

FERRY RECONNAISSANCE

6-24. Ferries are considered obstructions to traffic flow and are indicated by the abbreviation "OB" in the route classification formula. Ferryboat construction varies widely and ranges from expedient rafts to ocean-going vessels. Ferries differ in physical appearance and capacity depending upon the water's width, depth, and current and the characteristics of the traffic to be moved. Ferries may be propelled by oars; cable and pulleys; poles; the stream current; or steam, gasoline, or diesel engines. Detailed ferry reconnaissance information is recorded on DA Form 1252 (see appendix B).

6-25. Usually, the capacity of a civil ferryboat is expressed in tons and total number of passengers. In addition, it is often assigned an MLC number. Ensure that you record the capacity of each ferry when more than one is used at a given site. The ferries may vary in capacity.

6-26. Ferry slips (or piers) are usually provided on each shore to permit easy loading of passengers, cargo, and vehicles. The slips may range from simple log piers to elaborate terminal buildings. A distinguishing characteristic of a ferry slip is often the floating pier that adjusts, with changes in the water depth, to the height of the ferryboat.

6-27. Approach routes to ferry installations have an important bearing on using the ferry. Reconnoitering and recording the conditions of the approaches (including the load-carrying capacity of landing facilities) is very important.

6-28. Limiting characteristics of ferry sites that should be considered are the—

- Width of the water barrier from bank to bank.
- Distance and time required for the ferryboat to travel from one bank to the other.
- Depth of the water at each ferry slip.
- Ease in which each landing site can be defended.

6-29. Climatic conditions affect ferry operations. Fog and ice substantially reduce the total traffic-moving capacity and increase the hazard of the water route. Therefore, you must consider data on tide fluctuations, freezing periods, floods, excessive dry spells, and those effects on ferry operations.

6-30. Record limited ferry information (such as the following) on maps or overlays by using the symbol shown in figure 6-5. Figure 6-6 gives examples of completed ferry symbols.

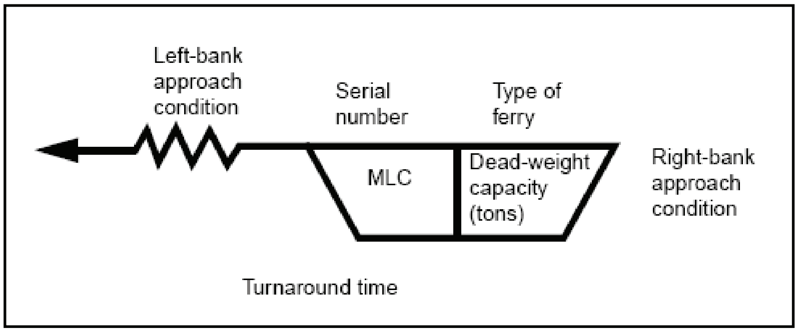


Figure 6-5. Ferry symbol

- The geographic location of the ferry is shown by an arrow from the symbol to the location of the ferry on a map or overlay. The symbol may be drawn on the map or overlay on either side of the stream.
- A serial number is assigned to each ferry, for later reference. Numbers must not be duplicated within any one map sheet, overlay, or document. Some maps will already show a ferry serial number. Use this number for your reconnaissance. If you do not find a number, record a number according to the unit's SOP.
- The type of ferry (V for vehicular and P for pedestrian) is shown after the serial number. If the ferry can haul vehicles, it can also haul pedestrians.
- The deck's MLC is placed in the bottom left box of the symbol. Most ferries have this information on the data plate.
- The dead-weight capacity of the ferry is the MLC plus the actual weight of the ferry, in short tons.
- The turnaround time is shown by the number of minutes required to cross the water obstacle, unload, and return.

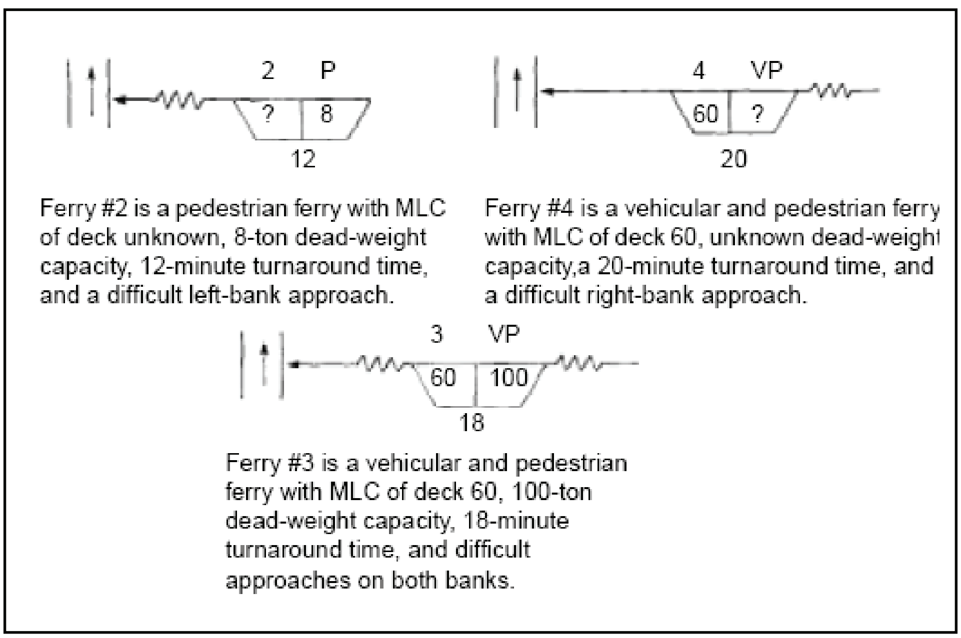


Figure 6-6. Sample ferry symbols

6-31. When drawing the approach-condition portion of the symbol, pay attention to the direction of stream flow. Left and right banks are determined by looking downstream. Approach conditions are determined in the same manner as for fords. A difficult approach is shown by irregular lines placed on the corresponding side of the basic symbol. A question mark is substituted for unknown or undetermined information.

RIVER RECONNAISSANCE

6-32. River reconnaissance may be conducted to collect technical information used to locate and report suitable sites for military rafting or bridging operations. River reconnaissance is also useful for identifying sites suitable for amphibious or vehicle swimming operations. Desirable site characteristics are—

- Current velocity between 0 and 1.6 meters per second.
- Banks that permit loading without a great deal of preparation.
- Approaches that permit easy access and egress.
- Strong, natural anchorage or holdfasts.
- Sites with no shoals, sandbars, or snags.
- Sites clear of obstacles immediately downstream.
- Sites clear of mines and booby traps.
- Sites with enough depth to prevent grounding the raft during loading and unloading operations or when crossing.
- Suitable raft-construction sites (depends on the type of raft).
- Holding areas for vehicles awaiting passage.
- A suitable road network to support crossing traffic.

Note. Refer to FM 90-13 for wet and dry gap crossing operations.

6-33. Units complete a river reconnaissance report to transmit important information about the river's location, nearshore and far shore characteristics, and river characteristics. The information is recorded on DA Form 7398 as shown in appendix B. Some confusion may exist regarding the use of the Ferry Reconnaissance Report and the River Reconnaissance Report. The Ferry Reconnaissance Report includes a section to record information about an existing ferry operating at the site targeted for reconnaissance. The River Reconnaissance Report is appropriate when no existing crossing means—such as ferry, ford, bridge, and so forth—are present.

6-34. Identify and report locations that permit smooth traffic flow and reduce route obstructions as much as possible. When conducting a river reconnaissance, record the river's depth, width, approaches, velocities, and natural and manmade obstacles (see figure 6-7).

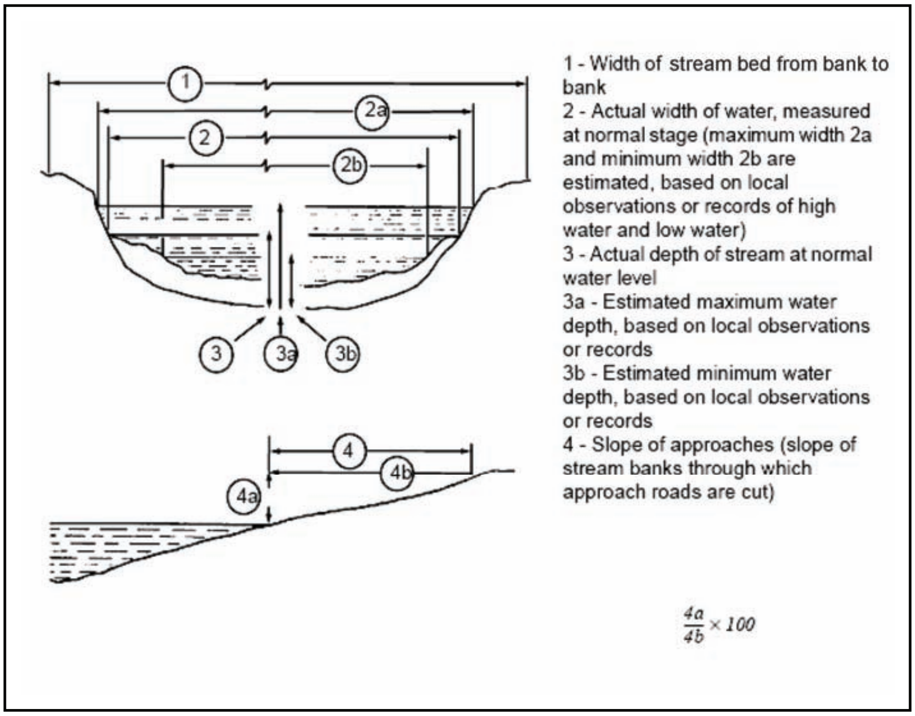


Figure 6-7. Dimensions required for streams

6-35. Stream depth is usually measured using field-expedient devices such as poles or weighted ropes. Measure the depth every 3 meters along the planned stream-crossing route. Recheck depths and currents frequently during inclement weather. As a result of sudden, heavy rainfall, a sluggish stream or river may become a torrent very quickly, particularly in tropical and arid regions. Monitor weather reports of the surrounding area. Storms occurring miles away can cause flash flooding. Always consider the importance of upstream dams and locks that may cause elevated levels or flooding when opened or destroyed.

Note. The actual depth you measure is recorded as normal depth when there is little time to reconnaissance.

6-36. Determine the stream width by using the compass method; an aiming circle, azimuth indicator, or alidade; or a GPS, or by taking a direct measurement.

- Compass method. Determine stream width by using a compass to take an azimuth from a point on the nearshore and close to the water's edge to a point on the opposite shore and close to the water's edge. (See figure 6-8, page 6-12). On the nearshore, establish another point that is on a line and at a right angle to the azimuth selected. The azimuth to the same point on the far shore is ± 45 degrees (800 mils) from the previous azimuth. Measure the distance between the two points on the nearshore. This distance is equal to the distance across the stream.

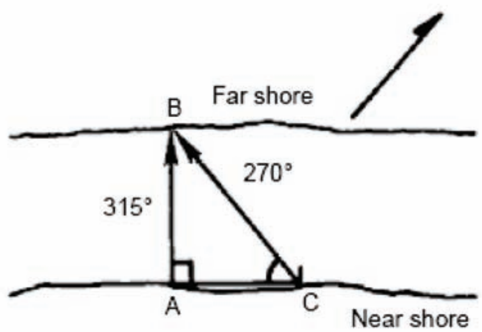


Figure 6-8. Measuring stream width with a compass

- Aiming circle, azimuth indicator, or alidade. Use an aiming circle, azimuth indicator, or alidade to measure the angle between two points that are a known distance apart on the nearshore and a third point directly across the river from one of these points. (See figure 6-9). Using trigonometric relationships, compute the distance across the stream.
- Global positioning system. Calculate the distance using two known grid points (from the GPS).
- Direct measurement. Measure short gaps with a tape measure or a dark rope that is marked and accurately measured.

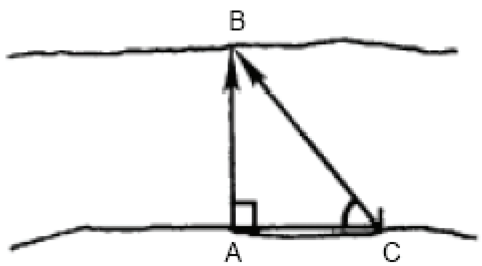


Figure 6-9. Measuring stream width with a surveying instrument

6-37. Current velocities vary in different parts of a stream. Velocity is usually slower near the shore and faster in the main channel. Perform the following procedure to determine stream velocity:

- Measure a distance along a riverbank.
- Throw a light floating object (not affected by the wind) into the stream.
- Record the time of travel it takes the object to travel the measured distance. Repeat the procedure at least three times. Use the average time of the test in the following formula (see figure 6-10) to determine the stream's velocity:

Stream velocity, in meters per second = measured distance, in meters/average time, in seconds.

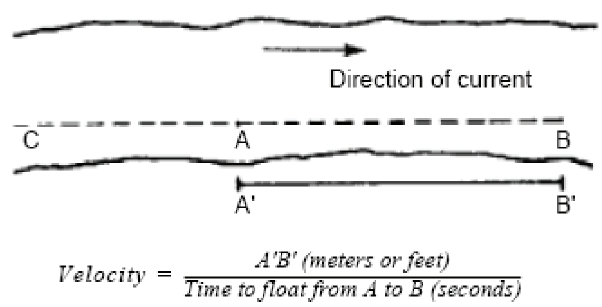


Figure 6-10. Finding stream velocity

6-38. Gently sloping stream approaches are desirable for fording and swimming operations. Slope is expressed in percent. Ensure that the slope-climbing capability is considered for the vehicles that are expected to ford/swim the stream. This information is found on the vehicle's data plate or dash plate or in the vehicle's TM. When considering slope-climbing capability, consider the degrading effects of weather, the condition of the vehicle's tires or tracks, and the condition of the ground surface of both sides of the stream. When bank improvements are necessary, include the amount and type of work on DA Form 1711. (See appendix B for further details on DA Form 1711.)

6-39. Consider the following obstacles during river reconnaissance:

- High, vertical banks.
- Mines and booby traps that are located at the entrance and exit or at likely approaches, submerged, or attached to poles and floating logs.
- Debris and floating objects such as logs and brush, poles, or floating logs with wire attached (which will foul propellers and suspension systems).
- Ice crusts.

UNDERWATER RECONNAISSANCE

6-40. In deeper water, divers may have to determine bottom conditions. Diving teams trained and equipped for underwater reconnaissance select deepwater fording sites. When the divers cannot easily span the distance between banks, inflatable combat rubber reconnaissance craft or bridge-erection boats enter the water at a selected entrance and drop off teams at regular intervals. Unless the area is under enemy fire or observation, the craft remain in the water during the reconnaissance and pick up divers when the operation has been completed. Helicopters may be used to drop teams in the water or place teams on the far shore if the situation permits. Engineer light diving teams routinely conduct river reconnaissance at night.

6-41. To assist underwater reconnaissance teams in maintaining direction, weighted lines (transverse lines) may be placed across the bottom of the water obstacle. Buoys or other floating objects are attached to the lines to indicate the survey area for the underwater reconnaissance team(s). When the current is greater than 1.3 meters per second, underwater reconnaissance personnel will have difficulty maintaining a position along the line selected. To assist divers, another transverse line, parallel to the original line and with lateral lines connecting both lines, may be placed upstream.

6-42. Bottom conditions are easily determined during periods of good visibility and when the water is clear. However, under blackout conditions or when the water is murky, the reconnaissance is much slower because swimmers must feel their way across. If the tactical situation permits, divers may use underwater lanterns.

6-43. Environmental conditions (such as depth, bottom type, tides and currents, visibility, and temperature) have an effect on divers, diving techniques, and equipment. The length of time that divers can remain underwater depends on water depth, time at depth, and equipment used. When conducting a reconnaissance in a current, swimmers expend more energy, tire more easily, and use their air supply more quickly. In water temperatures between 73 degrees and 85 degrees Fahrenheit, divers can work comfortably in their swimsuits but will chill in one to two hours if not exercising. In water temperatures above 85 degrees Fahrenheit, the divers overheat. The maximum water temperature that can be endured, even at rest, is 96 degrees Fahrenheit. At temperatures below 73 degrees Fahrenheit, unprotected divers will be affected by excessive heat loss and become chilled within a short period of time. In cold water, the sense of touch and the ability to work with the hands are affected. Air tanks vary in size and govern how long divers can operate. Extra tanks should be available for underwater reconnaissance teams, and the facilities to recharge equipment should be located close enough to respond to team requirements.

ENGINEER RESOURCE ASSESSMENT

6-44. ERTs, augmented ERTs, and assessment teams conduct an engineer resource assessment to assess the availability of materials and resources in an AO that may be useful or necessary to engineer support. ERTs will typically include an assessment of engineer resources as part of an area reconnaissance, while an assessment team may be nearly exclusively focused on collecting specific engineer resource information. FM 5-170, superseded by this manual, used the term “engineer recon” (DA Form 1711) to describe a “general engineer reconnaissance to gather engineer information of a broad nature within the AO. It considers material, resources, and terrain features having engineer applications.” This manual changes the designation of this task to an engineer resource assessment but retains the engineer resource assessment as a valid, relevant task employed by engineer elements in support of their operations.

6-45. The reconnaissance focus of an engineer resource assessment is to collect detailed technical information on the resources that may be useful or necessary to engineer support. An assessment team will typically be assigned to collect information on a more narrowly focused area or specified list of resources. The team assesses the availability of materials (aggregates, Portland cement, fill materials, and construction materials), terrain features that impact material availability or requirements (quarry sites, timber stands, water sources, and other significant features) as well as local engineering and/or construction capabilities (labor, equipment, contractors and firms, and other capabilities). The assessment can be conducted in conjunction with other reconnaissance operations or as a stand-alone mission but must be fully coordinated with maneuver forces in the targeted area. (Appendix B provides instructions for completing the resource assessment report, DA Form 1711.) The assessment report is also used to report engineer IR not adequately covered by any of the other reconnaissance capabilities.

INFRASTRUCTURE RECONNAISSANCE

6-46. ***Infrastructure reconnaissance*** **is focused on gathering technical information on the status of the large-scale public systems, services, and facilities of a country or region that are necessary for economic activity**. (See the complete definition in the glossary.) A common memory aid (SWEAT-MSO) reminds users of categories included or of concern within the infrastructure. (See figure C-1, page C-1, for a concise summary of the infrastructure reconnaissance categories.) However, several additional categories within the infrastructure have since been identified as areas of concern. Because this memory aid attempts to make it valid for all possible infrastructure requirements, the last letter is simply “O” to ensure we consider other aspects that may not be otherwise identified by the memory aid. Military commanders are increasingly concerned about infrastructure issues, the quality of the local infrastructure or problems within it, and how those infrastructure issues impact military operations.

6-47. Infrastructure reconnaissance is a multidiscipline task conducted by a base team augmented as necessary with additional expertise. The engineer will likely be responsible for coordinating infrastructure reconnaissance but should rely on other branches for help depending on the category or required expertise. The base infrastructure reconnaissance team includes expertise from at least engineer, CA, preventive medicine, and military police disciplines. Augmentation from additional disciplines is provided when possible. Table 6-2 lists the infrastructure reconnaissance categories and corresponding base and augmented teams that inspect those categories of the local infrastructure.

Table 6-2. Infrastructure reconnaissance categories and team composition

Infrastructure Category	***Base Team***	***Augmented Team***
Sewage	Engineer	FFE
Water	Engineer	FFE
Electricity	Engineer	Prime Power
Academics	Civil Affairs	
Trash	Engineer	Quartermaster
Medical	Medical Services	Civil Affairs, Veterinary Corps
Safety	MP	
Other: Roads and Railroads	Engineer	FFE
Other: Bridges and Waterways	Engineer	FFE
Other: Airports	Engineer	Transportation, Aviation/Air Force
Other: Housing	Engineer	Quartermaster
Other: Communications	Engineer	Signal
Other: Food Supply	Civil Affairs	Veterinary Corps
Other: Socio/Government	Civil Affairs	
Other: Cultural/ Historical/: Religious	Civil Affairs	Historian
Other: Hazardous Materials	Engineer	CBRN, Ordnance/Medical
Other: Attitude	All	

6-48. Infrastructure reconnaissance is accomplished in stages—the infrastructure assessment and the infrastructure survey. The assessment and survey are not clearly distinguishable but rather, as shown in figure 6-11, page 6-16, the stages overlap and vary according to METT-T[C]. Initially, especially during an offensive mission, it is most likely that combat engineer units will be on site first. Accordingly, it would be expected that those combat engineer units (and available discipline representatives organic or attached to the BCT/RCT) will have an extremely limited number of personnel with the training and experience to do a thorough analysis of the infrastructure (such as infrastructure survey). Therefore a sample infrastructure assessment (see appendix C) can be used to assist the ERT (and any other available discipline representatives) conducting this initial assessment. The ERT provides the initial infrastructure rating and assessment to be forwarded to more qualified personnel who follow in later stages of the mission. As operations continue, general engineer and other supporting technical support elements will become available to provide teams more qualified for infrastructure survey. The infrastructure survey teams use the infrastructure assessments from the ERTs to prioritize categories and parts of the infrastructure to be reassessed in more detail via an infrastructure survey. A series of smartcards (see appendix C) are available to assist with the more detailed infrastructure survey.

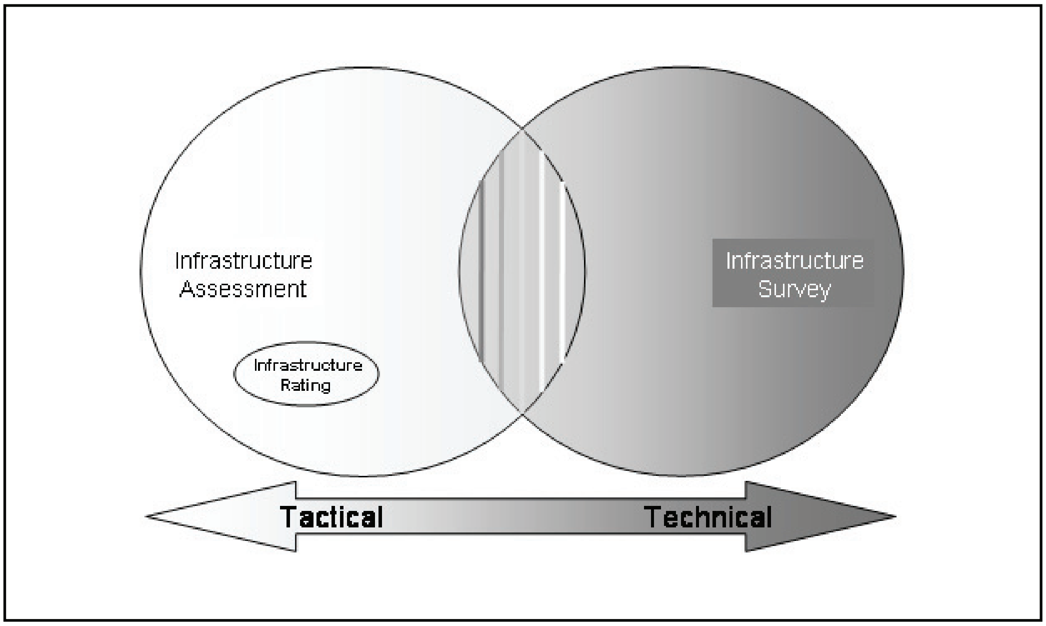


Figure 6-11. Assessment overlapping survey

6-49. As the commander becomes concerned about infrastructure issues and how those issues impact the military operation, demand for infrastructure information becomes a priority. Common questions of interest regarding the infrastructure include—

- Has the infrastructure been maintained?
- Who built that component of the infrastructure?
- Are repair parts and equipment available?
- Will the infrastructure be targeted by the HN?
- Will HN employees return to the site after hostilities?
- Is the infrastructure protected or can it be?

6-50. A systematic way of prioritizing infrastructure is needed to support this part of the commander's information priorities. The commander may establish a project coordination cell (PCC) within the staff to supervise the gathering of information and development of priorities. The PCC is responsible for resourcing, prioritizing, and executing civil-military operations (CMO) to achieve the commander's desired effects. Project nominations come to the PCC from subordinate TF commanders and the effects working group (EWG). The PCC then resources projects and provides the brigade commander with a staff recommendation for prioritization approval. Once a project is resourced and approved by the commander, the PCC brings them into the synchronization meeting for inclusion in the next effects tasking order (ETO).

6-51. The PCC manages projects by setting priorities. The first priority is the basic life support requirements of the population. (Secondary priorities are focused on as time and resources become available.) An infrastructure hierarchy is shown in figure 6-12, page 6-17. The highest priority infrastructure categories provide the foundation—basic human needs such as food, water, health care, safety, and so forth. Without them, the local populace may be forced to take extreme measures to see that their needs are met (such as stealing, rioting, demonstrating, committing terrorist acts, and so forth). Without meeting these basic needs, work on the other infrastructure categories may be ineffective or compromised. Once the basic human needs are met, the categories of electricity, water, trash, and sewage should be assessed. As time progresses and success is found on basic human needs, priorities shift to the upper tier categories of infrastructure.

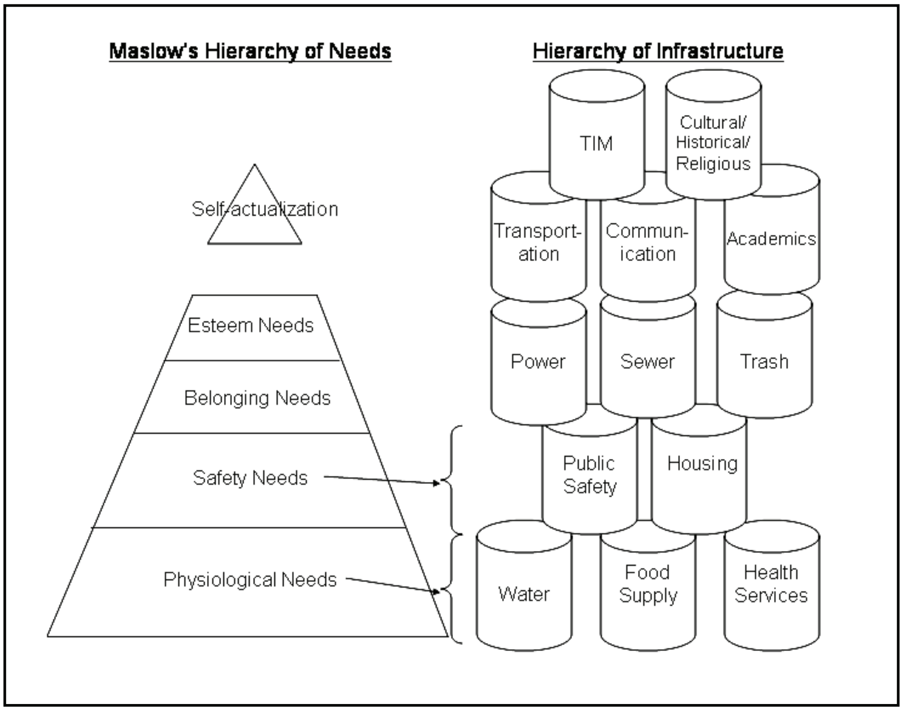


Figure 6-12. Hierarchy of infrastructure categories

6-52. In some infrastructure reconnaissance cases and typically with assessments, the assessment team will be required to collect information on or to inspect infrastructure categories without significant knowledge of the systems being inspected. The results will have significant gaps but should be adequate to help prioritize and plan further reconnaissance. Smartcards are employed to focus collection within each infrastructure category on the major technical components of the systems. The smartcards have the following objectives:

- Assist the inspector in identifying and inventorying the primary components of the system.
- Indicate what types of damage the inspector should be looking for and reporting.
- Provide guidance for collecting the information visually or from operators and locals workers.

6-53. Infrastructure reconnaissance smartcards are provided in appendix C. Specific situations may not require inspection and inventory of all the components covered in each smartcard. In general, the first part of the smartcard provides a brief overview of the infrastructure category; how it works, and some of the major components in the system. The second part is the form that the inspector uses to collect inventory and inspection information. In addition to the relevant smartcards, the assessment team should consider the following tools to assist in collecting information.

- Gerber knife.
- Flashlight.
- Hammer.
- GPS receiver.
- Digital camera.
- Safety equipment.
- Tape measure.
- Measuring wheel.
- Binoculars.

6-54. The assessment team may be required to determine an overall status for each infrastructure category. Color coding is a common status indicator. Table 6-3 provides guidance for the status color coding of each infrastructure category.

Table 6-3. Status color coding of infrastructure categories

Area	*Green*	*Amber*	*Red*	*Black*
Sewage	Sewage system works consistently	Sewage system works but treatment status undetermined	No treatment observed but treatment plant exists	No sewage treatment system, destroyed
	No sewage observed and no odor	No sewage observed but odor present and/or system damaged	Sewage observed and odor present	Presence of raw sewage is a public health issue
	Operational in 100% of public facilities	Operational in 50% or more of public facilities	Operational in less than 50% of public facilities	No operational sewage in public facilities
Water	Water distribution works at 100% capacity	Water distribution works at 50% or more of capacity/some leaks	Water distribution does not work	No water distribution system, destroyed
	Tested as clean and/or local populace is consuming	Appears clean, no smell and local populace states that it is clean	Does not appear clean and local populace states that it is not clean	Tested nonpotable and/or appears contaminated and has bad odor
	Running water in 100% of public facilities	Running water in 50% or more of public facilities	Running water in less than 50% of public facilities	No running water in public facilities
Electricity	Power distribution system works; blackouts are planned	Power distribution system works; blackouts unplanned	Power distribution system is unreliable; frequent blackouts	No power distribution system, destroyed
	Electric lines are 100%; no damage/no power loss	Electric lines are 50%; some minor damage/ undetermined power loss	Electric lines are less than 50%; major damage/ noticeable power loss	Electric lines are all down; hot wires exposed; significant power loss
	Power grid station intact; secure	Power grid station operational; unsecure	Power grid station nonoperational; unable to secure	Power grid station stripped; destroyed
Academics	Building is serviceable; all utilities operational; secure	Building is adequate; utilities operate over 50%; not secure	Building is useable; utilities operate less than 50%; not secure	Building is not useable; utilities are nonfunctional
	Academic resources available to all students	Academic resources available to 50% or more	Academic resources available to less than 50%	Extremely limited academic resources
Trash	Formal trash collection system is operational	Formal trash collection system exists but is limited	No formal trash collection system	No trash collection
	Trash collection is in a central area that does not present a health hazard	Unknown central trash collection area	Central trash collection area presents a possible health hazard	Trash is consolidated in an area that presents a health hazard
	No trash buildup in public facilities	Limited trash in public facilities; relatively clean	Public facilities have no means to remove trash	Public facilities have excess trash
Medical	Medical facilities are functional; backup power; minimal equipment issues; secure	Medical facilities are useable; no backup power; some equipment shortages; not secure	Medical facilities are unsanitary; significant equipment/supply shortages	Medical facilities are not useable due to damage and unsanitary conditions; looted
	Emergency services including multiple ambulatory services available	Emergency services exist; ground transport only	No emergency services; ground transport without medically trained personnel	No emergency services
	Veterinary services	Limited veterinary	On-call veterinary	No veterinary

Table 6-3. Status color coding of infrastructure categories

Area	***Green***	***Amber***	***Red***	***Black***
	available; animal holding area	services available; inadequate holding area	services; no holding area	services
Safety	Police department functional; secure building; equipment available and operational Fire department functional; secure building; equipment available and operational	Police department functional a minimum of 50%; building securable; equipment available and operational >50% Fire department functional a minimum of 50%; building securable; equipment available and operational more than 50%	Police department functional less than 50%; unable to secure building; limited equipment available Fire department functional less than 50%; unable to secure building; limited equipment available	Police department is nonfunctional; building is not useable; no equipment Fire department is nonfunctional; building is not useable; no equipment
Other Considerations: **Roads and Railroads**	Minimum of a Class C road; can be upgraded; no visible damage Operational railroad system	Minimum of a Class D road; damage/upgrade requirements will impact traffic flow Railroad is damaged but resources to repair are available; jacks available	Minimum of a Class E road; upgrade requirements are significant; materials not readily available Railroad damage is extensive; resources to repair are not readily available	Road is not trafficable Railroad system did exist but now has extensive damage to both track and trains
Other Considerations: **Bridges and Waterways**	Bridges are trafficable; no visible damage MLC verified through ERDC or other structural engineer Inspection/evaluation shows original strength assessment valid	Bridges are trafficable; damage to spans; supports intact MLC calculated but not verified due to damage Inspection/evaluation determines strength support issues	Bridges are not trafficable for military; risky for civilians; damage to spans and supports MLC is ineffective due to damage Inspection/evaluation determines minimal supportable strength	Bridges are not trafficable and are impassable Construction repair required before MLC can be determined Inspection/evaluation determines bridge cannot support weight
Other Considerations: **Airports**	Airport capable of supporting military and civilian traffic concurrently; no visible damage Runway/taxiway/parking aprons are serviceable; working and parking maximum aircraft on the ground (MOG) greater than or equal to 2 (military)	Airport can support limited military traffic; no visible damage Runway serviceable but taxiway and parking limited; C130/C17 only	Airport damaged; utilities and structures are not reliable or safe Runway is not serviceable; can repair with available resources	No working airport Runway is not serviceable; dimensions will not support military aircraft; major repair and upgrades required
Other Considerations: **Housing**	Residences are structurally sound and offer protection from the environment Utilities are working and reliable	Residences are damaged and need structural evaluation; offer limited protection from the environment Utilities are working over 50%; not reliable	Residences are damaged and structurally unsafe; no protection from the environment Utilities work less than 50%; require significant repairs	Residences are destroyed Utilities are nonoperational

Table 6-3. Status color coding of infrastructure categories

Area	*Green*	*Amber*	*Red*	*Black*
Other Considerations: Communications	Telephone system operational and reliable in public facilities	Telephone hookups available; some equipment available; somewhat reliable	Limited telephone hookups and equipment available; not reliable	No telephone hookups or equipment
	Postal system is operational and reliable	Postal system is slow; over 50% of mail delivered	Postal system exists; extremely slow; less than 50% of mail delivered	No postal system
	Media – television (TV), Internet, Radio, Newspaper operational, available, and reliable	One form of media exists, is operational, available, and reliable	One form of media exists but has limited availability and reliability	No form of media
Other Considerations: Hazardous Materials	Hazardous materials/hazardous waste properly segregated, stored, and labeled.	Some hazardous materials/hazardous waste not properly segregated, stored, or labeled	Hazardous materials/hazardous waste not properly segregated, stored, or labeled	Hazardous materials/hazardous waste not segregated, stored, or labeled.
	Containers adequate for the material	Containers not generally adequate, but limited corrosion or damage	Containers inadequate, corroded, and leaking	Containers inadequate, corroded, and leaking
	Safety measures/ secondary containment in place	Inadequate safety measures and secondary containment	No safety measures or secondary containment	No safety measures or secondary containment
	Hazards communications system in place	Limited hazards communications system	No hazards communications system	No hazards communications system
	No leaks or spills	Potential for leaks and spills	Some leaks and spills already present. Contaminants may enter air, soil, groundwater, or water courses	Gross contamination present; contaminants have entered air, soil, ground water, and water courses
	Spill prevention and cleanup measures in place/ available	Limited spill prevention and cleanup measures available	No ability to prevent or cleanup spills	No ability to prevent or cleanup spills
Other Considerations: Attitude	Community leaders not hostile; religious centers are intact; supportive of general engineering effort	Community leaders are neutral; religious centers are damaged but securable	Community leaders are negative; religious centers are damaged and not securable; skeptic of general engineering support	Community leaders hostile; religious centers destroyed; do not want general engineering assistance
	No ethnic tension	Distinct ethnic groups within AO; supportive of general engineering effort if equal among groups	Distinct ethnic groups within AO; one group dominant; general engineering tasks cannot be accomplished for all groups	Ethnic violence occurs; one group extremely dominant; general engineering effort would increase ethnic tension
	Unemployment is less than 50%	Unemployment is greater than 50%; willing and able to work to support general engineering effort	Unemployment is greater than 50%; unable to support general engineering work effort	Unemployment is a serious issue; unwilling to support general engineering work effort
	No formal paramilitary threat	Paramilitary threat briefed at the BCT/RCT level	Paramilitary threat a concern at BCT/RCT level	Paramilitary threat a concern at echelons above BCT/RCT level

Note. Food Supply and Cultural/Historical/Religious are still under development.

6-55. Infrastructure protection may be another element of the infrastructure reconnaissance process that would commonly be addressed as part of the survey stage. This may be important to maintaining the status quo of the infrastructure evaluated during the survey or in providing security while identified repairs are implemented. Infrastructure protection may also be necessary for a time after the infrastructure elements are in full operation to ensure continuing operation. Considering infrastructure protection in the survey phase requires identifying threats to the infrastructure elements, identifying vulnerabilities associated with those threats, and developing courses of action for mitigating those vulnerabilities. Those courses of action could involve hardening components of infrastructure elements, identifying forces to protect them, and identifying redundancies that make protection of individual elements unnecessary.

ENVIRONMENTAL RECONNAISSANCE

6-56. Environmental reconnaissance is focused on collecting technical information on existing environmental conditions and identifying areas that are environmentally sensitive or of relative environmental concern. The information collected is used to assess both the impact of military operations on the environment as well as to identify potential environmental impacts on safety and protection. Military commanders are increasingly aware of the linkage from environmental concerns to local or regional instabilities. Commanders are equally aware of the potential threats from environmental hazards. With adequate information on both the risks from environmental hazards and the potential for damage to environmentally sensitive areas, planners can mitigate the impact of environmental concerns on the operation.

6-57. Like infrastructure reconnaissance, environmental reconnaissance is a multidiscipline task conducted by a base team augmented as necessary with additional expertise. The engineer will likely be responsible for coordinating environmental reconnaissance but should rely on other branches (CBRN, medical, CA, and EOD) for help depending on expected areas of concern and required expertise.

6-58. Many operations require fixed facilities, structures, or other real property as logistics, command and control, administration, communications, billeting, base camp, or other mission purposes. If the tactical situation permits, commanders conduct or direct an EBS before occupying any of these sites. An EBS is typically performed by or with support from general engineer elements. However, ERTs may need to perform an initial site assessment prior to an EBS with or without assistance from general engineers. (Appendix D provides detailed EBS guidance and an example. Ideally the EBS is conducted in conjunction with an EHSA conducted by a medical base team that is also augmented with other specialties [engineer, chemical, and perhaps others]. For more information see FM 3-100.4.)

6-59. The initial site assessment gathers information which assists in determining whether a parcel of land is acceptable for military use. This assessment is only as detailed as the situation permits and is focused on determining whether the site is healthy for Soldiers and Marines. The paragraph below lists areas that are addressed by the site assessment and EBS. An EBS documents the proposed site's existing environmental conditions and the likelihood of past or ongoing activities that may have created environmental, safety, or health problems. These problems include contamination of air, soil, groundwater, and surface water by toxic substances or POL.

6-60. An EBS should address the following areas:

- Property description and condition.
- Soil type and land cover.
- Water supply and source.
- Air quality.
- Signs of contamination.
- Presence of drums or containers.
- Biological and biomedical hazards (medical wastes).
- Lead-based paint.
- Unexploded ordnance.
- Other environmental and health hazards.
- Adjacent land use.

- Topographic, hydrologic, and geologic features.
- Sanitary waste disposal.
- Solid waste and hazardous waste (HW) presence.
- Presence of storage tanks.
- Heating and ventilation.
- Electrical-associated hazards.
- Fire protection systems.
- Presence of asbestos-containing materials.
- Radiological hazards.

6-61. An environmental reconnaissance is conducted to collect the data and information necessary for the EBS. Before conducting an initial reconnaissance, planners focus the reconnaissance effort on areas identified in a review of any available records (records indicate POL usage in buildings or hospitals on site). The environmental reconnaissance then gathers as much information as possible as described below in the site reconnaissance steps. If additional, more detailed information is required, a follow-on site survey is conducted unless an EBS can be conducted.

- **Step 1.** Describe the location of the site in detail with grid coordinates and maps or sketches. Note the following:
  - Topography of the site (terrain is rolling, flat, mountainous, and so forth; composition is sandy, rocky, grassy, wooded, and so forth) and note any dramatic changes.
  - Soil condition (sandy, clay, and so forth.) and note any dramatic changes.
- **Step 2.** List the six-digit military grid location or latitude/longitude and legal address of the property being surveyed.
- **Step 3.** Document (using words and photos) improvements to the property such as new roads or a roof on a building. Include any damages such as damaged roads, a collapsed roof/building, abandoned storage tanks, or any other damages. Documenting these damages could prevent future liability.
- **Step 4.** Describe any environmental issues. Note any obvious environmental contamination using grid patterns or GPSs. Take as many photos as possible and include in the photo descriptions the direction the camera was facing when each picture was taken. The need for a good photographic record with descriptions of pictures taken of the initial site conditions cannot be overstated. Often times these are noted by—
  - Areas of dead vegetation (flora) and/or wildlife (fauna) and/or insects.
  - Underground storage tanks and/or aboveground storage tanks (use records and interviews as well as the site walk-through to determine locations of any storage tanks on site).
  - Stained areas.
  - Areas and/or water sources avoided by the local population.
  - Areas that may contain suspect materials (asbestos is typically found in roof and floor tiles and in pipe insulation; polychlorinated biphenyls are typically found in electrical transformers).
  - Areas, water supplies, and so forth avoided by the local populous.
- **Step 5.** Note and describe any industrial facility/activity. These may have been identified during the planning process and records review in the EHSA or through map reconnaissance. Common facilities include—
  - Hospitals.
  - Funeral homes.
  - Factories/buildings with smokestacks.
  - Maintenance area/motor pools.
  - Powerplants.
  - Fuel stations/processing.

- **Step 6.** Describe each existing building and location, size, basic construction type, number of stories, approximate age, and heating, ventilation, air conditioning systems (including fuel/power sources), and fire suppression systems.
- **Step 7.** Locate and describe utilities at or that enter or leave the site. Include the following:
  - Sewerage.
  - Water.
  - Power source.
  - Transmission lines.
  - Phone lines.
- **Step 8.** Note and describe public thoroughfares adjoining the property and describe all roads, streets, parking areas, and walkways.
- **Step 9.** List natural, geological, hydrological, and cultural/religious sites. Typical sites include—
  - Bodies of water and groundwater sources.
  - Caves, mines, wells, quarries.
  - Cemeteries.
  - Churches/mosques/temples.
- **Step 10.** Determine if current or past use involved hazardous material (HM) or POL and include a detailed description or indicators of this use (55-gallon drums, buildings with warning labels, and so forth.).
- **Step 11.** List limitations to the site reconnaissance such as physical obstructions, bodies of water, weather, uncooperative occupants, and so forth.
- **Step 12.** Conduct all of the above steps for adjacent properties as well, if possible.

6-62. The environmental reconnaissance can be reported on an EBS document (see appendix D). EBS documentation provides the necessary outline of information required and can serve to focus the reconnaissance team as well as provide a formatted report. The EBS and the closure report bracket the timeframe of use for each particular site/area. (Appendix D provides additional discussion on preparing the EBS.)

AIRFIELD ASSESSMENT

6-63. An airfield assessment is conducted to collect detailed technical information on selected airfields and heliports. It typically is preceded by the use of geospatial and other intelligence information to provide a baseline level of information and questions about the airfield before physically arriving at the airfield. The assessment is conducted as part of an infrastructure assessment or as a separate mission focused on the selected facility. Based on the situation, the assessment may be conducted by an ERT, an augmented ERT, an assessment team, or a survey team. The level of detail of the information collected increases in the progression from ERT to survey team. The highest level of survey team will often include Air Force technical participation. In every case, the information collected can be used to determine the airfield operating capacity and to estimate resources for repair or upgrade of the airfield and/or its supporting facilities. (The assessment is recorded using the airfields smartcard tool in the infrastructure reconnaissance smartcards package in appendix C.)

6-64. Contingency operation airfield and heliport planning involves much more than just the airfield layout (geometry) and pavement structure. It involves planning for all of the supporting facilities and infrastructure—such as the air traffic control and landing system, and POL and munitions storage facilities needed to sustain airfield operations. It also involves survivability, security measures, health, safety, and environmental factors. As discussed in chapter 4, FACE prepares or repairs LZs, FARPs, landing strips, or other aviation support sites in the forward combat area, and ERTs conduct area reconnaissance to collect the information required to support FACE. All other airfield and heliport planning, design, and construction are considered general engineering tasks, and an airfield assessment team collects the technical information required for general engineer support of airfields and heliports.

6-65. Army, Air Force, Navy, and Marine Corps engineers all have the capability to design, plan, construct, upgrade, repair, and maintain airfields and heliports; however, the level of expertise and organic resources vary with each of the Services. Army engineers are responsible for forcible entry airfield damage repair (combat engineering) and may assist other engineers as directed in airfield and heliport design, planning, construction, repair, and maintenance. The Army provides the following construction support to Air Force-controlled airfields:

- Develops engineering design criteria, standard plans, and material to meet Air Force requirements.
- Performs reconnaissance, survey, design, construction, or improvement of airfields, roads, utilities, and structures.
- Repairs Air Force bases and facilities beyond the immediate emergency recovery requirements of the Air Force (semipermanent and permanent repair).
- Supplies construction materials and equipment.
- Assists in emergency repair of war-damaged air bases.
- Assists in providing expedient facilities (force bed down).
- Manages war damage repair and base development; supervises Army personnel. The Air Force base commander sets priorities.
- Performs emergency and permanent repair of war damage to forward tactical airlift support facilities.

6-66. Airfields could be subjected to damage by an increasingly capable and complex array of destructive weapons, including cannon fire, rocket fire, small or large bombs, and bomblets. Explosive hazards such as UXOs (to include scatterable mines and unexploded bomblets) and IEDs, a variety of potential barriers, and other hindrances may challenge efforts to make airfields capable of supporting air traffic. The Army, USMC engineers, and Navy Seabees conduct rapid runway repair (RRR) to provide the minimal repairs necessary to facilitate the safe landing of the required sorties to establish the lodgment area. Before making these repairs, engineers must conduct a damage assessment, prepare for explosive hazards reconnaissance and removal, understand the repair quality criteria, and know the requirements for the minimum aircraft operating surface. Air Force technical experts may be included as a part of the Army combat engineer element participating in the forcible entry operation to—

- Approve the aircraft operating surface.
- Control aircraft landing and departure.
- Serve as liaison for follow-on RRR or airfield damage repair (ADR) with general engineer elements to take the runway and/or infrastructure associated with the airfield to a higher standard of repair after the lodgment area has been secured.

6-67. Pavement damage categories are shown in figure 6-13. Damage to the pavement includes both the apparent crater damage and the upheaval of pavement around the crater. The damage category for a given munition depends on the delivery method and extent of penetration as well as charge size. (For additional information, see UFC 3-270-07).

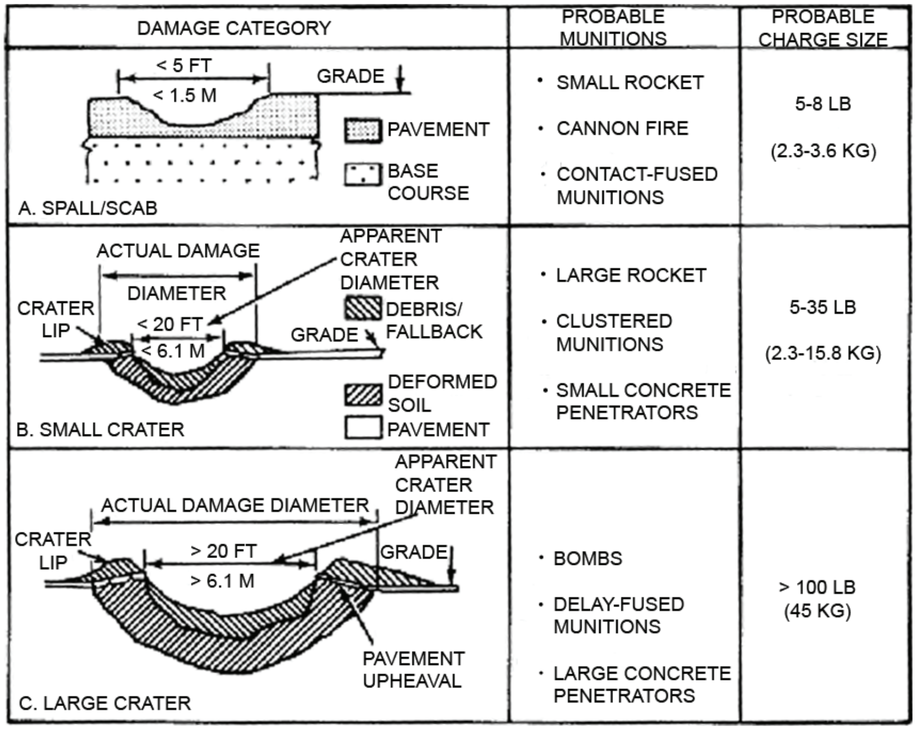


Figure 6-13. Airfield damage categories

6-68. The branch of Service that is the primary user of the airfield or heliport has the responsibility for certifying that facility for flight operations. In most cases during airfield contingency operations, this is an Air Force responsibility. Air Force engineers may assist other Army engineers, Navy construction engineers (Seabees), or Marine Corps engineers as directed in airfield and heliport design, planning, construction, repair, and maintenance. The Air Force provides the following engineer support:

- Performs primary emergency repair of war damage to air bases (RRR and repair of other critical operating facilities).
- Constructs expedient facilities for Air Force units and weapon systems. This excludes responsibility for Army base development.
- Operates and maintains Air Force facilities. Air Force engineer units perform maintenance tasks.
- Provides crash rescue and fire suppression.
- Provides HAZMAT response.
- Manages emergency repair of war damage and force bed-down construction.
- Provides infrastructure support for solid waste and hazardous waste disposal.
- Supplies material and equipment for its own engineering mission.
- Provides the EBS and EHSA for the airfield and its support facilities.

6-69. Airfields and heliports are classified by their degree of permanence and type of aircraft, either fixed- or rotary-wing, they are designed to support. These controlling aircraft, or aircraft combination, are identified for each kind of facility to establish limiting airfield and/or heliport geometric and surface strength requirements. For information on survivability (hardening) support to include the construction of revetments for helicopters, see FM 5-103. (For information on Air Force aircraft survivability, see AFM 91-201, Category Code 141-182, Hardened Aircraft Shelters.)

6-70. A bare base airfield is a site with a usable runway, taxiway, parking areas, and a source of water that can be made potable. It must be capable of supporting assigned aircraft and providing other mission-essential resources, such as a logistical support and services infrastructure composed of people, facilities, equipment, and supplies. This concept requires modular, mobile facilities, utilities, and support equipment packages that can be rapidly deployed and installed. A bare base airfield forms the baseline for contingency operations airfield planning.

6-71. The maximum (aircraft) on the ground (MOG) is the maximum number of aircraft that can be accommodated on an airfield. There are two types of MOG:

- Parking MOG is the total number of aircraft that can be parked at an airfield. Parking MOG is affected by both the overall size of the airfield and by how available space is managed.
- Working MOG refers to how many or how quickly parked aircraft can be offloaded, material throughputted from the aerial port of debarkation, and aircraft serviced and prepared for departure.

6-72. Materials handling equipment, trucks, buses, and other surface transport vehicles, road networks, aircraft support equipment, fuel tankers, personnel, and other factors affect working MOG. Ideally, working MOG equals parking MOG—when it does not, backlogs occur. MOG is normally expressed in terms of C-141s. A minimum of MOG 2 is desired for contingency operations airfields. (Refer to AFPAM 10-1403 for aircraft dimensions.)

6-73. Army airfields and heliports are divided into six classes:

- **Class I.** Helipads-heliports with aircraft 25,000 pounds (11,340 kilogram) or less. The controlling aircraft is a UH-60 aircraft at a 16,300-pound (7,395 kilogram) operational weight.
- **Class II.** Helipads-heliports with aircraft over 25,000 pounds (11,340 kilogram Marline Myers [sqdancer2005@gmail.com]). The controlling aircraft is a CH-47 aircraft at a 50,000-pound (22,680 kilogram) operational weight.
- **Class III.** Airfields with Class A runways. The controlling aircraft combination is a C-23 aircraft at a 24,600-pound (11,158 kilogram) operational weight and a CH-47 aircraft at a 50,000-pound (22,680 kilogram) operational weight. Class A runways are primarily intended for small aircraft such as C-12s and C-23s.
- **Class IV.** Airfields with Class B runways. The controlling aircraft is a C-130 aircraft at a 155,000-pound (70,307 kilogram) operational weight or a C-17 aircraft at a 580,000-pound (263,084 kilogram) operational weight. Class B runways are primarily intended for high performance and large heavy aircraft such as C-130s, C-17s, and C-141s.
- **Class V.** Contingency operations heliport or helipads supporting Army assault training missions. The controlling aircraft is a CH-47 aircraft at a 50,000-pound (22,680 kilogram) operational weight.
- **Class VI.** Assault Landing Zones for contingency operations airfields supporting Army training missions that have semi-prepared or paved surfaces (also known as forward landing strips). The controlling aircraft is a C-130 aircraft at a 155,000-pound (70,307 kilogram) operational weight or a C-17 aircraft at a 580,000-pound (263,084 kilogram) operational weight.

6-74. Air Force airfields are classified into six mission categories. A controlling aircraft or combination of controlling aircraft has been designated for each category to establish limiting airfield, geometric, and surface strength requirements. These airfield categories include—

- Light – F15, C-17.
- Medium – F-15, C-17, B-52.
- Heavy – F-15, C-5, B-52.
- Modified heavy – F-15, C-17, B-1.
- Auxiliary – F-15.
- Assault landing zone – C-130, C-17.

6-75. On normal operational airfields, pavements are grouped into the following four traffic areas based on their intended use and design load:

- **Type A.** Those traffic areas that receive concentrated traffic and the full design weight of the aircraft. These traffic areas require a greater pavement thickness than other areas on the airfield and include all airfield runways and, in some cases, taxiways as well. All airfield pavement structures on contingency operations airfields are considered Type A traffic areas.

- **Type B.** Those traffic areas that receive a more even traffic flow and the full design weight of the aircraft. These traffic areas include parking aprons, pads, and hardstands.
- **Type C.** Those traffic areas with a low volume of traffic or the applied weight of the operating aircraft is generally less than the design weight. These traffic areas include secondary taxiways and washrack pavements.
- **Type D.** Those traffic areas with an extremely low volume of traffic and/or the applied weight of the operating aircraft is considerably lower than the design weight.

6-76. An airfield can also be described based on its location within the AO:

- Forward airfields intended to provide focused logistics support and/or support combat missions of short-range aircraft such as attack helicopters and UASs during contingency operations. These airfields are designed to initial or temporary contingency operations standards depending on mission and operational requirements and may be paved or semiprepared. These may be initially prepared or repaired as FACE tasks.
- Intermediate airfields intended to provide general logistics support, support combat missions of longer-range aircraft during contingency operations, and/or training. These airfields are designed to temporary or semipermanent standards depending on mission and operational requirements. Normally these airfields are paved. These airfields provide a link between forward tactical airfields and sustainment level airfields.
- Airfields intended to provide logistics support forward from fixed, secure bases, support combat operations of long-range aircraft, and/or training. These airfields are designed to be semipermanent or permanent facilities.

6-77. For airfield planning and design, refer to the following manuals.

- FM 5-430-00-1/AFJPAM 32-8013
- FM 5-430-00-2/AFJPAM 32-8013
- FM 3-34.2 (specifically regarding FACE operations)
- TM 5-820-1
- TM 5-820-3/AFM 88-5
- UFC 3-260-01
- UFC 3-260-02
- UFC 4-141-10N

TECHNICAL RESOURCES AND FIELD FORCE ENGINEERING

6-78. This section discusses some of the support available for engineers conducting technical reconnaissance. Support from both the United States Army Engineer School (USAES) and the USACE is provided in the form of ad hoc (especially designed for a particular mission) teams, in modular deployable elements, or through nondeployed expertise supplied via reach-back support. This type of reach-back capability is one of the characteristics of FFE. The Air Force and Navy provide similar reach-back capabilities and support through the Air Force Civil Engineering Support Agency (AFCESA) and the Naval Facilities Engineering Command (NAVFAC). This section provides a broad overview of FFE, multi-Service, and interagency support. (Additional specific technical tools and resources are discussed in appendix H.)

FIELD FORCE ENGINEERING

6-79. FFE works to provide seamless general engineering (and associated geospatial) support for the warfighter by fusing the capabilities resident in USACE, USAES, the engineer command (ENCOM), public works, and civilian contractors. The mission of FFE is to support the engineer in theater by providing modular teams capable of deploying forward and focused technical engineer support through reach-back capabilities. FFE is applicable to the support of not only Army forces but also the other services and governmental agencies outside of DOD. Figure 6-14 highlights the majority of capabilities the engineer regiment offers to support contingency operations.

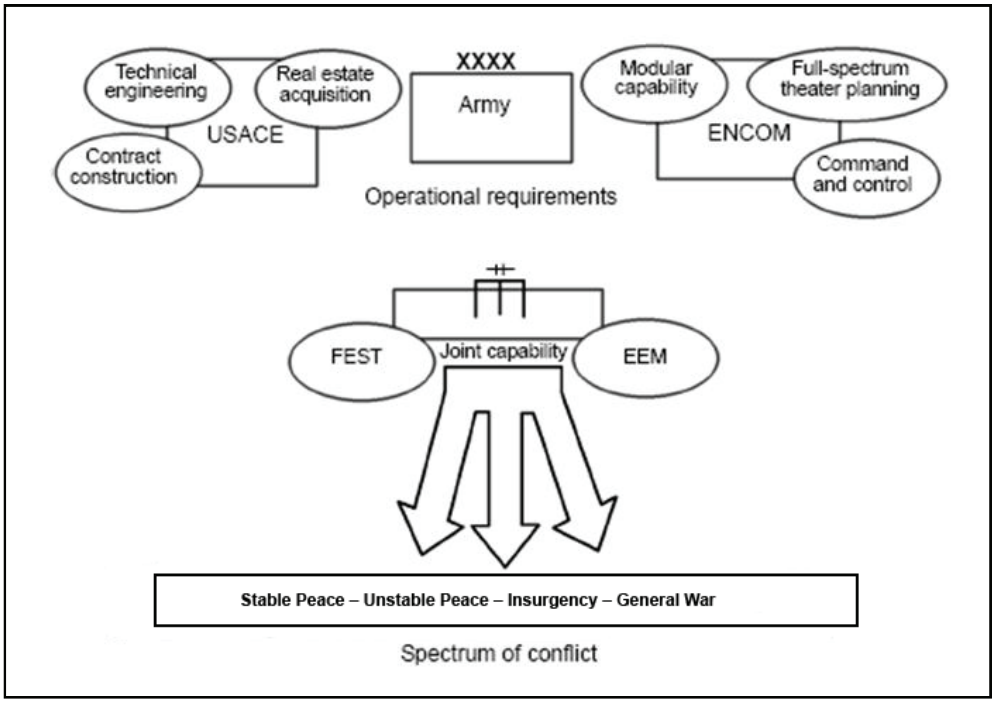


Figure 6-14. Field force engineering

6-80. Modular teams are available to meet the needs for general engineering staff, planning, facilities engineering, troop construction, topographic engineering, contract construction, technical engineering, real estate, and environmental engineering. Examples of USACE modular capabilities support are listed below:

- Forward engineer support team-main (FEST-M)—deployable USACE organization that executes the USACE mission in the AO; it is usually subordinate to the senior engineer commander in the AO.
- Forward engineer support team-advanced (FEST-A)—deployable planning augmentation cell that augments the engineer staff of other organizations to include combatant commander/joint force commander/Army service component commander (ASCC)/ENCOMs. If a FEST-M is also deployed, the FEST-A will come under the command of the FEST-M commander.
- Contingency real estate support team (CREST)—deployable 5- or 6-person real estate team and typically a component of a forward engineer support team (FEST); it can quickly execute real property (land and facilities) leases at forward locations.
- Environmental support team (ENVST)—deployable 4-person environmental team and typically a component of a FEST; it provides baseline and other environmental studies at forward locations and is staffed with environmental specialists that can provide technical expertise to staff engineers and ultimately the commander of the combined-arms force.
- Base development team—a nondeployable team that can quickly provide base development engineering and planning and facilities design for staging bases, base camps, forward operating bases, displaced persons camps, and any similar requirement.
- Infrastructure assessment team (IAT)—nondeployable team that provides engineering infrastructure assessments/surveys for military deployments and civil-military operations in forward areas. Focus areas for the IAT are infrastructure related to USACE missions and aspects of the AO impacting contract construction to include roads, utilities, water resources, and HNS.

6-81. A partial list of potential missions performed by deployed FFE units/organizations includes—

- Project management, to include supervising work done by military engineers of all Services, logistics civilian augmentation program-type contractors, and local contractors.
- Expertise in survivability engineering and engineering services, including areas such as wastewater treatment, nontactical power generation, water production, snow and ice removal, and entomology.
- Expertise in both theater operational (for example, inland petroleum distribution system) and infrastructure pipeline construction.
- Expertise in mining and demining.
- Development and maintenance of base camp standards according to ASCC guidance.
- Development of prioritized facilities requirements with supporting construction engineers.
- Management of the installation and regional/area of responsibility (AOR) master plan development process, such as—
  - Developing base camp master plans.
  - Reviewing and approving base camp master plans developed by others.
  - Developing regional master plans in support of the operational support structure.
- Base camp maintenance, to include—
  - Structures.
  - Utilities.
  - Roads and airfields.
  - Provision of water.
  - Treatment of wastewater.
  - Disposal of solid waste.
  - Training ranges.
- Management of base camp facilities use, to include—
  - Environmental compliance.
  - Maintenance of real property records.
  - Plans for future expansions or contractions of base camps.
  - Quality control for construction projects and facilities upgrades.
  - Establishment of a fire prevention program and management of fire-fighting teams.
  - Facility engineering supplies management.

6-82. Reach-back may be used to obtain much of the specialized support required forward. One method for this is the use of the USACE TeleEngineering Emergency Operations Center (TEOC) and a forward deployed TeleEngineering Communication Suite. Reachback and TeleEngineering describe the ability to conduct engineering analysis and support using expertise (professional engineers, scientists, and technicians), as well as databases that are not resident in the theater or the AO. The source of this expertise and data is real time via secure voice and video information technology to the forward mission site. The results are faster response times—the application of greater levels of expertise examining and solving problems and providing solution options. An additional set of benefits includes a reduced deployment footprint, associated support and protection requirements, and a general reduction in cost.

MULTI-SERVICE SUPPORT

6-83. Engineer operations in the COE are becoming increasingly integrated efforts by engineer units, elements, and support from two or more Services. United States Air Force (USAF) civil engineering expertise coupled with Army and USMC combat engineers routinely work in concert to repair and upgrade contingency airfields. United States Navy (USN) construction engineers are routinely integrated in general support of USMC forces and have begun teaming with USAF and Army engineers to support theaterwide requirements. Each service brings extensive engineering expertise which can be useful in support of the technical reconnaissance requirement.

6-84. USAF civil engineering capabilities are organized as Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer (RED HORSE) or Prime Base Engineer Emergency Force (Prime BEEF) units. RED HORSE units are deployable worldwide and provide support to force bed down, expedient airfield and heavy construction and repair, and environmental cleanup and spill response. Prime BEEF units are also deployable and provide force bed-down support, engineering and construction management, facilities operation and maintenance (O&M), emergency repair, EOD, fire protection, and CBRN monitoring and protection.

6-85. USN civil engineer capabilities are organized under both First Naval Construction Division and the Naval Beach Groups. The First Naval Construction Division is the operational command responsible for global force management of Seabees of the Naval Construction Regiments, Naval Mobile Construction Battalions, Construction Battalion Maintenance Units, Underwater Construction Teams, and its sole Naval Construction Force Support Unit. It also has Seabee Readiness Groups to conduct training and logistical support. The common thread that is woven throughout all Seabee units is responsiveness and flexibility. Naval Mobile Construction Battalions are the Navy's primary capability and possess robust vertical construction, bridging, and heavy earthmoving capabilities. Naval Mobile Construction Battalions are deployable, self sufficient and task-organize to provide general construction and disaster relief support. They also reinforce and augment the USMC limited general engineering capability. Under the Atlantic and Pacific Naval Beach Groups, the amphibious construction battalions deploy to provide specialized construction, barge ferry, elevated piers, offshore petroleum systems, and beach camp support. Refer to FM 3-34 and NWP 4-04 for additional information on these units.

6-86. Army and USMC engineers tasked to conduct technical engineer reconnaissance should determine what USAF and/or USN engineer elements are available to potentially provide general or specialized support. In many cases, the deployed USAF and/or USN elements will possess technical expertise not available elsewhere.

FEDERAL EMERGENCY MANAGEMENT AGENCY AND OTHER GOVERNMENT AGENCIES

6-87. Throughout the Nation's history, citizens have relied on the Army to respond to their needs in disasters. In a typical year, the Corps of Engineers responds to more than 30 presidential disaster declarations, plus numerous state and local emergencies. Emergency responses usually involve cooperation with other military elements and federal agencies in support of state and local efforts. The Corps of Engineers conducts its emergency response activities under two basic authorities: the Flood Control and Coastal Emergency Act (P.L. 84-99, as amended) and the Stafford Disaster and Emergency Assistance Act (P.L. 93-288, as amended). Under the Stafford Act, the Corps supports the Federal Emergency Management Agency (FEMA) in carrying out the Federal Response Plan, which calls on 26 federal departments and agencies to provide coordinated disaster relief and recovery operations. Under this plan, the Army has the lead responsibility for public works and engineering missions.

6-88. Under the National Response Plan, the USACE is designated as the lead agency for Public Works and Engineering. The USACE can be authorized to provide the following assistance on a temporary basis:

- Emergency services including supplying potable water, removing debris, conducting urban search and rescue, and providing emergency electrical power and ice.
- Technical advice and evaluations including structural analysis.
- Construction management and inspection.
- Emergency contracting.
- Emergency repair of public infrastructure and facilities such as water supply sources.
- Real estate support.

6-89. The FEMA, a former independent agency that became part of the new Department of Homeland Security (DHS) in March 2003, is tasked with responding to, planning for, recovering from, and mitigating against disasters. In March 2003, FEMA joined 22 other federal agencies, programs, and offices in becoming the DHS. The new department, headed by Secretary of Homeland Security, brings a coordinated approach to national security from emergencies and disasters, both natural and manmade. FEMA is one of four major branches of DHS. About 2,500 full-time employees in the Emergency Preparedness and

Response Directorate are supplemented by more than 5,000 standby disaster reservists. FEMA has 10 regional offices and two area offices. Each region serves several states, and the regional staffs work directly with the states to help plan for disasters, develop mitigation programs, and meet needs when major disasters occur. In response to a presidentially declared disaster, FEMA may work with up to 28 federal agencies and the American Red Cross to provide assistance. These agencies provide state and local governments with personnel, technical expertise, equipment, and other resources and assume an active role in managing the response.

6-90. To coordinate the federal efforts, FEMA recommends—and the president appoints—a federal coordinating officer (FCO) for each state that is affected by a disaster. The FCO and the state response team set up a disaster field office near the disaster scene. It is from there that the federal and state personnel work together to carry out response and recovery functions. These functions are grouped into 12 emergency support functions, each headed by an agency supported by other agencies. The federal agencies that provide assistance include the following:

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Education
- Department of Energy
- Department of Health and Human Services
- Department of Housing and Urban Development
- Department of the Interior
- Department of Justice
- Department of Labor
- Department of State
- Department of Transportation
- Department of the Treasury
- Internal Revenue Service
- Department of Veterans Affairs
- Agency for International Development
- American Red Cross
- Environmental Protection Agency
- Federal Communications Commission
- Federal Emergency Management Agency
- General Services Administration
- National Aeronautical and Space Administration
- National Communications System
- Nuclear Regulatory Commission
- Office of Personnel Management
- Office of Science and Technology Policy
- Small Business Administration
- Tennessee Valley Authority
- U.S. Postal Service

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Appendix A

Metric Conversion Table

A-1. When planning general engineering missions, it is often necessary to use metric units to standardize project measurements. Table A-1 is intended to serve as a basic conversion table for that purpose.

Table A-1. Metric conversion table

US Units	***Multiplied By***	***Equals Metric Units***
Acres	0.4947	Hectares
Acres	43,560	Square feet
Acres	4,047	Square meters
Bulk fuel, 55 gallon drum	0.17	Stons
Cubic feet	0.0283	Cubic meters
Cubic inches	16.3872	Cubic centimeters
Cubic inches	0.0164	Liters
Cubic yards	0.7646	Cubic meters
Feet	0.3048	Meters
Fluid ounces	29.573	Milliliters
Feet per second	18.288	Meters per second
Gallons	0.1337	Cubic feet
Gallons	0.00378	Cubic meters
Gallons	3.7854	Liters
Gallons (bulk fuel)	0.004	Stons
Inches	2.54	Centimeters
Inches	0.0254	Meters
Inches	25.4001	Millimeters
Miles (nautical)	1.85320	Kilometers
Miles(statue)	1.6093	Kilometers
Ounces	28.349	Grams
Pounds	453.59	Grams
Pounds	0.4536	Kilograms
Square inches	6.4516	Square centimeters
Square feet	0.0929	Square meters
Square miles	2.59	Square kilometers
Square yards	0.8361	Square meters
Yards	0.914	Meters
Degrees Fahrenheit	Subtract 32, multiply by 5, and divide the sum by 9	Degrees Celsius

Metric Units	***Multiplied By***	***U.S. Units***
Centimeters	0.3937	Inches
Cubic centimeters	0.061	Cubic inches
Cubic meters	35.3144	Cubic feet
Cubic meters	1.3079	Cubic yards
Milliliters	0.03380	Fluid ounces
Grams	0.03527	Ounces
Kilograms	2.2046	Pounds
Kilometers	0.5396	Miles (nautical)
Kilometers	0.62137	Miles (statute)
Meters	3.2808	Feet
Meters	39.37	Inches
Meters	1.0936	Yards
Millimeters	0.03937	Inches
Square centimeters	0.155	Square inches
Square kilometers	0.3861	Square miles
Square meters	1.196	Square yards
Square meters	10.764	Square feet
Degrees Celsius	By 9 and divide the sum by 5; add 32	Degrees Fahrenheit

Appendix B

Reporting

This appendix is intended to provide a quick reference for reporting of engineer related technical information. The first section provides, in table format, the various symbols used to describe the results of a route classification on an overlay (as discussed in chapter 5). The second section provides examples of various report formats useful in documenting and reporting the results of technical engineer reconnaissance support. (See MCRP 3-17B for additional report formats. See FM 3-34.210 for an explosive hazard survey form and instructions. Infrastructure smartcards, which support infrastructure reconnaissance, are provided separately in appendix C. The EBS is provided separately in appendix D.)

ROUTE CLASSIFICATION SYMBOLS

B-1. Table B-1 identifies symbols used on route classification overlays (as discussed in chapter 5).

Table B-1. Route classification symbols

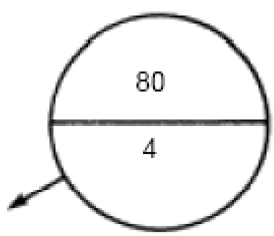
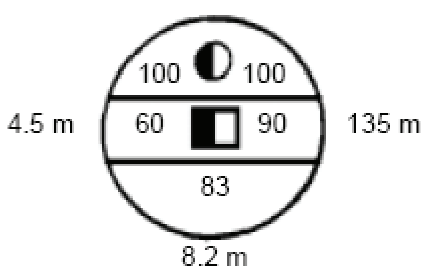
Symbol	*Definition*
	Bridge symbol (abbreviated). Use this symbol only when the map scale does not permit the use of the full NATO bridge symbol. Submit DA Form 1249 if this symbol is used. Draw an arrow to the map location of the bridge. Show the bridge's serial number in the lower portion of the symbol and the MLC for single-flow traffic in the upper portion. If there are separate load classifications for tracked or wheeled vehicles, show the lesser classification. Underline the classification number if the width or overhead clearance is below minimum requirements.
	Bridge symbol (NATO) shows: • Two-way wheeled classification, top left. • One-way wheeled classification, top right. • Two-way tracked classification, middle left. • One-way tracked classification, middle right. • Assigned serial number, bottom inside circle. • Traveled-way width, bottom outside circle. • Overhead clearance, outside left. • Length, outside right.

Table B-1. Route classification symbols

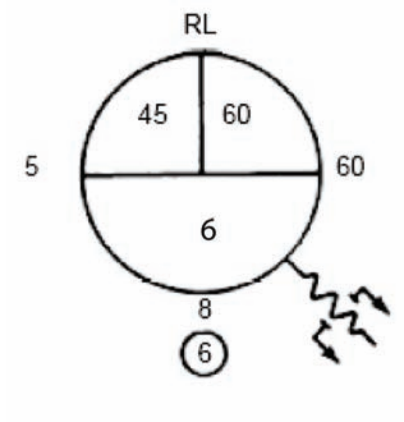
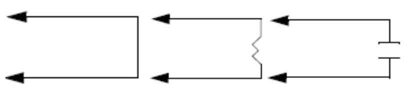
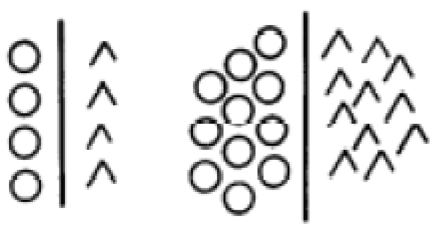
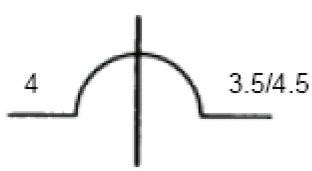
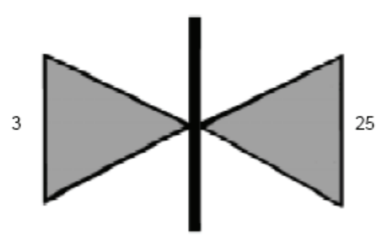
Symbol	***Definition***
	Bridge symbol (railway). Place RL above the symbol to indicate a railway bridge. At the left of the symbol, show the overhead clearance. Show the bridge's overall length at the right of the symbol. Indicate the traveled-way width below the symbol and underline it if it is below standard for the classification. Inside the symbol, show the bridge classification in the upper half. If the class is different for single- and double-flow traffic, show single flow on the left and double flow on the right. Place the railway bridge's serial number in the lower half of the symbol. Draw an arrow to the map location of the bridge. On the arrow shaft, indicate the ease of adapting the bridge for road-vehicle use. A zigzag line means it would be difficult to adapt; a straight line means it would be easy to adapt. Place the bypass symbol on the arrow shaft to indicate bypass conditions.
	Bypass, symbols shown indicate (from left to right) bypass is easy, difficult, or impossible.
	Concealment. Show roads lined with trees by a single line of circles for deciduous trees and a single line of inverted Vs for evergreen trees. Show woods bordering a road by several rows of circles for deciduous trees and several rows of inverted Vs for evergreen trees.
	Critical points. Number (in order) and describe critical points on DA Form 1711. Use critical points to show features not adequately covered by other symbols on the overlay.
	Constriction (underpass). The number on the left shows the narrowest width of the constriction; the number on the right is the overhead clearance (minimum/maximum). Both dimensions are in meters.
 Width constriction of 3 meters for a distance of 25 meters	Constriction (width). The number on the left shows the narrowest width of the constriction; the number on the right is the overhead clearance (minimum/maximum). Both dimensions are in meters.

Table B-1. Route classification symbols

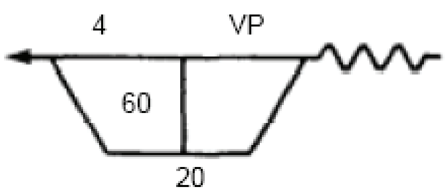
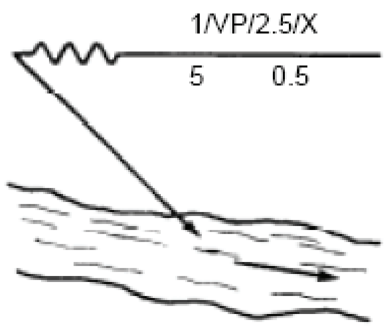
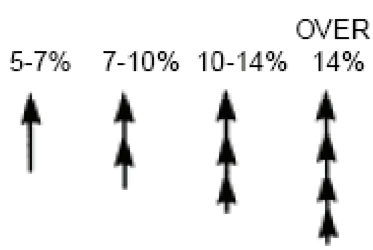
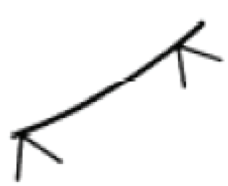
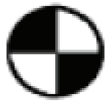
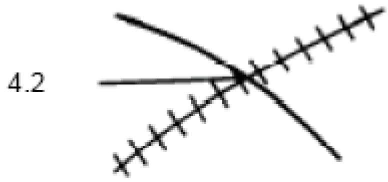
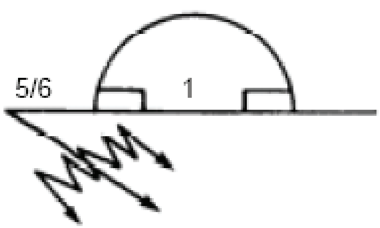
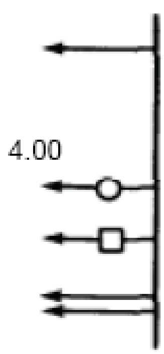
Symbol	***Definition***
 	Curve with a radius less than 45 meters. Symbol points toward curve location and shows actual radius of curve outside of triangle. Series of sharp curves shown with a triangle drawn inside another triangle. The number of curves followed by the radius of the sharpest curve shown outside of the triangles.
	Ferry symbol shows— • Assigned serial number, top left. • Ferry type (V, P, or both), top right. • MLC, enclosed left. • Dead-weight capacity (if known), enclosed right. • Ferry turnaround time, bottom bank conditions shown by arrow neck and tail.
	Ford symbol shows— • Assigned serial number, top left. • Ford type (V, P or both), top 2nd from left. • Stream's normal velocity, top 2nd from right. • Seasonal limiting factors (X or Y), top right. • Length of ford, bottom left. • Ford width, bottom 2nd from left. • Nature of ford bottom, bottom 2nd from right. - normal depth, bottom right
	Grades. • Single arrowhead pointing up—indicates grade between 5 – 7 percent. • Double arrowhead pointing up—indicates grade between 7– 10 percent. • Triple arrowhead pointing up—indicates grade between 10 – 14 percent. • Four arrowheads pointing up—indicates grade over 14 percent.
	Limits of sector. Show the beginning and ending of a section of a route covered by reconnaissance with this symbol.

Table B-1. Route classification symbols

Symbol	***Definition***
	Parking area.
	Railroad grade crossing. Use this symbol to show a level crossing where passing trains would interrupt traffic flow. If there is a power line present, show its height (in meters) from the ground. Underline the overhead clearance if it is less than 4.3 meters.
10.5 m/X/120/00 6 m/Z/30/4.1 m/(OB) 9 m/V/40/5 m/(OB) (W)	Route classification formula consists of, from left to right— • Route width, in meters. • Route type (X, Y, or Z). • Lowest MLC. • Lowest overhead clearance, in meters. • Obstructions to traffic flow (OB). • Special conditions (T or W).
	Tunnel symbol shows— • Minimum/maximum overhead clearance, top left. • Traveled-way width, bottom center. • Tunnel length, top right. • Assigned serial number, inside tunnel type sketch. • Bypass type, on arrow toward tunnel.
	Turnout. Use this symbol to show the possibility of driving off the road. Draw the arrow in the direction of the turnout (right or left of the road). For wheeled vehicles, draw a small circle on the arrow's shaft. For tracked vehicles, draw a small square on the arrow's shaft and place the length of the turnout, in meters, at the tip of the arrow. When a turnout is longer than 1 kilometer, use double arrows.

ENGINEER RECONNAISSANCE REPORTS

B-2. Table B-2 provides a summary of the various engineer reconnaissance reports and the page reference in this appendix where an example is provided.

Table B-2. Engineer reconnaissance reports

Route Classification Report, DA Form 1247	Page B-6
Road Reconnaissance Report, DA Form 1248	Page B-13
Bridge Reconnaissance Report, DA Form 1249	B-19
Tunnel Reconnaissance Report, DA Form 1250	Page B-22
Ford Reconnaissance Report, DA Form 1251	Page B-24
Ferry Reconnaissance Report, DA Form 1252	Page B-26
Engineer Reconnaissance Report, DA Form 1711	Page B-29
Demolition Reconnaissance Record, DA Form 2203	Page B-36
River Reconnaissance Report, DA Form 7398	Page B-41

ROUTE CLASSIFICATION REPORT

B-3. Use a Route Classification Report, DA Form 1247, to report the technical information collected during route classification. Additionally, route classification information is summarized on the route classification overlay as described in chapter 5. Complete the route classification form as follows (see figure B-1 on pages B-6 through B-11).

ROUTE CLASSIFICATION FORM

For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

SECTION I

1.1. SERIAL NUMBER *001*	1.2. TO *S-2, 21st Engr Bn*
1.3. FOR INFORMATION *fred.smith@us.army.mil*	1.4. DATE/TIME GROUP *1 Jul 07*
1.5. NUMBER OF SHEETS OR ENCLOSURES *3*	1.6. RECONNAISSANCE OFFICER/NCO *Fred Smith, SFC*
1.7. UNIT *A Co, 21st Engr Bn*	1.8. FORMATION *1 BCT*

1.9. SIGNATURE

SFC Fred Smith

1.10. UNITS USED IN THE FORM *(Please check)*

☐ CENTIMETERS ☐ INCHES ☐ FEET ☐ MILES ☐ METERS ☒ KILOMETERS ☐ CENTIGRADE ☐ FARENHIET

1.11. MAPS

1.12. COUNTRY *USA*	1.15. SHEET NUMBER *5561 IV*
1.13. NAME *Fort Belvoir Special*	1.16. SERIAL *V733*
1.14. EDITION *AMS*	1.17. SCALE *1:50,000*

SECTION II

2.1. ROUTE CLASSIFICATION *(See Section VII, Block 7.1.)*	2.2. LIMITED BY SECTIONS
6.7 / *Y* / *80* / *6* (*OB*) (*W*) ( ) 1 2 3 4 5 5 5	*C*

SECTION III

3.1. ROAD CLASSIFICATION	3.2. WEATHER *(Include last rainfall, if known, plus the temperture)*	3.3. GRID REFERENCE - START
	Fair; temperature 79 degrees *Last rainfall 15 Jun 07*	*UT 122864*

3.4. ROAD

SECTION A		3.5. PREFIX	3.6. LIMITED FACTORS	3.7. WIDTH	3.8. CONSTRUCTION MATERIALS	3.9. LENGTH	3.10. OBSTRUCTIONS
3.11. START GRID	3.12. FORMULA	*B*	*d*	*7.3/9.3*	*kb*	*5 km*	*OB*
UT 122864	3.13. SHOULDERS						
SECTION B							
3.11. START GRID	3.12. FORMULA	*A*		*7.0/9.0*	*kb*	*5 km*	*OB*
UT 110910	3.13. SHOULDERS						
SECTION C							
3.11. START GRID	3.12. FORMULA	*B*	*cgd*	*6.7/8.7*	*kb*	*6 km*	*OB*
UT 119921	3.13. SHOULDERS						
SECTION D							
3.11. START GRID	3.12. FORMULA						
	3.13. SHOULDERS						

3.14. GRID REFERENCE - END:

SECTION III

4.1. ENCLOSURES

SERIAL	TITLE	ATTACHED	SERIAL	TITLE	ATTACHED
1	OVERLAY(S)	*X*	6	RAPID BRIDGE ASSESSMENT(S)	
2	MAP(S)	*X*	7	DETAILED BRIDGE ASSESSMENT(S)	
3	DETAILED SKETCH(ES)		8	PHOTOGRAPH(S)	
4	CALCULATION(S)		9	OTHER *(Describe)*:	
5	WORK ESTIMATE(S)		10	OTHER *(Describe)*:	

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Page 1 of 6

Figure B-1. Sample DA Form 1247

SECTION V

5.1. OBSTRUCTIONS AND RECOMMENDATIONS FOR UPGRADES

5.2. SERIAL	5.3. OBSTRUCTION DETAILS *(Including existing MLC)*	5.4. ROAD SECTION	5.5. GRID	5.6. RECOMMENDATION FOR UPGRADE *(Including new MLC)*	5.7. MANPOWER	5.8. EQUIPMENT/ VEHICLES	5.9. CONSTRUCTION MATERIAL	5.10. TIME	5.11. NEW MLC
1	*Constriction - 7.3 m 250 m long*	*A*	*UT 119872*						
2	*Constriction - 7 m 20 m long*	*B*	*UT 115916*						
3	*Overpass - 6 m*	*B*	*UT 113922*						
4	*Sharp curve - 21 m*	*C*	*UT 112938*						
5	*Steep grade - 8 percent*	*C*	*UT 109957*						

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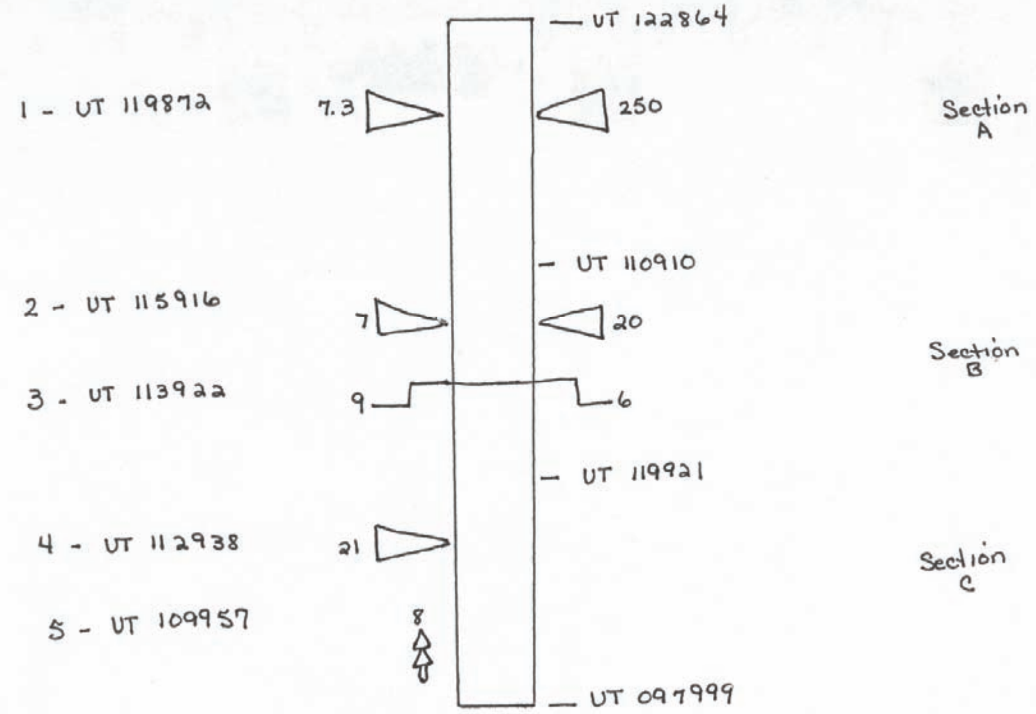
Figure B-1. Sample DA Form 1247 (continued)

SECTION VI

6.1. ROUTE CHART



NAME
SFC Fred Smith

UNIT
A Co, 21st Engr Bn

DATE/TIME GROUP
011430ZJUL07

SCALE
NA

REMARKS

6.2. NOTES

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Figure B-1. Sample DA Form 1247 (continued)

SECTION VII

7.1. FACTORS USED IN ROUTE CLASSIFICATION FORMULAS. *For example, 3.5/X/70/3.9(OB)*

SERIAL	FACTOR	SYMBOL	MEANING
1	WIDTH	For example, 3.5 meters	The width of the narrowest part for any given section.
2	ROUTE TYPE	X	All-weather route - waterproof surface, never closed by weather other than snow or flooding.
		Y	Limited all-weather route - loose or light surface, sometimes reduced volumeof traffic due to bad weather.
		Z	Fair weather route - quickly impassable in adverse weather.
3	MLC	For example, 70	The maximum MLC of the vehicle which can use the route in convoy.
4	OVERHEAD CLEARANCE	For example, 3.9	The minimum vertical distance between the route or road surface and any overhead obstruction. Only included if height is less than the required for the MLC.
5	OBSTRUCTION TO TRAFFIC OTHER THAN A BRIDGE	(OB)	Temporary or single obstructions.
		(T)	Regular, recurrent and serious snow blockage.
		(W)	Regular, recurrent, and serious flooding.

7.2. FACTORS USED IN ROAD CLASSIFICATION FORMULAS.

SERIAL	FACTOR	SYMBOL	MEANING
1	PREFIX	A	No limiting factors.
		B	One or more limiting factors.
2	LIMITING FACTORS: SHARP CURVES	c	Radius less than 25 meters and deflecting the direction more than 90°.
	STEEP GRADIENTS	g	Gradients of 7 percent or over.
	POOR DRAINAGE	d	Inadequete or blocked drainage.
	WEAK FOUNDATIONS	f	Unstable, loose, or easily displaced.
	ROUGH SURFACE	s	Likely to reduce convoy speed
	EXCESSIVE CAMBER OR SUPER ELEVATION	j	Likely to cause heavy vehicle to skid or drag towards roadside.
	DOUBTFUL CONDITIONS	?	Indeterminate or doubtful conditions expressed with ? and (). For example, (f?).
	SHOULDERS	-	No symbol, but written reports should specify.
3	WIDTH	__/__	Width of travelled way or total width including shoulders (when they are usable).
4	CONSTRUCTION MATERIAL: TYPE X ROUTE	k kb	Concrete. Bituminous or asphaltic concrete.
	TYPE X OR Y ROUTE	p rb	Paving brick or stone. Bitumen penetrated macadam, water-bound macadam with superficial asphalt or tar cover.
	TYPE Y ROUTE	r l	Water-bound macadam, crushed rock or coral. Gravel or lightly metalled.
	TYPE Y OR Z ROUTE	nb	Bituminious surface treatment on natural earth, stabilized soil, sand-clay, and so forth.
	TYPE Z ROUTE	n b v	Natural earth, stabilized soil, sand-clay, shell, cinders, and so forth. Bituminious construction. To be used alone only when type of bituminious construction cannot be determined. Various other types not mentioned above.
5	LENGTH	(km)	The length of the section in kilometers may be added in brackets if desired.
6	OBSTRUCTIONS: SNOW FLOODING	(OB)	Symbol at the end of the formula indicates existence of obstruction.
		(T)	Regular, recurrent and serious snow blockage.
		(W)	Regular and sufficiently flooding which impedes traffic flow.

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Figure B-1. Sample DA Form 1247 (continued)

7.2. FACTORS USED IN ROAD CLASSIFICATION FORMULAS. (continued)

NOTE. Consider the following as obstructions:

- Overhead clearance less than 4.3 meters.
- Reductions in road widths which limit traffic capacity, such as craters.
- Gradients of 7 percent and over.
- Curves with less than a 25-meter radius and deflecting more than 90°.
- Ford and ferries.

Example: B/c(f?)/3.2/4.8/p/(4.5km)(OB)(T)

According to the width, classify a route or road as follows:

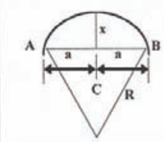
- **Limited access**. Up to 3.5 meters wide; it permits passage of isolated vehicles in one direction only.
- **Single lane.** From 3.5 to 5.5 meters wide; it permits use only in one direction at any one time.
- **Single flow.** From 5.5 to 7.5 meters wide; it permits isolated vehicles to pass or travel in the opposite direction to the main flow.
- **Double flow.** Over 7.3 meters wide; it permits two columns of vehicles to proceed simultaneously.

7.3. MEASURING THE RADIUS OF AN EXSISTING CURVE.

Step 1. A chord AB is set out as shown and bisected at C, so that AC = BC = a.

Step 2. From point C, the perpendicular offset (x) is measured at point D on the curve.

Step 3. The radius is calculated from the formula. $R = \frac{x^2 + a^2}{2x}$



7.4. CONVERSION FACTORS.

U.S. UNITS	MULTIPLIED BY	EQUALS METRIC UNITS
CENTIMETER	0.39370	INCH
FOOT	0.30480	METER
INCH	2.54000	CENTIMETER
KILOMETER	0.62137	MILE
METER	3.28084	FEET
MILE	1.60934	KILOMETER
	TEMPERTURE	
CENTIGRADE DEGREES	$C^{\circ} = \frac{5(F^{\circ} - 32)}{9}$	FARENHEIT DEGREES
FARENHEIT DEGREES	$F^{\circ} = \frac{9C^{\circ}}{5} + 32$	CENTIGRADE DEGREES

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Figure B-1. Sample DA Form 1247 (continued)

7.5. SYMBOLS AND DESCRIPTIONS

SYMBOLS	DESCRIPTION
17 7/15	Sharp curve. Less than 25 meters (the figure indicates radius) [left] Series of sharp curves. The figures indicate the number of curves/radius [right]
10-14% 7-10% 5-7% > 14%	Steep grade. Arrows point up hill; grade in percent (length of the arrows may show the length of the grade when the scale allows)
4 120	Constriction. Left-Width Right-Total length
4 3.5	Arch constriction. Left-Width Right-Overhead clearance
6 300 7/9	Tunnel. Left-Height Right-Length Bottom-Roadway and total width (include footpath)
5 4	Underpass constriction. Width [left] and height [right]
	Obstacle bypass. Easy-Can be crossed within the immediate vicinity by a NATO track equivalent to a 2.5-ton truck. Difficult-Can be crossed within the immediate vicinity, but some work will be necessary to prepare the bypass. Impossible-Can be crossed after repairing, building of a new construction, or by a detour.
4.2	Level crossing. The figure indicates the height of the power line aboveground.
0.4 3.5 30 6 6 3.6 C 0.6	Bridge. Arrow to the location Top segment-MLC Left-Overhead clearance In the middle-Serial number Underneath-Roadway width Right-Overall length Culvert. Arrow to location. Top-Depth of fill Bottom-Diameter of pipe]
3	Limits of sector. Left Critical point. Right-to be numbered and described in a remark frame)
400	Concealment. Line of trees (deciduous) Left-Evergreen Right-Woods Possibility of driving off the road. Denoted by an arrow. For wheeled vehicles, the figure indicates the length of road where driving off is possible [left] or for tracked vehicles [right]).
13/V 20	Ferry. Arrow to the location Top-serial number and type (V = vehicle, P = pedestrian) Bottom-MLC
3/V/1.6/X 18/2.5/G/0.4	Ford. Arrow to the location. Top-serial number, type, current velocity of stream, seasonal limitations (V = vehicle, P = pedestrian, X = without seasonal limitations, Y = seasonal limitations). Bottom-length of crossing, width of ford, nature of bottom, depth (M = mud, C = clay, S = sand, G = gravel, R = rock, P= artificial paving).
	Difficult approach to cross site. No symbol if approaches are easy.

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Figure B-1. Sample DA Form 1247 (continued)

ROAD RECONNAISSANCE REPORT

B-4. Use a Road Reconnaissance Report, DA Form 1248, to report the technical information collected during road reconnaissance. Additionally, the road information is summarized on the route classification overlay as described in chapter 5. Complete the road reconnaissance form as follows (see figure B-2 on pages B-13 and B-14).

- There are four Date blocks on the form (3 on the front side and 1 on the back); record the same date in each.
- Block 1a should indicate country and map name, not just the country.
- Block 1c should indicate sheet number and edition as well as the map sheet date.
- Block 3 requires at least a 6-digit grid coordinate.
- In section II, record information for the most limiting characteristics of the road.
- Section III (d) should read, "Curves with a radius of 25 meters and less. (Also record curves with a radius of 25.1 to 45 meters)."
- In section IV, complete the Scale block as follows, Scale:_____units = _____kilometers. Include the road classification formula (see chapter 5, pages 5-25 through 5-27) for each section of road. Indicate on sketch the location of all obstructions.

ROAD RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; proponent agency is TRADOC.

DATE: *1 Jul 07*

TO (Headquarters ordering the reconnaissance)	FROM (Name, grade, and unit of officer or NCO making reconnaissance)
Cdr, ATTN: S-2, 21st Engr Bn	*Doe, John, 1LT, Co A, 522nd Engr*

1. MAPS	a. COUNTRY	b. SCALE	c. SHEET NUMBER OF MAPS	2. DATE/TIME GROUP (of signature)
	USA, Fort Leonard Wood Special	*1:50,000*	*AMS V733 Sheet 5561 IV*	*011430ZJUL07*

SECTION I - GENERAL ROAD INFORMATION

3. ROAD GRID REFERENCE FROM	TO	4. ROAD MARKING (Civilian or military number of road.)	5. LENGTH OF ROAD (Miles or kilometers, specify)
UT 122864	*UT 097999*	*Missouri Route J*	*16 km*

6. WIDTH OF ROADWAY (Feet or meters, specify): *6.7 m to 9.3 m*

7. RECONNAISSANCE — DATE: *1 Jul 07* — TIME: *0615*

8. WEATHER DURING RECONNAISSANCE (Include last rainfall, if known): *Fair - temperature 79 degrees Last rainfall - 15 Jun 07*

SECTION II - DETAILED ROAD INFORMATION
When circumstances permit, more detailed information will be shown in an overlay or on the mileage chart on the reverse side of this form. Use standard symbols.

9. ALIGNMENT (Check one ONLY)

	(1) FLAT GRADIENTS AND EASY CURVES
	(2) STEEP GRADIENTS (Excess of 7 in 100)
	(3) SHARP CURVES (Radius less than 100 ft (30 m))
X	(4) STEEP GRADIENTS AND SHARP CURVES

10. DRAINAGE (Check one ONLY)

	(1) ADEQUATE DITCHES, CROWN/CAMBER WITH ADEQUATE CULVERTS IN GOOD CONDITION
X	(2) INADEQUATE DITCHES, CROWN/CAMBER OR CULVERTS, ITS CULVERTS OR DITCHES ARE BLOCKED OR OTHER-WISE IN POOR CONDITION

11. FOUNDATION (Check one ONLY)

X	(1) STABILIZED COMPACT MATERIAL OF GOOD QUALITY		(2) UNSTABLE, LOOSE, OR EASILY DISPLACED MATERIAL

12. SURFACE DESCRIPTION (Complete items 12a and b)

a. THE SURFACE IS (Check one ONLY)

X	(1) FREE OF POTHOLES, BUMPS, OR RUTS LIKELY TO REDUCE CONVOY SPEED		(2) BUMPY, RUTTED OR POTHOLED TO AN EXTENT LIKELY TO REDUCE CONVOY SPEED

b. TYPE OF SURFACE (Check one ONLY)

	(1) CONCRETE		(6) WATERBOUND MACADAM
X	(2) BITUMINOUS (Specify type where known): *Asphalt*		(7) GRAVEL
			(8) LIGHTLY METALLED
			(9) NATURAL OR STABILIZED SOIL, SAND CLAY, SHELL, CINDERS, DISINTEGRATED GRANITE, OR OTHER SELECTED MATERIAL
	(3) BRICK (Pave)		(10) OTHER (Describe):
	(4) STONE (Pave)		
	(5) CRUSHED ROCK OR CORAL		

SECTION III -OBSTRUCTIONS

List in the columns below particulars of the following obstructions which affect the traffic capacity of a road. If information of any factor cannot be ascertained, insert "NOT KNOWN".
(a) Overhead obstructions, less than 14 feet or 4.25 meters, such as tunnels, bridges, overhead wires, and overhanging buildings.
(b) Reductions in road widths which limit the traffic capacity, such as craters, narrow bridges, archways, and buildings.
(c) Excessive gradients (above 7 in 100).
(d) Curves less than 100 feet (30 meters) in radius.
(e) Fords.

SERIAL NUMBER	PARTICULARS	GRID REFERENCE	REMARKS
1	*Steep grade - 8 percent*	*UT 119872*	*200 m long*
2	*Sharp curve*	*UT 112877*	*Radius 21 m*
3	*Constriction*	*UT 112878*	*6.7 m wide, 300 m long*
4	*Constriction*	*UT 105896*	*7 m wide, 100 m long*
5	*Built-up area*	*UT 094856*	*7.3 m wide, 2,000 m long*

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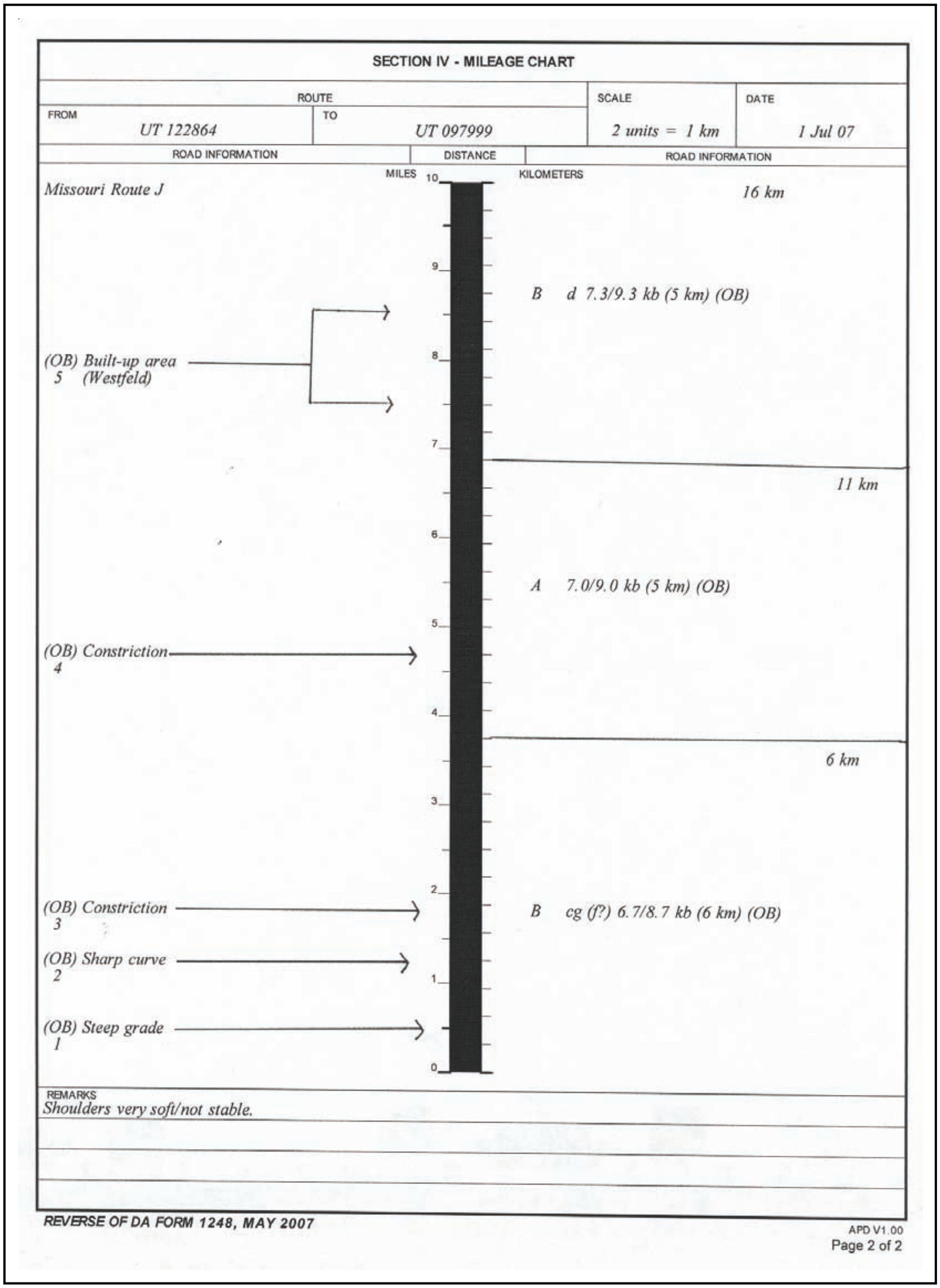
Figure B-2. Sample DA Form 1248



SECTION IV - MILEAGE CHART

ROUTE FROM	TO	SCALE	DATE
UT 122864	*UT 097999*	*2 units = 1 km*	*1 Jul 07*

ROAD INFORMATION | DISTANCE (MILES / KILOMETERS) | ROAD INFORMATION

Missouri Route J

16 km

B d 7.3/9.3 kb (5 km) (OB)

(OB) Built-up area
5 (Westfeld)

11 km

A 7.0/9.0 kb (5 km) (OB)

(OB) Constriction
4

6 km

(OB) Constriction
3

B cg (f?) 6.7/8.7 kb (6 km) (OB)

(OB) Sharp curve
2

(OB) Steep grade
1

REMARKS
Shoulders very soft/not stable.

REVERSE OF DA FORM 1248, MAY 2007

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Figure B-2. Sample DA Form 1248 (continued)

BRIDGE RECONNAISSANCE REPORT

B-5. Use a Bridge Reconnaissance Report, DA Form 1249, to report the technical information collected during a bridge reconnaissance. Additionally, when part of a route classification, the bridge information is summarized on the route classification overlay as described in chapter 5. (For rapid classification procedures see appendix F.) Complete the bridge reconnaissance form as follows (see figure B-4 on pages B-19 through B-20).

- **Column 1**. Record the assigned serial number. This number matches the serial number used in the bridge symbol of the route classification overlay.
- **Column 2**. Record the 8-digit grid coordinates, with the map identifier, of the actual bridge site.
- **Column 3**. Record horizontal clearance information, in meters. Horizontal clearance is the clear distance between the inside edges of the bridge structure, measured at a height of 0.3 meter above the surface of the traveled way and upwards. However, horizontal clearance for truss bridges is measured 1.21 meters above the traveled way. Any horizontal clearance less than the minimum required for the bridge's roadway width, as shown in table B-3, is underlined. Unlimited clearance is indicated by the symbol ∞.

Table B-3. Minimum roadway widths

Roadway Width (meters)	*Bridge Classification*	
	One-Way	*Two-Way*
2.75 to 3.34	12	0
3.35 to 3.99	30	0
4 to 4.49	60	0
4.5 to 4.99	100	0
5 to 5.4	150	0
5.5 to 7.2	150	30
7.3 to 8.1	150	60
8.2 to 9.7	150	100
Over 9.8	150	150
Note. Minimum overhead clearance for all classes is 4.3 meters		

- **Column 4.** Record under-bridge clearance, in meters. It is the clear distance between the underside of each span and the surface of the water. The height above the stream bed and the height above the estimated normal water level (pertaining to the appropriate bridge type) are included in this column for each span.
- **Column 5.** If the bridge is oriented more north to south, start with the northern most span and work south. Place the letter N in column 5 before the first span in sequence. If the bridge is oriented more east to west, start with the eastern most span and work west. Place the letter E in column 5 before the first span in sequence. For each span, list a sequence number followed by a slash and the total number of spans. Columns 5, 6, 7, and 8 are completed for each span.
- **Column 6.** Record the type of span construction. Refer to the numbers in table B-4, page B-16, and the diagrams in figure B-3, page B-17, for this information.

Table B-4. Span construction types

Span Type	***Number***
Truss	1
Girder (including steel multigirder and two girder spans)	2
Beam (including reinforced or prestressed concrete and steel box beam spans)	3
Slab	4
Arch (closed spandrel)	5
Arch (open spandrel)	6
Suspension	7
Floating	8
Swing	9 (specify type in additional information)
Bascule	10 (specify type in additional information)
Vertical lift	11
Other	12 (specify type in additional information)

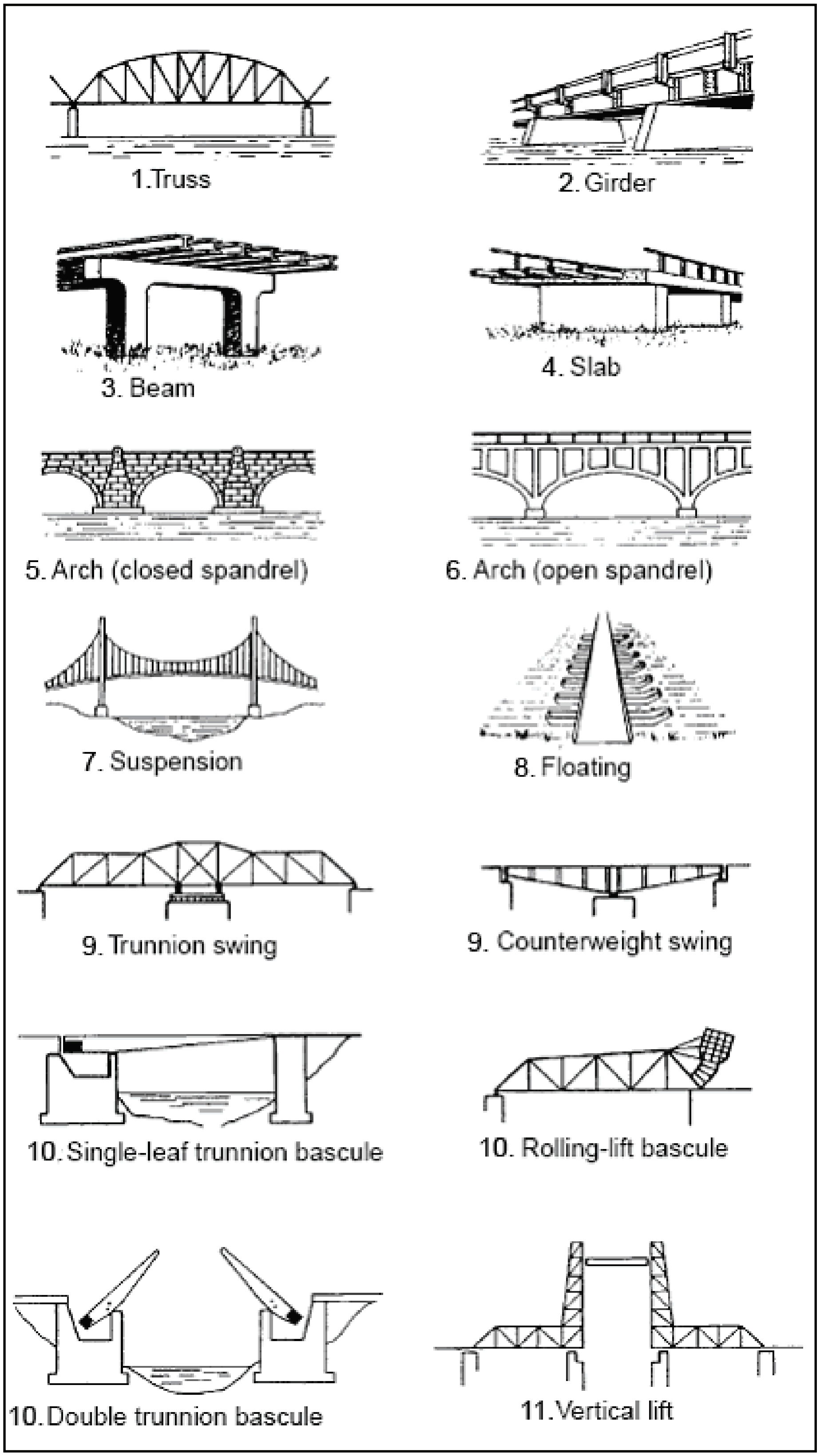

Figure B-3. Typical bridge spans

- **Column 7.** Record the type of construction material. Refer to table B-5 for this information.

Table B-5. Construction material

Material of Span Construction	*Letter Symbol*
Steel or other metal	a
Concrete	k
Reinforced concrete	ak
Prestressed concrete	kk
Stone or brick	p
Wood	h
Other (to be specified by name)	o

- **Column 8.** Record span length, in meters. This is a center-to-center spacing between bearings. The sum of the span length may not equal the overall length. Spans that are not usable because of damage or destruction are indicated by the pound symbol (#), placed after the dimension of the span length. Spans that are over water are indicated by placing the letter W after the dimension of the span length (see figure B-4).

B-6. Under "Additional Bridge Information," columns are added to give the MLC, overall length, roadway width, overhead clearance, and bypass possibilities (specify use easy, use difficult, or use impossible). Indicate whether the bridge is simply supported or continuous (see figure B-4).

BRIDGE RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

DATE 1 Jul 07

SIGNATURE SFC Gerald Smith

TO (Headquarters ordering reconnaissance)
Cdr, ATTN: S-2, 21st Engr Bn

FROM (Name, grade, and unit of officer or NCO conducting reconnaissance)
Gerald Smith, SFC, Co A, 21st Engr Bn

MAPS (Country, scale, and sheet number or name.)
USA, 1:50,000, AMS V733 5561 IV, Quantico

DATE/TIME GROUP (Of signature)
011430ZJUL07

ESSENTIAL BRIDGE INFORMATION								9. ADDITIONAL BRIDGE INFORMATION (Add columns as needed.) (Military load class, overall length, roadway width, vertical clearance, bridge by-pass)				
		CLEARANCE		SPANS								
SERIAL NUMBER 1	LOCATION 2	HORIZONTAL 3	UNDER BRIDGE 4	NUMBER 5	TYPE OF CONSTRUCTION 6	TYPE OF CONSTRUCTION MATERIAL 7	LENGTH AND CONDITION 8	Military Load Class	Overall Length	Traveled Way Width	Vertical Clearance	Bypass Conditions
21	LA 07216874		9	N 1/6	3	h	4 m W	16	27.6 m	7.3 m		Easy, ford safe located next to bridge
				2/6	3	h	4.2 m W					
				3/6	3	h	4.3 m W					
				4/6	3	h	4.3 m W					
				5/6	3	h	4.5 m W					
				6/6	3	h	4.3 m W					

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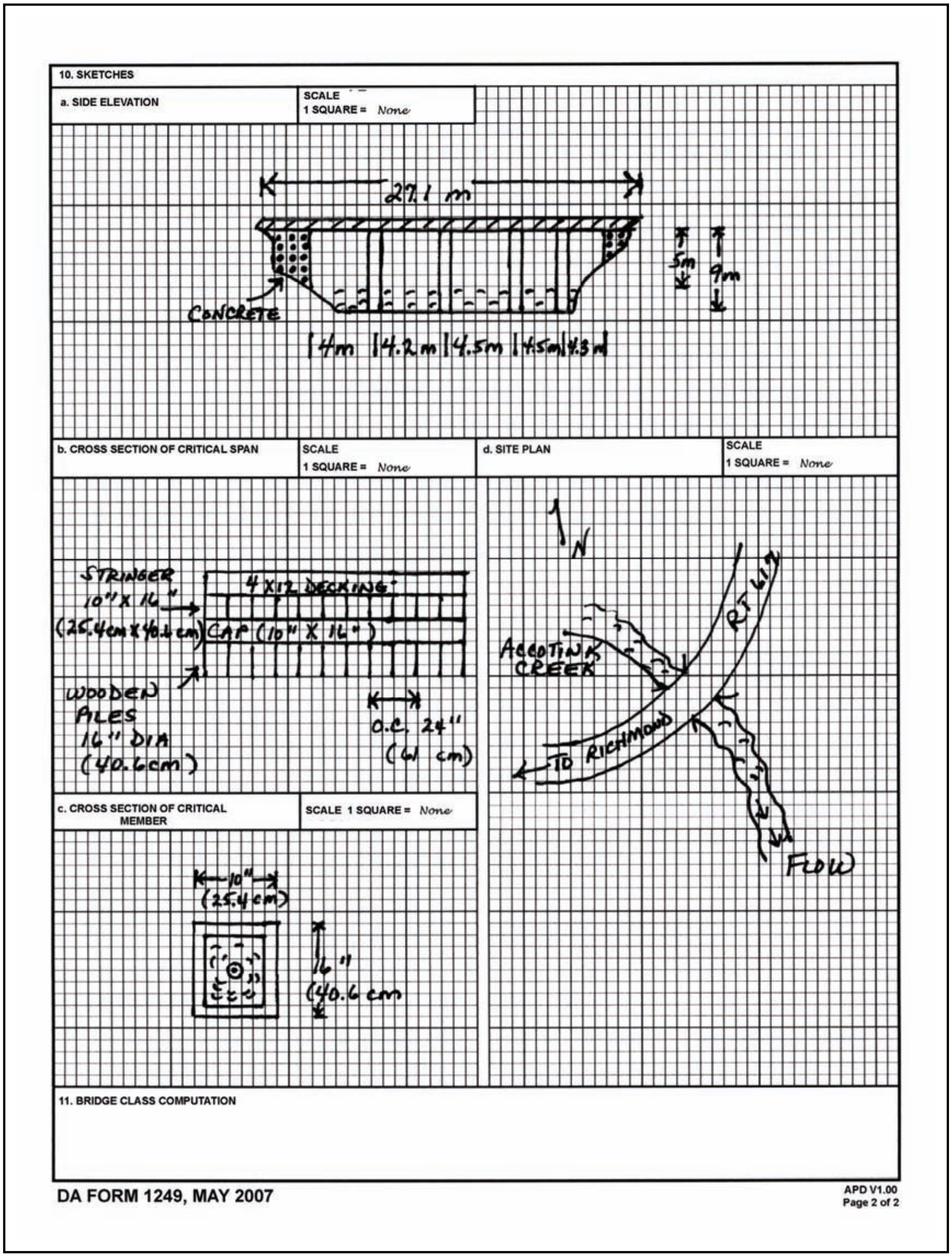
Figure B-4. Sample DA Form 1249

B-7. The bridge reconnaissance report should include a sketch as well as photographs when possible. Show as much information as possible when sketching the bridge on the backside of DA Form 1249 (see figure B-5). For bridges that present a challenge to reconnaissance elements collecting information and/or determining a classification, USACE assistance is available through reach-back support as discussed under FFE in appendix H.


10. SKETCHES

a. SIDE ELEVATION — SCALE 1 SQUARE = None

27.1 m
5m
9m
CONCRETE
4m | 4.2 m | 4.5m | 4.5m | 4.3 m

b. CROSS SECTION OF CRITICAL SPAN — SCALE 1 SQUARE = None

STRINGER 10" X 16" (25.4cm X 40.6 cm)
4 X 12 DECKING
CAP (10" X 16")
WOODEN PILES 16" DIA (40.6cm)
O.C. 24" (61 cm)

c. CROSS SECTION OF CRITICAL MEMBER — SCALE 1 SQUARE = None

10" (25.4cm)
16" (40.6 cm)

d. SITE PLAN — SCALE 1 SQUARE = None

N
ACCOTINK CREEK
RT 619
TO RICHMOND
FLOW

11. BRIDGE CLASS COMPUTATION

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Figure B-4. Sample DA Form 1249 (continued)

TUNNEL RECONNAISSANCE REPORT

B-8. Use a Tunnel Reconnaissance Report, DA Form 1250, to report the technical information collected during reconnaissance of tunnels on routes. Additionally, the tunnel information is summarized on the route classification overlay as described in chapter 5. Complete the tunnel reconnaissance form as follows (see figure B-5 on pages B-22 through B-23).

- **Blocks 2 and 3.** Record the grid coordinates for the start and end points of the route on which the tunnel is located.
- **Block 8.** Record the tunnel number found on the map sheet or on the head wall (or data plate) of the actual tunnel. If a number is not on the map or tunnel, then assign an appropriate number based on the unit's SOP. If there is a different number on the map than on the tunnel, record both serial numbers.
- **Block 9.** Record the distance and direction from the nearest town.
- **Block 13.** Record the number of railroad tracks passing through the tunnel, if applicable.
- **Block 15.** Record the vertical clearance (the shortest clearance from the road surface in the tunnel to the lowest point on the ceiling above the traveled way). Also, record the distance from the sidewalk to the ceiling if traffic can travel on the sidewalks.
- **Block 15 (continued).** Record the horizontal clearance. It is the roadway width or the roadway width and sidewalks/emergency lanes (where vehicles can move through the tunnel without striking the top or sides).
- **Block 16.** Record the internal tunnel grade. Record the grade of the tunnel entrances in block 27.
- **Block 17.** State whether the tunnel is straight or curved. Record curves that may restrict traffic flow.
- **Block 19.** Record a description of what the tunnel entrances (portals) look like and their composition.
- **Block 22.** Mark the applicable box. Some tunnels are chambered for demolition. This means that the tunnel has predesigned locations for placing demolitions to destroy the tunnel and deny use by the enemy.
- **Block 23.** Record the date that the tunnel was constructed.
- **Block 29.** Inspect the rock or soil at the tunnel's entrances. If there is a chance of a rock or mud slide, record the location and possible solution to the problem.

TUNNEL RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

TUNNEL RECONNAISSANCE REPORT For use of this form, see FM 3-34.170; the proponent agency is TRADOC.					DATE *1 Jul 07*	
TO: (Headquarters ordering the reconnaissance) *Cdr, ATTN: S-2, 21st Engr Bn*			FROM: (Name, grade, and unit of reconnaissance officer) *Fred Smith, SFC, Co C, 21st Engr Bn*			
1. ROUTE OR LINE — HIGHWAY *PA 126*	RAILROAD *NA*	2. FROM (Initial point) *QQ 366311*	3. TO (Terminal point) *QQ 508367*		4. DATE/TIME (Of signatuer) *011430ZJUL07*	
5. MAP SERIES *PP01*	6. SHEET NUMBER *PA 872*	7. GRID REFERENCE — TYPE *1:25,000*	COORDINATES *QQ 381330*		8. TUNNEL NUMBER *T1*	
9. LOCATION FROM NEAREST TOWN — DISTANCE *2.5 km*	DIRECTION *Northeast*	NAME OF NEAREST TOWN *Breezewood, PA*			10. TYPE (Subaqueous, rock, soil) *Rock*	
11. NAME (Mountain or water feature) *Ray's Hill*			12. LENGTH *1,077 m*	13. NUMBER OF TRACKS *0*	14. ROADWAY WIDTH *7 m*	
15. CLEARANCE — VERTICAL *5 m*	HORIZONTAL *7.5 m*	16. GRADE (Percent) *1*	17. ALIGNMENT (Straight or radius of curve) *Straight*			
18. LINING (Material) *Concrete*	19. PORTALS (Material) *Concrete*	20. VENTILATION (Type) *Air shaft above tunnel; exhaust fan on western portal. Fan is inoperative.*				
21. DRAINAGE *Storm drains every 25 meters; 75 cm piping.*						
22. CHAMBERED FOR DEMOLITION ☐ YES	☒ NO	23. COMPLETED (Year) 1940	24. CONDITION (Check appropriate box.) ☐EXCELLENT	☐GOOD	☒FAIR	☐POOR
25. BYPASS ABILITY *Impossible on both sides.*						
26. ALTERNATE CROSSING *From Breezewood, travel east on I-76 to Sidling Hill Plaza.*						
27. APPROACHES *Western approach to portal 1 percent up slope and four lane highway in fair condition.* *Eastern exit from portal 4 percent down slope and four lane highway in fair condition.*						
28. IN-TUNNEL RESTRICTIONS *None.*						
29. GEOLOGIC DATA *Surrounding area near portals stable on both ends.*						

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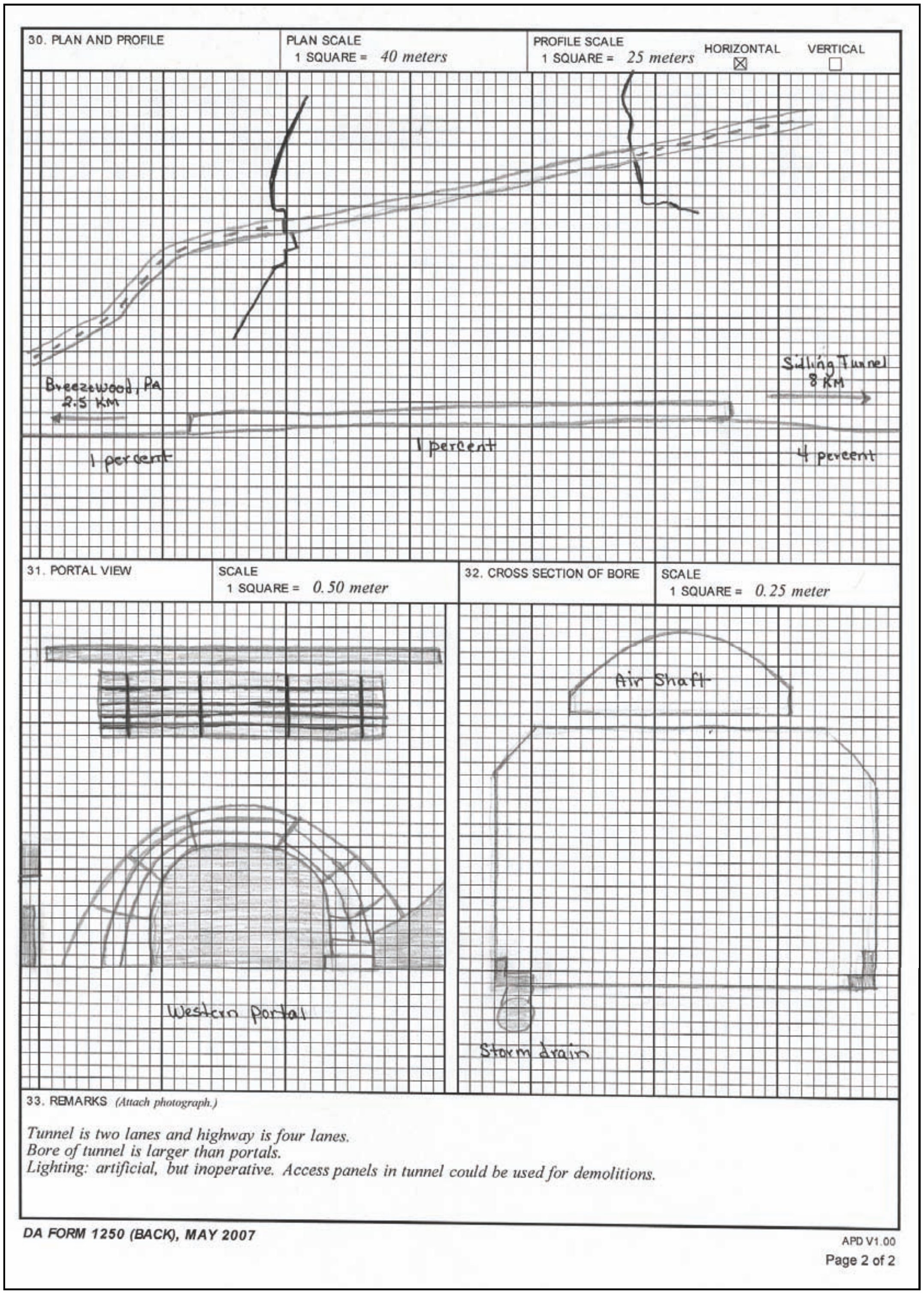
Figure B-5. Sample DA Form 1250



30. PLAN AND PROFILE

PLAN SCALE
1 SQUARE = *40 meters*

PROFILE SCALE
1 SQUARE = *25 meters*

HORIZONTAL ☒ VERTICAL ☐

31. PORTAL VIEW

SCALE
1 SQUARE = *0.50 meter*

32. CROSS SECTION OF BORE

SCALE
1 SQUARE = *0.25 meter*

33. REMARKS *(Attach photograph.)*

Tunnel is two lanes and highway is four lanes.
Bore of tunnel is larger than portals.
Lighting: artificial, but inoperative. Access panels in tunnel could be used for demolitions.

DA FORM 1250 (BACK), MAY 2007

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Figure B-5. Sample DA Form 1250 (continued)

FORD RECONNAISSANCE REPORT

B-9. Use a Ford Reconnaissance Report, DA Form 1251, to report the technical information collected during ford reconnaissance. Additionally, when the ford reconnaissance is part of a route classification, the ford information is summarized on the route classification overlay as described in chapter 5. Complete the ford reconnaissance form as shown in figure B-6).

FORD RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

DATE: *1 Jul 07*

TO: (Headquarters ordering the reconnaissance)	FROM: (Name, grade, and unit of reconnaissance officer)
Cdr, ATTN: S-2, 21st Engr Bn	*Fred Smith, SFC, Co A, 21st Engr Bn*

1. ROUTE NUMBER	2. FROM (Initial point)	3. TO (Terminal point)	4. DATE/TIME OF SIGNATURE
Virginia 617	*UT 122864*	*UT 097899*	*011430ZJUL 07*

5. MAP SERIES NUMBER	6. SHEET NUMBER	7. GRID REFERENCE: TYPE	7. GRID REFERENCE: COORDINATES	8. FORD NUMBER
V734	*5561 III*	*1:50,000*	*UT 100886*	*001*

9. LOCATION FROM NEAREST TOWN: DISTANCE	DIRECTION	NAME OF NEAREST TOWN	10. CROSSING (Name of stream or other body of water)
14 km	*SE*	*Fort Belvoir, VA*	*Accotink Creek*

11. CHARACTERISTICS OF CROSSING

WATER LEVELS	WIDTH	DEPTH	VELOCITY	DATE	SEASON OR MONTH(S)
TODAY	*7.3 m*	*0.5 m*	*1.5 m/sec*	*1 Jul 07*	
LOW	*6.1 m*	*0.3 m*	*1.1 m/sec*		*Fall*
MEAN	*7.3 m*	*0.5 m*	*1.5 m/sec*		*Summer, Winter*
HIGH	*8.4 m*	*1.8 m*	*2.2 m/sec*		*Spring*

12. BOTTOM	13. APPROACHES	14. SLOPE RATIO
☐ SAND ☒ GRAVEL ☐ STONE ☐ OTHER (Specify):	☐ FIRM ☐ SOFT ☒ PAVED	*3:1*

15. TYPE OF PAVEMENT	16. USABLE WIDTH	17. HAZARDS (Flash floods, quicksand, and so forth.)
Bituminous	*7.3 m*	*Unknown*

18. REMARKS (Description of approach roads, guide markers, depth gauges, and so forth.)

Bottom is loose gravel. Ford bottom is 9.8 m long and 7.3 m wide.
Approach conditions on both ends are easy.
No guide markers or depth gauge present.

DA FORM 1251, MAY 2007

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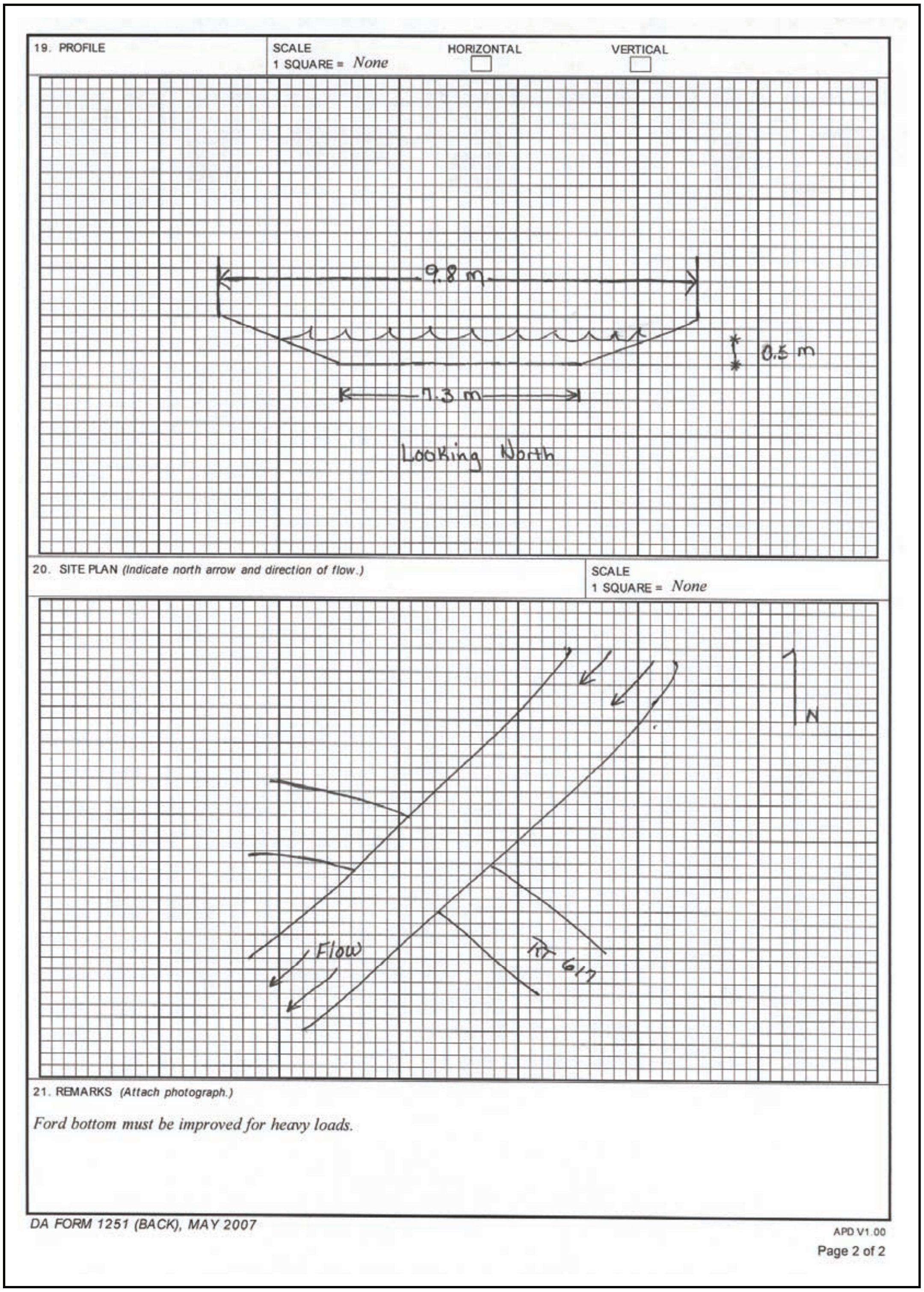
Figure B-6. Sample DA Form 1251



19. PROFILE | SCALE 1 SQUARE = *None* | HORIZONTAL ☐ | VERTICAL ☐

20. SITE PLAN *(Indicate north arrow and direction of flow.)* | SCALE 1 SQUARE = *None*

21. REMARKS *(Attach photograph.)*

Ford bottom must be improved for heavy loads.

DA FORM 1251 (BACK), MAY 2007

APD V1.00

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Figure B-6. Sample DA Form 1251 (continued)

FERRY RECONNAISSANCE REPORT

B-10. Use a Ferry Reconnaissance Report, DA Form 1252, to report the technical information collected during ferry reconnaissance. Additionally, when the ferry reconnaissance is part of a route classification, the ferry information is summarized on the route classification overlay as described in chapter 5. Complete the ferry reconnaissance form as shown in figure B-7).

FERRY RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; proponent agency is TRADOC.

DATE (YYYYMMDD) *1 Jul 07*

TO: (Headquarters ordering the reconnaissance)	FROM: (Name, grade, and unit of reconnaissance officer)
Cdr, ATTN: S-2, 21st Engr Bn	*Fred Smith, SFC, A Co, 21st Engr Bn*

1. ROUTE OR LINE: HIGHWAY	RAILROAD	2. FROM (Initial point)	3. TO (Terminal point)	4. DATE/TIME (Of signature)
VA 617	*NA*	*Lorton, VA*	*Hoby, MD*	*011430ZJul07*

5. MAP SERIES	6. SHEET NUMBER	7. GRID REFERENCE: TYPE	COORIDINATES	8. FERRY	9. CLASS
V734	*5661 III*	*1:50,000*	*UT134830*	*1*	*45*

10. LOCATION FROM NEAREST TOWN: DISTANCE	DIRECTION	NAME OF NEAREST TOWN	11. CROSSING (Name of stream or body of water)
8 km	*East*	*Lorton, VA*	*Potomac River*

12. LIMITING FEATURE (Condition of vessels, terminals, floods, low water, freezing, tides, and so forth.)(Seasons and dates)
Freezing likely in winter months.

13. WATER LEVELS (Depths): LOW	MEAN	HIGH	14. CROSSING TIME	15. LENGTH
3.2 m	*4.7 m*	*7.6 m*	*20 minutes*	*1 km*

16. VESSEL FEATURES (Attach photographs)

UNITS	CONSTRUCTION TYPE	PROPULSION METHOD: TYPE	UNITS	HP	LENGTH	BEAM	DRAFT	TONNAGE: GROSS	NET	CAPACITY: PASS	VEHICLE	RAILROAD
2	*Open*	*Diesel*	*2*	*610*	*22.5 m*	*1.6 m*	*1.6 m*	*85*	*85*	*200*	*8 maximum*	*NA*

17. TERMINAL FEATURES

DIRECTION OF BANK	NAME	SLIP: WIDTH	DEPTH	CAPACITY	DOCKING FACILITIES	APPROACHES: HIGHWAY: SURF	LANES	CLASS	RAILROAD: TRACKS	SIDING
N E S W N	*Little Reno*	*13.2 m*	*3 m*	*1*	*Good*	*Asphalt*	*2*	*45*	*NA*	*NA*
N E S W N	*Angels Point*	*14 m*	*4 m*	*1*	*Good*	*Concrete*	*2*	*55*	*NA*	*NA*

18. REMARKS (Amplify above details. Note obstructions, navigational, and other pertinent data.)

Anchorage uses 30.5 centimeters piles spaced approximately 10 meters center to center.

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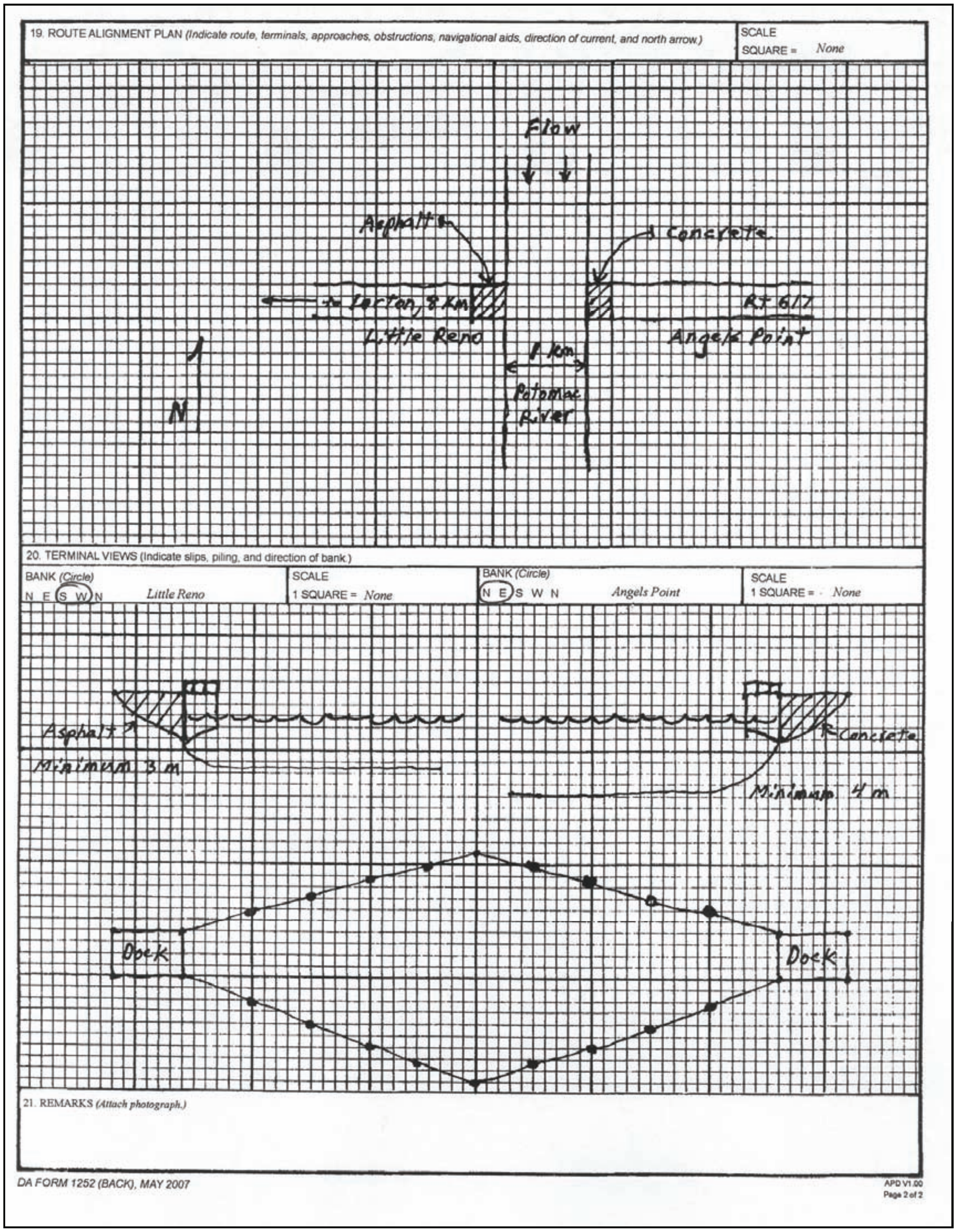
Figure B-7. Sample DA Form 1252


19. ROUTE ALIGNMENT PLAN *(Indicate route, terminals, approaches, obstructions, navigational aids, direction of current, and north arrow.)*

SCALE
SQUARE = *None*

20. TERMINAL VIEWS (Indicate slips, piling, and direction of bank.)

BANK (Circle)	SCALE	BANK (Circle)	SCALE
N E S W N *Little Reno*	1 SQUARE = *None*	N E S W N *Angels Point*	1 SQUARE = *None*

21. REMARKS *(Attach photograph.)*

DA FORM 1252 (BACK), MAY 2007

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Figure B-7. Sample DA Form 1252 (continued)

ENGINEER RECONNAISSANCE REPORT

B-11. Use the Engineer Reconnaissance Report, DA Form 1711, to report the technical information collected during an engineer resource assessment. Additionally, the engineer reconnaissance report can be used to report other significant engineer information not covered by any of the other reports in this appendix. Complete the engineer reconnaissance form as follows (see figure B-8 on pages B-29 through B-33).

- **Heading.** Self-explanatory.
- **Key.** The key references the item of the report and its corresponding location on the map overlay. The object's serial number (or critical point number) is entered in this column.
- **Object.** Shown by a conventional symbol (see figure B-9, pages B-32 through B-33) or a brief written description.
- **Work estimate.** If a work estimate is included as part of the report, enter yes; if not, enter no.
- Additional Remarks. In this column, report the object's location by grid coordinates followed by remarks, calculations, and sketches. Make this information as detailed as possible to alleviate the necessity for an additional reconnaissance.
- **Authentication block.** This is for the company commander's signature block and signature.
- **Work estimate.** The work estimate is on the back of the DA Form 1711. Each work estimate is keyed by a serial or critical point number to the appropriate object on the reverse side of the form. Only those columns that are appropriate need be completed. Draw additional sketches when necessary (see figure B-8).

ENGINEER RECONNAISSANCE REPORT

For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

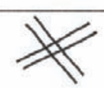
PAGE *1* OF *4* PAGES

TO	FROM
Cdr, ATTN: S-2, 21st Engr Bn	*Fred Smith, SFC, Co A, 21st Engr Bn*

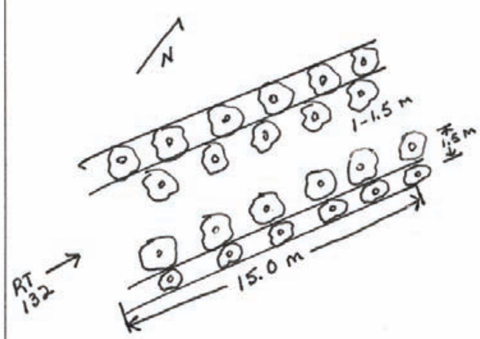
FILE NUMBER	PARTY LEADER (Name, grade, unit)	PLACE, HOUR, DATE
REPORT NUMBER *1*	*John Doe, 1LT, Co A, 21st Engr Bn*	*UT 586708* *011430ZJUL07*

MAPS	SCALE
Quantico, Virginia - Sheet 5561 III	*1:50,000*

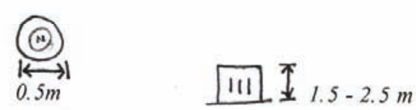
DELIVER TO (Organization, place, hour, and date)
S-2, 21st Engr Bn, UT 556461, 021200ZJUL07

KEY	OBJECT	TIME OBSERVED	WORK ESTIMATE	ADDITIONAL REMARKS AND SKETCH
		*0730*	*Yes*	*UT 058684 - Log post obstacle blocking Route 132*

Sketch



(24) Logs at 0.5 m diameter
C-C 1.5 m on all sides
1.5 - 2.5 m aboveground



Obstacle not defended
Bypass - Difficult (swampy) due to swampy terrain

Engineer work estimate on reverse side.

TYPED NAME, GRADE, ORGANIZATION	SIGNATURE
Fred Smith SFC, Co A, 21st Engr Bn	*SFC Fred Smith*

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Figure B-8. Sample DA Form 1711

ENGINEER RECONNAISSANCE REPORT

For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

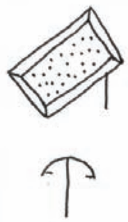
PAGE 2 OF 4 PAGES

TO	FROM
Cdr, ATTN: S-2, 21st Engr Bn	*Fred Smith, SFC, Co A, 21st Engr Bn*

FILE NUMBER	PARTY LEADER (Name, grade, unit)	PLACE, HOUR, DATE
REPORT NUMBER *1*	*John Doe, 1LT, Co A, 21st Engr Bn*	*UT 586708 011430ZJUL07*

MAPS	SCALE
Quantico, Virginia - Sheet 5561 III	*1:50,000*

DELIVER TO (Organization, place, hour, and date)
S-2, 21st Engr Bn, UT 556461, 021200ZJUL07

KEY	OBJECT	TIME OBSERVED	WORK ESTIMATE	ADDITIONAL REMARKS AND SKETCH
2		*0815*	*No*	*UT 509686 - Gravel pit in opeation* *6,000 cy + in stockpile* *1 inch to 3 inches crushed limestone* *Good access roads and ample turnaround*
3		*0920*	*No*	*UT 509740 - Abandoned heavy equipment: (2) "Ziplo" Model 200 crawler cranes - operational.* *Checked for booby traps--found none*

Engineer work estimate on reverse side.

TYPED NAME, GRADE, ORGANIZATION	SIGNATURE
Fred Smith SFC, Co A, 21st Engr Bn	*SFC Fred Smith*

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Figure B-8. Sample DA Form 1711 (continued)

ENGINEER RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

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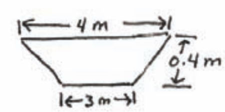
TO	FROM
Cdr, ATTN: S-2, 21st Engr Bn	*Fred Smith, SFC, Co A, 21st Engr Bn*

FILE NUMBER	PARTY LEADER (*Name, grade, unit*)	PLACE, HOUR, DATE
REPORT NUMBER *1*	*John Doe, 1LT, Co A, 21st Engr Bn*	*UT 586708 011430ZJUL07*

MAPS	SCALE
Quantico, Virginia - Sheet 5561 III	*1:50,000*

DELIVER TO (*Organization, place, hour, and date*)
S-2, 21st Engr Bn, UT 556461, 021200ZJUL07

KEY	OBJECT	TIME OBSERVED	WORK ESTIMATE	ADDITIONAL REMARKS AND SKETCH
4	*Bivonac area*	*1015*	*No*	*UT 512692 - Possible bivonac area. 700 m x 900 m* *Good access roads with adequate drainage and hard surface.* *Adequate site drainage.*
5		*1035*	*No*	*UT 558680 - Possible water point.* *Quantity:* *~ 3,000 GPM* *Quality:* *Cloudy, no odor* *No observed source of contamination, sample collected for testing* *Site conditions:* *Firm soil, gradual slope, possible bivouac site available nearby*



Engineer work estimate on reverse side.

TYPED NAME, GRADE, ORGANIZATION	SIGNATURE
Fred Smith SFC, Co A, 21st Engr Bn	*SFC Fred Smith*

DA FORM 1711, MAY 2007 APD V1.00
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Figure B-8. Sample DA Form 1711 (continued)

ENGINEER RECONNAISSANCE REPORT

For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

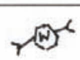
PAGE 4 OF 4 PAGES

TO	FROM
Cdr, ATTN: S-2, 21st Engr Bn	Fred Smith, SFC, Co A, 21st Engr Bn

FILE NUMBER	PARTY LEADER (Name, grade, unit)	PLACE, HOUR, DATE
REPORT NUMBER 1	John Doe, 1LT, Co A, 21st Engr Bn	UT 586708 011430ZJUL07

MAPS	SCALE
Quantico, Virginia - Sheet 5561 III	1:50,000

DELIVER TO (Organization, place, hour, and date)
S-2, 21st Engr Bn, UT 556461, 021200ZJUL07

KEY	OBJECT	TIME OBSERVED	WORK ESTIMATE	ADDITIONAL REMARKS AND SKETCH
		1115	No	UT 761432 - Existing water treatment plant supplying water to town of Philo. Output = 50,000 gallons per day

Engineer work estimate on reverse side.

TYPED NAME, GRADE, ORGANIZATION	SIGNATURE
Fred Smith SFC, Co A, 21st Engr Bn	SFC Fred Smith

DA FORM 1711, MAY 2007

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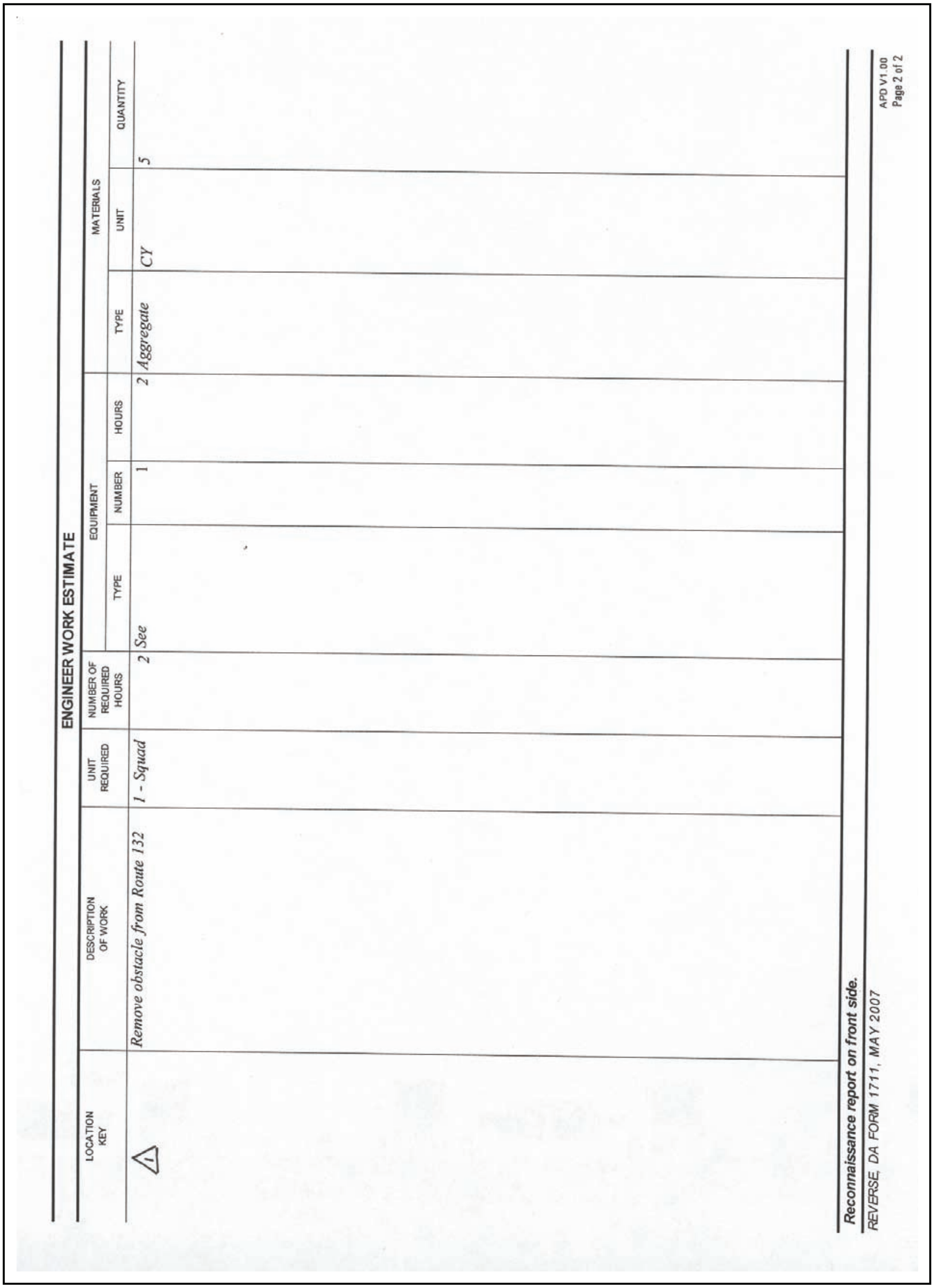
Figure B-8. Sample DA Form 1711 (continued)



ENGINEER WORK ESTIMATE

LOCATION KEY	DESCRIPTION OF WORK	UNIT REQUIRED	NUMBER OF REQUIRED HOURS	EQUIPMENT			MATERIALS		
				TYPE	NUMBER	HOURS	TYPE	UNIT	QUANTITY
1	Remove obstacle from Route 132	1 - Squad	2	See	1	2	Aggregate	CY	5

Reconnaissance report on front side.

REVERSE, DA FORM 1711, MAY 2007

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Figure B-8. Sample DA Form 1711 (continued)

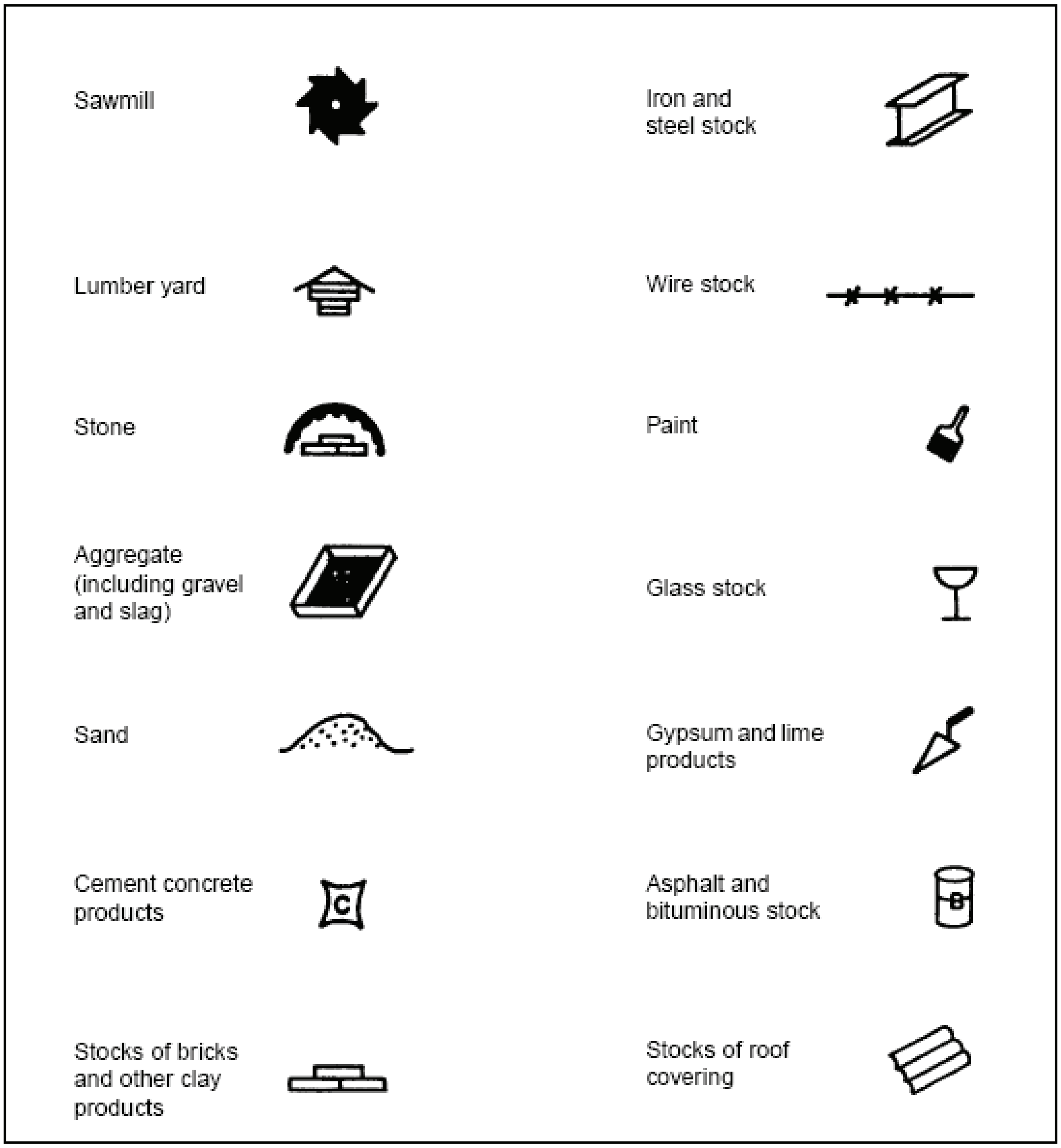

Figure B-9. Engineer resource symbols

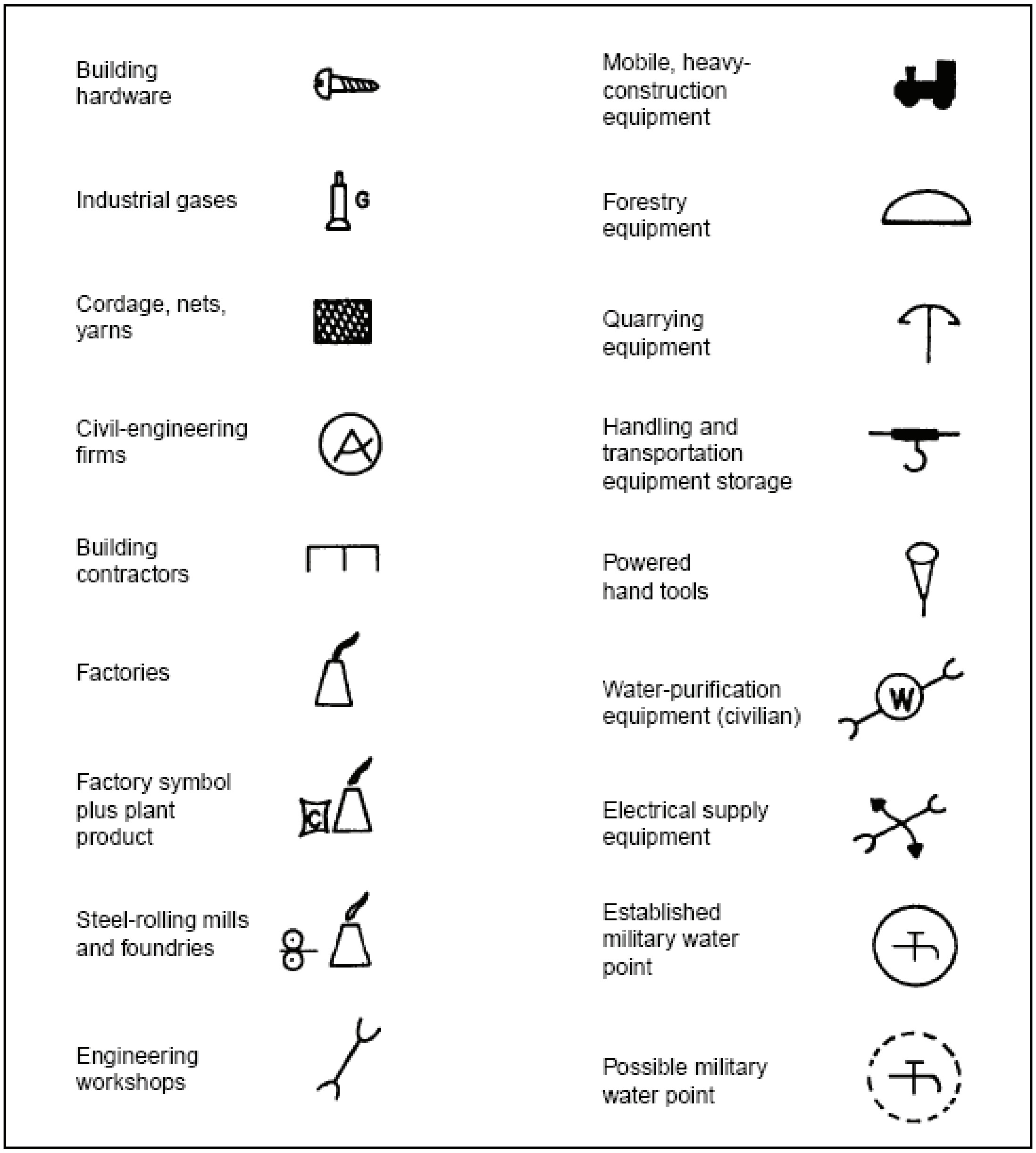

Figure B-9. Engineer resource symbols (continued)

DEMOLITION RECONNAISSANCE RECORD

B-12. Use a Demolition Reconnaissance Record, DA Form 2203, to report the technical information collected during demolition reconnaissance. This form can also be a component of a demolition target folder (see FM 3-34.214). The demolition reconnaissance is discussed in chapter 4. Complete the demolition reconnaissance record as follows (see figure B-10 pages B-36 through B-40).

DEMOLITION RECONNAISSANCE RECORD

For use of this form, see FM 3-34.214; the proponent agency is TRADOC.

SECTION I - GENERAL

		NAME AND RANK	ORGANIZATION
1. FILE NO.			
2. DEMOLITION RECON REPORT NO.	5. RECON ORDERED BY	*COL John Smith*	*3d EN Bde*
3. DATE *1 October 2005* / 4. TIME *1200*	6. PARTY LEADER	*SSG Joe Brown*	*B Co, 294 EN BN*

7. MAP INFORMATION

Name *Waynesville*

Scale *1:50,000*

Sheet No. *7759-1*

Series No. *V-779*

11. GENERAL DESCRIPTION *(Use block 20 for sketches.)*

Type Construction: [ ] Earth; [ ] Timber; [X] Concrete; [ ] Asphalt; [ ] Steel

Other Data: [X] Roadway width *18 m*; [X] Number of bridge spans *8*; [X] Number of lanes *4*; [X] Bridge class: W- *100* T- *100*

Condition: *No visible damage to key components*

8. TARGET AND LOCATION

Z Highway Bridge (contd block 19)

12. NATURE OF PROPOSED DEMOLITION *(Use block 21 for sketches.)*

Partial destruction.

9. TIME OBSERVED

1730

10. COORDINATES

WM 81708935

13. UNUSUAL FEATURES OF SITE

[ ] High tension [X] *Water under bridge*

[ ] Radar installation [X] *House within 100 yards*

[ ] Underwater blasting [X] *AT/AP minefield 20 yards northeast of bridge (contd block 19)*

SECTION II - ESTIMATES

Determine availability of items 14, 15, and 16 before conducting reconnaissance.

14. MATERIAL REQUIRED	UNIT OF ISSUE	TYPE MISSION: CRATERING	CUTTING	OTHER/SPEC PURPOSE
Modernized Demolition Initiators:				
M11 Shock tube	ea		*4*	
M12 Shock tube	ea		*4*	
M13 Shock tube	ea		*4*	
M14 Delay fuse	ea			
Firing Device	ea			
Electric caps	ea			
Detonating cord	ft		*2,400*	
Firing wire	ft			
Igniters:				
M60	ea			
M81	ea			
Explosive:				
TNT	lb		*1,200*	
C4	lb		*272*	
(Other)				
Cratering:				
Crater charge, 40-lb	ea			
Shape charge, 15-lb	ea			
Other Demolitions:	ea			

15. EQUIPMENT AND TRANSPORT REQUIRED *(Continued on page 2.) (Examples: trucks, ram sets and cartridges, demolition sets, post-hole diggers, nails, adhesives, tapes, sandbags, and lumber.)*

NOTE: Troops may not ride in vehicles transporting explosives.

Life jackets (6)
Demo sets (2)
Ram set Gu1 (1)
Post-hole digger (2)
2 x lumber for bracing (100 ft)
(contd on reverse)

16. PERSONNEL AND TIME REQUIRED FOR	NCOs	ENL	Time
a. Preparing and placing charges	*2*	*10*	*2 hr*
b. Arming and firing demolition	*2*	*0*	*10 m*

17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS *(Continued on page 2.) (Specify location and method. Specify equipment to clear the site after demolition and available bypasses that allow units to bypass the site.)*

Available bypass - 1-44 bridge, 1.2 miles northwest
- At Big Piney/Devil's Elbow 2 miles East
Bypass at demo site after blast
- To ford 1 dozer, 1 bucket loader, 2 hrs (contd)

18. REMARKS *(Continued on page 2.)*

A grader between the northwest corner of bridge and minefield would enhance the obstacle and slow down the enemy.

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Figure B-10. Sample DA Form 2203

DEMOLITION RECONNAISSANCE RECORD *(Continued)*

Place additional comments in the appropriate blocks.

15. EQUIPMENT AND TRANSPORT REQUIRED *(Continued)*

HMMWV (1 - transport of caps)
2 1/2 ton cargo (1 - transport of demo)
Rope 3/4 in (200 ft)
Squad vehicle (1 - transport of troops)

17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS *(Continued)*

To bridge at site: 1 dozer, 1 bucket loader, 3.5 hours to clear and improve approach.
Ribbon bridge assembly - 10 interior bays, 2 ramp bays, 30 minutes MGB - 1 company, 3 hours

18. REMARKS *(Continued)*

19. ADDITIONAL COMMENTS *(Specify block)*

Block 8 contd. Bridge is over Big Piney River, near town of Devil's Elbow.

Block 13 contd. Antivehicle ditch (wheel only) on southeast side of bridge.

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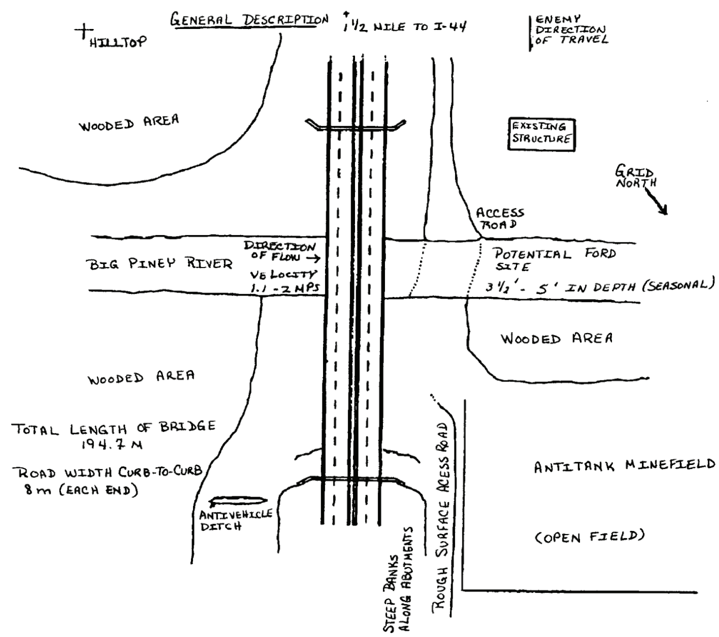
Figure B-10. Sample DA Form 2203 (continued)

DEMOLITION RECONNAISSANCE RECORD *(Continued)*

Place additional comments in the appropriate blocks.

20. GENERAL DESCRIPTION SKETCH *(Attach additional sketches if required)*



21. PURPOSE OF PROPOSED DEMOLITION SKETCH *(Attach additional sketches if required)*

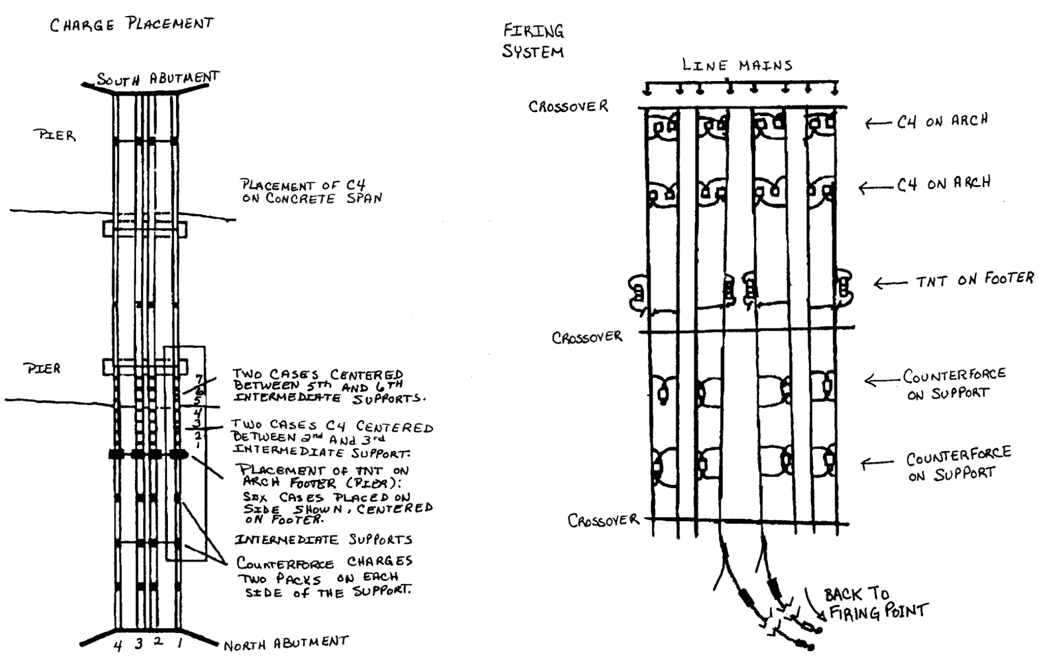


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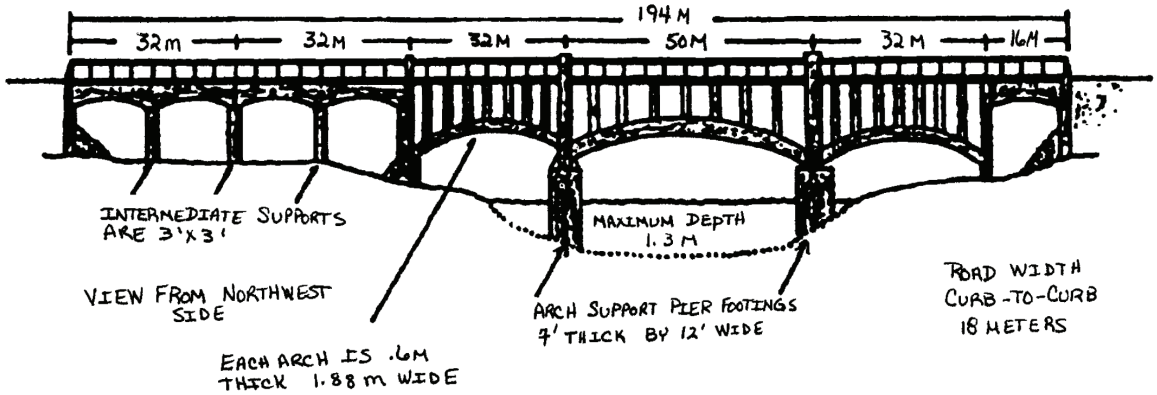
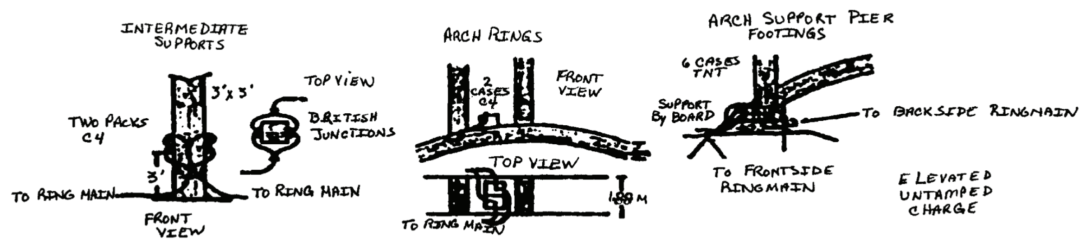
Figure B-10. Sample DA Form 2203 (continued)

BLOCK 20. GENERAL DESCRIPTION (CONTINUED)



BLOCK 21. NATURE OF PROPOSED DEMOLITION SKETCH (CONTINUED)

METHOD OF PRIMING AND CHARGE CALCULATIONS



INTERMEDIATE SUPPORT
(USE COUNTERFORCE CHARGE)

1. CRITICAL DIMENSIONS: SUPPORT IS 3'x 3'
2. SOLVE FOR TNT: (1 1/2 lbs per Foot)
   1 1/2 x 3 = 4.5 lbs of C4 (C4 REQUIRED)
3. DIVIDE BY RE: (USING C4, RE: 1.34)
   NO CONVERSION REQUIRED, COUNTERFORCE IS CALCULATED IN C4.
4. SOLVE FOR SINGLE CHARGE PACKAGE:
   4.5 ÷ 1.25 (PKG WT C4) = 3.6 Ø 4 PACKAGES
5. NUMBER OF CHARGES: 8 SUPPORTS
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
   4 PACKAGES x 8 SUPPORTS = 32 PACKAGES

ARCH RINGS (USE CONCRETE STRIPPING CHARGE)

1. CRITICAL DIMENSIONS: 1.88 M WIDE BY 6 M DEEP
2. SOLVE FOR TNT = P = (3.3 X .6 + .5)³ 1.5

   P = (.248)³ 1.5
   P = (15.25) 1.5 = 22.875 Kg/m
   22.875 x 1.88 = 43.005 Kg/Sq M
   43.005 x 2.2046 = 94.81 LBS TNT
3. DIVIDE BY RE (RE FOR C4 = 1.34)
   94.61 ÷ 1.34 = 70.75 LBS C4
4. SOLVE FOR SINGLE CHARGE:
   70.75 ÷ 1.25 = 56.67 Ø 57 PKGS
5. NUMBER OF TARGETS = 8

ARCH RINGS (CONTD)

6. TOTAL REQUIRED: (STEP 4 x STEP 5)
   57 x 8 = 456 PKGS
   600 PKGS PER BOX = 15.2 Ø 16 CASES

PIER FOOTINGS
(USE BREACHING FORMULA: P = R³ KC)

1. CRITICAL DIMENSIONS: PIER IS 2 1/2' x 7' x 9'
2. SOLVE FOR TNT: R = 7' 7³ = 343
   K FOR REINFORCED CONCRETE OR > = .54
   C FOR ELEVATED UNTAMPED = 1.8
   343 x .34 x 1.8 = 333.39
3. DIVIDE BY RE: (RE FOR TNT = 1)
   333.39 ÷ 1 = 333.89
4. SOLVE FOR SINGLE CHARGE PACKAGE:
   333.39 ÷ 1 (1 LB PKG OF TNT): 333.39
   333.39 Ø = 384 PACKAGES
5. NUMBER OF CHARGES = 4 PIER
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
   334 x 4 = 1336 PACKAGES
   (36 PKG PER BOX > 23.8 CASES)
   23.8 Ø 24 CASES

Figure B-10. Sample DA Form 2203 (continued)

DEMOLITION RECONNAISSANCE RECORD *(Continued)*

Instructions for completing the DA Form 2203

Use the following instructions to complete DA Form 2203.

Block 1 (FILE NO.). Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after the form has been submitted.

Block 2 (DEMOLITION RECON REPORT NO.). Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after the form has been submitted. The company SOP may specify the procedures for determining this number.

Block 3 (DATE). Enter the date the reconnaissance was performed.

Block 4 (TIME). Enter the time the reconnaissance party arrived at the target site (local or Zulu time).

Block 5 (RECON ORDERED BY). Enter the name, rank, and organization of the command authority authorizing the reconnaissance action.

Block 6 (PARTY LEADER). Enter the name, rank, and organization of the NCOIC or OIC of the reconnaissance party who was physically at the site when the reconnaissance was performed.

Block 7 (MAP INFORMATION). Obtain this information from a map of the reconnaissance area. Enter the information in this block.

Block 8 (TARGET AND LOCATION). Enter a brief description of the target and the distance and direction from an identifiable landmark (railroad bridge, crossroads, hilltop, and so forth). For example, "Target is 275°, 300 meters from the railroad bridge, 2 miles east of Hanesville, on Route 2." Continue the information in block 19 if needed.

Block 9 (TIME OBSERVED). Enter the time you last saw the target as you departed the site.

Block 10 (COORDINATES). Enter the complete 8-digit map coordinates of the target.

Block 11 (GENERAL DESCRIPTION). When applicable, include the type of construction, width of the roadway, number of lanes or tracks, type of pavement, number of spans, condition of spans or entire bridge, and bridge categorization and classification. For example, "Prestressed-concrete T beam bridge, four simple spans supported by six concrete columns, two lanes; total bridge length is 140 feet; roadway width is 30 feet; overall bridge width is 36 feet; height is 16 feet; Class 80; very good condition."

Block 12 (NATURE OF PROPOSED DEMOLITION). State the expected amount of destruction and the priority for placing charges, if feasible. Provide a sketch showing the number and type of charges to use (tamped or untamped), where the charges should be placed, and the type of firing system required.

Block 13 (UNUSUAL FEATURES OF SITE). Include any special features of the target or site that might affect the method of demolition (high-tension lines, radar installation, underwater blasting, and so forth). Give any details that may affect the security of the target and the demolition work party.

Block 14 (MATERIAL REQUIRED). Indicate the mission types, quantities, caps, detonators, and so forth proposed for the demolition.

Block 15 (EQUIPMENT AND TRANSPORT REQUIRED). Specify the amount and type of transportation required (for example, two 5-ton dump trucks, one ram set with 50 cartridges, two post-hole diggers, two demolition sets, 10 pounds of 16d nails, twelve 8-foot 2 by 4s). Continue comments in block 15 on page 2 of the form.

Block 16 (PERSONNEL AND TIME REQUIRED FOR). Complete subsections a and b, indicating the number of personnel and amount of time necessary for placing the demolitions. The distance between the firing points and firing systems will be a consideration for determining the amount of time necessary to arm and fire the explosives.

Block 17 (TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS [Enter the location and method]). Enter the equipment necessary to clear the site after demolition and the available bypasses that allow units to bypass the site. Continue comments in block 17 on page 2 of the form.

Block 18 (REMARKS). Include any appropriate remarks that are not covered in blocks 1 through 17. Continue remarks in block 18 on page 2 of the form.

Block 19 (ADDITIONAL COMMENTS). Use this block as a continuation for all other blocks. Identify the block being continued.

Block 20 (GENERAL DESCRIPTION SKETCH). Include on this sketch--

The avenues of approach to the target and possible bypasses in the vicinity of the target. Indicate route numbers and the direction to cities.
The rivers or streams including name, direction of flow, and velocity in meters per second.
The terrain features, including observation points, cover and concealment, swampy areas, deep valleys, and so forth.
A compass arrow indicating north (indicate grid or magnetic).
The dimensions of the proposed target.
The number and length of bridge spans.
The height of the bridge from the ground or water.

Block 21 (PURPOSE OF PROPOSED DEMOLITION SKETCH). Include on this sketch the--

Dimensions of members to be cut.
Placement of charges.
Charge calculations. Use either the formula or table method, but show the work.
Priming of charges.
Branch lines.
Ring mains.
Firing systems.
Firing points.

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Figure B-10. Sample DA Form 2203 (continued)

RIVER RECONNAISSANCE REPORT

B-13. Use a River Reconnaissance Report, DA Form 7398, to report the technical information collected during river reconnaissance. Additionally, when the river reconnaissance is part of a route classification, the river information is summarized on the route classification overlay as described in chapter 5. Complete the river reconnaissance form as shown in figure B-11).

RIVER RECONNAISSANCE REPORT
For use of this form, see FM 3-34.170; the proponent agency is TRADOC.

DATE: 24 Jul 07

TO: (Headquarters ordering the reconnaissance)	FROM: (Name, grade, and unit of reconnaissance officer)
Cdr, ATTN: S-2, 536th Engr Bn	Mark A. Wilson, SFC, A Co, 536th Engr Bn

1. ROUTE NUMBER	2. FROM (Initial point)	3. TO (Terminal point)	4. DATE/TIME of signature
AP Hill 004	TT 945209	TT 938180	29 0800 Jul 07

5. MAP SERIES NUMBER	6. SHEET NUMBER	7. GRID REFERENCE TYPE	7. GRID REFERENCE COORDINATES	8. RECONNAISSANCE NUMBER
V7345	5560 III	1:50,000	TT 945185	1

9. LOCATION FROM NEAREST TOWN

DISTANCE	DIRECTION	NAME OF NEAREST TOWN	10. CROSSING (Name of river or other body of water.)
2 km	SW	Collins Crossing	Cattlet Creek

11. CHARACTERISTICS OF NEARSHORE

BANK HEIGHT	BANK SLOPE	BANK STABILITY	BANK SOIL TYPE	MINES	OBSTACLES (Type)
1.8 m	6 percent	Firm	Grass	None	None

SLOPE TO DEPTH OF 2M	SOIL TYPE TO DEPTH OF 2M	MINES OF DEPTH OF 2M	OBSTACLES TO DEPTH OF 2M
10 percent	Soft mud	None	None

12. CHARACTERISTICS OF RIVER

GAP WIDTH	VELOCITY (m/sec)	FLOW DIRECTION	BOTTOM COMPOSITION (Mud, sand, gravel; hard-packed or soft)
143 m	1.5 mps	SW	1/4 GAP soft mud 1/2 GAP soft mud 3/4 GAP soft mud

MAXIMUM DEPTH	ANCHORAGE SUITABILITY (Describe)	OBSTACLES
1/4 GAP 12 ft 1/2 GAP 18 ft 3/4 GAP 10 ft	Very good/recommend using kedge anchors	None

13. CHARACTERISTICS OF FARSHORE

BANK HEIGHT	BANK SLOPE	BANK STABILITY	BANK SOIL TYPE	MINES	OBSTACLES (Type)
0.8 m	9 percent	Firm	Grass	None	None

SLOPE TO DEPTH OF 2M	SOIL TYPE TO DEPTH OF 2M	MINES OF DEPTH OF 2M	OBSTACLES TO DEPTH OF 2M
9 percent	Soft mud	None	Stump located at 3 ft

REMARKS (Describe the farshore and nearshore approaches, assembly areas, available cover and concealment, and overall assessment of crossing-site potential for freezing over or flooding.)

Nearshore approach is about 150 meters wide with firm soil and grass, but no overhead cover.

Far shore approach is about 80 meters wide with firm soil and grass.

Note. Stump located at 3 feet, measuring 26 inches in diameter. Stump needs to be removed before far shore can be used.

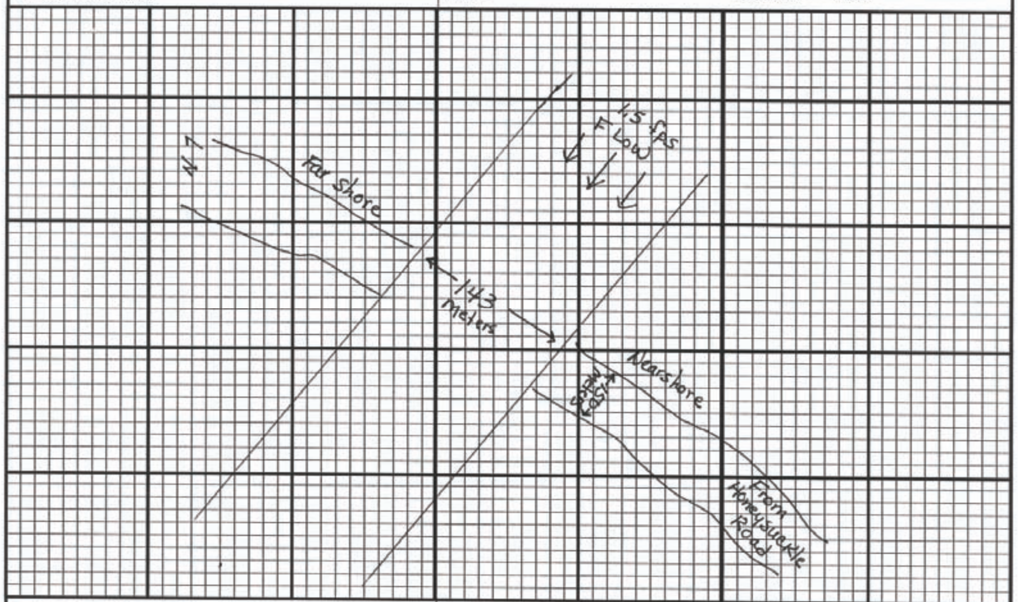
Crossing site has no histroy of flooding, but has potential for freezing over in late January through March.

DA FORM 7398, MAY 2007

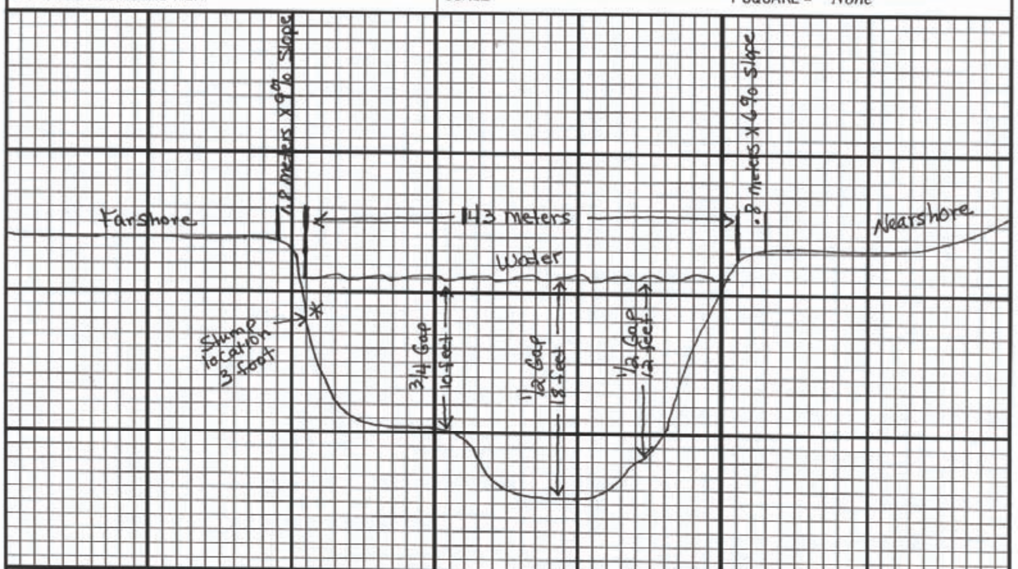
APD V1.00
Page 1 of 2

Figure B-11. Sample DA Form 7398

14. OVERHEAD VIEW	SCALE	1 SQUARE = *None*



15. CROSS-SECTIONAL VIEW	SCALE	1 SQUARE = *None*



16. REMARKS *(Attach photograph)*

Stump needs to be removed before far shore can be used. Stump measures 26 inches in diameter.

DA FORM 7398 (BACK), MAY 2007

APD V1.00

Page 2 of 2

Figure B-11. Sample DA Form 7398 (continued)

NORTH ATLANTIC TREATY ORGANIZATION AGREEMENTS

B-14. NATO nations have concluded a number of agreements on a wide range of engineer matters, which are regularly reviewed with more subject areas under negotiation. This section provides a summary of the standardization agreements (STANAGs) of relevance to engineer reconnaissance. The list of STANAGs relevant to engineer reconnaissance is shown below with the custodians shown in brackets.

- STANAG 2002 – *Warning Signs for the Marking of Nuclear, Biological, and Chemical Contaminations* (JSB - NBC).
- STANAG 2010 – *Military Load Classification Markings* (France).
- STANAG 2017 – *Orders to the Demolition Guard Commander and Demolition Firing Party Commander (Non-nuclear)* (United Kingdom).
- STANAG 2021 – *Military Load Classification of Bridges, Ferries, Rafts and Vehicles Classifications* (France).
- STANAG 2036 – *Land Mine Laying, Marking, Recording and Reporting Procedures* (United States).
- STANAG 2101 – *Establishing Liaison* (Military Committee Joint Standardization Board [MCJSB]).
- STANAG 2123 – *Obstacle Folder* (Germany).
- STANAG 2143 – *Explosive Ordnance Reconnaissance/Explosive Ordnance Disposal* (EOD).
- STANAG 2221 – *Explosive Ordnance Disposal Reports and Messages* (Allied Explosive Ordnance Disposal Publication [AEODP-6]) (EOD).
- STANAG 2259 – *Military Geographic Documentation - Terrain* (International Geospatial [IGEO]).
- STANAG 2269 – *Military Geographic Documentation - Engineer Resources* (IGEO).
- STANAG 2282 – *Interservice EOD Operations on Multinational Deployments* (EOD).
- STANAG 2369 – *Identification and Disposal of Surface and Air Munitions* (EOD).
- STANAG 2370 – *Principles of Improvised Explosive Device Disposal* (AEODP-3(A) (EOD).
- STANAG 2430 – *Land Forces Combat Engineer Messages, Reports and Returns* (AEngrP-2(B)) (United Kingdom).
- STANAG 2929 – *Airfield Damage Repair* (Supreme Headquarters Allied Powers, Europe [SHAPE]).
- STANAG 2989 – *Transfer of Barriers* (Spain).
- STANAG 2991 – *NATO Combat Engineer Glossary* (Allied Administrative Publication [AAP] 19(D)) (Combined Arms).
- STANAG 3680 – NATO Glossary of Terms and Definitions (AAP-6).

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Appendix C

Infrastructure Reconnaissance

This appendix provides a quick reference for collecting and reporting technical information from the major and several "other" categories of infrastructure. For each category, the appendix provides a smartcard with a brief overview of the infrastructure category and its component systems followed by a checklist to guide the collection of relevant information.

ASSESSMENT

C-1. The infrastructure assessment and the infrastructure survey are two stages/levels of infrastructure reconnaissance used to gather this necessary infrastructure information. The purpose of the assessment is to provide immediate feedback concerning the status of the basic services necessary to sustain the local population. The memory aid to describe this assessment is SWEAT-MSO with each of the letters describing a major area within the assessment (see figure C-1). The model can be adapted for use at the tactical level in either stability or civil support operations. In either type of operation, the infrastructure assessment and survey model can be used during course of action development to delineate tasks, missions, and effects that support civil-military-related objectives.

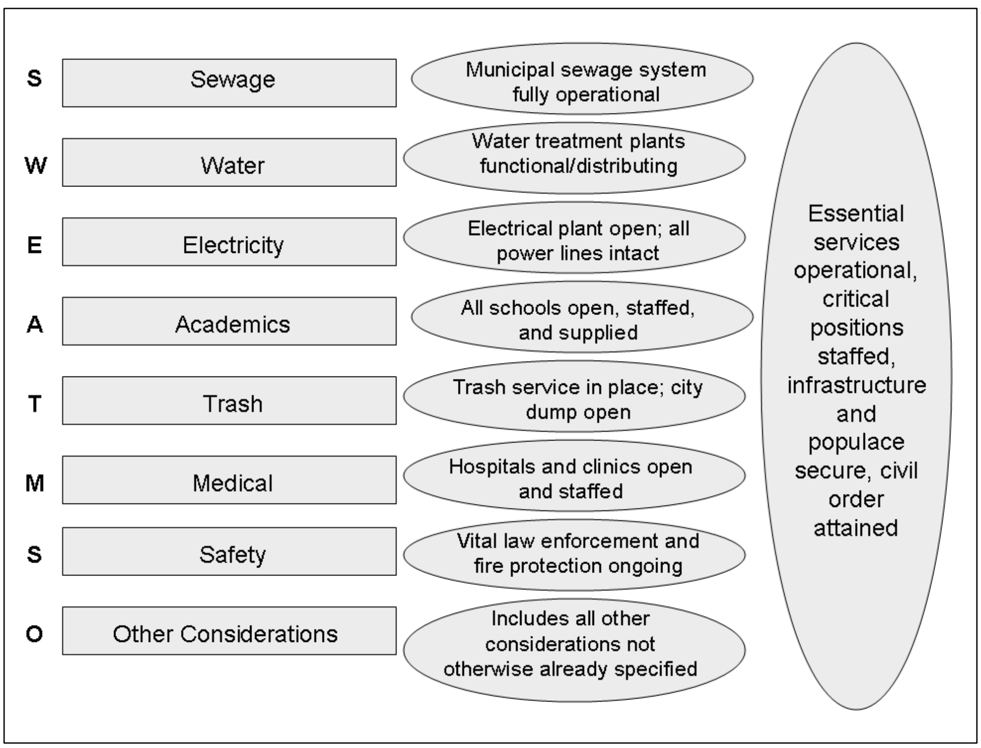


Figure C-1. The infrastructure assessment and survey model

C-2. The basic services or categories evaluated depend on the situation, mission, and commander's intent. While it is typically performed by engineers, it may be accomplished by others when an engineer is not available, depending on the expertise available and the desired type/quality of information required. If available, leaders should also consult military and NGO units and agencies in the area to determine if there are extenuating circumstances that may influence the outcome of the assessment. Typically, engineer planners use this information to define immediate needs and determine priorities of work. While an infrastructure assessment is designed to support the resolution of the immediate challenges, it will normally set the conditions for a successful transition. Some of the primary considerations for the assessment are—

- **Sewage.** What is the status of the local sewage system? What health and environmental risks exist?
- **Water.** What potable water sources are available? Are they adequate? Have they been tested?
- **Electricity.** What is the status of electrical generation facilities to include availability of generators? What is the status of the transmission infrastructure? What critical facilities to include hospitals, government buildings, and schools are not having their needs met? What is the availability of fuel for transportation, heating, and cooking? Is there an adequate system of distribution?
- **Academics.** What schools are in need of repair and rebuilding?
- **Trash.** Is there a system in place for removing waste? What hazardous waste streams are being generated that may have detrimental impacts on health and the environment? What is the ultimate disposal system for trash?
- **Medical.** Are medical services available and operational? Does an emergency service exist? Are services available for animals?
- **Safety.** Is there a police and fire service? Are UXO or other EHs an issue?

C-3. Other considerations. Other considerations that leaders may consider as a part of the assessment include—

- **Transportation networks.** Are roads, bridges, and railroads trafficable? Is the airport operational? Do helicopter landing sites exist and are they useable? Can they sustain the local, humanitarian assistance traffic?
- **Fuel distribution.** Is there a fuel distribution system available to commercial and residential customers?
- **Housing.** Are the homes structurally sound and habitable? Do they include basic utilities?
- **Explosive hazards.** Are ordnance hazards observed?
- **Environmental hazards.** Are environmental hazards observed?
- **Communications.** Is the telephone network available and operational? Does the town have TV, radio, and newspaper access and, if so, do they work?
- **Places of worship.** Are there adequate facilities to support religious activities for all groups?
- **Attitude.** Are local people and community leaders supportive? Is there ethnic tension?

C-4. Table C-1 provides an example checklist for an initial infrastructure assessment of a town or location to assist in determining the humanitarian and civic assistance needs of the town at the beginning of a stability operation. This example is not intended to be all-inclusive but rather another aid to support an assessment. The formal survey will be much more specific and in depth than the information in any assessment, and survey smartcards are provided in the second half of this appendix to support the conduct of a survey. The example uses the SWEAT-MSO model introduced in table C-2 on pages C-3 through C-5 to assist the Soldier and Marine in organizing an assessment strategy. Chapter 6 provides an infrastructure assessment rating to assist in rating each of the assessed categories. Leaders may use these resources to begin developing priorities, obtaining resources, and refining a plan. Many of the tasks derived from this process will be general engineering tasks (such as facilities construction, well drilling, power generation, and road repair).

Table C-1. Sample infrastructure assessment

<table>
<tr><td colspan="6">General Engineering Requirements – Infrastructure Assessment</td></tr>
<tr><td colspan="2">Town/Village/Neighborhood:</td><td colspan="2">Location:</td><td colspan="2">Assessor:</td></tr>
<tr><td colspan="6">Local Points of Contact (Name, Location, Phone Number, etc.)</td></tr>
<tr><td colspan="3">Mayor:
City Council:
City Engineer:
Religious Leaders:
Community Leaders:</td><td colspan="3">Police Chief:
Fire Chief:
School Administrators:
NGOs:</td></tr>
<tr><td>Population:</td><td>Male:</td><td>Female:</td><td>Religious Breakdown:</td><td colspan="2">Ethnic Breakdown:</td></tr>
<tr><td>S</td><td colspan="5">Sewage System Assessment</td></tr>
<tr><td colspan="6">Status of municipal sewage system/distribution system:

Status of sewage systems in commercial/residential properties:

Immediate needs:</td></tr>
<tr><td>W</td><td colspan="5">Water Assessment</td></tr>
<tr><td colspan="6">Status of water treatment plants/distribution system:

Status of potable water in commercial/residential properties:

Storage capacity:

Wells (location and capacity):

Immediate needs:</td></tr>
<tr><td>E</td><td colspan="5">Electricity Assessment</td></tr>
<tr><td colspan="6">Status of electric plant/distribution system:

Status of electric power in commercial/residential properties:

Alternate power sources:

Immediate needs:</td></tr>
</table>

Table C-1. Sample infrastructure assessment

A	***Academics Assessment***
Status of school building(s): Status of teachers and supplies: Immediate needs:	
T	***Trash Assessment***
Status of trash collection system: Status of disposal site: Immediate needs:	
M	***Medical Assessment***
Status of hospital/clinic buildings: Status of physicians and supplies: Immediate needs:	
S	***Safety Assessment***
Status of police/fire departments: Status of safety personnel and supplies: Immediate needs:	
O	***Other Considerations***
Transportation System Assessment	
Status of road system (attach sketch if necessary): Impact on critical transportation needs: Immediate needs:	
Fuel Distribution Assessment	
Status of fuel distribution system: Storage capacity: Immediate needs:	

Table C-1. Sample infrastructure assessment

Housing Assessment		
Status of structures: Status of utilities: Immediate needs:		
Explosive Hazard Assessment		
Explosive ordnance locations/type (send 9-line UXO report as required by the mission): Explosive ordnance marked (if yes, marking description): Immediate needs:		
Environmental Hazard Assessment		
Do known hazards exist (if yes, describe): Are chemicals visible on the ground (if yes, describe): Abandoned manufacturing buildings (if yes, are waste products/streams contained): Immediate needs:		
Other Critical Considerations:		
Recommended Priorities:		
Remarks:		
Signature:	Organization:	Date:

SURVEY

C-5. Infrastructure reconnaissance is accomplished in stages—the infrastructure assessment and the infrastructure survey. As a follow-on to the assessment, the infrastructure survey provides a detailed description of the condition of major services. The primary difference between the assessment and the survey is the degree of technical information and the expertise required and available to perform the reconnaissance. The survey is normally conducted by forward USACE personnel assigned or attached to a FEST-M team and will integrate other technical specialties (medical, CA, and others) to enhance the quality of the survey. A large urban area may require more than one survey team to accomplish the necessary breadth of survey requirements. A survey may also require that the area be secure in order for it to be performed while the assessment may be performed in an area that is not secured yet. Both are best performed when other branch specialties are available to support the base engineer element. The following series of smartcards are available to assist with the more detailed infrastructure survey.

C-6. Figures C-2 through C-8 on pages C-7 through C-29 address the following:

- Sewage (figure C-2).
- Water (figure C-3).
- Electricity (figure C-4).
- Academics (figure C-5).
- Trash (figure C-6).
- Medical (figure C-7).
- Safety (figure C-8).

C-7. Figures C-9 through C-18 on pages C-30 through C-67 address other considerations including:

- Roads and railroads (figures C-9 and C-10).
- Bridges and waterways (figure C-11).
- Airports (figure C-12).
- Housing (figure C-13).
- Communications (figure C-14).
- Food supply (figure C-15).
- Socio/government (figure C-16).
- Cultural/historical/religious (figure C-17).
- Hazardous materials (figure C-18).

Form: Sewer – Collection Systems (Target ID __________________)

Inspector ID______________________________

Inspection date/time_________________________

Lift Station #______ of ________(GPS)_____________

Does the lift station operate? ☐ Yes ☐ No ☐ Unknown Does it have power? ☐ Yes ☐ No

Check breaker and switches for pumps and other equipment. Note any damage and available information on the capacity of the breaker box feeds and breakers____

Does effluent enter or discharge from the station? ☐ Enter ☐ Discharge ☐ Unknown

Note any leakage or flooding including source and quantity ________________________________

Direction of flow to/from the lift station: ☐ To (Direction: _________) ☐ From (Direction: _________)

Pipe Information (for pipes entering or exiting the station):

Enter: Size in diameter: _______ : IN / MM Material Type (if able to determine): ___________

Exit: Size in diameter: _______ : IN / MM Material Type (if able to determine): ___________

Are pipes damaged: ☐ Yes ☐ No If so, explain: ___________________________________

Are pipes leaking steadily: ☐ Yes ☐ No If so, explain: ___________________________________

Do pipes have heavy corrosion: ☐ Yes ☐ No If so, explain: ___________________________________

Lift Station Pump Information:

Type of Pump: ☐ centrifugal ☐ screw ☐ pneumatic ejector ☐ grinder ☐ other (specify): ____________

Does pump operate? ☐ Yes ☐ No ☐ Unknown Is it a backup pump? ☐ Yes ☐ No

Power source for pump: ☐ electrical service ☐ combustion motor Is fuel available? ☐ Yes ☐ No

Size: __________ IN / MM Amperage:_________ AMPS Wattage: ________ WATTS

Capacity: _________ GAL/SEC or LITER/SEC Flow Rate: _________ GAL/SEC or LITER/SEC

Other Relevant Information: ____

Does pump show signs of steady leakage? ☐ Yes ☐ No If yes, give details: ______________________

Does pump generate excessive noise? ☐ Yes ☐ No If yes, give details: ______________________

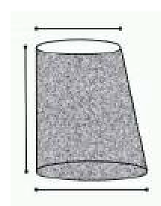
Does pump show signs of heavy corrosion? ☐ Yes ☐ No If yes, give details: ______________________

Describe condition of fuel tank and/or fuel lines ____

Describe security measures at the lift station._ ____

Manhole #______ of ________ Identify this manhole: ___________________________(GPS)

Label the dimensions of the manhole on diagram at the right. FT / M



Does the area around the manhole exhibit signs of distress? ☐ Yes ☐ No

If yes, give details: ____

Is manhole missing or severely damaged? ☐ Yes ☐ No

Are walls out of plumb (1 inch horizontal to 24 inches vertical?) ☐ Yes ☐ No

Do walls show signs of shifting or movement? ☐ Yes ☐ No

If yes, give details: ____

Pipe Information (for pipes entering or exiting the manhole):

Enter: Size in diameter: _______ IN / MM Material Type (if able to determine): ___________

Exit Size in diameter: _______ IN / MM Material Type (if able to determine): ___________

Are pipes damaged: ☐ Yes ☐ No If so, explain: ___________________________________

Are pipes leaking steadily: ☐ Yes ☐ No If so, explain: ___________________________________

Do pipes have heavy corrosion: ☐ Yes ☐ No If so, explain: ___________________________________

Direction of flow to/from the manhole? ☐ To (Direction: __________) ☐ From (Direction: __________)

Photograph Estimate Map Detail Measure Sketch

Figure C-2. Sewer smartcard

Form: Sewer – Treatment Plant Assessment (Target ID ______________)

Inspector ID____________________

Inspection date/time________________________

Describe security measures at the treatment plant.____

Using the guide, identify major plant components

Identify this plant:_________________________ (GPS)____________Approx. area serviced:________________

Population serviced: _____________Capacity of plant: _________________ **Million gallons/day / million liters/day**

Does the system appear to be operating? ☐ Yes ☐ No If not, is there power at the site? ☐ Yes ☐ No

Check breaker and switches for pumps and other equipment. Note any damage and available information on the capacity of the breaker box feeds and breakers ____

Are open containers overflowing? ☐ Yes ☐ No If yes, identify: ________________________________

Are racks operational? ☐ Yes ☐ No ☐ Unknown Clogged? ☐ Yes ☐ No Damaged? ☐ Yes ☐ No

Are the screens operational? ☐ Yes ☐ No ☐ Unknown Clogged? ☐ Yes ☐ No Damaged? ☐ Yes ☐ No

Describe any damage and other problems ____

\# tanks _______ for each tank, fill out a tank detail. # pumps ________for each pump, fill out a pump detail.

Is the water disinfected before discharge? ☐ Yes ☐ No. Form of disinfection used: Chlorine gas ☐

Sodium hypochlorite ☐ Calcium hypochlorite ☐ Ozonation ☐ Ultraviolet ☐ Other: _____________

Pipe Information (for pipes entering or exiting the source):

Enter: Size in diameter: _______ **IN / MM** Material Type (if able to determine): ___________

Exit: Size in diameter: _______ **IN / MM** Material Type (if able to determine): ___________

Are pipes damaged: ☐ Yes ☐ No If so, explain: ____________________________________

Are pipes leaking steadily: ☐ Yes ☐ No If so, explain: ____________________________________

Do pipes have heavy corrosion: ☐ Yes ☐ No If so, explain: ____________________________________

Direction of flow to/from the station? ☐ To (Direction: __________) ☐ From (Direction: __________)

Plant Tank Detail Information for Tank #____ of ____Description: ________________ Location: ________________

Shape: ________________ Component type: ____

Height: _____________ **FT / M** Width: ______________ **FT / M**

Length: _____________ **FT / M** Capacity: __________ **GALLONS / LITERS**

Is the aerator working? ☐ Yes ☐ No ☐ Unknown

Is the water entering the sand or trickling filter clear? ☐ Yes ☐ No

Is scum removing equipment operating on clarifying tank surface? ☐ Yes ☐ No

Does the sludge move from the clarifier? ☐ Yes ☐ No To the sludge digester? ☐ Yes ☐ No

To the drying bed? ☐ Yes ☐ No Is the sludge removed at the last processing stage? ☐ Yes ☐ No How?

Describe any problems with the above listed equipment here ________________________________

Plant Pump Detail: Information for Pump#___of ____Description: ________________Location: ____________

Does the pump operate? ☐ Yes ☐ No ☐ Unknown Is there a backup pump? ☐ Yes ☐ No

Check breakers and switches for pumps and other equipment. Record any relevant information on capacity of breaker box feeds:____

Power source for pump: ☐ electrical service ☐ combustion motor Size:_____**IN / MM** Wattage: _________ **WATTS**

Amperage:_________ **AMPS** Flow Rate: __________ **GALLONS/SEC or LITERS/SEC** Other Relevant Information:

____

Does pump show signs of steady leakage? ☐ Yes ☐ No If so, explain: __________________________

Does pump generate excessive noise? ☐ Yes ☐ No If so, explain: __________________________

Does pump show signs of heavy corrosion? ☐ Yes ☐ No If so, explain: __________________

Photograph Estimate Map Detail Measure Sketch

Figure C-2. Sewer smartcard (continued)

Form: Sewer – Septic System Overview (Target ID ____________________)

Inspector ID____________________

Inspection date/time_________________________

List and Map Buildings serviced: ____

Random survey of local users:

- Note buildings and areas serviced and not serviced by the collection system.
- Does the system backup into buildings? ☐ Yes ☐ No
- How often do backup problems occur? ☐ regularly ☐ irregularly ☐ during power outages ☐ when it rains ☐ other (specify): ____

Septic Drainage Field Information

Approx. size of septic field:______ by _____Unit of Measure: _____Note any surface water or wetness in this area

Septic Tank Information

Size of tank: ☐ Round or Cylindrical Height: ______ Diameter: ______Unit of measure: _______

☐ Rectangular Height: ______ Width: ______ Length: _______ Unit of measure: _______

☐ Other Shape Specify: ____

Height: ______ Width: ______ Length: ______ Unit of measure: _______

What is the tank capacity? ________ Unit of measure: _______

Describe openings to tank: ____

Approximate size in diameter of openings: ______________ Unit of measure: ______

Baffles? ☐ Yes ☐ No If so, detail __________________ Multiple tanks? ☐ Yes ☐ No number: _________

Thickness of the scum layer ________ Unit of measure: ________Thickness of the water layer ________ Unit of measure: ________Thickness of the sediment layer ________ Unit of measure: ________

Of what material is the tank constructed? ☐ Concrete ☐ Steel ☐ Wood ☐ other (specify): ______________

Does the tank show signs of: ☐ Leakage? ☐ Corrosion? ☐ Distress in outer finish or coating?
☐ Other (specify): ____

Photograph Estimate Map Detail Measure Sketch

Figure C-2. Sewer smartcard (continued)

Form: Water- Water Sources Surface (Target ID ____________________)
Inspector ID______________________________
Inspection date/time_________________________

Surface Water Source #______ of _____ Location of this source: _________________(GPS)
Production capacity per year: _______ GAL / LIT
Describe security measures at the well site. ____
Water level sufficient at the intake? ☐ Yes ☐ No
If no, explain:____________________________
Obvious contamination risks in the area? ☐ Yes ☐ No
If yes explain:____________________________
Inspect the intake screens:
Are there signs of blockage or damage? ☐ Yes ☐ No
If yes, explain: ____

Pipe Information: Size in diameter(IN): _______ IN / MM Material Type: ______________________________
Size in diameter(OUT): _________________________ IN / MM
Material Type : ____________________________________
Are pipes damaged: ☐ Yes ☐ No
If so, explain: ___________________________________
Are pipes leaking steadily: ☐ Yes ☐ No
If so, explain: ___________________________________
Do pipes have heavy corrosion: ☐ Yes ☐ No
If so, explain: ___________________________________
Direction of flow to/from the station?
☐ To (Direction: _________________________________)
☐ From (Direction: ______________________________)

Pump Information:
Are there pumps located at this water source? ☐ Yes ☐ No
Information for Pump#________ of ________
Description: ___________________________Location: ____________________________________
Power source for pump:
☐ electrical service ☐ combustion motor
Does the pump operate? ☐ Yes ☐ No ☐ UNK
Is there a backup pump? ☐ Yes ☐ No
If NO or UNKNOWN CHECK: Is the power switch on? ☐ Yes ☐ No Is the safety switch on? ☐ Yes ☐ No
Check breakers and switches for pumps and other equipment. Record any relevant information on capacity of breaker box feeds:____
Pipe Diameter (in): __________ IN / MM Pipe Diameter (out): _________ IN / MM
Pump Wattage: __________ WATTS Pump Amperage: _________ AMPS
Capacity: ________ GALLONS/SEC / LITERS/SEC
Is the pump leaking steadily? ☐ Yes ☐ No Does pump show signs of heavy corrosion? ☐ Yes ☐ No
If yes, what is leaking out? ☐ Water ☐ Lubricant Does pump generate excessive noise? ☐ Yes ☐ No
Describe security measures at the pump._ ____

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard

Form: Water- Water Sources Well (Target ID ____________________)

Inspector ID_______________________________

Inspection date/time_________________________

Well #______ **of** ________ Location of this well: __________________ (GPS)

Production capacity per year: _______ GAL / LIT

Describe security measures at the well site.____

Indicate type of well: ☐ Dug ☐ Driven ☐ Drilled ☐ Unknown ___________________________

What is the depth of the well? _________ FT / METERS

Are there multiple well heads at the source? ☐ Yes ☐ No

If yes, how many? _________

Well casing diameter? Size in diameter: _________ IN /MM

Pipe access from well to surface: ☐ Through well head ☐ Underground ☐ In vault or tunnel ☐ Unknown ☐ other specify):_____________________________________

Type of well cover: ☐ Cap ☐ Seal

Is it damaged? ☐ Yes ☐ No

If yes, detail:___________________________________

Is there a vent in the well head? ☐ Yes ☐ No

Is the well operating? ☐ Yes ☐ No ☐ Unknown

If answer is NO or UNKNOWN for operating, then check to see if power switch is on.

Is the power switch on? ☐ Yes ☐ No

Is the safety switch on? ☐ Yes ☐ No

Are wires properly connected? ☐ Yes ☐ No

Is there power at this site? ☐ Yes ☐ No

Pump Information: Information for Pump#________ of ________

Is there a pump on this well? ☐ Yes ☐ No ☐ Unknown

If UNKNOWN, is there a conduit box or electrical wires indicating the existence of a submerged pump? ☐ Yes ☐ No

If yes, is the pump operating? ☐ Yes ☐ No ☐ Unknown ☐ No pump indicated.

Type of pump: ☐ Submerged ☐ Surface ☐ Unknown

If Surface pump, where is it located? ☐ Above the Well Head

☐ In a separate pump house

☐ In an underground vault

Is there any flooding in the area of the well head or does the well head appear to be submerged? ☐ Yes ☐ No

If yes, explain:_________________________________

Does the well head appear to be leaking heavily? ☐ Yes ☐ No If yes, explain:______________________

Has the exposed well casing shifted or moved? ☐ Yes ☐ No If yes, explain:______________________

Can you hear water running down the well casing? ☐ Yes ☐ No

Pipe Diameter (in): __________ IN / MM

Pipe Diameter (out): _________ IN / MM

Pump Wattage: __________ WATTS

Pump Amperage: _________ AMPS

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Capacity: ________ GALLONS/SEC / LITERS/SEC

Is the pump leaking steadily? ☐ Yes ☐ No If yes, what is leaking out? ☐ Water ☐ Lubricant

Does pump generate excessive noise? ☐ Yes ☐ No

If yes, explain: ____

Does pump show signs of heavy corrosion? ☐ Yes ☐ No

If yes, explain: ____

Describe security measures at the pump._ ____

Pipe Information: Size in diameter(IN): ____________ IN / MM Material Type :

____

Size in diameter(OUT): ________________________ IN / MM

Material Type ____

Are pipes damaged: ☐ Yes ☐ No

If so, explain: ____

Are pipes leaking steadily: ☐ Yes ☐ No

If so, explain: ____

Do pipes have heavy corrosion: ☐ Yes ☐ No

If so, explain: ____

Direction of flow to/from the station?

☐ To (Direction: ____________________________________)

☐ From (Direction: _________________________________)

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Form: Water - Production Facilities-Treatment (Target ID ________________)
Inspector ID____________________________
Inspection date/time________________________

Identify this plant: ____________________ (GPS)__________Approx area serviced: ____________________
Population serviced: ___________Capacity of plant: _____________ MGD / MLD
Are there known problems or issues at this site? If yes, give details : ______________________________________
Describe security measures at the site. ____
Does the plant appear to be operating? ☐ Yes ☐ No ☐ Unk If not, is there power at the site? ☐ Yes ☐ No
Check breaker and switches for pumps and other equipment. Note any damage and available information on the capacity of the breaker box feeds and breakers____

Which types of equipment are in use at the plant? (Identify them on your plant diagram.)
☐ **Raw Water Storage** How many? _____ Where is water stored? ☐ Tank ☐ Reservoir ☐ other ________
☐ **Pre-Filtration Units** How many? _____
☐ **Rapid Mixer** How many? _____ Is it working? ☐ Yes ☐ No ☐ Unknown
What chemicals are being added? ______________________________________
☐ **Flocculators** How many? _____
Inspect agitators, paddle wheels and impellers. Note problems:
____
☐ **Clarification Basins** How many? _____
Inspect agitators, paddle wheels and impellers. Note problems:
____
Is sludge being siphoned off of the basin? ☐ Yes ☐ No Where is sludge being discharged to? _____________ How is sludge treated or disposed? ____
☐ **Sedimentation Basins** How many? _____
☐ **Filters** How many? _____
Is there flow through it? ☐ Yes ☐ No ☐ UNK
filter capacity: __________ ☐ **Tanks** How many? _____
Do tanks show cracks or distresses? ☐ Yes ☐ No
Note any leakage, wetness, puddles, flow, unexpected water levels: ________________________________
☐ Pumps How many? _____
Information for Pump#_______ of _______
Description: ______________________________
Location: ________________________________
Power source for pump:
☐ electrical service ☐ combustion motor
Does the pump operate? ☐ Yes ☐ No ☐ UNKNOWN
Is there a backup pump? ☐ Yes ☐ No
If NO or UNKNOWN CHECK: Is the power switch on? ☐ Yes ☐ No Is the safety switch on? ☐ Yes ☐ No
Check breakers and switches for pumps and other equipment. Record any relevant information on capacity of breaker box feeds:____
Pipe Diameter (in): _________ IN / MM Pipe Diameter (out): ________ IN / MM Pump Wattage: _________ WATTS
Pump Amperage: ________ AMPS Capacity: _______ GALLONS/SEC / LITERS/SEC

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Is the pump leaking steadily? ☐ Yes ☐ No If yes, what is leaking out? ☐ Water ☐ Lubricant
Does pump generate excessive noise? ☐ Yes ☐ No If yes, explain: ________________________
Does pump show signs of heavy corrosion? ☐ Yes ☐ No If yes, explain: ________________________

Pipe Information:
Size in diameter(IN): _______ IN / MM
Material Type : ____________
Size in diameter(OUT): _______ IN / MM
Material Type : ____________
Are pipes damaged: ☐ Yes ☐ No If so, explain: ________________________________
Are pipes leaking steadily: ☐ Yes ☐ No If so, explain: ________________________________
Do pipes have heavy corrosion: ☐ Yes ☐ No If so, explain: ________________________________
Direction of flow to/from the station?
☐ To (Direction: ___________)
☐ From (Direction: ___________)

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Form: Water - Storage Facilities **(Target ID ____________________)**
Inspector ID_____________________________
Inspection date/time_________________________

Tank #______ of ________Location of tank: ____________________ (GPS)____________
Type of tank: ☐ Elevated ☐ At Grade ☐ Below Ground ☐ other (specify): _______________
Shape of tank: ☐ Round or Cylindrical Height: ________ Diameter: _______ Circle unit of measure: FT / M
☐ Rectangular Height: ________ Width: ________ Length: _________ FT / M
☐ Other Shape Specify: __________________
Height: ________Width: ________Length: _______FT / M
Is the tank: ☐ Open to Air ☐ Sealed/Closed to Air. What is the capacity? __________ GALLON / LITER
Material is the tank constructed: ☐ Concrete ☐ Steel ☐ Wood ☐ other (specify): ___________________________
Does the tank show signs of: ☐ Steady Leakage ☐ Heavy Corrosion ☐ Distress in outer finish or coating ☐ Other (specify): ____
Describe security measures at the site. ____

Pump Information: Are there pumps located on this tank?
☐ Yes ☐ No
Information for Pump#________ of ________
Description: ____________________________
Location: ______________________________
Power source for pump:
☐ electrical service ☐ combustion motor
Does the pump operate? ☐ Yes ☐ No ☐ UNKNOWN
Is there a backup pump? ☐ Yes ☐ No
If NO or UNKNOWN CHECK: Is the power switch on? ☐ Yes ☐ No Is the safety switch on? ☐ Yes ☐ No
Check breakers and switches for pumps and other equipment. Record any relevant information on capacity of breaker box feeds:____
Pipe Diameter (in): __________ IN / MM
Pipe Diameter (out): _________ IN / MM
Pump Wattage: __________ WATTS
Pump Amperage: _________ AMPS
Capacity: ________ GALLONS/SEC / LITERS/SEC
Is the pump leaking steadily? ☐ Yes ☐ No
If yes, what is leaking out? ☐ Water ☐ Lubricant
Does pump generate excessive noise? ☐ Yes ☐ No
If yes, explain: ____________________________________
Does pump show signs of heavy corrosion? ☐ Yes ☐ No If yes, explain:
____
Pipe Information: Size in diameter(IN): _______ IN / MM Material Type :
____
Size in diameter(OUT): _________________________ IN / MM

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Material Type : ____________________________________

Are pipes damaged: ☐ Yes ☐ No

If so, explain: ____________________________________

Are pipes leaking steadily: ☐ Yes ☐ No

If so, explain: ____________________________________

Do pipes have heavy corrosion: ☐ Yes ☐ No

If so, explain: ____________________________________

Direction of flow to/from the station?

☐ To (Direction: ________________________________)

☐ From (Direction: ______________________________)

For Elevated Tanks, additional: What is the elevation of the tank?__________ FT / M

Where is the pump housed? ☐ In a separate pump house ☐ Within the lower base

Observe any access doors or inspection ports to the lift and supply pipes. Do they show signs of leakage or distress?

☐ Yes ☐ No If yes, explain: ____

Do legs and supports show signs of damage or distress?

☐ Yes ☐ No If yes, explain: ______________

Any cross braces: ☐ Missing ☐ Damaged ☐ Broken

If yes to any, explain: ____________________

Any base supports sinking? ☐ Yes ☐ No

If yes, explain: ____________________________________

Note any damage or distress to ladders, railings and cat walks: ____________________________________

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Form: Water- Distribution System (Target ID ________________)
Inspector ID____________________________
Inspection date/time______________________

- Locate major elements on map. Sketch layout. This may be based solely on location of fire hydrants and pump stations. However, at the minimum note the location of possible problem areas and unique or unusual components
- Estimate the locations of transmission, and distribution mains on map.
- If possible, identify the type of the distribution system: ☐ Grid System ☐ Branch System ☐ Dead-end System
- Visually check source pipes and shut-off valves for damage, leaks or corrosions. Note severity and location of any leaks or damage: ____

- What is the approximate distance between pump stations? ________ FT / M

Pump Information:

Information for Pump#________ of ________Description: ________________________Location: ____________

Power source for pump:
☐ electrical service ☐ combustion motor

Does the pump operate? ☐ Yes ☐ No ☐ UNKNOWN Is there a backup pump? ☐ Yes ☐ No

If NO or UNKNOWN CHECK: Is the power switch on? ☐ Yes ☐ No Is the safety switch on? ☐ Yes ☐ No

Check breakers and switches for pumps and other equipment. Record any relevant information on capacity of breaker box feeds:____

Pipe Diameter (in): _________ IN / MM Pipe Diameter (out): ________ IN / MM

Pump Wattage: _________ WATTS Pump Amperage: ________ AMPS

Capacity: ________ GALLONS/SEC / LITERS/SEC

Is the pump leaking steadily? ☐ Yes ☐ No

If yes, what is leaking out? ☐ Water ☐ Lubricant

Does pump generate excessive noise? ☐ Yes ☐ No If yes, explain: ______________________

Does pump show signs of heavy corrosion? ☐ Yes ☐ No If yes, explain: ______________________

Describe security measures at the pump. ____

Pipe Information:

Size in diameter(IN): ______________________ IN / MM

Material Type : ______________________________

Size in diameter(OUT): _______ _______________ IN / MM

Material Type : ______________________________

Are pipes damaged: ☐ Yes ☐ No

If so, explain: ___________________________

Are pipes leaking steadily: ☐ Yes ☐ No

If so, explain: ___________________________

Do pipes have heavy corrosion: ☐ Yes ☐ No

If so, explain: ___________________________

Direction of flow to/from the station?

☐ To (Direction: _______________________________)

☐ From (Direction: _____________________________)

Photograph Estimate Map Detail Measure Sketch

Figure C-3. Water smartcard (continued)

Form: Power – Power Plant **(Target ID ____________________)**
Inspector ID______________________________
Inspection date/time_________________________

Identify this plant:___________________#____of____ GPS__________Type of power production:________________
Number of Generator Units: ______________ Capacity of plant (MW or MVA): _______________
Number of overhead circuits (lines) leaving power plant:___________Overall Plant Appearance (Age)_____________
Describe overall conditions of plant (age, maintenance, appearance, etc.):
____
Describe security measures at the plant. ____

Generator Nameplate & Info

1. Mfg/Brand/Model ________________#____of___ Capacity (kW/kVA)___________ Output voltage:________
   Other Nameplate Info____
   Generator Age:_______ Prime Mover: (circle) - engine, gas turbine, steam turbine, other_____________
   Fuel: (circle) – Diesel, Natural Gas, Steam from coal boiler, Steam from nuclear, other_______________
2. Mfg/Brand/Model ________________#____of___ Capacity (kW/kVA)___________ Output voltage:________
   Other Nameplate Info____
   Generator Age:_______ Prime Mover: (circle) - engine, gas turbine, steam turbine, other_____________
   Fuel: (circle) – Diesel, Natural Gas, Steam from coal boiler, Steam from nuclear, other_______________
3. Mfg/Brand/Model ________________#____of___ Capacity (kW/kVA)___________ Output voltage:________
   Other Nameplate Info____
   Generator Age:_______ Prime Mover: (circle) - engine, gas turbine, steam turbine, other_____________
   Fuel: (circle) – Diesel, Natural Gas, Steam from coal boiler, Steam from nuclear, other_______________
4. Mfg/Brand/Model ________________#____of___ Capacity (kW/kVA)___________ Output voltage:________
   Other Nameplate Info____
   Generator Age:_______ Prime Mover: (circle) - engine, gas turbine, steam turbine, other_____________
   Fuel: (circle) – Diesel, Natural Gas, Steam from coal boiler, Steam from nuclear, other_______________

Non -Generator Equipment

1. Equipment Type___________________________ Description:____________________________________
Condition: ____
2. Equipment Type__________________________ Description:____________________________________
Condition: ____

Questions for Power Plant Operator/Engineer

1. Is plant able to output rated capacity?____
2. Are all generators functional? If not, explain.____
3. What is typical kW load of plant peak ? __________ off-peak?_________________
4. Controls: Automated synchronization? _______Remotely controlled?_______
5. Major causes for downtime?____

Photograph Estimate Map Detail Measure Sketch

Figure C-4. Electricity smartcard

Form: Power – Substations **(Target ID ____________________)**

Inspector ID____________________________

Inspection date/time________________________

Transmission/Distribution Substations: number:_____

Identify this substation: ___________________#____of_____GPS ____________

Transformer Capacity (MVA) ________ Incoming Lines (qty)_______ Voltage In (kV): _______

Outgoing Lines (qty)_______ Voltage Out (kV):_______

Substation Type: ☐ step up transmission station ☐ step down transmission station ☐ distribution substation

Structures: Note the overall stability of the structures: (Any loose bolts, discoloration from fire or chemicals, bending, etc.)____

Transformers: Number of transformers:______#____of ____

Name plate information:________________________________Describe any damage to the transformers: (oil leaking, fire damage,etc) ____

Describe security measures at the site. ____

Describe terrain features that provide cover for the site. ____

Transmission / Distribution Towers and lines: Number of total circuits:________

Define your starting location: #___of ___ Point A:_____________ GPS ________

your ending location: Point B:_________ GPS_________ number of poles_____ distance______ mile/km

Structure Type: ☐ transmission ☐ sub transmission Structure Height:___________

Structure Material: ________________ If wood, describe condition: (Note any deterioration, leaning, etc.)

____

Is there any damage to the towers and lines at the points defined? ☐ Yes ☐ No If yes, describe (look for structural stability, discoloration, obstructions or downed lines, damaged transformers and components, etc.)

____

Sketch Layout: (show transmission lines connecting substations, indicate voltage levels, indicate qty. of circuits going out of distribution substations)

Photograph Estimate Map Detail Measure Sketch

Figure C-4. Electricity smartcard (continued)

Form: Academics **(Target ID ____________________)**

Inspector ID____________________

Inspection date/time__________________________

List information on building's name and address and additional location information (including GPS). Locate major elements on local map. Note accessibility by Roads:

____

These forms should be filled out as completely as possible by the inspector(s). Do not leave blank spaces; use "UNK" for "Unknown", "NA" for "Not Applicable", or "None" when appropriate. Talk with the owner to obtain as much information as possible. Assure him/her that detailed name and address information will not be released to the public. Photos should be taken of each exterior building elevation, and of any locations where significant damage is visible.

General Information

Name of school: ____

Chief school administrator: ____

Is the school public or private? ____________________

Is school currently in session? ☐ Yes ☐ No

School hours: ___________ through ___________

What is the normal school year? __________________ through __________________

Can the school currently operate as is? ☐ Yes ☐ No if no, what is required to bring into operation? __________

____

____

How many students is the school responsible for? If unknown, note geographical area: ____________________

% of students enrolled in the area the school is responsible for? ___________________

What is the capacity of the school: ___________________

What is daily average attendance: ________%

How many grades are provided or ages of students who attend? __________ thru __________

How many teachers are there? _________

How many teachers' aides or assistants are there? _________

How many administration personnel are there? _________

Is there a school nurse? ☐ Yes ☐ No

Is the school currently short of teachers? ☐ Yes ☐ No if yes, explain: _________________________________

____

What is the schools annual budget in local currency? __________________________

Where does school receive its funding? ____

Do citizens pay so their children can attend? ☐ Yes ☐ No

Who does the school report too? ____

Is there mandatory testing? ☐ Yes ☐ No if yes, how often: ________________________________

Is the school a specialty school? ☐ Yes ☐ No if yes, what type: _________________________________

Are there male and female students in the same classroom? ☐ Yes ☐ No

Is the school segregated? ☐ Yes ☐ No if yes, explain: ____

____

Is the school religiously affiliated? ☐ Yes ☐ No if yes, explain: __________________________________

Does the school have security personnel? ☐ Yes ☐ No

Can the school be secured via doors or gates? ☐ Yes ☐ No

Figure C-5. Academics smartcard

Describe the surrounding area. What type of neighborhood is it, upper or lower class etc. Are there any nearby facilities that are of interest. Is there anything in the area that could pose a threat? ___________________________________

____

____

Are there any NGOs working with the facility? ☐ Yes ☐ No of yes, include POC, services provided, and frequency of support. ____

____

Curriculum and Facilities

Is English taught? ☐ Yes ☐ No if yes, to what extent? ____________________

Who sets the curriculum (the school, province, government)? ____

What subjects are taught? ____

Mathematics: Grades/Ages taught: __________________________________

textbook to student ratio: ____ : ____

textbook copyright: __________

Science: Grades/Ages taught: ______________________________________

textbook to student ratio: ____ : ____

textbook copyright: __________

Language Arts: Grades/Ages taught: ________________________________

textbook to student ratio: ____ : ____

textbook copyright: __________

Social Studies: Grades/Ages taught: ________________________________

textbook to student ratio: ____ : ____

average textbook age: __________

Health Education: Grades/Ages taught: ______________________________

textbook to student ratio: ____ : ____

average textbook age: __________

Government Education: Grades/Ages taught: _________________________

textbook to student ratio: ____ : ____

average textbook age: __________

Religion: Grades/Ages taught: _____________________________________

textbook to student ratio: ____ : ____

average textbook age: __________

Vocational Education: Grades/Ages taught: ___________________________

textbook to student ratio: ____ : ____

average textbook age: __________

Physical Education: Grades/Ages taught: _____________________________

textbook to student ratio: ____ : ____

average textbook age: __________

List any additional subjects taught: ____

Does the school provide extracurricular activities? ☐ Yes ☐ No if yes, list: ____________________________

____

Does the school provide education for special needs children? ☐ Yes ☐ No if yes, list: ___________________

____

Figure C-5. Academics smartcard (continued)

Is the school teaching any propaganda? ☐ Yes ☐ No if yes, explain: ____________________

____

____

What level of technology does the school have (computer, internet, telephone, etc)? Explain: ____________

____

Does the school have a library? ☐ Yes ☐ No If yes, how many books or size: ____________

Does the school provide lunch for students? ☐ Yes ☐ No

if yes, does cafeteria and kitchen appear adequate and sanitary? ☐ Yes ☐ No if no, explain:

____

____

Are there adequate supplies for teachers and students (paper, pencils, chalk boards, etc)

☐ Yes ☐ No If no list needed supplies:

____

____

____

Is there adequate equipment for the school (desks, tables, chairs, copiers, etc)? ☐ Yes ☐ No

If no, list needed equipment:

____ Is there any equipment that has been damage and is in need of immediate repair of replacement?

____

Describe the construction of the building, including walls, roof, any other supporting superstructure, windows, and doors.

____

How far from roads is the building? __________ Are there drive-up / drop-off points to the building? __________

How far from parking is the building? __________ Can access to parking be limited? __________

Is there a loading dock on the building? __________ How far are trash containers from the building? __________

Identify any vantage points from which students or faculty could be targeted with direct fire weapons.

____

Are there any areas of the school that could be used for shelter? ____________________

Describe any security measures that limit access to the school and school grounds. ____________________

____

Are there adequate fire escape considerations? ____________________

Safety and Public Sentiment

Does the school have a crisis management plan for: ☐ Fire ☐ Natural Disaster ☐ Medical Emergencies ☐ Intruders ☐ Terrorist Acts ☐ Other: ____________________

Do teachers feel safe? ☐ Yes ☐ No if no, explain: ____________________

Do students feel safe? ☐ Yes ☐ No if no, explain: ____________________

Do parents feel school is safe? ☐ Yes ☐ No if no, explain: ____________________

What is public sentiment about the school (positive or negative) and explain: ____________________

Does school appear to be a healthy environment? ☐ Yes ☐ No if no, explain: ____________________

Does the school appear to be adequate in size? ☐ Yes ☐ No if no, explain: ____________________

Does the school appear to be well maintained? ☐ Yes ☐ No if no, explain: ____________________

Does the building owner/ operator seem trustworthy? ☐ Yes ☐ No if no, explain: ____________________

Figure C-5. Academics smartcard (continued)

Form: Trash (Target ID ____________________)

Inspector ID____________________

Inspection date/time_________________________

General Information

Name of town/area: ____

Do the townspeople burn their trash individually (in backyard burn pits)? ☐ Yes ☐ No

Is trash being hauled out of town by a company/organization? ☐ Yes ☐ No

If yes, does that company/organization have sufficient:

- Trucks ☐ Yes ☐ No
- Personnel ☐ Yes ☐ No
- Permits ☐ Yes ☐ No
- Landfill space ☐ Yes ☐ No

Are there trash piles in the streets? ☐ Yes ☐ No

How much trash has to be removed? ☐ 1 days worth ☐ multiple days worth ☐ 1 week of trash ___________

Is the trash removal system public or private? ____________________

What is the trash removal schedule? Certain days of the week, etc ________________

Is there any recycling program in effect? ☐ Yes ☐ No

Is trash valuable in that location (scrap metal,etc)? ☐ Yes ☐ No

Landfills

What is the location of the landfill? ________________________

Who owns the landfill? ________________________________

Who manages the landfill (name/organization)? ________________________

Does the landfill burn any trash? ☐ Yes ☐ No

Does the landfill compact the trash? ☐ Yes ☐ No

Does the landfill bury the trash? ☐ Yes ☐ No

Does the landfill have sufficient personnel/equipment to operate? ☐ Yes ☐ No

If no, what does the operation need? ______________________

Does the landfill have any security/containment system (ie – fence, berm, etc)? ☐ Yes ☐ No

If yes, what is that system? ____________________

Are there any obvious health issues to address (ie – water source nearby, etc)? ☐ Yes ☐ No

If yes, what are those concerns? ________________________________

Photograph Estimate Map Detail Measure Sketch

Figure C-6. Trash smartcard

Form: Medical - Hospital/Clinic Assessment **(Target ID ______________)**

Inspector ID____________________

Inspection date/time________________________

List information on building's name and address and additional location information (including GPS). Note accessibility by

Roads: ____ Locate major

____ elements on local map

These forms should be filled out as completely as possible by the inspector(s). Do not leave blank spaces; use "UNK" for "Unknown", "NA" for "Not Applicable", or "None" when appropriate. Talk with the owner to obtain as much information as possible. Assure him/her that detailed name and address information will not be released to the public. Photos should be taken of each exterior building elevation, and of any locations where significant damage is visible.

General Information

Name of facility: ____

Chief facility administrator: ____

Is the facility a hospital or clinic? ____________________________

What type of service does the facility provide: ☐ Inpatient ☐ Outpatient ☐ Emergency/Trauma Care ☐ Minor Surgery ☐ Major Surgery ☐ Intensive Care ☐ Other: ______________________________

What is normal day-to-day bed capacity? _______________ Emergency Capacity? _______________

Average number of patients on a daily basis: _______________

How many people does the facility service (population): _______________

Is the facility public or private? ____________________

Facility hours: _______ through ________

What is the facility's annual budget in local currency? ________________________

Is the facility currently receiving funding? ☐ Yes ☐ No if no, explain: ____________________________

____

Where does facility receive its funding from? ____

How do patients pay for their care? ____

Does the facility have security personnel? ☐ Yes ☐ No

Can the facility be secured via doors or gates? ☐ Yes ☐ No

Describe the surrounding area. What type of neighborhood is it, upper or lower class etc. Are there any nearby facilities that are of interest. Is there anything in the area that could pose a threat? ____________________________

____

____

Personnel/ Specialists

How many doctors are there? ___________________

How many nurses are there? ___________________

How many administration personnel are there? ___________________

How many non-medical personnel are there? ___________________

What types of specialists are there? ☐ Anesthesiologist ☐ General practice ☐ OBGYN ☐ Ophthalmologist ☐ Pediatrician ☐ Pathologist ☐ Psychiatrist ☐ Radiologist ☐ Surgeon ☐ Other: ______________

____

Is the facility currently short of doctors or nurses? ☐ Yes ☐ No if yes, explain: ______________________

____

Figure C-7. Medical smartcard

Emergency Services

Does the facility have a crisis management plan for: ☐ Fire ☐ Natural Disaster ☐ Medical Emergencies ☐ Terrorist Acts ☐ Other:____

Does the facility have ambulances ☐ Yes ☐ No if yes, how many: ____________________

What are the ambulances used for? ____

Who operates the ambulances? ☐ EMT ☐ Medical students ☐ Non-medical Personnel ☐ Other:__________

What equipment and services are provided by the ambulance? ____

Services

What services is the facility able to provide? ____

Does the facility have a pharmacy? ☐ Yes ☐ No if yes, attach a copy of pharmacy's stock inventory (BDE Surgeon or BN PA can assess to determine care that they can provide)

Are there any drugs the facility is critically short of? ☐ Yes ☐ No if yes, list:__________________________

Does the facility have capability to sterilize equipment? ☐ Yes ☐ No if yes explain: ____________________

When facility is unable to provide required level of care where are patients sent? Include name and location of facility:

Name: __________________________________ Location/ travel time: __________________________

Does the facility have the ability to take X-rays? ☐ Yes ☐ No

Does the facility have a lab where blood tests and cultures can be processed? ☐ Yes ☐ No

What level of technology does the facility have (computer, internet, telephone, etc)? Explain: ____________________

What level is the facility currently operating at ______% If not 100% what is needed to increase to 100%? Explain:

Are there any smaller facilities the facility is responsible for? ☐ Yes ☐ No if yes, provide name and location:

Where does the facility receive its supplies from? ____

How does the facility dispose of medical waste? ____

Is the facility short of any supplies?

Drugs: ____

Medical Supplies (syringes, bandages, etc): ____

Medical Equipment (x-ray machine, etc): ____

Non-medical equipment (beds, tables, chairs, etc): ____

Figure C-7. Medical smartcard (continued)

Is there any equipment that has been damage and is in need of immediate repair of replacement? ____________

____

Does the facility have an isolation ward? ☐ Yes ☐ No

Are there any NGOs working with the facility? ☐ Yes ☐ No if yes, include POC, services provided, and frequency of support. ____

____

____

Hospital Organizational Structure.

Sketch a flow chart to detail how the facility is organized and which department provides what service.

Public Sentiment

Do doctors and nurses feel safe? ☐ Yes ☐ No if no, explain: ____

What is public sentiment about the facility (positive or negative) and explain: ________________________________

Does the facility appear to be adequate in size? ☐ Yes ☐ No if no, explain: ____________________________

Does the facility appear to be well maintained? ☐ Yes ☐ No if no, explain: ____________________________

Does the facility appear to be sanitary? ☐ Yes ☐ No if no, explain: ________________________________

List any additional comments or impressions not otherwise noted above: __________________________________

Buildings and Grounds

Describe the construction of the building, including walls, roof, any other supporting superstructure, windows, and doors.

____

How far from roads is the building? ____________

Is there an emergency drive-up / drop-off point to the building? ________ Other drive-up / drop-off points? ___________

How far from parking is the building? __________ Can access to parking be limited? ___________________________

Is there a loading dock on the building? _________ How far are trash containers from the building? ________________

Identify any vantage points from which patients or staff could be targeted with direct fire weapons.

____

Are there any areas of the facility that could be used for shelter? ____

Describe any security measures that limit access to the facility or grounds. __________________________________

____

Are there adequate fire escape considerations? ____

Figure C-7. Medical smartcard (continued)

Form: Public Safety - Station Assessment (Target ID ____________________)

Inspector ID____________________

Inspection date/time__________________________

List information on building's name and address and additional location information (including GPS). Note accessibility by

Roads: ____ Locate major

____ elements on local map

These forms should be filled out as completely as possible by the inspector(s). Do not leave blank spaces; use "UNK" for "Unknown", "NA" for "Not Applicable", or "None" when appropriate. Talk with the owner to obtain as much information as possible. Assure him/her that detailed name and address information will not be released to the public. Photos should be taken of each exterior building elevation, and of any locations where significant damage is visible.

General Information

Name of facility: ____

Chief of Police: ____

Is the facility a hospital or clinic? ________________________________

What type of service does the facility provide: ☐ Administration ☐ Patrol ☐ Other: ____________________

How many people does the facility service (population): ________________

Facility hours: _______ through ________

What is the facility's annual budget in local currency? __________________________

Is the facility currently receiving funding? ☐ Yes ☐ No if no, explain: ______________________________

____

Where does facility receive its funding from? ____

Describe the surrounding area. What type of neighborhood is it, upper or lower class etc. Are there any nearby facilities that are of interest. Is there anything in the area that could pose a threat? ______________________________

____

____

What is the total area the department is responsible for? Should be marked on a map __________________________

Personnel/ Specialists

How many officers are there? _____________________

How many patrolmen are there? _____________________

How many administration personnel are there? _____________________

How many non-medical personnel are there? _____________________

How many reserve policemen? _________________________

Are there any other security organizations operating in the area? ____

Who do they report to? ______________________________________

Is the facility currently short of policemen? ☐ Yes ☐ No if yes, explain: ______________________________

____

Have senior personnel been vetted? ☐ Yes ☐ No

Services

Does the facility have a crisis management plan for: ☐ Fire ☐ Natural Disaster ☐ Medical Emergencies ☐ Terrorist Acts ☐ Other: ____

Does the facility have vehicles ☐ Yes ☐ No if yes, how many: _____________________

How are vehicles marked? ____

What services are provided by the vehicles? Patrol, admin, personal use, etc ____________________________

Figure C-8. Safety smartcard

What services is the facility able to provide? ____________________

Percentage of officers with uniforms? ______% describe uniforms: ____________________

Do the police have photo IDs? ☐ Yes ☐ No if yes, attach a copy of ID

How are police armed? (note: in most place handguns are a status symbol, whereas criminals have AK-47's pistols handguns aren't enough) ☐ Yes ☐ No if yes, list type and quantities ____________________

Do the police have enough ammunition? ☐ Yes ☐ No if no, list quantity and type needed

Do the police have enough equipment (handcuffs, flashlights, etc) ____________________

Dos the station have radios? ☐ Yes ☐ No if yes, include number and type ____________________

Does the station have a jail? ☐ Yes ☐ No if yes, explain ____________________

Does the station have a secure arms room? ☐ Yes ☐ No if yes, describe and include capacity____________

What percentage of the police force is trained in policing? ______% Where did they receive their training? __________

What is the background of different policemen? (army, air force, national guard, etc) ____________________

Are there any crime concerns for the local area? ____________________

What is the crime fighting strategy / (in some countries police do not patrol, they merely react to reports of crime) _____

Who does the department answer to? (mayor, city council, province, government, etc) ____________________

Does the department maintain criminal records? ☐ Yes ☐ No if yes, how far back do they go (years) _________

What level of technology does the facility have? (computer, internet, telephone, etc) Explain: ____________________

What level is the facility currently operating at ______% If not 100% what is needed to increase to 100%? Explain:

Are there any smaller facilities the facility is responsible for? ☐ Yes ☐ No if yes, provide name and location:

Where does the facility receive its supplies from? ____________________

Is the deportment short of any equipment (beds, tables, chairs, etc): ____________________

Figure C-8. Safety smartcard (continued)

Is there any equipment that has been damage and is in need of immediate repair of replacement? ____________
____
____

Are there any NGOs working with the facility? ☐ Yes ☐ No of yes, include POC, services provided, and frequency of support. ____
____
____

Police Department Organizational Structure.

Sketch a flow chart to detail how the facility is organized and which department provides what service.

Public Sentiment

Do policemen feel safe? ☐ Yes ☐ No if no, explain:________________________________

What is public sentiment about the police department (positive or negative) and explain: ____________________

Does the department appear to be adequate in size? ☐ Yes ☐ No if no, explain: ____________________

Does the facility appear to be well maintained? ☐ Yes ☐ No if no, explain: ______________________

Does the facility appear to be sanitary? ☐ Yes ☐ No if no, explain: ____________________________

Do you feel the police force is effective? ☐ Yes ☐ No if no, explain: ___________________________

Do you feel that the answers provided by the police are truthful? ☐ Yes ☐ No if no, explain: ____________

Do you feel the police are trustworthy? ☐ Yes ☐ No if no, explain: ____________________________

List any additional comments or impressions not otherwise noted above:

Public Sentiment

Describe the construction of the building, including walls, roof, any other supporting superstructure, windows, and doors.
____

How far from roads is the building? ___________

Are there drive-up / drop-off points to the building? ________________

How far from parking is the building? _________ Can access to parking be limited? ______________________

Is there a loading dock on the building? ________ How far are trash containers from the building? ______________

Identify any vantage points from which occupants could be targeted with direct fire weapons.
____

Are there any areas of the facility that could be used for shelter? ____________________________________

Describe any security measures that limit access to the facility or grounds. ______________________________
____

Are there adequate fire escape considerations? ____

Figure C-8. Safety smartcard (continued)

Form: Transportation – CONCRETE ROADWAY **(Target ID ___________)**

Inspector ID____________________

Inspection date/time_________________________

(Circle One) Roadway / Parking Lot Surface Material: ____________ Function: ________________

Length: __________________ Width: _________________ # of Lanes: ________________

Start Location: ____________________ (GPS coord if available) End Location: _____________________

Identify surface distresses present. Record the location and size (ft^2 or m^2) of each instance as applicable.

	Location	Size	Location	Size	Location	Size	Location	Size
Blowups								
Depression								
Potholes								
Railroad Crossing								
Shattered Slab								

Describe surrounding area, to include prominent structures, landmarks, distinctive natural features, major crossroads, and evidence of recent work or tampering with the traffic surface:

____

____

____

____

Photograph Estimate Map 1 Detail Measure Sketch

Figure C-9. Roads smartcard

Form: Transportation – ASPHALT ROADWAY (Target ID ___________)

Inspector ID____________________

Inspection date/time_________________________

(Circle One) Roadway / Parking Lot Surface Material: ____________ Function: ________________

Length: __________________ Width: _________________ # of Lanes: ________________

Start Location: ____________________ (GPS coord if available) End Location: _____________________

Identify surface distresses present. Record the location and size (ft^2 or m^2) of each instance as applicable.

	Location	Size	Location	Size	Location	Size	Location	Size
Alligator Cracking								
Corrugation								
Depression								
Potholes								
Railroad Crossing								
Slippage Cracking								

Describe surrounding area, to include prominent structures, landmarks, distinctive natural features, major crossroads, and evidence of recent work or tampering with the traffic surface:

____

____

____

____

Photograph Estimate Map 2 Detail Measure Sketch

Figure C-9. Roads smartcard (continued)

Form: Transportation – UNSURFACED ROADWAY (Target ID __________)

Inspector ID______________________

Inspection date/time___________________________

(Circle One) Roadway / Parking Lot   Surface Material: ______________   Function: __________________

Length: ____________________   Width: ___________________   # of Lanes: __________________

Start Location: _________________ (GPS coord if available)   End Location: _________________

Identify surface distresses present. Record the location and size (ft^2 or m^2) of each instance as applicable.

	Location	Size	Location	Size	Location	Size
Corrugation						
Dust						
Deformation						
Potholes						
Ruts						
Depressions						

Describe surrounding area, to include prominent structures, landmarks, distinctive natural features, major crossroads, and evidence of recent work or tampering with the traffic surface:

____

____

Photograph   Estimate   Map   Detail   Measure   Sketch

Figure C-9. Roads smartcard (continued)

Form: Transportation – RAILROAD **(Target ID _______________)**

Inspector ID____________________

Inspection date/time_________________________

TRACK INVENTORY (Structure, Turnouts, Curves, Grade, Drainage, Appliance)

Track ID:_________________ Begin Location:____________ End Location:_______________

General

Category:		Use:			
Year Built:		Area:		Construction Type:	Perm Semi Temp Leased

Track Structure

Begin Location	Rail Weight	Rail Length	Tie Size	Tie Material	Tie Spacing	Gauge Rods (Y/N)	Rail Anchors (Y/N)

Turnouts

ID	Location	Length of Point Rails	Guard Rail Length

Curves

Begin Location	End Location	Curvature	Direction	Superelevation

Photograph Estimate Map 1 Detail Measure Sketch

Figure C-10. Railroads smartcard

Grade

Begin Location	End Location	% Grade

Bridges

Begin Location	End Location	Const Type	Bridge ID

Drainage

Location	Type	Material	Size	Length

Other Track Appliances (wheel stops, car bumpers, derails, grounds and bonds, etc.)

Location	Item

Rail Crossings

Location	Crossing Track	Angle	Rail Weight

Grade Crossings

Begin Location	End Location	Road Name	Surface Material	Flangeway Material	Protection Type*

*Grade Crossing Protection Types include: Signs, Flashers, Gates, or No Protection.

Photograph Estimate Map 2 Detail Measure Sketch

Figure C-10. Railroads smartcard (continued)

TRACK INSPECTION

Track ID:__________________ Begin Location:____________ End Location:_______________

Inspector ID:_______________ Inspection Date/Time:____________

Location	Component	ID*	Defect	Measurement	Length	Density	Qty

*ID refers to the Turnout or Grade Crossing ID. It is not necessary to denote the location of each defect tie found during the inspection. Instead, a count of the number of defective ties for a given track or segment of track is adequate for inspection recording purposes. Due to natural weakness and increased tie loads at rail joints, defective ties at joints should be noted separately in the defective tie count. In addition, due to safety concerns, clusters of defective ties are particular problem areas. Track location of clusters of 3 or more defective ties should be noted and recorded during the inspection.

Photograph Estimate Map Detail Measure Sketch

Figure C-10. Railroads smartcard (continued)

Form: Transportation – BRIDGES (Target ID ____________)

Inspector ID______________________

Inspection date/time___________________________

Bridge Location: ____ (GPS coord if available)

Bridge Length: _____________ Number of Spans: _____________ Span Length: _____________

Overhead Clearance: _____________ Number of Lanes: _____________ Lane Width: _____________

If Present, Watercourse:

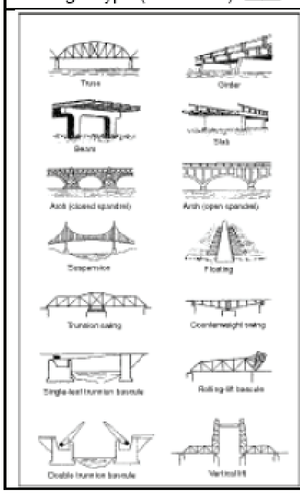
Depth: ________ Width: _______ Direction of Flow: ________ Velocity: _______

Number & Type of Nearby Boats/Barges:

____

Bank Height: ________ Bank Slope: ________ Bank Composition: _________________________

Bridge Type (circle one):



Check the box for the material type for each bridge component:

	Steel	Concrete	Pre-stressed Concrete	Reinforced Concrete	Stone or Brick	Wood	Other
Deck							
Railing							
Pier							
Stringer or Girder							
Abutment							
Truss or Cables							
Other							

Describe any apparent damage to bridge:____

____

____

____

____

____

Photograph Estimate Map Detail Measure Sketch

Figure C-11. Bridges and waterways smartcard

Describe and annotate the type and dimensions of structural member (stringers, piers, etc):________________

____
____
____
____

Describe roadway connections and approaches:
____
____
____
____

Photograph Estimate Map Detail Measure Sketch

Figure C-11. Bridges and waterways smartcard (continued)

Form: Transportation – Airfield Overview (Target ID ___________)

Inspector ID____________________

Inspection date/time_________________________

Identify this Airfield:_________________________ (GPS coord)

Inspector ID ______________________

Inspection date/time ___________

Photograph problem areas.

Identify problem areas and important components on the map.

Sketch Layout

Sketch the roofing plan layout, denoting scale and Cartesian coordinates. Provide dimensions where appropriate. Indicate the location of roof terminations,

Photograph Estimate Map Detail Measure Sketch

Figure C-12. Airports smartcard

Form: Transportation – UNSURFACED AIRFIELD (Target ID _________)

Inspector ID____________________

Inspection date/time_________________________

(Circle One) Runway / Apron / Taxiway Surface Material: ____________ Function: ________________

Length: __________________ Width: _________________ Thickness: ________________

Start Location: ____________________ (GPS coord if available) End Location: ____________________

Identify surface distresses present. Record the location and size (ft^2 or m^2) of each instance as applicable.

	Location	Size	Location	Size	Location	Size
Corrugation						
Dust						
Deformation						

Describe in detail the nature of other damage, to include foreign objects placed on the surface for the purpose of denial, UXO, and craters or other battle damage:

____

____

Photograph Estimate Map Detail Measure Sketch

Figure C-12. Airports smartcard (continued)

Form: Transportation – SURFACED AIRFIELD (Target ID ___________)

Inspector ID____________________

Inspection date/time_________________________

(Circle One) Runway / Apron / Taxiway Surface Material: _____________ Function: _________________

Length: ___________________ Width: __________________ Thickness: _________________

Start Location: ______________________ (GPS coord if available) End Location: _______________________

Identify surface distresses present. Record the location and size (ft^2 or m^2) of each instance as applicable.

	Location	Size	Location	Size	Location	Size
Alligator Cracking						
Blowups						
Depression						
Patches						
Shattered Slabs						
Spalling						

Describe in detail the nature of other damage, to include foreign objects placed on the surface for the purpose of denial, UXO, and craters or other battle damage:

____

Photograph Estimate Map Detail Measure Sketch

Figure C-12. Airports smartcard (continued)

Form: Transportation – Airfield Control Tower (Target ID __________)

Inspector ID____________________

Inspection date/time_________________________

Bldg ID: ___________________ Bldg Name: ___________________________________# Floors:_________________ Height ________ Length ________ Width _________

Bldg Location: ____ (GPS coord)

Photograph or describe the exterior of the control tower.

____

Is the observation deck enclosed? ☐ Yes ☐ No Heated ☐ Yes ☐ No AC ☐ Yes ☐ No

List the equipment on the observation deck

____

____

List other control equipment for air traffic monitoring

____

____

List backup power systems

____

Describe any security measures limiting access to the control tower or surrounding site.

____

Photograph Estimate Map Detail Measure Sketch

Figure C-12. Airports smartcard (continued)

Form: Transportation – Airfield Lighting (Target ID ___________)
Inspector ID____________________
Inspection date/time_________________________

For each runway and taxiway, map the lighting, signs, and markings. Describe their condition.

Locate the power equipment for the lighting. Estimate the age of the equipment

Circuit breaker Capacity __________ Note any damage.______________________________

Current regulators – Note any obvious damage such as rust, heavy blackness, leaking oil, etc. Also note any excessive humming, although some humming should be heard.____

Transfer Switch – Note any damage.____

Main Breaker – Note any damage.
____

Remote controls ☐ Yes ☐ No

List backup power systems
____

How often is backup generator operated? _______________ If possible observe generator being operated and used to power lights ☐ Yes ☐ No Describe any problems

Type of Approach Permitted (VFR, non-precision, Precision)______________________

Photograph Estimate Map Detail Measure Sketch

Figure C-12. Airports smartcard (continued)

Form: Housing - Building Inspection **(Target ID ____________________)**

Inspector ID____________________

Inspectiondate/time__________________________

List information on building's name and address and additional location information (including GPS). Note accessibility by

Roads: ____

Locate major elements on local map

____

These forms should be filled out as completely as possible by the inspector(s). Do not leave blank spaces; use "UNK" for "Unknown", "NA" for "Not Applicable", or "None" when appropriate. Talk with the owner to obtain as much information as possible. Assure him/her that detailed name and address information will not be released to the public. Photos should be taken of each exterior building elevation, and of any locations where significant damage is visible.

General Information

Approximate footprint (estimate dimensions and attach sketch): ________________________________

# of stories: ______________ Stories above ground ____________ Stories below ground__________

Year of construction or approximate age: ______________

Is the building occupied? ☐ Yes ☐ No ____

Does the building appear habitable? ☐ Yes ☐ No

Are building administrators available? ☐ Yes ☐ No Names/ Position ________________________

____

Type of occupancy: ☐ Residential ☐ School ☐ Hospital ☐ Police ☐ Fire ☐ Medical

☐ Other public ____________

No. of Units / Beds / Classrooms ________________

Is this building historic? ☐ Yes ☐ No

Describe Building Contents:

____

____

Safety- Do conditions exist that would make the building unsafe or restrict usage-

Overall: building collapse, building or story lean or drift, displaced foundation ☐ Yes ☐ No

Structural: failure of significant column pier or bearing wall, failure of rood/floor frame, failure of horizontal or vertical support-unstable floor or wall systems ☐ Yes ☐ No

Non-structural: failure of canopy, failure of false ceiling, failure in stairs, exits, access walkways, gratings, failure of essential mechanical or electrical equipment, HAZMAT threat ☐ Yes ☐ No

Geotechnical: slope failure, debris (i.e. tree) impact, ground movement (i.e. erosion) ☐ Yes ☐ No

Security –

Has the building been vandalized? ☐ Yes ☐ No

Does the building have armed conflict damage ☐ Yes ☐ No

Can the building be locked and secured? ☐ Yes ☐ No

Are there personnel guarding the building? ☐ Yes ☐ No

Describe existing setbacks from roads and any barricades or how that might be accomplished: ____________

Photograph Estimate Map Detail Measure Sketch

Figure C-13. Housing smartcard

Building Damage

Note any apparent hazards from loose materials and other overhead dangers ______________________

Describe observed structural damage to building. Indicate where damage is to local members, an area, or throughout. Types of damage common to many materials: Missing, failed, & bent members; Missing & failed connectors; Settlement;

Damage common to steel: Distortion; Cracks; Corrosion
Damage common to wood: Rot; Insect damage; Checking; Crushing;
Damage common to concrete and masonry: Cracking; Differential movement; Crushing;

Exterior

Wall Assembly Type: ☐ Stacked Unit ☐ Monolithic ☐ Framed ☐ Curtain Grid ☐ Curtain Panel ☐ Other

Describe the observed damage to the wall. Be sure to specify quantity (SF area) of damage. If damage is a potential safety hazard, indicate and explain why. ______________________

What is the predominate roofing surface:: ☐ Asphalt Shingle; ☐ Wood Shingle; ☐ Slate Shingle; ☐ Metal Shingle; ☐ Clay/Concrete Tile; ☐ Standing Seam Metal; ☐ Nailed Metal Sheet; ☐ Pre-formed Panels; ☐ Thatched Roofs.

While walking through the interior space, denote locations of water leakage from above. Describe location and nature of any roof leaks:______________________

Electrical

Transformers – Note any obvious damage such as rust, heavy blackness, leaking oil, etc. Also note any excessive humming, although some humming should be heard.______________________

Main Breaker – Note any damage. ______________________

Backup Generator Yes ☐ No ☐, Document the type of generator (e.g. diesel) and the size (in kW). Note damage.

Lighting – Note the adequacy of the lighting. Note if the lights dim when other electrical equipment starts up (may need to ask a building operator):______________________

Switchgear – Describe overall condition. Note and document any physical differences in the fuses (e.g. obvious blown wires, blackness). ______________________

Panel Boards – CIRCUIT BREAKERS AND FUSES: Document any physical differences (e.g. obvious blown wires, blackness). ______________________

Receptacles – Describe the availability of the receptacles (extension cords necessary, receptacles overloaded). Note the availability of receptacles that accept three-prong plugs. Create a drawing with locations noted if necessary.

Plumbing

According to locals is the water drinkable? ☐ Yes ☐ No

Photograph Estimate Map Detail Measure Sketch

Figure C-13. Housing smartcard (continued)

Does the water exhibit an unusual taste, color or odor? ☐ Yes ☐ No
If yes, give details:____

- Does the water pressure ever drop? ☐ Yes ☐ No If yes, how often? ☐ Regularly ☐ Sporadically ☐ Rarely
- Does the water temperature fluctuate? ☐ Yes ☐ No If yes, how often? ☐ Regularly ☐ Sporadically ☐ Rarely

Give Details: ____

- Are there any known issues with the plumbing pipes or fixtures in the building? ☐ Yes ☐ No if yes, explain

Hot Water Supply: ☐ Boiler ☐ Water heater ☐ None ☐ Other (specify): ____________
Is there a fire suppression system? ☐ No ☐ Yes, ______ % of Building Protected: ________
Note any distresses in pipes such as broken pipes, leaks, corrosion, damages insulation etc.

HVAC

Cooling System Type: ☐ Central Plant ☐ Central Air Conditioner ☐ Room Air Conditioners ☐ Chiller ☐ Heat Pump ☐ Evaporative Cooling ☐ Thermal Storage ☐ Other (specify): ____________

Heating System Type: ☐ Central Plant ☐ Boiler ☐ Electric Resistance Heat ☐ Forced Air Furnace ☐ Heat Pump ☐ Passive Solar ☐ Radiant ☐ Other (specify): ____________

Heat source location ☐ Central ☐ Distributed to local units
If central plant, identify plant location or ID number: ____________

Fuel Type(s): ☐ Coal ☐ Natural Gas ☐ Fuel Oil ☐ Crude Oil ☐ Wood ☐ Electric ☐ Propane ☐ Other (specify): ____________

Fuel Storage: ☐ No ☐ Yes Capacity: ____________ Location: ____________

If possible, provide fuel specifications, i.e. grade, heating value, delivery means, etc.) : ____________

Communications

What type of communications system does the building have. Radio, phone, internet, etc:____________

Other

Are there any critical issues with the building that must be addressed immediately: ____________

Does the building owner/ operator seem trustworthy? ☐ Yes ☐ No if no, explain: ____________

List any additional comments or impressions not otherwise noted above:

Photograph Estimate Map Detail Measure Sketch

Figure C-13. Housing smartcard (continued)

Sketch overall facility to include buildings, barriers, and utility locations. If building is multiple stories then a sketch of each should be included. Rooms and areas should be numbered and following table completed. Use following table to identify contents, dimensions, and damage. Sketch should include approximate dimensions:

Room/ Area #	Dimensions	Description	Contents	Damage

Photograph Estimate Map Detail Measure Sketch

Figure C-13. Housing smartcard (continued)

Form: **Telecommunication – WIRE & CABLE NETWORK (Target ID ________________)**
Inspector ID____________________
Inspection date/time_________________

Photograph problem areas.

Identify problem areas and important components on the map.

Sketch cable network and

- Locate major elements on map. Sketch layout on separate page. This may be based solely on location of customer service boxes, main cable boxes stations, fiber optic cables, com towers
- Note location of visible copper wires or fiber optic cables and describe situation.

____

____

- Note any damage to wires/cables and other components

____

- Note and describe com towers in the system and location

____

Random survey of local users:

- Note buildings and areas serviced and not serviced by the CO system.
- Do pulse/ring tones register in buildings? ☐ Yes ☐ No
- How often do dial tone problems occur?
  ☐ regularly ☐ irregularly ☐ during power outages ☐ when it rains
  ☐ other (specify): ____

-What is the frequency of network down time or dial tone problems? ____________________________

-Note facility locations with inoperable service, dropped calls, intermittent network availability, etc.

____

- Note any reports of irregular dial tones, describe conditions and location. ____________________________________

____

-Is there an established wire labeling designation (e.g. color, symbols, etc.) ____________________________________

Questions if local operator is available:

-What is the frequency and nature of maintenance practices on these components? ____________________________

Figure C-14. Communications smartcard

Form: **Telecommunication -** CUSTOMER SERVICE BOX **(Target ID ___________)**
Inspector ID____________________
Inspection date/time__________________

-Customer service box #______ of ________
-Identify this customer service box: ____ (GPS coord if available)
-Does the customer service box operate? ☐ Yes ☐ No are there nearby facilities that it serves? ☐ Yes ☐ No
-Identify facilities serviced by the customer service box. Note any damage to box or interior wiring:_______________

____

Note any cables exposed or damaged wire insulation ____

-What is the labeling practice on wires/cables entering the customer service box?
☐ To (Direction: __________) ☐ From (Direction: __________)

Wiring Information (for wires entering or exiting the customer service box): Does the wire have any labeling or color?
If so, what is the color scheme for the wires? ____

Customer Service Box Information:
-Type of Box: ☐ Multiple facility ☐ Single facility ☐ other (specify): ____________________
-Do markings or colored codes exist on the box exterior to indicate what facilities are connected to the box?
☐ Yes ☐ No
-Does box have any other higher-level boxes in the vicinity? ☐ Yes ☐ No
-Are there telephone poles nearby and is there a visible connection to other network components?
____
-Is there any other communications infrastructure in the area (e.g. telephone poles)? ☐ Yes ☐ No
-Other Relevant Information: ____
-Does box show signs of heavy corrosion or rust? ☐ Yes ☐ No If yes, give details:
____
-Does box generate excessive noise? ☐ Yes ☐ No If yes, give details:
____
-Are any other signs of improper operation present? ☐ Yes ☐ No If yes, give details:
____
-Is an operator present with working knowledge of system information? ☐ Yes ☐ No

Questions if local operator is available:
-What is the frequency and nature of maintenance practices on these components? _______________________
____

Figure C-14. Communications smartcard (continued)

Form: **Telecommunication** – CENTRAL OFFICE **(Target ID ___________________)**

Inspector ID____________________

Inspection date/time_________________

Photograph problem areas.

Identify problem areas and important components on the map.

-Identify this CO:___________________________(GPS coord if available)

-Approximate area serviced: ____________________________________

-Population serviced: ____________________________

-Capacity of CO: ______________________________

-Is there an operator or system administrator present with schematic or data flow documentation of the CO?

-Using the guide book, identify major CO components, sketch layout of plant on separate page. Indicate problem areas on sketch. Is the system operating? ☐ Yes ☐ No If not, is there power at site? ☐ Yes ☐ No

-Do any system components have nameplates or labels that provide specifications?

Is there backup power for this facility? ☐ Yes ☐ No Is there an Uninterruptible Power System? ☐ Yes ☐ No

Fiber Optic Cables

-Note any cables exposed or showing damaged insulation ____

-What is the labeling practice on cables entering the CO? ☐ To (Direction: ______) ☐ From (Direction: ______)

Does the cable have any labeling or color? _________ If so, what is the color scheme for the cables? _______

-Are any fiber optic cables visible from inside or outside the CO? _____________________________________

If cable can be identified from outside the CO, -is the cable entering and exiting the building buried?

☐ Buried ☐ Above ground ☐ Unknown

CO Equipment

Check breaker, switches, and communication electronics. Note any damage and available information on data capacities or bandwidths of all components present: ____

-Indicate quantity and operational state of dry-cell batteries if present: ________________________________

-Indicate quantity and operational state of fiber optic connectors if present: ______________________________

-Indicate quantity and operational state of output current monitors if present: ____________________________

-Is an operator present with working knowledge of system operation? ☐ Yes ☐ No

Questions if local operator is available:

-What is the frequency and nature of maintenance practices on these components? ________________________

-What is the capacity of data processing components present? _______________________________________

-What is the typical day-time data flow loading level? ____

-What is the frequency of down time for this CO? ____

Building and Surrounding Site

Describe the construction of the building, including walls, roof, any other supporting superstructure, windows, and doors.

____

How far from roads is the building? ___________ Are there drive-up / drop-off points to the building? _____________

How far from parking is the building? _________ Can access to parking be limited? __________________________

Is there a loading dock on the building? ________ How far are trash containers from the building? _______________

Identify any vantage points from which occupants could be targeted with direct fire weapons.

____

Are there any areas of the facility that could be used for shelter? _____________________________________

Describe any security measures that limit access to the facility or grounds. _______________________________

____

Are there adequate fire escape considerations? ____

Figure C-14. Communications smartcard (continued)

Form: Telecommunication – NETWORK CONTROL OFFICE (Target ID ________)

Inspector ID____________________

Inspection date/time_________________

Photograph problem areas.

Identify problem areas and important components on the map.

-Information for Network Control Office #________ of ________

-Description (service provider info): ___________________________

-Location: ____

-Shape: ________________ Components present:

____

-Height: ____________ unit of measure: ________ Width: ______________ unit of measure: ________

-Length: ____________ unit of measure: ________ Capacity: ____________ unit of measure: ________

-Is an operator present with working knowledge of system information? ☐ Yes ☐ No

-Are central data processing terminals present at the site? ☐ Yes ☐ No

Are mobile switching centers (MSC's) present at this site? ☐ Yes ☐ No

If switching centers (MSC's) are present, what is their capacity? ____________ unit of measure: ________

Describe any problems with the above listed equipment here: ____

____

-Is an operator present with working knowledge of system operation? ☐ Yes ☐ No

Questions if local operator is available:

-What is the frequency and nature of maintenance practices on these components?

____

-What is the capacity of data processing components present? ____

-What is the typical day-time data flow loading level? ____

-What is the frequency of down time for this network control office? ______________________________________

Figure C-14. Communications smartcard (continued)

Form: **Telecommunication –** COMMUNICATION TOWER SITE **(Target ID ________)**
Inspector ID____________________
Inspection date/time__________________

Photograph problem areas.

Identify problem areas and important components on the map.

Communications Towers #______ of ________
Identify this Com tower____ (GPS coord if available)
What is the approximate distance between com towers? _____________ unit of measure: _____________
Map communication towers and base stations.
Is the area at the tower base fenced with other communications equipment? ☐ Yes ☐ No
If yes, give details:
____
Describe any security measures that limit access to the tower or grounds. ___________________________________
____
What electronics and data processing components exist at the tower's base (e.g. base station controllers, transcoding devices, generators, etc.)?
Record component make and model numbers.
____

Nameplate Information (for all electronic equipment at the base of the tower):
Data flow capacity: _____________ unit of measure: ________
-Is an operator present with working knowledge of system operation? ☐ Yes ☐ No

Questions if local operator is available:
- What is the frequency and nature of maintenance practices on these components? ________________________
- Where is the associated network control office (could be 300 km away)? ________________________________
- Is there a data flow map or schematic that indicates what part of the system this communication tower is in (sketch layout of data flow on separate page)

Figure C-14. Communications smartcard (continued)

Form: Food Supply Chain (Target ID ______________________)

Inspector ID__________________________
Inspection date/time ____________________________

List information on area surveyed; if applicable list name and address and additional location information (including GPS). Note accessibility by Roads: ____

Locate major elements on local map____
____

These forms should be filled out as completely as possible by the inspector(s). Do not leave blank spaces; use "UNK" for "Unknown", "NA" for "Not Applicable", or "None" when appropriate. Talk with the owner/operator to obtain as much information as possible. Assure him/her that detailed name and address information will not be released to the public. Photos should be taken of each animal/crop, and of any significant farm/distribution equipment.

Section 1: General Information

Type of operation ☐ Farm ☐ Market ☐ Store ☐ Other: ____________________________________

Name of Farm/Market/Store: ____

Chief administrator: ____

Is Farm/Market/Store currently operating? ☐ Yes ☐ No

Operating hours: ___________ through ___________

Is the Farm/Market/Store seasonal? ☐ Yes ☐ No If yes, from when to when?______________________

Can the Farm/Market/Store currently operate as is? ☐ Yes ☐ No if no, what is required to bring into operation?
____
____
____

What is the principle product of Farm/Market/Store? (mark all that apply) ☐ Grains ☐ Vegetables ☐ Fruits ☐ Poultry ☐ Eggs ☐ Meat ☐ Milk ☐ Other:____

What type(s) of product? (example: Cow, chicken, oranges, potatoes, etc.) ___________________________
____
____
____

What are average prices of key products?

Wheat	_________	Corn	_________	Potatoes	_________	Oranges	_________
Apples	_________	Limes	_________	Lemons	_________	Chicken	_________
Cow	_________	Pig	_________	Sheep	_________	Goat	_________
Milk	_________	Eggs	_________	Cheese	_________		

Type of currency? (Use most Common examples: Dollars, pounds, dinars, etc.)__________________________

Remarks:____
____
____

How many personnel are employed by Farm/Market/Store? _____________________________________

What is the capacity of the Market/Store: __________________

What is the size of the Farm in acres or animals?
☐ Small (0-49) ☐ Med (50-499) ☐ Large (500-1000) ☐ Industrial (1001+)

Section 1: Remarks ____
____
____

Figure C-15. Food supply smartcard

Section 2: Store/Market Supply Chain (*if this is a farm operation only mark N/A on top of chain and proceed to Section 2 Farm operations*) The following section is broken into most common types of operations if a section is Not applicable mark N/A and draw a line to the correct section. Repeat Section 2 for as many different types of products as available (example: Meat, poultry, Eggs, Grains, milk, different processors, etc.) This section may be skipped if time critical, but must be completed as soon as possible.

Consumer

Who is the end user?____

Retail

What type of retail operation is it?

☐ Storefront ☐ Supermarket ☐ Butcher ☐ Local market ☐ Other:____________________

Name of Store: ____

Chief administrator: ____

Is Processor currently operating? ☐ Yes ☐ No

Operating hours: ____________ through ____________

What type of transport is being used to the consumer? (Check all that apply)

☐ Truck ☐ Car ☐ Cart ☐ Horse/Mule/Camel ☐ Hand ☐ Rail ☐ Other:______________________

Describe the surrounding area. What type of neighborhood is it, upper or lower class etc. Are there any nearby facilities that are of interest. Is there anything in the area that could pose a threat? ______________________________

____

____

Are there any NGOs working with the facility? ☐ Yes ☐ No of yes, include POC, services provided, and frequency of support. ____

____

____

Manufacturing/Processing

Is any type of Processing done ? (example: cereal made from grain, dressed cuts of meat) ☐ Yes ☐ No

if yes, to what extent?____

Name of Processor: ____

Chief administrator: ____

Is Processor currently operating? ☐ Yes ☐ No

Operating hours: ____________ through ____________

What type of transport is being used to the retail operation? (Check all that apply)

☐ Truck ☐ Car ☐ Cart ☐ Horse/Mule/Camel ☐ Hand ☐ Rail ☐ Other:______________________

Remarks:____

____

Figure C-15. Food supply smartcard (continued)

Section 2: Store/Market Supply Chain Cont.

Agricultural Logistics

How does the Processor/Retail operation obtain its supplies? ☐ Stock Market ☐ Auction ☐ Contract with farm ☐ Local purchase ☐ Local Market ☐ Other:____

What type of transport is being used to the Processor/Retail operation? (Check all that apply)

☐ Truck ☐ Car ☐ Cart ☐ Horse/Mule/Camel ☐ Hand ☐ Rail ☐ Other:____________________

Remarks:____

____

Farming

Name of Farm: ____

Owner: ____

Type of Farm: ☐ Grains ☐ Vegetables ☐ Fruits ☐ Poultry ☐ Eggs ☐ Meat ☐ Milk

☐ Other:____

Is Farm currently operating? ☐ Yes ☐ No

Operating season: ___________ through ___________

What type of transport is being used to bring product to market? (Check all that apply)

☐ Truck ☐ Car ☐ Cart ☐ Horse/Mule/Camel ☐ Hand ☐ Rail ☐ Other:____________________

What type of farm equipment is being used? (Check all that apply) ☐ Hand ☐ Animal ☐ Tractors ☐ Plows ☐ Combines ☐ Threshers ☐ Bailers ☐ Others:____________________________________

How much equipment? (Example: 20 laborers with hand tools and 1 tractor)____________________________

____

____

____

What is the overall condition of the equipment? ☐ Brand New ☐ Good ☐ Used ☐ Poor ☐ Broken, in need of replacement ☐

Other:____

What is the size of the Farm in acres or animals?

☐ Small (0-49) ☐ Med (50-499) ☐ Large (500-1000) ☐ Industrial (1001+)

Remarks:____

____

Section 2 Remarks:____

____

____

____

____

Section 3: Overall Region assesments

Safety and Public Sentiment

Does the Farm/Market/Store Farm/Market/Store have a crisis management plan for:

☐ Fire ☐ Natural Disaster ☐ Medical Emergencies ☐ Intruders ☐ Terrorist Acts

☐ Other: ____

Figure C-15. Food supply smartcard (continued)

Do owners feel safe? ☐ Yes ☐ No if no, explain:____

____

Do workers feel safe? ☐ Yes ☐ No if no, explain: ____

____

What is public sentiment about the Farm/Market/Store (positive or negative) and explain: ________________________

____

Does Farm/Market/Store appear to be a healthy environment? ☐ Yes ☐ No if no, explain: _________________

____

Does the Farm/Market/Store appear to be adequate in size? ☐ Yes ☐ No if no, explain: __________________

____

Does the Farm/Market/Store appear to be well maintained? ☐ Yes ☐ No if no, explain: ___________________

____

Does the building owner/ operator seem trustworthy? ☐ Yes ☐ No if no, explain: _______________________

____

Describe any security measures that limit access to food at any stage of its production, distribution, or sale or any vulnerabilities to food of contamination at any of those stages. ____

List any additional comments or impressions not otherwise noted above:

Figure C-15. Food supply smartcard (continued)

Form: Socio-Government (Target ID ____________________)

Inspector ID____________________

Inspectiondate/time_________________________

These forms should be filled out as completely as possible by the inspector(s). Do not leave blank spaces; use "UNK" for "Unknown", "NA" for "Not Applicable", or "None" when appropriate. Talk with the local leaders, business owners, and people to obtain as much information as possible. Assure them that detailed name and address information will not be released to the public. Photos should be taken of each key government building and key business.

General Information

Town Name: ______________________ Location: (Grid) ____________________

Major Landmark: ____________________

Approximate size of town: Population___________ Area___________

Local Media:

Name: ______________________ Type: ☐ Newspaper ☐ Radio ☐ T.V.

Owner/Manager: ______________________________

☐ Government ☐ Private Address: ______________________________

☐ Pro-US ☐ Anti-US ☐ Neutral

Name: ______________________ Type: ☐ Newspaper ☐ Radio ☐ T.V.

Owner/Manager: ______________________________

☐ Government ☐ Private Address: ______________________________

☐ Pro-US ☐ Anti-US ☐ Neutral

Name: ______________________ Type: ☐ Newspaper ☐ Radio ☐ T.V.

Owner/Manager: ______________________________

☐ Government ☐ Private Address: ______________________________

☐ Pro-US ☐ Anti-US ☐ Neutral

Name: ______________________ Type: ☐ Newspaper ☐ Radio ☐ T.V.

Owner/Manager: ______________________________

☐ Government ☐ Private Address: ______________________________

☐ Pro-US ☐ Anti-US ☐ Neutral

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard

Government Information

Name of Key Leader: ______________________ ☐ Male ☐ Female

Title: ______________ Length of Term: ________

☐ Pro-US ☐ Anti-US ☐ Neutral

Description of Duties: ______________________

____

☐ Elected ☐ Appointed (Self/ Higher Government) ☐ Religious Appointed

Years in position: _______ Age: _______ Education: _________ Religionist Affiliation: __________

Home Address: ______________________

____

Phone Number: ________ Married ☐ Yes ☐ No Number of Children ________

Speaks English: ☐ Yes ☐ No Other Languages spoken ______________________

Office Address:

____

____

Name of Key Leader: ______________________ ☐ Male ☐ Female

Title: ______________ Length of Term: ________

☐ Pro-US ☐ Anti-US ☐ Neutral

Description of Duties: ______________________

____

☐ Elected ☐ Appointed (Self/ Higher Government) ☐ Religious Appointed

Years in position: _______ Age: _______ Education: _________ Religionist Affiliation: __________

Home Address: ______________________

____

Phone Number: ________ Married ☐ Yes ☐ No

Number of Children ________

Speaks English: ☐ Yes ☐ No Other Languages spoken ______________________

Office Address: ______________________

____

Name of Key Leader: ______________________ ☐ Male ☐ Female

Title: ______________ Length of Term: ________

☐ Pro-US ☐ Anti-US ☐ Neutral

Description of Duties: ______________________

____

☐ Elected ☐ Appointed (Self/ Higher Government) ☐ Religious Appointed

Years in position: _______ Age: _______ Education: _________ Religionist Affiliation: __________

Home Address: ______________________

____

Phone Number: ________ Married ☐ Yes ☐ No Number of Children ________

Speaks English: ☐ Yes ☐ No Other Languages spoken ______________________

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard (continued)

Office Address:

____

____

Name of Key Leader: ______________________________ ☐ Male ☐ Female
☐ Pro-US ☐ Anti-US ☐ Neutral
Title:_____________________________ Length of Term: __________
Description of Duties: ____
____
☐ Elected ☐ Appointed (Self/ Higher Government) ☐ Religious Appointed
Years in position: _____ Age: _____ Education: _______ Religionist Affiliation: ____________
Home Address: ____
____
Phone Number: _____ _____ Married ☐ Yes ☐ No Number of Children __________
Speaks English: ☐ Yes ☐ No Other Languages spoken ______________________________
Office Address: ____
____

Government Services
Post Office: ☐ Yes ☐ No Post Master's Name: ________________________
Functioning: ☐ Yes ☐ No Reason if No: ____________________________________
____
Address: ____
____
Concerns/Issues:____
____
____
____

Town Treasurer: ☐ Yes ☐ No
Treasurer's Name: ___________________________
Do they collect local taxes: : ☐ Yes ☐ No If no, how do they fund town services: ______________
Last date of taxes collected: _________ Amount collected: ________ Amount remaining ________
Where is the money kept:: ___________________________ Is the money safe: : ☐ Yes ☐ No
How much money is needed to run the town each month: __________ each year: ________
Concerns/Issues:____
____
____
____
____

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard (continued)

Court House: ☐ Yes ☐ No Number of judges: __________
Head Judge's Name: ____________________ ☐ Pro-US ☐ Anti-US ☐ Neutral
Address: ____
____
Judge's Name: ____________________ ☐ Pro-US ☐ Anti-US ☐ Neutral
Address: ____
____
Judge's Name: ____________________ ☐ Pro-US ☐ Anti-US ☐ Neutral
Address: ____
____
Concerns/Issues: ____
____
____
____
____

Mortuary: ☐ Yes ☐ No
Point of contact: ____
Max Number of burials per day they can handle: ______________________
Will they need assistance: ☐ Yes ☐ No
Concerns/Issues: ____
____
____
____
____

Library: ☐ Yes ☐ No
Librarian's Name: ______________________________
Functioning: ☐ Yes ☐ No Reason if No: ______________________________
____
Address: ____
____
Concerns/Issues: ____
____
____
____
____

Environmental Agency (like the EPA): ☐ Yes ☐ No
Point of contact: ____
Functioning: ☐ Yes ☐ No Reason if No: ______________________________
____
Address: ____
____
Concerns/Issues: ____
____
____

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard (continued)

Department of Labor: ☐ Yes ☐ No
Point of contact: ____
Functioning: ☐ Yes ☐ No Reason if No: ____

Address: ____

Concerns/Issues: ____

Geological Office: ☐ Yes ☐ No
Point of contact: ____
Functioning: ☐ Yes ☐ No Reason if No: ____

Address:

Information they possess :

Concerns/Issues: ____

Water Resources/Water Ways: ☐ Yes ☐ No
Point of contact: ____
Functioning: ☐ Yes ☐ No Reason if No: ____

Address: ____

Information they possess : ____

Concerns/Issues: ____

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard (continued)

Economic Information

Name of currency: ____________________ Value to U.S. Dollar: ______________

Main form of payment: ☐ Cash ☐ Credit ☐ Barter ☐ Other: ________________________________

Number of Business: ________________ Number of Business currently open: ____________________

Reason(s) business are closed: ____

____

____

____

Number of people currently employed: _________________

Number of people normally employed: _________________

Average Work Duration: ________Hours per Day ___________ Days per week

Average Pay: _____________per Hour or _________________ per day

Main mode of travel to work: ☐ Automobile ☐ Foot ☐ Public

☐ Other: ____

Types of Business:

☐ Farm: (List Crops) ____

Number of Farms: __________ Number employed: ___________

☐ Mining: (List Ore) ____

Number of Mines: __________ Number employed: ___________

☐ Factory(s): (List Products) ____

Number of Factories: __________ Number employed: ___________

☐ Other: (List) ____

____

____

Key Employer: _________________________ Number employed: ____________________

Type of Business: ______________________ ☐ Open ☐ Closed Reason if closed: __________________

____

Address: ____

____

Key Employer: _________________________ Number employed: ____________________

Type of Business: ______________________ ☐ Open ☐ Closed Reason if closed: __________________

____

Address: ____

____

Key Employer: _________________________ Number employed: ____________________

Type of Business: ______________________ ☐ Open ☐ Closed Reason if closed: __________________

____

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard (continued)

Address: ____

____

Key Employer: ____________________ Number employed: ______________

Type of Business: ________________ ☐ Open ☐ Closed Reason if closed: ____________

____

Address: ____

____

Social Information

Religion:

Type/Sect: ________________ Percent of Population: ________

Name of Leader: ______________________________ ☐ Pro-US ☐ Anti-US ☐ Neutral

Address: ____

____

Type/Sect: ________________ Percent of Population: ________

Name of Leader: ______________________________ ☐ Pro-US ☐ Anti-US ☐ Neutral

Address: ____

____

Type/Sect: ________________ Percent of Population: ________

Name of Leader: ______________________________ ☐ Pro-US ☐ Anti-US ☐ Neutral

Address: ____

____

Entertainment:

Forms: ☐ Dancing ☐ Bars ☐ Gambling ☐ Movies ☐ T.V. ☐ Radio ☐ Reading

☐ Swimming ☐ Sports (List): ______________________________________

☐ Other: ____

Which forms of entertainment are closed and why: ______________________________

____

____

Living Conditions:

Average Type of home: ☐ Apartment ☐ Single Family Home ☐ Row Houses ☐ Tent

☐ Other: ____

Average form(s) of construction: ☐ Brick ☐ Wood ☐ Concrete ☐ Mud ☐ Metal ☐ Grass

☐ Other: ____

Percent of homes still livable ________ Reason(s) homes non-livable: ____________________

____

____

Photograph Estimate Map Detail Measure Sketch

Figure C-16. Socio/government smartcard (continued)

Form: Historical, Cultural, Religious Inspection (Target ID _____________)
Inspector ID____________________________
Inspection date/time______________________

Photograph problem areas.
Identify problem areas and important components on the map.

- Current DTG: ________________________
- What are the grid coordinates of the site?
____

- Local climate/topography:
☐ Mountains, ☐ Plains, ☐ Rainforest, ☐ Beach, ☐ Lakes,
☐ Rivers, ☐ Desert, ☐ Arctic, ☐ Other (specify) _____________________________
Describe briefly:
____
____
____

- How large is the site? Acreage, Square Miles or Kilometers
____

- Is there a visitor's guide, tour, or local map or flyer available? ☐ Yes ☐ No If yes, please include all literature available

- Who are the leaders/decision makers in the area? ie. Tribal, Religious, Civil, Administrative

NAME	POSITION	TIME IN POSITION

- List the top religions/sects/ethnicities/factions/tribes in the region and annotate the majority/most powerful:
____
____
____
____

- Are there other important groups, leaders, or officials (government or non-government) to be noted with respect to this site? ☐ Yes ☐ No If yes, give details:
____
____

- Does this site hold the same meaning/symbolism to all religions/sects/ethnicities/factions/tribes involved?
☐ Yes ☐ No
If No, give details and annotate key differences that are potential points or sources of conflict
____
____

Figure C-17. Cultural/historical/religious smartcard

- Are the religions/sects/ethnicities/factions/tribes themselves in conflict currently ☐ Yes ☐ No
  If yes, give details and annotate if it is related to the site in particular:

____

- Is this site a source or point of special or extreme tension or conflict? ☐ Yes ☐ No If yes, give details:

____

____

- Who controls this site? What agency, government or non-government, tribe, religious sect/faction?

____

____

- Is this site protected by an agency, government or non-government, local law, tribe, religious sect/faction?
  ☐ Yes ☐ No give details:

____

____

- Is this site more Cultural, Historical or Religious in Nature?
  ☐ Cultural, ☐ Historical, ☐ Religious, Check all that apply, give details (ie. Birth place of local leader)

____

____

- Is this site very well defined or well marked? ☐ Yes ☐ No give details:

____

____

- Is this site easily maintainable and securable with respect to current OPTEMPO? ☐ Yes ☐ No give details:

____

____

- What size element is necessary to adequately secure the site?

____

- Will the local populace demand access to this site? ☐ Yes ☐ No give details:

____

____

- Does the local populace, leaders, or decision makers have an agenda or plans for this site and what they want done?
  ☐ Yes ☐ No give details: if possible, obtain copies of plans

____

Figure C-17. Cultural/historical/religious smartcard (continued)

- This area is ☐ Urban ☐ Rural ☐ Suburban ☐ Other specify: ______________________________

- Include brief description of surroundings; ie. Farmland, what type, # of buildings, etc.

____

____

- Take some photographs of key areas of interest at this site. (i.e. damage, signs, buildings, etc.) describe briefly:

____

____

- Is the site damaged? ☐ Yes ☐ No

If yes, to what extent is the damage? ☐ Mild ☐ Some ☐ A Lot ☐ Destroyed describe briefly:

____

____

- What was the cause of damage? ☐ Bombing ☐ Looting ☐ Vandalism ☐ Natural Disaster ☐ Accident ☐ Other Describe briefly:

____

____

- Is the site salvageable? ☐ Yes ☐ No give details:

____

____

- If possible interview multiple local populace and record viewpoints, ideas, concerns about this site.

NAME GROUP AFFILIATION POSITION CONCERN, VIEW, IDEAS

____

____

____

____

Figure C-17. Cultural/historical/religious smartcard (continued)

Form: HAZMAT **(Target ID ________________)**

Inspector ID____________________

Inspection date/time_________________________

Occupancy/Location

Classify the location: ☐ Residential ☐ Industrial ☐ Commercial (GPS)______________

Name of location: ____

Container Shapes

Container: ☐ Transportation or ☐ Fixed Site?

Transportation

If Transportation, is the container: ☐ Highway ☐ Water ☐ Air ☐ Rail ☐ Pipeline

If Highway, is it: ☐ Box Trailer ☐ Flatbed ☐ Dry Bulk ☐ Van ☐ Tank Trailer ☐ Tube Trailer ☐ POV

If Tank Trailer, is it: ☐ Atmospheric ☐ Low Pressure ☐ High Pressure ☐ Ultra High Pressure

Note make, model, license plate, and all other information about vehicle: ______________________________

Are any placards or labels visible? ☐ Yes ☐ No

Description of placard or label: ___________________

If Rail, is it: ☐ Boxcar ☐ Flatcar ☐ Hopper ☐ Tank Car ☐ Tube Car

If Tank Car, is it: ☐ Non-Pressure ☐ Pressure

Note all other information about vehicle: _____________________________

Are any placards or labels visible? ☐ Yes ☐ No

Description of placard or label: ___________________

Fixed Site Containers

Is the container: ☐ Atmospheric ☐ Low Pressure ☐ High Pressure ☐ Ultra High Pressure

Is it: ☐ Above Ground or ☐ Below Ground

If an Atmospheric Container, is it: ☐ Bag ☐ Jar ☐ Box ☐ Can ☐ Drum ☐ Liquid Fuel Storage Tank

If a Low Pressure Container, is it: ☐ Drum ☐ Equipment Processing ☐ Storage Tank ☐ Pipeline

If a High Pressure Container, is it: ☐ Cylinder ☐ Sphere ☐ Tube ☐ Pipeline ☐ Reactor

If an Ultra-High Pressure Container, is it: ☐ Tube bank ☐ Pipeline ☐ Cylinder

Are any placards or labels visible? ☐ Yes ☐ No

Description of placard or label: ___________________

Describe any security measures that limit access to food at any stage of its production, distribution, or sale or any vulnerabilities to food of contamination at any of those stages. ____

Other Concerns

Are there vent pipes ☐ fill pipes ☐ or access ways indicating a fill pipe protruding from the ground ☐ ?

Is there electrical ☐ or transformer ☐ equipment present?

Are there injection wells ☐ cisterns ☐ sumps ☐ drains ☐ or walls stained by substances other than water or emitting foul odors ☐ ? If yes, explain?____

Is there visible trash? Yes ☐ No ☐

Are there damaged or discarded automobile or industrial batteries? ☐ Yes ☐ No

Is there stained, discolored, barren, exposed or foreign (fill) soil? ☐ Yes ☐ No If yes, explain:____

Photograph Estimate Map Detail Measure Sketch

Figure C-18. Hazardous materials smartcard

Is there an oil sheen or films on surface water, seeps, lagoons, ponds, or drainage basins? ☐ Yes ☐ No If yes, explain:____

Is there pits, ponds, or lagoons associated with waste treatment or waste disposal? ☐ Yes ☐ No If yes, explain:____

Are there protected areas that have security fencing, placards, and/or warning signs? ☐ Yes ☐ No If yes, explain:____

Is there any dead, damaged, or stressed vegetation? ☐ Yes ☐ No If yes, explain:____

Are there any dead animals, possibly due to contamination? ☐ Yes ☐ No If yes, explain:____

Local Population

Do locals report anything unusual possibly linked to TIC/TIM (explosions, fog, haze, odors, etc)? ☐ Yes ☐ No If yes, explain:____

Do the locals exhibit any signs of TIC/TIM exposure (coughing, high cancer rate, blindness, etc)? ☐ Yes ☐ No If yes, explain:____

Photograph Estimate Map Detail Measure Sketch

Figure C-18. Hazardous materials smartcard (continued)

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Appendix D

Environmental Baseline Survey

The EBS is a multidiscipline site survey. It is conducted during the initial stage of any Service or joint operational deployment, and followed by a closeout survey when a site is returned to the HN or when joint forces depart the site. The EBS documents existing deployment area environmental conditions (to include cultural), determines the likelihood for present and past site contamination (for example, hazardous substances, petroleum products, and derivatives), and identifies potential vulnerabilities (to include occupational and environmental health risks). The closeout survey defines the conditions existing at the time of departure from a site and documents any changes/variations in conditions from the EBS. Surveys accomplished in conjunction with operational deployments that do not involve training or exercises (contingency/expeditionary operations) should be completed to the extent practicable—consistent with operational requirements for all occupations exceeding 30 days. In cases where less than 30 days of occupation are expected, an environmental assessment should still be conducted to support servicemember force health protection. The EBS is generally performed in conjunction with an EHSA.

PREPARATION AND IMPLEMENTATION OF THE SURVEY

D-1. This appendix provides guidance for preparing the EBS (see FM 3-100.4). As discussed in chapter 6, environmental reconnaissance is conducted to collect the information necessary for the EBS. The reconnaissance is typically focused by IR identified by environmental staff planners researching the potential AO. An EBS is typically performed by or with support from general engineer elements, including an on-site visit by environmental specialists as soon as the situation permits. However, ERTs may need to perform an initial site assessment before an EBS with or without assistance from general engineers. While this appendix provides guidance to the general engineer and environmental specialist for completing a detailed EBS including the site survey, it can also guide the ERT conducting an initial assessment to begin developing the EBS.

PREPARATION

D-2. The EBS addressed in this manual is focused for use during contingency/expeditionary operations where other established HN agreements or arrangements for a base campsite may not exist. (See FM 5-104 and AFDD 2-4.4 for specific planning considerations). Guidance should be provided in annex L of the joint OPORD/OPLAN to direct the conduct of surveys, especially in those situations where specific HN agreements or arrangements may not exist, or a HN government may not be operating. It may also come from appendix 2 (Environmental Considerations) to annex L (Engineer) of an OPORD/OPLAN. By using the EBS, services can maintain situational awareness, maximize combat power, and reduce and/or eliminate the negative effects of occupational health and environmental exposures.

D-3. The primary purposes for an EBS are—

- The protection of service personnel (eliminating, minimizing, or mitigating environmental health risks to servicemembers).
- Allowing for a sustainability determination of designated location (includes encroachment considerations and potential requirements to increase the population of servicemembers or their actions performed at a site).

- Sensitivities involved with cultural or architectural considerations.
- Minimizing any potential U.S. liability for the condition of a site at the time U.S. forces depart.

D-4. Environmental specialists initiate EBS planning and preparation during the initial planning stages of any military operation through deliberate information gathering and staff estimates. These specialists include, but are not limited to, engineer and medical expertise that incorporate medical intelligence and geospatial information into the planning process. While containing some considerations of force health protection, the EBS is not a complete medical assessment, and so it is always linked to the conduct of the EHSA and ideally accomplished in direct conjunction with this document and process. (See United States Army Center for Health Promotion and Preventive Medicine [USACHPPM] Technical Guide 251, *A Soldiers Guide to Environmental and Occupation Field Sampling for Military Deployment (Draft)," August 2001,* for more information on the EHSA.)

D-5. Researching the AO and the specific potential sites that the operational commander will want to inhabit and use for base camps, airfields, logistic sites, and a host of other relatively permanent locations in an AO are part of the staff planning process. This includes map reconnaissance with supporting geospatial products, review of medical information and intelligence about a site, and any other information obtainable (historical or current information) about proposed locations during the planning process. The respective staff estimates by the engineer, surgeon, logistician, joint staff/component/brigade or battalion civil-military operations officer (J-9/G-9/S-9) (with CA support), and others must include this assessment as a part of their normal planning process to evaluate all relevant environmental considerations. The preparation work performed at this point is not considered an EBS but rather the preparation work to minimize the likelihood of choosing poor sites from an environmental and force health protection viewpoint. If adequate information is not available on likely sites to be used, this information becomes IR that are fed into the IPB. Some of these may be critical enough to be considered PIR. All of this assessment process is a part of the predeployment work required to ultimately create an EBSs for each specific site, but does not in itself create an EBS. A physical visit of each site by environmental specialists is required for an EBS to be completed. Similarly, while research and preparation are completed to be able to perform a site closeout, a physical survey is required for one to be accomplished.

D-6. The preventive aspects present through the planning of required EBSs serve as a force multiplier and mission enabler through the early identification of environmental, health, and safety conditions that may pose potential health threats to military personnel and civilians that occupy designated areas within the theater of operations. They also assist in making recommendations on a particular site by taking into consideration suitability (to include both natural and cultural considerations) and sustainability determinations for that site. It is critical to obtain an assessment of projected/sustained use for a site and a projected duration of use for a given site from the operational planners. The engineer staff officer is directly involved and uses this information in the engineering support plan (ESP) and integrates this information into staff planning.

IMPLEMENTATION

D-7. Estimates from the planning process are confirmed or adjusted based upon physical site inspection during the EBS. An EBS is conducted for any base camp or similar site that will be in existence for greater than 30 days. Ideally the EBS will be accomplished in conjunction with an EHSA. This survey (and potential preceding assessment) conducted during contingency/ expeditionary operations documents environmental conditions before (or immediately after) the occupation of any base camp or related site. This serves to protect servicemembers by documenting property suitability as well as prevent the United States from receiving unfounded claims for past environmental damage.

D-8. While damage claims are the primary focus for many of the other EBSs performed by the DOD, it is of secondary importance in supporting the operational commander during contingency operations. When ultimately departing from a site, a closure survey is completed using the same basic format as the EBS to provide comparative information documenting the change in conditions over the life of occupation of that site by servicemembers.

D-9. The importance of a standardized multi-Service format should be apparent. This format is intended to include adequate minimal medical considerations in the case where an EHSA is not able to be conducted in conjunction with the EBS. While each situation/site will be unique, the format for the EBS is intended to provide the standardized multi-Service framework for completing the physical survey/assessment. Additional applicable references and tools are also listed with this template. (See table D-1 on page D-5.)

D-10. In between the timeframe of the EBS and the closure report is a requirement to periodically conduct inspections of the base camp or other similar facility to ensure environmental considerations are being actively incorporated in the life of the site. This report is called an environmental conditions report (ECR) and is focused on how well the commander of that site is applying relevant and directed environmental considerations. ECRs will be conducted for as long as the site is occupied and not less than on a quarterly basis to measure the environmental health/status of the base camp or similar site. These are ideally linked to medical survey efforts to both combine their effect and to minimize their administrative effects on the command. A standardized template is included as figure D-1 on page D-7.

ENVIRONMENTAL BASELINE SURVEY CONTENT

D-11. Ideally, an EBS will be prepared to the fullest extent possible for each site to document environmental and environmental health conditions prior to the time of servicemember arrival. This snapshot provides immediate information to the commander as well as creating a baseline record of conditions at that time. At some point it is also likely that a closure report will also be completed, but this is not the focus of the commander occupying the site. The EBS investigation is designed to provide the commander and his staff with an overview of the designated location/site using real-time field sampling, historical information, and readily available intelligence. Information sources include, but are not limited to,—

- IPB.
- Current reconnaissance reports of a given location/site.
- Intelligence reports.
- Digital information sources (National Geospatial-Intelligence Agency, Armed Forces Medical Intelligence Center, Defense Intelligence Agency, and others).
- Other geospatial information and products.

D-12. Deliberate information gathering and research for environmentally specific and historical information must be part of the investigative process in the execution of the EBS. This will include interviews with personnel having knowledge of the designated location to gain historical information about a site if possible. In some cases, this may be performed by real estate personnel before a site is ever occupied.

D-13. A physical site inspection is performed by environmental specialists to obtain firsthand visual and physical information pertaining to the property to identify recognized environmental conditions and characteristics. The linkage of environmental and occupational health hazards are integrated as a part of the inspection. These inspections include the information categories contained in the EBS format. This inspection should include (as a minimum) the following:

- **Physical description and condition.** Note the condition and location of facilities/improvements (if applicable) including the presence of buildings and other structures. Also record sites of known contamination within or immediately adjacent to the property boundaries and, if possible, try to determine the contaminant(s) of concern and the media affected. Include information, if available, on any remediation efforts and sampling conducted.
- **Historical use(s) and user(s).** Identify any visual and physical indications of past use(s) that may have impacted the property through the use, treatment, storage, disposal, or generation of hazardous substances or petroleum products. Include a list of past owners, occupants, and past uses of the property where available.
- **Adjacent land use.** The general type of property usage (such as residential, commercial, industrial) should be documented. Identify any visual and physical indications (for example, soil

staining, stressed vegetations) of current and past land use practices that may be indicative of a contaminant release.

- **Soil type and land cover.** Note the soil type and general types of vegetation present on the property. Include in this paragraph any observations of stressed vegetation and potential causes (for example, hazardous substances or petroleum product release, lack of irrigation, high traffic area, and so forth).
- **Hydrologic and geologic features.** In this portion, include hydrologic features important to drainage such as creeks, ditches, and riverbeds.
- **Water supply.** Identify any sources of potable water on the property as well as an estimated associated capacity. Note the presence of water facilities such as pump stations, storage tanks, system age and condition, and its components. In addition, document any wastewater or other liquids discharging from the property into a drain, ditch, or stream on or adjacent to the location/property.

D-14. Typically an EBS will come upon situations that require the survey team to take samples to obtain more detailed analysis. The procedures associated with sampling, whether their focus is engineering or medical related, are very similar. (Refer to FM 3-100.4 for a discussion of these procedures.)

Table D-1. Environmental baseline survey format

1. Cover page for EBS
    1.1. Title will be "Environmental Baseline Survey"
    1.2. Location identification
        1.2.1. This identification will indicate the location's recognized name or similar means of identification, such as *Logistics Staging Area Doe*
        1.2.2. Name of city, township, or area of operation for the location of the site
    1.3. Identification of lead surveyor
        1.3.1. Organization/agency with responsibility for conducting EBS
        1.3.2. Standard name line of project leader
        1.3.3. Period of survey
            1.3.3.1. Start date of survey
            1.3.3.2. End date of survey
        1.3.4. DSN phone number (if available)
2. Executive summary (separate page)
    2.1. Findings. Written to provide users of the EBS a broad overview of the findings regarding the designated location where the EBS was conducted. Discuss specific PIRs addressed/evaluated in the EBS
    2.2. Recommendations. General recommendations to be considered by users of the EBS that addresses any controls or actions that should be addressed. Recommendations must be supported by findings during the execution of the EBS
    2.3. Notes. General comments regarding sampling, additional testing conducted, and related items considered during the development of the recommendations in 2.2
3. Introduction
    3.1. Purpose of the EBS, include PIRs to be addressed
    3.2. Limitations of assessment in the execution of the EBS
        3.2.1. Current use of site
        3.2.2. Historical use of site
    3.3. Use of adjoining properties
        3.3.1. Current use of adjoining properties
        3.3.2. Historical use of adjoining properties
4. Site description
    4.1. Location. General description of the site location that will include the following information:
        4.1.1. Detailed description of the site location
        4.1.2. Organization designated for occupation of the site
        4.1.3. Grid location of area
        4.1.4. Map series
    4.2. Site and vicinity characteristics
        4.2.1. Physical setting
        4.2.2. Topography
        4.2.3. Geology
        4.2.4. Soils
        4.2.5. Vegetation
        4.2.6. Hydrology
        4.2.7. Raw materials
    4.3. Detailed site description
        4.3.1. Structures
        4.3.2. Roads
        4.3.3. Drinking water sources
        4.3.4. Waste disposal
        4.3.5. Other improvements
    4.4. Use of site
5. Information sources and supporting documents

Table D-1. Environmental baseline survey format

6. Information from site reconnaissance 6.1. Background of location upon identification for occupation 6.2. Detailed analysis of information gathered that includes (but not limited to)— 6.2.1. Presence of animals or other vectors such as insects (mosquitoes, sand flies, and so forth.) 6.2.2. Potential radioactive sources (present or past) 6.2.3. Hazards and health risks 6.2.3.1. Site specific 6.2.3.2. Offset site 6.2.4. Environmental hazards 6.2.4.1. Site specific 6.2.4.2. Offset site 6.2.5. Waste disposal 6.2.5.1. Current status 6.2.5.2. Historical perspective 6.2.5.3. Planned Improvements or changes 6.2.6. Agricultural implications 6.2.6.1. Site specific 6.2.6.2. Offset site 6.2.7. Identified environmental and environmental health hazards 6.2.7.1. Historical 6.2.7.2. Present 6.2.7.3. Potential future 6.2.8. Site assessment to include detailed walk-through with building and infrastructure assessments	7. Environmental and environmental health sampling data 7.1. Sampling and analysis plan(s) to include justification for number, type, and location of samples collected, as well as analysis to be performed on the samples collected. Sampling should be identified as either confirmation or delineation 7.2. Sampling results analysis to include a summary table of sampling results 7.3. Environmental health site assessment summary (if applicable) 8. Findings and conclusions 8.1. Identification of environmental conditions that have the potential for significant impacts to health or mission 8.2. Detailed concerns 9. Recommendations 9.1. Usability 9.2. Further investigation and additional assessments required to fully address concerns 9.3. Identify and recommend controls to address concerns where applicable

D-15. The primary purpose for a base camp is mission support, synchronized with the overall military mission of the deployed force. To execute mission support, a base camp must provide force protection to deployed forces, resource management of critical infrastructure, training opportunities for deployed forces and permanent party, and maintenance of the facilities. Included in that mission support is the continued application of environmental considerations, to include the critical aspects of force health protection. This includes periodic, sustained site surveys/assessments similar to those performed by an installation staff. The ECR (see figure D-1) assists with that requirement.

CLASSIFICATION

ENVIRONMENTAL CONDITIONS REPORT [ECR]

References:

a. DODD 6050.7, "Environmental Effects Abroad of Major Department of Defense Actions," 31 March 1979.

b. JSI 3820.01, "Environmental Engineering Effects of DOD Actions," 28 September 1993.

c. DODD 6050.16, "Policy for Establishing and Implementing Environmental Standards at Overseas Installations," 20 September 1991.

d. Other applicable environmental laws and regulations, OPORD, and unit SOP.

e. Site specific EBS (if applicable).

1. Site/Incident Location. List the legal address and 6-digit military grid location or latitude and longitude of the incident location or reference the applicable EBS to link the ECR to a given site. Refer to the electronic environmental message formats at Tab E. (The ECR functions as a situation report, or interim report, for a given site. The frequency of ECR reports is a higher headquarters' decision but supports the need to document the condition of a given site over time [interim snapshots], as well as helping to ensure that an appropriate environmental focus is being maintained at a given site. The basic format of the ECR may also be used when reporting an incident, such as a POL spill, not related to a given EBS or site location).

2. Site/Incident Description and Background. Give a brief description of the site (installation), including its related EBS/historical use(s) or the circumstances surrounding the incident. For an incident at a location not covered by an EBS, it is critical to provide the same sort of information contained in a standard accident report.

3. Map/Description of the Incident Location. If the ECR is related to a site covered by an EBS, this entry is able to relate to the information already provided in the EBS (a baseline document). If the ECR defines a location where an incident has occurred that is not covered by an EBS, the description needs to be adequate to direct a follow-on element to the site. In this respect, it is similar to the graves-registration report if the incident occurs during a tactical operation where time precludes remaining at the site.

4. Summary of Environmental Conditions. List the environmental event(s) at the site/location. All spills should be inventoried. If the ECR is a periodic report for a given site, significant events, such as major spills, should have been reported using the basic ECR format. In this case, simply reference any significant incident report ECRs that may have occurred at the given site over the time frame that the periodic ECR covers. Also provide a "snapshot" report of the types of HW/HM that are stored at the site. Describe minor spills and other events that have occurred over the time frame in question in basic terms, including quantities and the method(s) used to clean the site.

Example: Four gallons of waste oil spilled at the hazardous waste accumulation site located northwest of the maintenance building (shown on map) at 1600 hours on 16 December 2000. The 22nd Military Police Battalion (MP Bn), contained the spill with assistance by White & Jones, by 1725 hours. About 3 cubic yards of contaminated soil was taken to the White & Jones HW disposal area in Juvonia.

CLASSIFICATION

Figure D-1. Environmental conditions report format

CLASSIFICATION

Example: Raw sewage ran from a pump house behind the main warehouse (shown on map) for an estimated 3 days during the initial stages of occupying the camp in early June 2000. The problem was identified on 13 June and corrected when the pump was repaired on 14 June.

Example: A fuel tanker overturned at the road intersection vicinity NV 123456 (see map) at 092000 November 2000 during the road march to Bigtown. Immediate mitigation included spill containment by the employment of all available spill kits with the unit. Higher HQ was immediately notified. An estimated 4000 gallons of jet petroleum (JP)-8 spilled at that site. The vehicle has been righted, and excavation of the site will begin at first light, 10 November.

5. Interior and Exterior Observations. These entries should be viewed as an abbreviated version of the information that would be found in an EBS. Items should only be addressed if they differ from the last ECR or vary from the initial EBS.

6. Findings and Determinations with Qualification Statement. A statement similar to the following should appear in this paragraph of the ECR:

According to _________ Reg _______, I have considered whether or not significant environmental impacts will occur as a result of turnover/return of this site (base camp, logistics area) and have determined that (include one of the following statements):

a. Turnover of this base camp area will not result in environmental impacts significant enough to warrant additional environmental analysis.

OR

b. Turnover of this base camp area will result in environmental impacts significant enough to warrant additional environmental analysis. Environmental actions or projects must continue after transfer of the base camp area because of substantial (imminent) threat to human health or safety. The impacts of concern are (list impacts):

(If the report is due to an incident not connected to a specific site/installation, this paragraph is an assessment by the commander/individual on the scene).

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CLASSIFICATION

Figure D-1. Environmental conditions report format (continued)

Appendix E

Military Load Classification

The basis for MLC is the effect (load, vehicle speed, tire width, and so forth) a vehicle has on a bridge when crossing. Heavy loads, such as artillery and tanks, make vehicle classification an important factor in determining bridge capacity as well as classifying the overall trafficability of a route.

REQUIREMENT FOR CLASSIFICATION NUMBERS

E-1. Classification numbers are mandatory for all self-propelled vehicles having a total weight of 3 tons or more, as well as all trailers with a payload of 1 ½ tons or greater (in compliance with STANAGs 2010 and 2021). Trailers with a rated capacity of less than 1 ½ tons are usually combined with their towing vehicle for classification.

E-2. MLC information is found in the vehicle's TM or on the vehicle data plate. Table E-1 provides a reference list of common vehicles and their MLCs.

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
AAV	Amphibious assault vehicle		(use 26.5 tons)	
Abrams	See M1			
AGS	Armored gun system		(use 24.75 tons)	
ASWDS	Airborne scraper	Wheeled: truck, 2-axle	19	
ASWDS	Airborne water distribution system	Wheeled: truck, 2-axle	19	33
ATEC	All terrain crane	Wheeled: truck, 2-axle	22	
All terrain lifter, army system (ATLAS)	ATLAS with 10,000-pound carriage	Wheeled: truck, 2-axle		17
ATLAS	ATLAS with 10,000-pound and 6,000-pound carriage	Wheeled: truck, 2-axle		17
ATLAS	ATLAS with 6,000-pound carriage	Wheeled: truck, 2-axle		19
ATLAS	With armor protection	Wheeled: truck, 2-axle		19
AVLB with M48 chassis	AVLB launcher with bridge	Tracked: vehicle	49	67
AVLB with M60 chassis	AVLB launcher with bridge	Tracked: vehicle	43	58
Breacher	Breacher at gross curb weight	Tracked: vehicle		73
Buffalo	MRAP- Cat III	Wheeled: truck, 3-axle	30 (Preliminary)	
Buffalo	With expedient armor	Wheeled: truck, 3-axle	38 (Preliminary)	
C7	Loader, scoop 2.5 cubic yards without roll cage			20

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
Caiman	Mine resistant ambush protected (MRAP) - Cat I	Wheeled: truck, 2-axle		15
Caiman	MRAP - Cat II	Wheeled: truck,, 3-axle		19
CB-543	Roller, motorized, vibrating	Wheeled: truck, 2-axle		11 (Estimated)
CCE 130G	Grader, road		18	
Cougar	MRAP - Cat I	Wheeled: truck, 2-axle		19
Cougar	MRAP - Cat II	Wheeled: truck, 3-axle		25
Crane, crawler mounted, 12.5-ton at 12 feet		Tracked: vehicle		23
Crusader	Crusader - resupply vehicle	Tracked: vehicle		50
Crusader	Crusader - self-propelled howitzer	Tracked: vehicle		50
Deuce	Deuce, special	Tracked: vehicle		23
D4	Tractor, tracked, Caterpillar™	Tracked: vehicle	13	
D5BNS	Tractor, full tracked, air droppable, nonsectionalized	Tracked: vehicle	21	
D5BS	Tractor, full tracked, air droppable, nonsectionalized	Tracked: vehicle	22	
D7 dozer	With blade, with winch		23	
D7F	Tractor, full tracked, diesel engine driven (DED): with ripper, rollover protective structures (ROPS), and blade	Tracked: vehicle	34	
D7F	Tractor, full tracked, DED: with winch and blade	Tracked: vehicle	23	
D7F	Tractor, full tracked, DED: with winch, ROPS, and blade	Tracked: vehicle	24	
D7F DV29	Tractor, full tracked, DED: with ripper and blade	Tracked: vehicle	31	
D7G dozer	D7G dozer with blade, ripper, 10,000 pounds of armor	Tracked: vehicle	44 (Estimated)	
D7G dozer	D7G dozer with blade, ripper, 5,000 pounds of armor	Tracked: vehicle	38 (Estimated)	
D7G	D7G tractor crawler	Tracked: vehicle	32	
D7G	D7G with ROPS	Tracked: vehicle	35	
D7G	D7G with armor	Tracked: vehicle	40 (Preliminary)	
D9 dozer	With ROPS capability and ripper, armored	Tracked: vehicle	133 (Preliminary)	

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
D9R	D9R Caterpillar dozer	Tracked: vehicle	110 (Estimated)	
Engineer squad vehicle (ESV)	Stryker - engineer squad vehicle with mine roller	Wheeled: truck, 4-axle		20
ESV	Stryker - engineer squad vehicle with surface mine plow	Wheeled: truck, 4-axle		19
FLU 419	Tractor, with excavator and front loader	Wheeled: truck-tractor, 2-axle	9	
FLU 10244	Tractor, all wheel drive with hatch, high mobility entrencher	Wheeled: truck, 2-axle	9	
FMTV	FMTV expansible van	Wheeled: truck, 3-axle	14	17
FMTV	FMTV load handling system (LHS) truck	Wheeled: truck, 3-axle	11	20
FMTV	FMTV LHS truck and trailer	Wheeled, combination: 3-axle truck with 2-axle trailer	13	28
FSCS/Tracer concept		Wheeled, combination: 3-axle truck with 1-axle trailer	26 (Estimated)	
HMEE Type III	Backhoe Loader	Loader, 2-axle	10	12
Husky	Husky	Wheeled: truck, 2-axle	8	
Husky	With expedient armor	Wheeled: truck, 2-axle	10	
Husky	Husky with trailer set	Wheeled, combination: 2-axle truck with >4-axle trailer		26
HYEX	HYEX, Type I	Tracked: vehicle	29	
HYEX w/ Armor	HYEX, Type I	Tracked: vehicle	31	
HYEX	HYEX, Type II	Tracked: vehicle	33	
HYEX	HYEX, Type III	Tracked: vehicle	36	
ICV	Stryker - infantry carrier vehicle (rifle)	Wheeled: truck, 4-axle		20
Interim - high mobility engineer excavator (I-HMEE)	I-HMEE without armor	Wheeled: truck, 2-axle	12	
I-HMEE	I-HMEE with armor	Excavator, 2-axle	14	
JD-410	Loader	Wheeled: truck-tractor, 2-axle	9	10
Joint explosive ordnance disposal rapid response vehicle (JERRV)	JERRV	Wheeled: truck, 3-axle	19	
JERRV	JERRV with expedient armor	Wheeled: truck, 3-axle	23	
Light assault vehicle	Light assault vehicle	Wheeled: truck, 4-axle		14 (Estimated)
LMTV	Trailer, cargo, 2.5-ton		<3	4
LRT-110	Crane, rough terrain, Type I, 7.5-ton	Wheeled: truck, 2-axle	11	

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	*Name*	*Description*	*MLC Empty*	*MLC Loaded*
MaxxPro	MRAP - Cat I	Wheeled: truck, 2-axle		18
MaxxPro XL	MRAP - Cat II	Wheeled: truck, 2-axle		21
Modular base petroleum laboratory (MBPL)	Modular base petroleum laboratory	Wheeled: semitrailer, 2-axle		14
Mortar carrier (MC) - (B)	Stryker - mortar carrier vehicle (Version B)	Wheeled: truck, 4-axle		21
Mortar carrier vehicle (MCV) –A	Stryker - mortar carrier vehicle (Version A)	Wheeled: truck, 4-axle		21
Medical evaluation vehicle (MEV)	Stryker - medical evaluation vehicle	Wheeled: truck, 4-axle		20
Mobile gun system (MGS)	Stryker - mobile gun system with slat armor	Wheeled: truck, 4-axle		25
MGS	Stryker - mobile gun system without slat armor	Wheeled: truck, 4-axle		24
Mill unit	Mill unit, mobile pipe mill	Tracked: trailer, quadritracked		62
MK 48/17	Logistics vehicle system, LVS, articulated drop side cargo truck	Wheeled: truck, 4-axle	20	41
MT 250	Crane, truck mounted, 25-ton	Wheeled: truck, 4-axle	31	
M1	Abrams towing explosive standoff minefield breacher (ESMB) trailer	Tracked, combination: vehicle		75 (Estimated)
M1	Abrams with minefield clearing blade	Tracked: vehicle		79 (Estimated)
M1	Abrams with mine roller (lowered)	Hybrid, combination: half track with 1-axle trailer		109
M1	Abrams at 70-short tons	Tracked: vehicle		71
M1 towing M1	Abrams towing Abrams	Tracked: quadritracked		150+
M1	Abrams with Abrams reactive armor tile (ARAT) and belly armor	Tracked: vehicle		80
M1	Abrams with belly armor	Tracked: vehicle		77
M1 with mine roller	Abrams with mine roller (raised)	Tracked: vehicle		88

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
M1A2	Abrams with tank urban survivability kit (TUSK) and belly armor	Tracked: vehicle		82
M1A2 towing M1A2	Abrams with TUSK and belly armor towing Abrams with TUSK and belly armor	Tracked, combination: vehicle		150+
M2	Bradley, fighting vehicle, cavalry	Tracked: vehicle	21	25
M2A1	Bradley, fighting vehicle, infantry	Tracked: vehicle	23	30
M2A2	Bradley, fighting vehicle, infantry	Tracked: vehicle	27	33
M2A3	Bradley fighting vehicle with reactive armor kit	Tracked: vehicle		36
M2A3	Bradley fighting vehicle without reactive armor	Tracked: vehicle		33
M3	Bradley, fighting vehicle, cavalry	Tracked: vehicle	21	25
M5	Landing vehicle, track personnel	Tracked: vehicle	31	43
M6	Bradley linebacker without hybrid armor	Tracked: vehicle		30 (Estimated)
M6	Bradley linebacker with hybrid armor	Tracked: vehicle		33
M7	Bradley fire support vehicle with hybrid armor	Tracked: vehicle		34
M7	Bradley fire support vehicle without hybrid armor	Tracked: vehicle		31
M9	Armored combat earthmover	Tracked: vehicle	18	36
M9	Bulldozer, earthmoving, tank mounted	Tracked: vehicle		54
M35A2 towing M200A1	Truck, cargo, 2.5-ton 6x6 with trailer with mine-clearing line charge	Wheeled, combination: 3-axle truck with 1-axle trailer	8	10
M35A2C	Truck, cargo: 2.5-ton, 6x6, drop side, M35A2C	Wheeled: truck, 3-axle		7
M48A1	Tank, combat, full tracked, 90-mm gun	Tracked: vehicle	48	54
M48A1 with bulldozer	Tank, combat, full tracked, 90-mm gun with bulldozer	Tracked: vehicle	54	62
M50 towing M2	Truck, cargo, van, 5-ton, 6x6, towing, howitzer	Wheeled, combination: 3-axle truck with 3-axle trailer	21	30
M52	Truck-tractor, 5-ton, 6x6 with winch	Wheeled: truck-tractor, 3-axle	8	

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	*Name*	*Description*	*MLC Empty*	*MLC Loaded*
M52 towing M967	Truck-tractor, 5-ton, 6x6 with winch towing semitrailer, 5,000-allon, bulk haul, self-load/unload	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	14	29
M52 towing M969	Truck-tractor, 5-ton, 6x6 with winch towing semitrailer, 5,000-gallon, automotive fueling dispenser	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	14	30
M52 towing M970	Truck-tractor, 5-ton, 6x6 with winch towing semitrailer, 5,000-allon, underwing/overwing aircraft fueling dispenser	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	15	30
M52A1	Truck-tractor, 5-ton, 6x6 with winch	Wheeled: truck-tractor, 3-axle	9	
M52A2	Truck-tractor, 5-ton, 6x6 with winch	Wheeled: truck-tractor, 3-axle	8	
M54	Truck, cargo, 5-ton, 6x6 with winch	Wheeled: truck, 3-axle	9	19
M54 towing M198A1	Truck, cargo, 5-ton, 6x6, towing semitrailer, tank, gasoline, 5,000 gallon	Wheeled, combination: 3-axle truck with 3-axle trailer	14	36
M60A1	Tank, combat, 105-mm gun	Tracked: vehicle	47	52
M60A2	Tank, combat 152-mm	Tracked: vehicle		58
M60A3	Tank, combat 105-mm	Tracked: vehicle		58
M93A1	Reconnaissance system, NBC Fox	Wheeled: truck, 3-axle		18 (Estimated)
M107	Gun, 175-mm, self-propelled	Tracked: vehicle		31
M109A4/A5	Howitzer, 155-mm, self-propelled	Tracked: vehicle		28
M110A2	Howitzer, heavy, self-propelled, 8 inch	Tracked: vehicle	28	31
M113	M113	Tracked: vehicle		12
M113A1	Carrier, personnel, tracked, armored	Tracked: vehicle		12
M116	Carrier, cargo, amphibious, tracked	Tracked: vehicle		5
M123 6x6 towing 6k water trailer	Truck-tractor with 6,000-gallon water semitrailer	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	17	38
M158	Truck, firefighting: 1,000 gallons per minute, tactical type, multipurpose, M158	Wheeled: truck, 2-axle		14
M172A1	Trailer, low-bed, 25-ton	Wheeled: semitrailer, 2-axle	6	36
M198	Howitzer, towed, 155-m	Wheeled: trailer, 1-axle		10
M270A1	Semitrailer, low-bed, 12-ton	Wheeled: semitrailer, 2-axle	7	17
M270/A1	MLRS	Tracked: vehicle	22	27

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	*Name*	*Description*	*MLC Empty*	*MLC Loaded*
M328A2	Bridge transporter, 5-ton	Wheeled: truck, 3-axle	12	22
M412 RT240	Kalmar RTCH	Wheeled: truck, 2-axle	118	
M54 series	Truck, cargo, 5-ton, 6x6, with winch, with equipment		9	19
M520	Truck, cargo, 8-ton	Wheeled: truck, 2-axle	12	18
M548	Carrier, cargo, 6-ton		7	13
M551	Armored reconnaissance ABN vehicle	Tracked: vehicle	15	17
M553	Truck, wrecker, 10-ton	Wheeled: truck, 2-axle	18	24
M559	Truck, tank, 2,500 gallon	Wheeled: truck, 2-axle	12	22
M577A1	Carrier, command post	Tracked: vehicle	11	12
M578	Recovery vehicle, light	Tracked: vehicle		27
M728	Combat engineer vehicle	Tracked: vehicle		59
M747	HET semitrailer 52, 5-ton	Wheeled: semitrailer, 4-axle and higher	13	68
M88	Hercules	Tracked: vehicle		55
M88A1	Hercules			56
M88A2	Hercules	Tracked: vehicle		71
M813A1	Truck, cargo: drop side, 5-ton	Wheeled: truck, 3-axle	9	20
M814	Truck, cargo, 5-ton	Wheeled: truck, 3-axle	10	21
M816	Truck, tactical, 5-ton	Wheeled: truck, 3-axle	18	32
M818 towing M172A1 with D7	Truck tractor 5-ton towing low-bed 25-ton trailer	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	14	30
M870	Semitrailer, low-bed, 40-ton	Wheeled: semitrailer, 3-axle	7	50
M871A1	Semitrailer, dual purpose, 22.5-ton	Wheeled: semitrailer, 2-axle	7	52
M872A1	Semitrailer, flatbed, 34-ton, container transporter	Wheeled: semitrailer, 3-axle	8	39
M901	Combat vehicle, TOW	Tracked: vehicle		12
M911	Truck-tractor, commercial heavy equipment transporter (C-HET)	Wheeled: truck-tractor, 4-axle	18	
M911 towing 604 NL	M911 towing 604 NL	Wheeled, combination: 3-axle truck-tractor with 4-axle semitrailer		82
M911 towing 635 N	M911 towing 635 N	Wheeled, combination: 3-axle truck-tractor with 5(>4)-axle semitrailer		95
M915	Line haul tractor	Wheeled: truck-tractor, 3-axle	9	
M915 with XM 990 with XM21	Line hauler tractor and semitrailer	Wheeled, combination: 3-axle truck-tractor with 1-axle semitrailer		17

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
M915A1/A2	Truck-tractor	Wheeled: truck-tractor, 3-axle	8	
M915A3 towing M872A4	Truck-tractor towing 34-ton semitrailer	Wheeled, combination: 3-axle truck-tractor with 3-axle semitrailer		42
M915A3	Truck-tractor, line haul	Wheeled: truck-tractor, 3-axle	8	
M915A3 towing M969	Truck-tractor, line haul towing semitrailer, 5,000 gallon, automotive fuel dispensing	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	14 (Estimated)	30 (Estimated)
M915A3 towing M967	Truck-tractor, line haul towing semitrailer, 5,000-gallon, bulk haul self load/unload	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	13 (Estimated)	29 (Estimated)
M916	Truck-tractor		12	*
M916 towing 6K W6DS/M60 PRS	20-ton, light equipment, 5,600 GVW, towing 6,000-gallon water distributor	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	16	37
M916 towing M870A1	20-ton, light equipment, 6x6 towing semitrailer, low-bed: construction equipment transporter	Wheeled, combination: 3-axle truck-tractor with 3-axle semitrailer	18	42
M916A1 towing M870	Truck, tractor, 20-ton, 6x6, towing semitrailer, low-bed, 40-ton	Wheeled, combination: 3-axle truck-tractor with 3-axle semitrailer	18	50
M916A1 towing M172A1	20-ton, light equipment, 6x6, 56,000 gross vehicle weight towing semitrailer, low-bed: 25-ton, 4 wheel	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	18	39
M916A3	Truck-tractor,	Wheeled: truck-tractor, 3-axle	12	
M916A3 towing M969	Truck-tractor, LET towing semitrailer, 5,000-gallon, automotive fuel dispensing	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	18 (Estimated)	33 (Estimated)
M916A3 towing M967	Truck-tractor, LET towing semitrailer, 5,000-gallon, bulk haul self-load/unload	Wheeled, combination: 3-axle truck-tractor with 2-axle semitrailer	17 (Estimated)	32 (Estimated)
M916A3 towing M1143	Truck-tractor, LET towing semitrailer, SLOT	Wheeled, combination: 3-axle truck-tractor with 3-axle semitrailer	21	56 (Estimated)
M917	Truck, dump, 20-ton, 8x6, 75,000-pound gross vehicle weight	Wheeled: truck, 4-axle		47
M918	Distributor, bituminous	Wheeled: truck-tractor, 3-axle		21
M919	Truck, concrete, mobile, 8x6, 75,000-pound gross vehicle weight	Wheeled: truck, 4-axle		43
M920	Truck-tractor, medium equipment transport (MET)	Wheeled: truck-tractor, 3-axle	14	

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
M920 towing 6K water distribution trailer	Truck-tractor, 20-ton, 8x6, towing 6,000 gallon water distribution trailer	Wheeled, combination: 4-axle truck-tractor with 2-axle semitrailer	18	39
M920 towing M870A1	Truck-tractor, 20-ton, 8x6, towing semitrailer, low-bed, 40-ton	Wheeled, combination: 4-axle truck-tractor with 3-axle semitrailer	20	52
M923A1	Truck, cargo: 5-ton, 6x6, M923A1 (without winch)	Wheeled: truck, 3-axle		12
M923 towing M1061A1	Truck, cargo, drop side, 5-ton, 6x6, towing dolly set, lift, transportable shelter 5 ¼-ton	Wheeled, combination: 3-axle truck with 2-axle trailer	11	19
M923 towing M1061A1	Truck, cargo, drop side, 5-ton, 6x6, towing trailer, 5-ton	Wheeled, combination: 3-axle truck with 2-axle trailer		17
M923 towing M1073	Truck, cargo, drop side, 5-ton, 6x6, towing trailer, flatbed, 7.5-ton	Wheeled, combination: 3-axle truck with 2-axle trailer	11	18
M925A1	Truck, cargo: 5-ton, 6x6, M925A1 (with winch)	Wheeled: truck, 3-axle	11	16
M927 with M200A1	M927 towing M200 A1 with power unit	Wheeled, combination: 3-axle truck with 1-axle trailer		17
M928A	Truck, cargo: 5-ton, 6x6, M928A2 (with winch)	Wheeled: truck, 3-axle	11	17
M929A2	Truck, dump, 5-ton, without winch	Wheeled: truck, 3-axle	10	16
M930A	Truck, dump: 5-ton, 6x6, M930A2 (with winch)	Wheeled: truck, 3-axle	11	17
M931	Tractor, 5-ton	Wheeled: truck, 3-axle	9	17
M966	HMMWV, TOW missile carrier	Wheeled: truck, 2-axle		4
M967	Semitrailer, 5,000-gallon, bulk haul, self load/unload	Wheeled: semitrailer, 2-axle	6	21
M969	Semitrailer, 5,000-gallon, automotive fuel dispensing	Wheeled: semitrailer, 2-axle	7	22
M970	Semitrailer, 5,000-gallon underwing/overwing aircraft fuel dispensing	Wheeled: semitrailer, 2-axle	15	22
M977	Heavy expanded mobility tactical truck (HEMTT)		18	28
M978	HEMTT, tanker	Wheeled: truck, 4-axle		25
M981	Fire support vehicle		14	14
M984	HEMTT, wrecker	Wheeled: truck, 4-axle		19
M984A1 towing M966	HEMTT towing rear of truck, light duty, TOW missile carrier	Wheeled, combination: 4-axle truck with 1-axle trailer	24	
M985	HEMTT, cargo	Wheeled: truck, 4-axle	18 (Estimated)	28
M985 towing	HEMTT towing heavy	Wheeled, combination:	20	39

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
M989A1	expanded mobility ammunition trailer (HEMAT) (MLRS) trailer	4-axle truck with 2-axle trailer		
M985 with M1076	HEMTT with PLS trailer	Wheeled, combination: 4-axle truck with 3-axle trailer	23 (Estimated)	46 (Estimated)
M992	Carrier, ammunition (FAASV)	Tracked: vehicle		29
M997	HMMWV, ambulance	Wheeled: truck, 2-axle		4
M998	HMMWV, cargo/troop carrier	Wheeled: truck, 2-axle		4
M1000	HET trailer		18	*
M1002	Truck, tactical, wrecker, 8x8	Wheeled: truck, 4-axle	21	
M1028 w S-250	Truck, cargo: 1 ¼-ton, 4x4, shelter carrier, M1028, with shelter, S-250	Wheeled: truck, 2-axle		4
M1031 with PU-573	M1031 with shelter towing PU-753/M generator set	Wheeled, combination: 2-axle truck with 1-axle trailer	5	5
M1037	HMMWV, S250 shelter carrier	Wheeled: truck, 2-axle		4
M1038	HMMWV, cargo/troop carrier	Wheeled: truck, 2-axle		4
M1059	Carrier, smoke generator M157	Tracked: vehicle		13
M1068	Carrier, armored, command	Tracked: vehicle		13
M1070 with M1000	HET with trailer	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer	31	*
M1070 towing M1000	HET carrying M1A2	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		96
M1070 towing M1000	HET equipped with sand mobility enhancement kit carrying M1	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		94
M1070 towing M1000	HET equipped with Simula Armor Kit (SAK) carrying M1	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		98
M1070 towing M1000	Unarmored HET carrying M1with TUSK and belly armor	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		100
M1070	HET tractor	Wheeled: truck-tractor, 4-axle	18	
M1070 with Dolly with M1000	HET with dolly, 70-ton payload	Wheeled, combination: 4-axle truck-tractor with >5-axle semitrailer		96 (Estimated)
M1070 towing M1000	HET with relocated Abrams	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		100 (Estimated)
M1070 towing M1000	HET with Simula Armor carrying 74.5-ton Abrams (similar to TUSK)	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		101

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	*Name*	*Description*	*MLC Empty*	*MLC Loaded*
M1070 towing M1000	HET with tank with mine-clearing blade	Wheeled, combination: 4-axle truck-tractor with 5-axle semitrailer		101
M1074	PLS, with MHC	Wheeled: truck-tractor, >4-axle	25	41
M1074 towing M1076	PLS with MHC towing PLS trailer	Wheeled, combination: 4-axle truck with 4-axle trailer	30	62
M1074 towing M1076	PLS without MHC towing PLS trailer	Wheeled, combination: 4-axle truck with 4-axle trailer	30	59
M1075	PLS, without MHC	Wheeled: truck-tractor, >4-axle	23	39
M1076	PLS trailer	Wheeled: trailer, 3-axle	8	26
M1078	Truck, cargo, 4x4 LMTV with equipment		9	12
M1078	LMTV cargo with winch	Wheeled: truck, 2-axle	10	12
M1080	LMTV chassis	Wheeled: truck, 2-axle		8
M1081	LMTV cargo, air drop	Wheeled: truck, 2-axle	9	12
M1081	LMTV cargo, air drop, with winch	Wheeled: truck, 2-axle	12	12
M1083	MTV cargo	Wheeled: truck, 3-axle	10	16
M1083	MTV cargo with winch	Wheeled: truck, 3-axle	10	16
M1084	MTV cargo with MHE	Wheeled: truck, 3-axle	11	17
M1085	MTV long cargo	Wheeled: truck, 3-axle	10	16
M1085	MTV long cargo with winch	Wheeled: truck, 3-axle	11	17
M1086	MTV long cargo with MHE	Wheeled: truck, 3-axle	12	17
M1088	MTV off-road tractor	Wheeled: truck, 3-axle	9	18
M1088	MTV off-road tractor with winch	Wheeled: truck, 3-axle	9	19
M1088	MTV tractor	Wheeled: truck, 3-axle	9	22
M1088	MTV tractor with winch	Wheeled: truck, 3-axle	9	22
M1089	MTV wrecker	Wheeled: truck, 3-axle	13	22
M1090	MTV dump	Wheeled: truck, 3-axle	11	17
M1090	MTV dump with winch	Wheeled: truck, 3-axle	11	17
M1092	MTV chassis	Wheeled: truck, 3-axle		9
M1093	MTV cargo, air drop	Wheeled: truck, 3-axle	10	16
M1093	MTV cargo, air drop, with winch	Wheeled: truck, 3-axle	11	17
M1094	MTV dump, air drop	Wheeled: truck, 3-axle	11	17
M1094	MTV dump, air drop with winch	Wheeled: truck, 3-axle	11	17
M1096	MTV long chassis	Wheeled: truck, 3-axle		8
M1097	Truck, utility: HMMWV	Wheeled: truck, 2-axle	<3	4
M1114	HMMWV, utility truck, up-armored	4x4 carrier	4	6

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	***Name***	***Description***	***MLC Empty***	***MLC Loaded***
M1121	HMMWV utility tow carrier, 1 ¼-ton,	Wheeled: truck, 2-axle		4
M1142	HEMTT, tactical firefighting truck	Wheeled: truck, 4-axle	23*	29
M1143	Semitrailer, SLOT	Wheeled: semitrailer, 3-axle	11	56
M1975	DSB launcher	Wheeled: truck-tractor, >4-axle		41
M1975	DSB launcher with armor, A/C kit	Wheeled: truck-tractor, >4-axle		42 (Preliminary)
M1975 towing M1076	DSB launcher with trailer	Wheeled, combination: 4-axle truck with 4-axle trailer		49
M1977	Common bridge transporter	Wheeled: truck, 4-axle		27
M1977 and M1076	Common bridge transporter towing PLS trailer	Wheeled, combination: 4-axle truck with 3-axle trailer		44
NBCRV	Stryker - NBC reconnaissance vehicle (NBCRV)	Wheeled: truck, 4-axle		20
NBCRV	Stryker - NBCRV with slat armor	Wheeled: truck, 4-axle		22
Power unit	Power unit, mobile pipe mill	tracked: quadritracked		50
RG-31	MRAP - Cat I	Wheeled: truck, 2-axle	15	
RG-31 extended	MRAP - Cat II	Wheeled: truck, 2-axle	17	
RG-31	RG-31 MK5	Wheeled: truck, 2-axle	18	
RG-31	RG-31 MK5 with expedient armor	Wheeled: truck, 2-axle	21 (Preliminary)	
RG33	MRAP - Cat I	Wheeled: truck, 2-axle		20
RG33L	MRAP - Cat II	Wheeled: truck, 3-axle		31
RTCC	Crane, rough terrain, 40-ton, container	Wheeled: truck, 2-axle	85	150+
RTCCS	Crane, rough terrain, 40-ton, container, service life extension program upgrade	Wheeled: truck, 2-axle	87	
RTCH 988F	50,000-pound rough terrain container handler (RTCH) without top handler	Wheeled: truck, 2-axle	105	
RTCH 988F	50,000-pound RTCH with 40-foot top handler	Wheeled: truck, 2-axle	123	
RTCH 988F	50,000-pound RTCH with pallet fork kit	Wheeled: truck, 2-axle	107	
RTCH 988F	50,000-pound RTCH with 20-foot top handler	Wheeled: truck, 2-axle	115	
RTCH 988F	50,000-pound RTCH (with either 20- or 40-foot top handler carrying 50,000-pound load)	Wheeled: truck, 2-axle		150+

Table E-1. Reference list of common vehicles with MLCs

Nomenclature	*Name*	*Description*	*MLC Empty*	*MLC Loaded*
SM54A	Roller, towed, vibrating, Raygo	Wheeled: trailer, 2-axle		1
Talbert Trailer	WHH with dolly with booster	Wheeled, combination: 4-axle truck-tractor with >5-axle semitrailer		76 (Estimated)
Terrain crane	USMC ATC	Crane	31	
Tractor 830M towing scraper 18M	Tractor, wheeled, towing scraper, earth moving 18 cubic yards	Wheeled, combination: 2-axle truck-tractor with 1-axle semitrailer	45	68
Truck-tractor with M127A2C	Truck-tractor, special RO/RO, with 40-foot semitrailer	Wheeled, combination: 2-axle truck-tractor with 2-axle semitrailer	21	39
Vibratory roller	Vibratory roller, Types I and III	Wheeled: truck, 2-axle	8	
Vibratory roller	Vibratory roller, Type II	Wheeled: truck, 2-axle	12	
WD6S water distributor	WD6S water distributor	Wheeled: semitrailer, 2-axle		24
XM916 towing M870	Truck-tractor, 10-ton (modified) with trailer	Wheeled, combination: 4-axle truck with 3-axle trailer		49
XM1070 towing M747	XM1070 towing M747	Wheeled, Combination: 4-axle truck-tractor with 4-axle semitrailer		77
613 BNS	Tractor, scraper, Type I	Wheeled: truck, 2-axle	15	36
613 BWDS	Water distributor, Type II	Wheeled: truck, 2-axle	15	30
966H heavy loader	966H heavy loader (Type I and II)	Wheeled: truck-tractor, 2-axle	31	

Notes.
* The MLC is determined by the equipment being hauled.
Model: This field relates to the model description for a National Stock Number (NSN). Vehicles contained in the table are sorted alphabetically and numerically by their model number.
MLC of the heaviest vehicle is given in the MLC column.
MLC loaded estimations on actual loads were determined from calculations and not actually measured.

E-3. MLC information for allied vehicles must be provided by the vehicle's operator or on a vehicle data plate. Table E-2 provides a reference list of common allied vehicles and their MLCs.

Table E-2. Reference list of selected allied vehicles with MLCs

Model	***Item Description***	***MLC***
Grove All-Terrain AT635B Crane	Crane, wheel mounted, grove	40
CAT E200B [1]	Excavator multipurpose crawler, MED E200B	24
CAT E120B	Excavator multipurpose crawler, MTD E120B	16
CAT 14G	Grader, road, motorized	20
CAT 130G	Grader, road, motorized, CAT 130G	16
CAT 920	Loader, scoop type, CAT 920B	12
CAT 950E	Loader, scoop type, CAT 950	16
CAT 966D	Loader, scoop type, CAT 966D	20
CAT 966C	Tractor, wheeled, 966C	20
Bomag 120AD	Roller, motorized, BW120AD	4
Bomag 172D	Roller, motorized, BW172D	8
Bomag 213D	Roller, motorized, BW213D	12
Bomag 213PD	Roller, motorized, BW213PD	12
CAT D6C	Tractor, full track, D6C	24
CAT D8N	Tractor, full tracked caterpillar, D8N	50
CAT D4E	Tractor, full tracked, low speed, D4E	16
CAT D6D	Tractor, full tracked, low speed, D6D	24
CAT D7E	Tractor, full tracked, low speed, D7E	30
CAT D8H	Tractor, full tracked, CAT D8H	50
JCB 3CX [2]	Tractor, wheeled, earthmoving (JCB)	8
Pinzgauer General Service	Truck, utility, NZ-Pinz-GS	5
Pinzgauer Comd & Control	Truck, utility, NZ-Pinz-C2	5
Pinzgauer Shelter (Information Systems)	Truck, utility, NZ-Pinz-S(I)	5
Pinzgauer Shelter (Maintenance)	Truck, utility, NZ-Pinz-S(M)	5
Pinzgauer Ambulance	Truck, utility, NZ-Pinz-Amb	5
Pinzgauer Special Ops	Truck, utility, NZ-Pinz-SO	5
Unimog U1700L	Truck, cargo 4-ton, GS, 4x4, Unimog U1700L	12
NZ LAV [3]	NZ light armoured vehicle, infantry	19
NZ LAV-R	Light armoured vehicle, recovery	19
Notes. [1] CAT – Caterpillar Inc. [2] JCB – JCB Co. Ltd. [3] NZ – New Zealand		

REQUIREMENT FOR VEHICLE CLASSIFICATION

E-4. The mathematical computation of a vehicle's MLC is beyond the scope of this manual. If a requirement to determine a vehicle's classification exists when time allows, classification is requested through reachback by supplying the dimensions of the vehicle in question and requesting computation of the MLC number. Requests for classification of vehicles should be sent directly to the U.S. Army Tank Automotive Research, Development, and Engineering Center, ATTN: AMSRD-TAR-D/BRDG MS#21, 6501 East 11 Mile Road, Warren, Michigan 48397-5000 (commercial telephone 1-800-574-5608). If not practical, you may send your requests for reachback through the TEOC or Engineering Infrastructure Intelligence Reachback Center (EI2RC) who will coordinate the classified action for you. Listed below are the appropriate e-mail, Web sites, and telephone numbers for the TEOC and EI2RC.

TELEENGINEERING EMERGENCY OPERATIONS CENTER

- Classified e-mail. teoc@teleengineering.army.smil.mil
- Unclassified e-mail. teoc@usace.army.mil
- Classified Web site. http://www.teleengineering.army.smil.mil
- Nonclassified Web site. https://teleengineering.usace.army.mil
- Commercial telephone. (601) 634-2735/3485 or 1-877-223-8322
- Secure voice telephone number: (601) 634-4231
- Defense switched network (DSN). (312) 446-2735/3485

ENGINEERING INFRASTRUCTURE INTELLIGENCE REACHBACK CENTER

- Classified e-mail. OrgMBoxCEEI2RC@usace.army.smil.mil
- Unclassified e-mail. CEEI2RC@usace.army.mil
- Classified Web site. http://ei2rc.usace.army.smil.mil
- Nonclassified Web site. http://ei2rc.usace.army.mil
- Classified FTP. ftp://ei2rc.usace.army.smil.mil
- Nonclassified FTP. ftp://155.82.160.151
- Commercial telephone number. (251) 690-2039 (STUIII)
- DSN. (312) 457-2039 (STUDIII)

E-5. Requests for classification that do not include all of the necessary information may not be met. Some of the data may be obtained from the vehicle weight and dimension card (STANAG 2021) that is displayed by vehicles during transport. The following information must be supplied:

- Weight (empty, loaded for cross-country, and loaded for highway).
- Load on each axle (empty, loaded for cross country, and loaded for highway).
- Load on lunette, pintle, or fifth wheel (empty, loaded for cross-country, and loaded for highway).
- Tires (number per axle, size, and inflation pressure).
- Distance between axles.
- Distance from nearest axle(s) to pintle, lunette, or fifth wheel.
- Outside-to-outside width of tires or tracks and inside-to-inside width of tires or tracks.
- Length of track in contact with the ground.
- The national stock number (NSN), if available.

TEMPORARY PROCEDURES FOR VEHICLE CLASSIFICATION

E-6. Temporary vehicle classification numbers may be assigned under special conditions. Sometimes military vehicles carry loads that are more than or less than their normal payloads. In this case, a temporary vehicle MLC number may need to be assigned. The classification number assigned increases or decreases by an amount equal to the overload or underload.

E-7. It is sometimes necessary to classify a vehicle under field conditions. This may be done in one of two ways. A temporary MLC may be assigned either through comparison with a similarly classified vehicle or through the expedient classification procedure. In both cases the using unit must verify the classification as soon as possible.

VEHICLE COMPARISON

E-8. For all vehicles, a comparison of the unclassified vehicle may be made by comparing the axle loads, gross weight, and dimensions of the unclassified vehicle with those of a similar classified vehicle. If no comparable vehicle is available, then use the expedient vehicle classification.

EXPEDIENT VEHICLE CLASSIFICATION

E-9. This expedient procedure to estimate the MLC is available and effective when the situation requires an immediate determination. During the classification process, vehicles are divided into two categories—those with trailers (vehicle combination class number [CCN]) and those without (single vehicle classification number)—and calculated accordingly.

E-10. When a vehicle tows another vehicle at a distance less than 30.5 meters and the vehicles are not designed to operate as one unit, the combination is referred to as a nonstandard combination. A temporary vehicle MLC number may be assigned to this combination. The classification number assigned is nine tenths the sum of the normal vehicle classification numbers if the total of both classifications is less than 60. If the sum of the two military classification numbers is 60 or over, the total becomes the MLC number for the nonstandard combination.

$$CCN = 0.9\,(A + B) \text{ if } A + B < 60$$

$$CCN = A + B \text{ if } A + B > 60$$

where—

A = *class of first vehicle*

B = *class of second vehicle*

E-11. The expedient classification for a wheeled vehicle is estimated to be 85 percent of its total weight. Therefore, you must determine the vehicle's gross weight. Multiply the air pressure in the tires (in pounds per square inch [psi]) by the total area (in square inches) of the tires in contact with the ground. If a gauge is not available, use 75 psi as an average value. This yields an approximate weight of the vehicle in pounds. Convert this figure to tons and find 85 percent of the weight in tons. The resulting figure is the expedient classification.

$$WT = ATPTNT / 2{,}000$$

where—

WT = gross weight of vehicle, in tons
AT = average tire contact-area (hard surface), in square inches
PT = tire pressure, in psi
NT = number of tires

Estimated classification (wheeled vehicles) = 0.85 WT

E-12. Tracked vehicles weigh about one ton per square foot of track contact with the ground. By determining the area of track in contact with the ground, the vehicle's gross weight can be assigned. The estimated classification equals the gross weight of the vehicle in tons (WT) for tracked vehicles. In the case of vehicles that weigh a fraction over whole tonnage, the next higher classification number is assigned.

E-13. A wheeled vehicle MLC for a flexible surface road can be estimated using the bearing capacity determined in Chapter 5 (see figure 5-20 on page 5-26). Classification numbers and their relationship to wheel loads are shown in table 5-7 on page 5-25. Since the maximum allowable single wheel load for all vehicles from 50 to 120 is the same (20,000 pounds), the load class for roads in this range relies on a determination of the single axel load and exceeds the scope of this manual. Road classification for tracked vehicles is normally not assigned.

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Appendix F

Rapid Classification of Bridge Spans

Bridge and vehicle classification allows vehicle operators to avoid bridge failure due to overloading. Vehicle operators may drive across without restrictions if their vehicles' MLC numbers are less than or equal to the bridge classification number. Appendix E provides a table of classifications for standard vehicles. This appendix provides a rapid method of estimating bridge capacity in the field—but only as a temporary measure. A full analytical classification must be performed as soon as possible to determine an accurate classification of the bridge (see FM 3-34.343).

BRIDGE DIMENSIONS

F-1. The reconnaissance team collects specific bridge dimensions if the information will be necessary to determine the hasty bridge load-classification. The dimensions required vary for each of the seven basic bridge types. Table F-1 on page F-2 summarizes the dimensions that the reconnaissance team must collect if the information will be used to classify the bridge. Entries in the table correspond to figures F-1 through F-6 on pages F-4 through F-9 as indicated in parenthesis under the span type.

Table F-1. Entries required for Bridge Reconnaissance Report, DA Form 1249

Front of Report

Dimension Reference	*Dimension Data*	*Simple Stringer (F-1)**	*Slab (F-2)**	*T-Beam (F-2)**	*Truss (F-3)**	*Girder (F-4)**	*Arch (F-5)**	*Suspension (F-6)**
1	Overall length	X	X	X	X	X	X	X
2	Number of spans	X	X	X	X	X	X	X
2	Span length	X	X	X	X	X	X	X
2a	Panel length				X			X
3	Height above streambed	X	X	X	X	X	X	X
3a	Height above mean water level	X	X	X	X	X	X	X
4	Traveled-way width	X	X	X	X	X	X	X
5	Overhead clearance				X			X
6	Horizontal clearance	X	X	X	X	X	X	X

Note:
* Figure number for various spans is in parenthesis under the span heading.

Back of Report

Dimension Reference	*Capacity[(a)] Dimension Data*	*Simple Stringer (F-1)**					*Slab (F-2)**	*T-Beam (F-2)**	*Truss (F-3)**	*Girder (F-4)**	*Arch (F-5)**	*Suspension (F-6)**
a	Wearing surface thickness	X					X	X	X	X	X	X
b	Flooring and deck thickness or depth of fill at crown	X					X	X	X	X	X	X
		Timber		*Steel*								
		Rectangle	*Log*	*I-Beam*	*Channel*	*Rail*						
c	Distance, c-to-c, between T-beams, stringers, or floor beams	X	X	X	X	X		X	X	X	X	X
d	Number of T-beams or stringers	X	X	X	X	X		X	X	X		X
e	Depth of T-beam or stringer	X	(b)	X	X	X		X	X	X		X

Table F-1. Entries required for Bridge Reconnaissance Report, DA Form 1249 (continued)

Back of Report												
Dimension Reference	***Capacity[(a)] Dimension Data***	***Simple Stringer (F-1)****					***Slab (F-2)****	***T-Beam (F-2)****	***Truss (F-3)****	***Girder (F-4)****	***Arch (F-5)****	***Suspension (F-6)****
		Timber		***Steel***								
		Rectangle	***Log***	***I-Beam***	***Channel***	***Rail***						
f	Width of T-beam or stringer	X		(c)	(c)	(c)		X	X	X		X
g	Web thickness of I-beams, wide flange (WF) beams, channels, or rails			X	X	X			X	X		X
h	Sag of cable											X
i	Number of each size of cable											X
j	Thickness of arch ring										X	
k	Rise of arch										X	
l	Diameter of each size of cable											X
m	Depth of plate girder										X	
n	Width of flange plates										X	
o	Thickness of flange plates										X	
p	Number of flange plates										X	
q	Depth of flange angle										X	
r	Width of flange angle										X	
s	Thickness of flange angle										X	
t	Depth of web plate										X	
u	Thickness of web plate										X	
v	Average thickness of flange	X										
w	Cover depth										X	

Note:
* Figure number for various spans is in parenthesis under the span heading. (a) Capacity is computed using formulas and data in FM 3-34.343. (b) Diameter (c) Width of flange

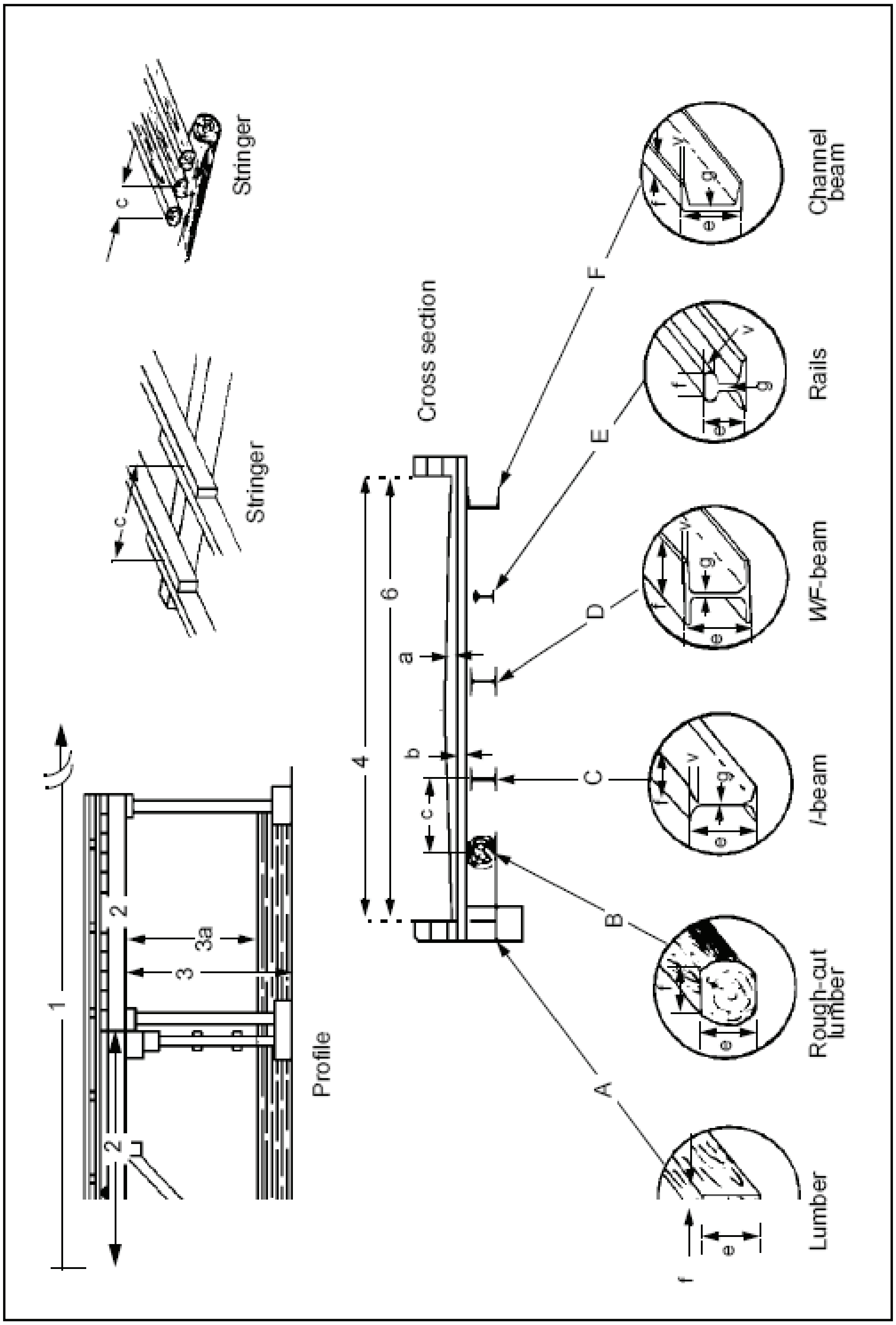


Figure F-1. Dimensions for a simple stringer bridge

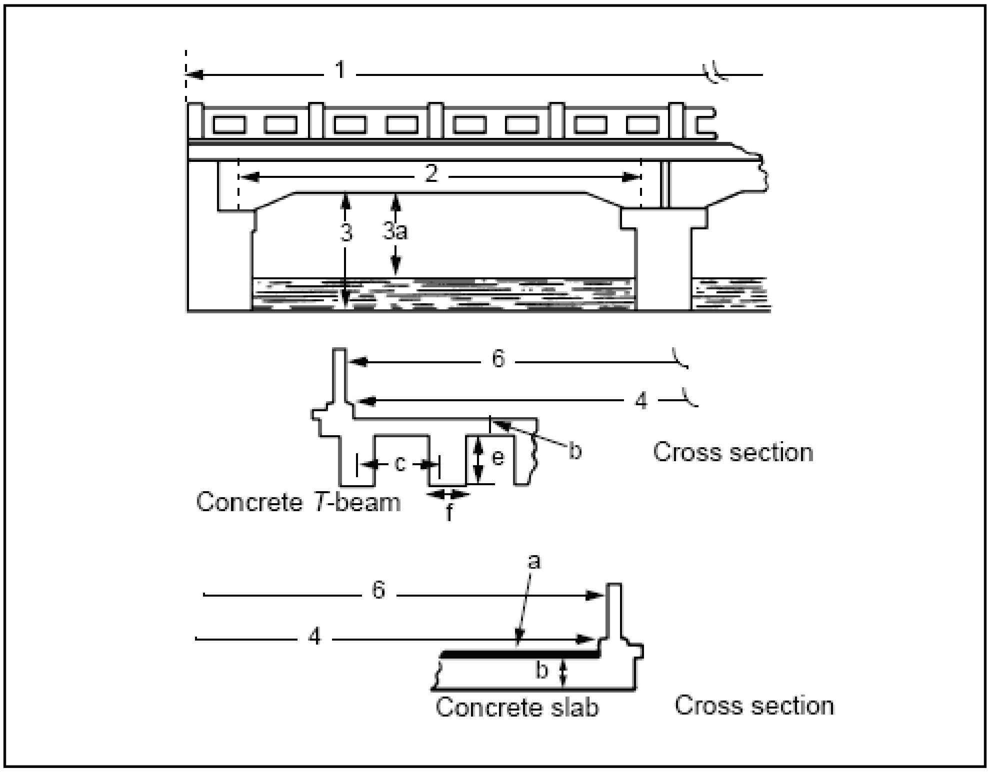


Figure F-2. Dimensions for concrete bridges

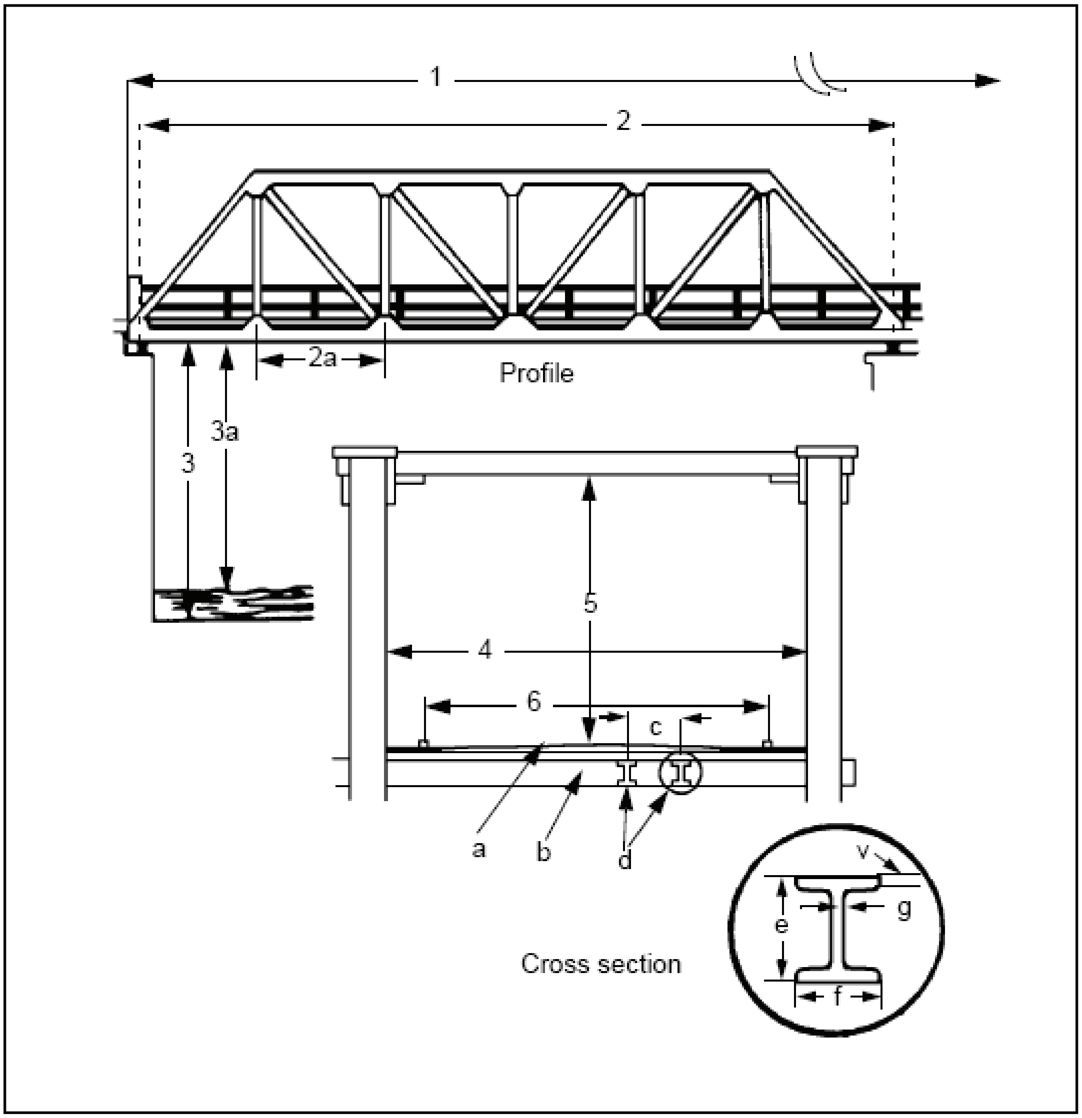


Figure F-3. Dimensions for a steel truss bridge

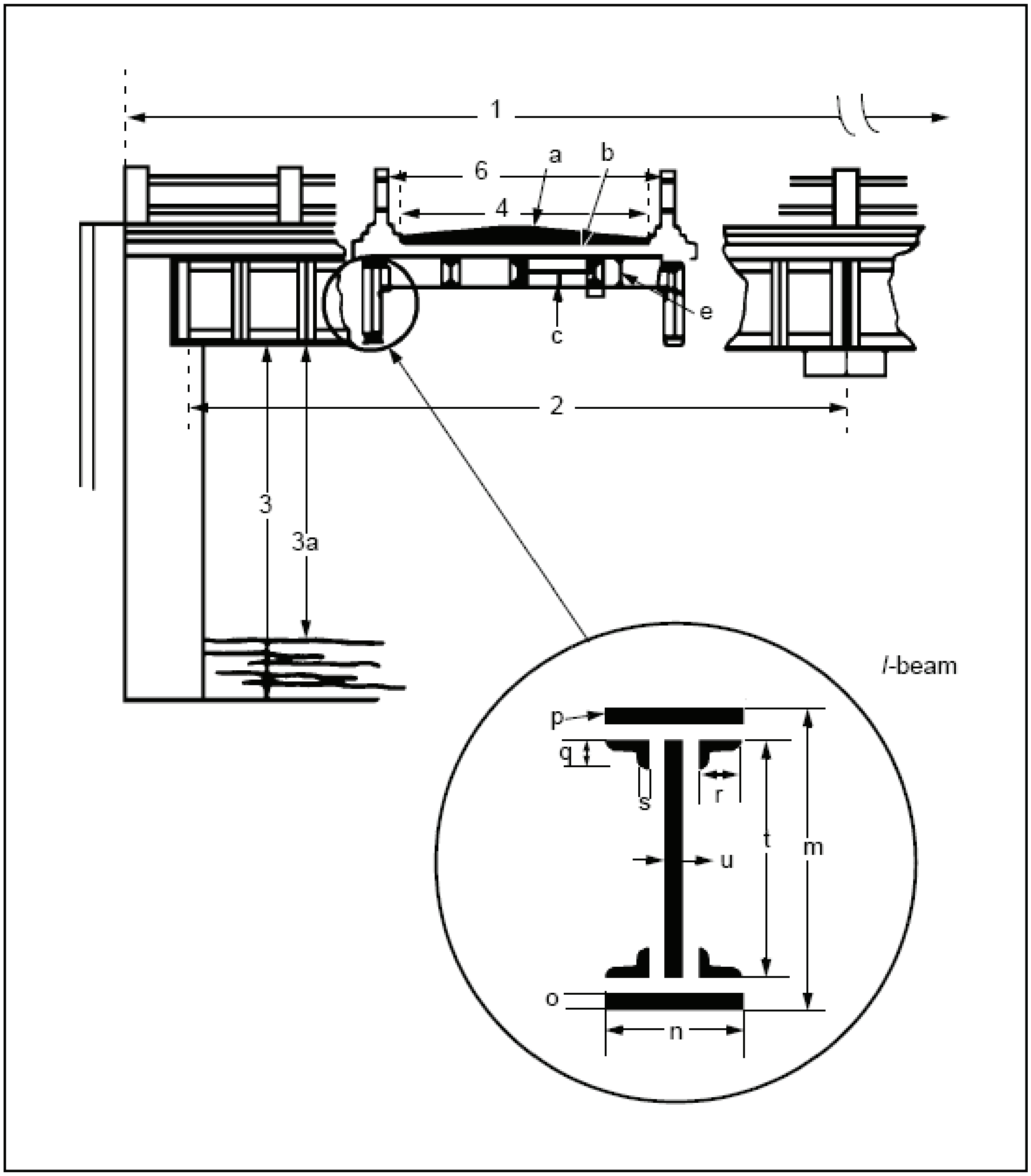


Figure F-4. Dimensions for plate girder bridges

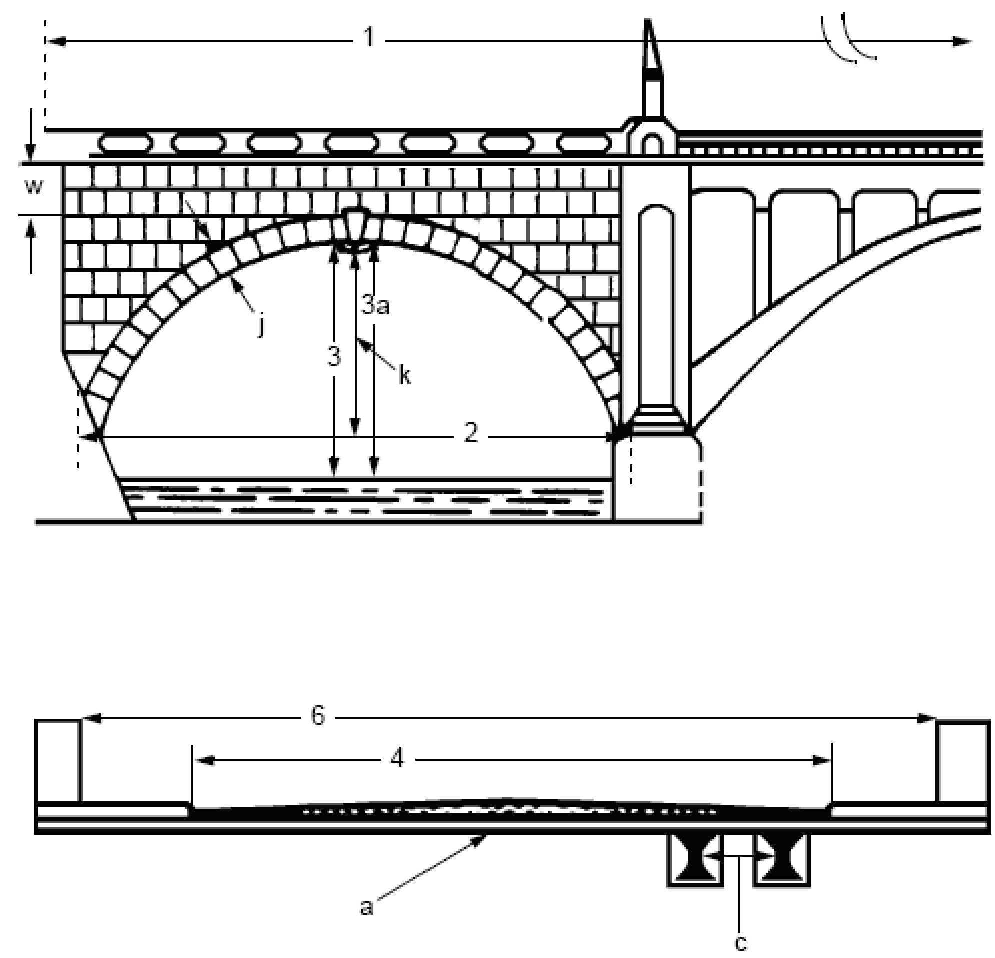


Figure F-5. Dimensions for arch bridges

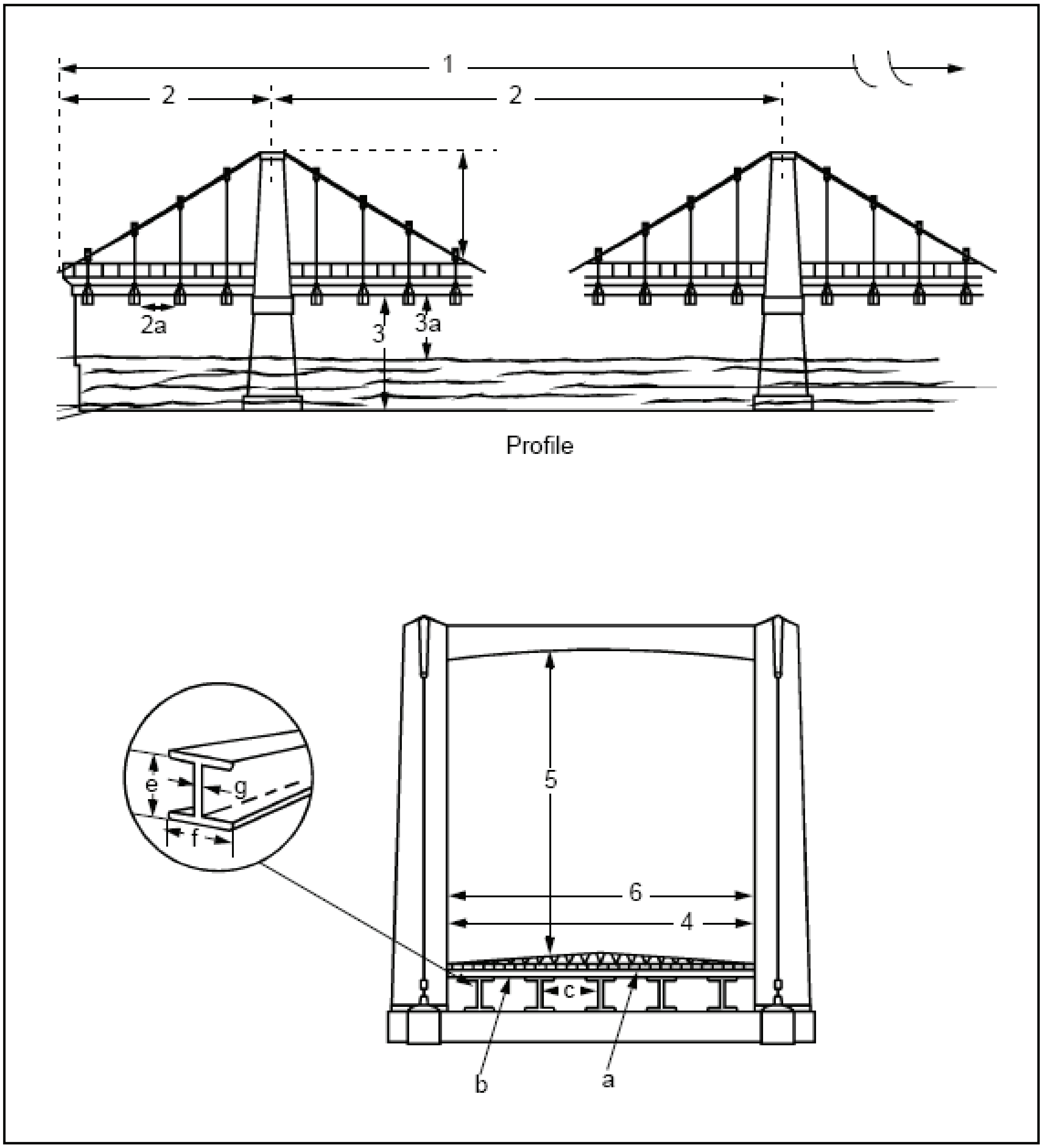


Figure F-6. Dimensions for suspension bridges

CLASSIFICATION PROCEDURES

F-2. Table F-2 on page F-10 provides a key for the notations used in the classification worksheets shown in figures F-7 through F-11 on pages F-11 through F-15. Those classification worksheets provide the rapid classification procedure for the basic bridge types. In tables F-3 through F-9 on pages F-15 through F-34 and figures F-12 through F-16 on pages F-34 through F-38 following the worksheet figures, various properties of bridge members are provided. These properties are used to determine appropriate values in the worksheets.

Table F-2. Notations

Variable	***Definition***	***Variable***	***Definition***
b	stringer width, in inches	N_2	effective number of stringers for two-lane traffic
bd	concrete slab width, in feet	PLC	provisional load classification
be	effective slab width, in feet	R	rise of arch, in feet
be1	effective slab width for one-lane traffic, in feet	S	section modulus, in cubic inches
be2	effective slab width for two-lane traffic, in feet	S_b	actual brace spacing, in feet
br	curb-to-curb roadway width, in feet	S_s	center-to-center stringer spacing, in feet
d	stringer depth, in inches	t_c	crown thickness, in inches
df	depth of fill, in inches	t_d	deck thickness, in inches
Fy	yield stress	t_{eff}	effective deck thickness, in inches
ksi	kips per square inch	t_f	flange thickness, in inches
L	span length, in feet	t_w	web thickness, in inches
Lc	maximum brace spacing, in feet	T_1	one-lane, tracked-vehicle classification
m	moment capacity per stringer, in ft-kips	T_2	two-lane, tracked-vehicle classification
mDL	dead-load moment per stringer, in ft-kips	v	shear capacity per stringer, in kips
mLL	live-load moment per stringer, in ft-kips	v_{DL}	dead-load shear per stringer, in kips
MLL	live-load moment per lane, in ft-kips	V_{DL}	estimated dead-load shear of span, in kips
MLL1	live-load moment for one-lane traffic, in ft-kips	v_{LL}	live-load shear per stringer, in kips
MLL2	live-load moment for two-lane traffic, in ft-kips	V_{LL}	live-load shear per lane, in kips
Nb	number of braces	W_s	stringer weight, in lbs/ft
NL	number of lanes	W_1	one-lane, wheeled-vehicle classification
NS	number of stringers	W_2	two-lane, wheeled-vehicle classification
N1	effective number of stringers for one-lane traffic		

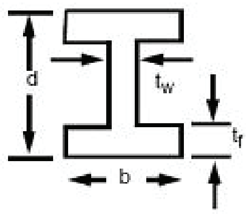
Map sheet	Grid	
Recon officer/NCO	Unit	Date

Bridge dimensions

L ______ ft
b_r ______ ft

N_L ______ (2 if $b_r \geq 18$ ft)

N_S ______
S_S ______ in
N_b ______
S_b ______ ft

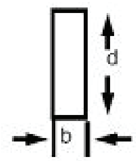


Deck: Single-layer, multilayer, or laminated
t_d ______ in

Stringer dimensions

Timber: *(Table F-3)*
b ______ in
d ______ in

Steel: Type______ *(Table F-4)*
d ______ in
b ______ in
t_w ______ in
t_f ______ in



Procedure

1. m __________
   a. Timber: Use $0.73(m)$ ***(see table F-3 for m)***
   b. Steel: Use $0.83(m)$ ***(see table F-4 for m)***
2. W_s ________ ***(Table F-4)*** Omit this step for timber stringer.
3. m_{DL} ______
   a. Timber: $m_{DL} = 0.0000434L^2[(b)(d)+(t_d)(S_s)]$
   b. Steel: $m_{DL} = 0.00013L^2[W_s+0.347(t_d)(S_s)]$
4. m_{LL} ________
   a. Timber: $m - m_{DL}$
   b. Steel: $\dfrac{m - m_{DL}}{1.15}$
5. N_1 ______ $\left(\dfrac{60}{S_S}\right) + 1$
6. N_2 ______ $0.375N_S$; calculate only if $b_r \geq 18$ ft
7. M_{LL1} ______ $(N_1)m_{LL}$
8. M_{LL2} ______ (smaller of N_1 or N_2)m_{LL}
9. Moment classification ***(Table F-5)***
   T_1 ____ T_2 ____ W_1 ____ W_2 ____
10. Do not perform Steps 10-14 for steel stringer bridge.
    v _____ Use $0.63(v)$ ***(see Table F-3 for v)***
11. v_{DL} ______, where $v_{DL} = 0.000174L[(b)(d)+(t_d)(S_s)]$
12. v_{LL} ______ $(v - v_{DL})$
13. V_{LL} ___ $5.33(v_{LL})\dfrac{(\text{smaller of } N_1 \text{ or } N_2)}{(\text{smaller of } N_1 \text{ or } N_2) + 1}$
14. Shear classification ***(Table F-6)***
    T_1 ____ T_2 ____ W_1 ____ W_2 ____
15. Width classification ***(Table F-9)***
    T_1 ____ T_2 ____ W_1 ____ W_2 ____
16. Deck classification ***(Figure F-12)***
    T_1 ____ T_2 ____ W_1 ____ W_2 ____
    a. Single layer: $t_{eff} = t_d$
    b. Multilayer: $t_{eff} = t_d - 2''$
    c. Laminated: $t_{eff} = t_d$
    Use $S_s = 0.75(S_s)$ for laminated decks.
17. $N_{b(required)}$ _____
    a. Timber: 3 required if $d \geq 2(b)$
    b. Steel: $\left(\dfrac{L}{L_c}\right) + 1$ ***(L_e in Table F-4)***
    Add braces if $N_b < N_{b(required)}$
18. **Final classification:**

	T_1	T_2	W_1	W_2
Moment (Step 9)				
Shear (Step 14)				
Width (Step 15)				
Deck (Step 16)				
Final				

Figure F-7. Timber or steel trestle bridge with timber deck

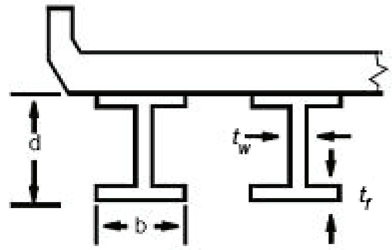
Map sheet | Grid
Recon officer/NCO | Unit | Date

Bridge dimensions

L ______ ft
b_r _____ ft

N_L _____ *(2 if $b_r \geq 18$ ft)*

N_S _____
S_S _____ in
t_d _____ in (Do not include the wearing surface.)



Stringer dimensions

Type: ________ ***(Table F-4)***
b _____ in
d _____ in
t_f _____ in
t_w _____ in

Procedure

1. m ______ Use $0.83(m)$ ***(see Table F-4 for m)***
2. W_S _____ ***(Table F-4)***
3. m_{DL} _____ $0.00013L^2[W_S + (t_d)(S_S)]$
4. m_{LL} _____ $\frac{m - m_{DL}}{1.15}$
5. N_1 _____ $\frac{60}{S_S} + 1$
6. N_2 _____ $0.375N_S$; calculate only if $b_r \geq 18$ ft
7. M_{LL1} ______ $(N_1)m_{LL}$
8. M_{LL2} ______ *(smaller of N_1 or N_2)m_{LL}*
9. Moment classification ***(Table F-5)***

   T_1 _____ T_2 _____ W_1 _____ W_2 _____

10. Width classification ***(Table F-9)***

    T_1 _____ T_2 _____ W_1 _____ W_2 _____

11. Deck classification:

    T_1 _____ T_2 _____ W_1 _____ W_2 _____

    a. $t_d < 5$ *in:* Class 40
    b. $t_d \geq 5$ *in:* Class 150

12. **Final classification:**

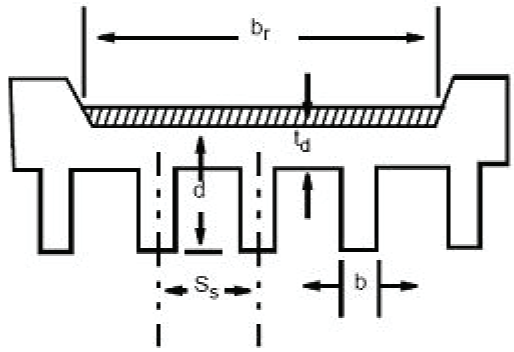
	T_1	T_2	W_1	W_2
Moment (Step 9)				
Width (Step 10)				
Deck (Step 11)				
Final				

Figure F-8. Steel stringer bridge with concrete deck

Map sheet Grid
Recon officer/NCO Unit Date

Bridge dimensions

L ______ ft
b_r _____ ft
t_d _____ in (Do not include the wearing surface.)
N_s _____
S_s _____ in



Stringer dimensions

b______ *in*
d______ *in*

Procedure

1. m _____ $0.0116(S_s)(d^2)$
2. m_{DL} _____ $0.00013\ L^2[(b)(d) + (t_d)(S_s)]$
3. m_{LL} _____ $\dfrac{m - m_{DL}}{1.15}$
4. N_1 _____ $\dfrac{60}{S_s} + 1$
5. N_2 _____ $0.375N_s$; calculate only if $b_r \geq 18\ ft$
6. M_{LL1} _____ $(N_1)m_{LL}$
7. M_{LL2} _____ (smaller of N_1 or N_2)m_{LL}
8. Moment classification *(Table F-5)*
T_1 _____ T_2 _____ W_1 _____ W_2 _____
9. Width classification *(Table F-9)*
T_1 _____ T_2 _____ W_1 _____ W_2 _____

10. **Final classification:**

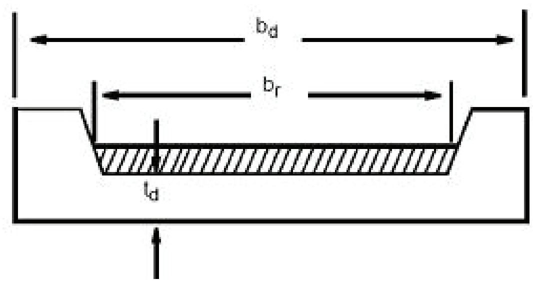
	T_1	T_2	W_1	W_2
Moment (Step 8)				
Width (Step 9)				
Final				

Figure F-9. Reinforced concrete t-beam bridge with asphalt wearing surface

Map sheet	Grid	
Recon officer/NCO	Unit	Date

Bridge dimensions

L ______ ft
b_d ______ ft
b_r ______ ft
t_d ______ in (Do not include the wearing surface.)



Procedure

1. m_{LL} ______ *(Figure F-13)*
2. b_e ______
   a. One lane:

$$b_{e1} = \frac{L}{0.75 + \frac{L}{b_d}}$$

   b. Two lane:

$$b_{e2} = \frac{L}{0.25 + \frac{2L}{b_d}}$$

   (Calculate b_{e2} only if $b_r \geq$ 18 ft)

3. M_{LL1} ______ $(b_{e1})m_{LL}$
4. M_{LL2} ______ $(b_{e2})m_{LL}$
5. Moment classification *(Table F-5)*

   T_1 ______ T_2 ______ W_1 ______ W_2 ______

6. Width classification *(Table F-9)*

   T_1 ______ T_2 ______ W_1 ______ W_2 ______

7. **Final classification:**

	T_1	T_2	W_1	W_2
Moment (Step 5)				
Width (Step 6)				
Final				

18. **Final classification:**

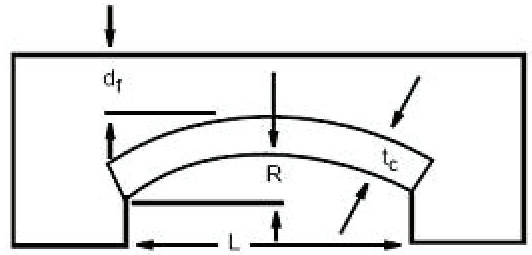
	T_1	T_2	W_1	W_2
Moment (Step 9)				
Shear (Step 14)				
Width (Step 15)				
Deck (Step 16)				
Final				

Figure F-10. Reinforced concrete-slab bridge with asphalt wearing surface

Map sheet Grid
Recon officer/NCO Unit Date

Bridge dimensions

L ______ ft
t_c _____ ft
d_f _____ ft
b_r _____ ft
R _____ ft



Procedure

1. PLC ____ *(Figure F-14)*
2. Arch factors:
   a. Span-to-rise ratio $(SR = \frac{L}{R})$ ______
   b. Profile factors *(Table F-7)*
   c. Material factors *(Table F-8)*
   d. Joint factors *(Table F-8)*
   e. Deformations *(Table F-8)*
   f. Crack factors *(Table F-8)*
   g. Abutment size factors *(Table F-8)*
   h. Abutment fault factors *(Table F-8)*
3. Classification of arch factors:
   T_1 _____ *(PLC x product of factors 2b through 2h)*
   T_2 _____ *(0.9T_1)*
   W_1 _____ *(Figure F-15)*
   W_2 _____ *(Figure F-15)*
4. Width classification *(Table F-9)*
   T_1 _____ T_2 _____ W_1 _____ W_2 _____
5. **Final classification:**

	T_1	T_2	W_1	W_2
Factors (Step 3)				
Width (Step 4)				
Final				

Figure F-11. Masonry arch bridge

Table F-3. Properties of timber stringer

Rectangular Stringers				*Rectangular Stringers*			
Nominal Size (b x d, in)[1]	***m (ft-kips)[2]***	***v (kips)[3]***	***L_m (ft)[4]***	***Nominal Size (b x d, in)[1]***	***m (ft-kips)[2]***	***v (kips)[3]***	***L_m (ft)[4]***
4 x 6	4.80	2.40	7.14	16 x 16	136.50	25.60	19.10
4 x 8	8.53	3.20	9.50	16 x 18	172.80	28.80	21.50
4 x 10*	13.33	4.00	11.90	16 x 20	213.00	32.00	23.80
4 x 12*	19.20	4.80	14.30	16 x 22	258.00	35.20	26.20
6 x 8	12.80	4.80	9.50	16 x 24	307.00	38.40	28.60
6 x 10	20.00	6.00	11.90	18 x 18	194.40	32.40	21.50
6 x 12	28.80	7.20	14.30	18 x 20	240.00	36.00	23.80
6 x 14*	39.20	8.40	16.70	18 x 22	290.00	39.60	26.20
6 x 16*	51.20	9.60	19.10	18 x 24	346.00	43.20	28.60
6 x 18*	64.80	10.80	21.50	*Round Stringers (Nominal Size is Diameter)*			
8 x 8	17.07	6.40	9.50				
8 x 10	26.70	8.00	11.90	8	10.05	5.70	9.50
8 x 12	38.40	9.60	14.30	9	14.31	7.20	10.70
8 x 14	52.30	11.20	16.70	10	19.63	8.80	11.90
8 x 16	68.30	12.80	19.10	11	26.10	10.60	13.10
8 x 18*	86.40	14.40	21.50	12	33.90	12.70	14.30
8 x 20*	106.70	16.40	23.80	13	43.10	15.00	15.50
8 x 22*	129.10	17.60	26.20	14	53.90	17.40	16.70
8 x 24*	153.60	19.20	28.60	15	67.50	20.20	17.80
10 x 10	33.30	10.00	11.90	16	80.40	22.60	19.10
10 x 12	48.00	12.00	14.30	17	98.20	26.00	20.20
10 x 14	65.30	14.00	16.70	18	114.50	28.60	21.50
10 x 16	85.30	16.00	19.10	19	137.10	32.40	22.60
10 x 18	108.00	18.00	21.50	20	157.10	35.40	23.80
10 x 20	133.30	20.00	23.80	21	185.20	39.60	24.90
10 x 22	161.30*	22.00	26.20	22	209.00	42.70	26.20
10 x 24	192.00*	24.00	28.60	23	243.00	47.60	27.30
12 x 12	57.60	14.40	14.30	24	271.00	50.80	28.60
12 x 14	78.40	16.80	16.70	25	312.00	56.20	29.70
12 x 16	102.40	19.20	19.10	26	351.00	60.80	30.90
12 x 18	129.60	21.60	21.50	27	393.00	65.60	32.10
12 x 20	160.00	24.00	23.80	28	439.00	70.50	33.30
12 x 22	193.60	26.40	26.20	29	487.00	75.60	34.50
12 x 24	230.00	28.80	28.60	30	540.00	81.00	35.70
14 x 14	91.50	19.60	16.70	31	595.00	86.40	36.80
14 x 16	119.50	22.40	19.10	32	655.00	92.10	38.00
14 x 18	151.20	25.20	21.50	33	718.00	98.00	39.20
14 x 20	186.70	28.00	23.80	34	786.00	104.00	40.40

Table F-3. Properties of timber stringer

Rectangular Stringers				***Rectangular Stringers***			
Nominal Size (b x d, in)[1]	***m (ft-kips)***[2]	***v (kips)***[3]	***L_m (ft)***[4]	***Nominal Size (b x d, in)***[1]	***m (ft-kips)***[2]	***v (kips)***[3]	***L_m (ft)***[4]
14 x 22	226.00	30.80	26.20	35	857.00	110.20	41.60
14 x 24	269.00	33.60	28.60	36	933.00	116.60	42.80

Notes.

* A minimum of three lateral braces is required.

[1] If d > 2b, bracing is required at the midspan and at both ends.

[2] Moment capacity for rectangular stringers not listed is $b(d^2)/30$. Moment capacity for round stringers not listed is $0.02(d)^3$.

[3] Shear capacity for rectangular stringers not listed is b(d)/10. Shear capacity for round stringers not listed is $0.09(d^2)$.

[4] Maximum span length for stringers not listed is 1.19d.

Table F-4. Properties of steel stringers (F_y = 36 ksi, f_b = 27 ksi, f_v = 16.5 ksi)

Nominal Size	***d (in)***	***W_s (lbs/ft)***	***b (in)***	***t_f (in)***	***t_w (in)***	***m (ft-kips)***	***v (kips)***	***L_m (ft)***	***L_c (ft)***
W39x211	39.250	211	11.750	1.438	0.75	1,770	450	100	12.4
W37x206	36.750	206	11.750	1.438	0.75	1,656	425	95	12.4
W36x300	36.750	300	16.625	1.688	0.94	2,486	520	94	17.6
W36x194	36.500	194	12.125	1.250	0.81	1,492	431	93	12.8
W36x182	36.375	182	12.125	1.187	0.75	1,397	406	93	12.8
W36x170	36.125	170	12.000	1.125	1.06	1,302	381	92	12.7
W36x160	36.000	160	12.000	1.000	1.06	1,217	365	92	12.7
W36x230	35.875	230	16.500	1.250	0.75	1,879	421	91	17.4
W36x150	35.875	150	12.000	0.937	0.62	1,131	350	91	12.7
W36x201	35.375	201	11.750	1.438	0.75	1,545	402	90	12.4
W33x196	33.375	196	11.750	1.438	0.75	1,433	377	85	12.4
W33x220	33.250	220	15.750	1.250	0.81	1,661	392	85	16.6
W33x141	33.250	141	11.500	0.937	0.62	1,005	313	85	12.1
W33x130	33.125	130	11.500	0.875	0.56	911	300	85	12.1
W33x200	33.000	200	15.575	1.125	0.56	1,506	362	84	16.6
W31x180	31.500	180	11.750	1.312	0.75	1,327	327	80	12.4
W30x124	30.125	124	10.500	0.937	0.68	797	273	77	11.1
W30x116	30.000	116	10.500	0.875	0.62	738	263	76	11.1
W30x108	29.875	108	10.500	0.750	0.56	672	255	76	11.1
W30x175	29.500	175	11.750	1.312	0.56	1,156	304	75	12.4
W27x171	27.500	171	11.750	1.312	0.68	1,059	282	70	12.4
W27x102	27.125	102	10.000	0.812	0.68	599	217	69	10.6
W27x94	26.875	92	10.000	0.750	0.50	546	205	68	10.6
W26X157	25.500	157	11.750	1.250	0.50	915	237	65	12.4
W24x94	24.250	94	9.000	0.875	0.62	497	191	62	9.5
W24x84	24.125	84	9.000	0.750	0.50	442	174	61	9.5

Table F-4. Properties of steel stringers (F_y = 36 ksi, f_b = 27 ksi, f_v = 16.5 ksi)

Nominal Size	***d (in)***	***W_s (lbs/ft)***	***b (in)***	***t_f (in)***	***t_w (in)***	***m (ft-kips)***	***v (kips)***	***L_m (ft)***	***L_c (ft)***
W24x100	24.000	100	12.000	0.750	0.50	560	173	61	12.7
S24x120	24.000	120	8.000	1.125	0.50	564	286	61	8.4
S24x106	24.000	106	7.875	1.125	1.18	527	224	61	8.3
S24x80	24.000	80	7.000	0.875	0.62	391	183	61	7.4
W24x76	23.875	76	9.000	0.687	0.50	394	163	61	9.5
W24x153	23.625	153	11.750	0.250	0.43	828	217	60	12.4
S24x134	23.625	134	8.500	1.250	0.62	634	283	60	9.0
S22x75	22.000	75	7.000	0.812	0.81	308	168	56	7.4
W21x139	21.625	139	11.750	1.187	0.50	699	198	55	12.4
S21x112	21.625	112	7.875	1.187	0.62	495	238	55	8.3
W21x73	21.250	73	8.250	0.750	0.75	338	148	54	8.7
W21x68	21.125	68	8.250	0.687	0.50	315	140	54	8.7
W21x62	21.000	62	8.250	0.625	0.43	284	130	53	8.7
S20x85	20.000	85	7.125	0.937	0.37	337	195	51	7.5
S20x65	20.000	65	6.500	0.812	0.68	245	132	51	6.9
W20x134	19.625	134	11.750	1.187	0.43	621	177	50	12.4
W18x60	18.250	60	7.500	0.687	0.62	243	115	46	7.9
S18x86	18.250	86	7.000	1.000	0.43	326	184	46	7.4
W18x55	18.125	55	7.500	0.625	0.37	220	108	46	7.9
S18x80	18.000	80	8.000	0.937	0.50	292	133	46	8.4
W18x50	18.000	50	7.500	0.562	0.37	200	99	46	7.9
S18x55	18.000	55	6.000	0.687	0.50	199	126	46	6.3
S18x122	17.750	122	11.750	1.062	0.56	648	145	45	12.4
S18x62	17.750	62	6.875	0.750	0.37	238	100	45	7.3
S18x77	17.750	77	6.625	0.937	0.62	281	163	45	7.0
W16x112	16.750	112	11.750	1.000	0.56	450	136	42	12.4
S16x70	16.750	70	6.500	0.937	0.62	238	146	42	6.9
W16x50	16.250	50	7.125	0.625	0.37	181	94	41	7.5
W16x45	16.125	45	7.000	0.562	0.37	163	85	41	7.4
W16x64	16.000	64	8.500	0.687	0.43	234	106	40	9.0
W16x40	16.000	40	7.000	0.500	0.31	145	75	40	7.4
S16x50	16.000	50	6.000	0.687	0.43	155	105	40	6.3
W16x36	15.875	36	7.000	0.437	0.31	127	74	40	7.4
W16x110	15.750	110	11.750	1.000	0.56	345	127	40	12.4
S16x62	15.750	62	6.125	0.875	0.56	200	129	40	6.5
S16x45	15.750	45	5.375	0.625	0.43	150	104	40	5.7
W15x103	15.000	103	11.750	0.937	0.56	369	121	38	12.4
S15x56	15.000	56	5.875	0.812	0.50	173	110	38	6.2
S15x43	15.000	43	5.500	0.625	0.43	132	93	38	5.8
W14x101	14.250	101	11.750	0.937	0.56	344	114	36	12.4
S14x40	14.250	40	5.375	0.375	0.37	119	83	36	5.7
S14x51	14.125	51	5.625	0.750	0.50	150	104	36	5.9

Table F-4. Properties of steel stringers (F_y = 36 ksi, f_b = 27 ksi, f_v = 16.5 ksi)

Nominal Size	***d (in)***	***W_s (lbs/ft)***	***b (in)***	***t_f (in)***	***t_w (in)***	***m (ft-kips)***	***v (kips)***	***L_m (ft)***	***L_c (ft)***
S14x70	14.000	70	8.000	0.937	0.43	204	87	35	8.4
S14x57	14.000	57	6.000	0.875	0.50	153	101	35	6.3
W14x34	14.000	34	6.750	0.437	0.31	121	78	35	7.1
W14x30	13.875	30	6.750	0.375	0.25	109	61	35	7.1
W14x92	13.375	92	11.750	0.875	0.50	297	96	34	12.4
S14x46	13.375	46	5.375	0.687	0.50	126	99	34	5.7
S13x35	13.000	35	5.000	0.625	0.37	85	72	33	5.3
S13x41	12.625	41	5.125	0.687	0.37	108	104	32	5.4
W12x36	12.250	36	6.625	0.565	0.31	103	56	31	7.0
S12x65	12.000	65	8.000	0.937	0.43	182	73	30	8.4
W12x27	12.000	27	6.500	0.375	0.25	76	44	30	6.9
S12x50	12.000	50	5.500	0.687	0.68	113	120	30	5.8
S12x32	12.000	32	5.000	0.562	0.37	81	62	30	5.3
S12x34	11.250	34	4.750	0.625	0.43	81	72	28	5.0
W11x76	11.000	76	11.000	0.812	0.50	202	67	28	11.6
S10x29	10.625	29	4.750	0.562	0.31	67	48	27	5.0
W10x25	10.125	25	5.750	0.437	0.25	59	38	25	6.1
S10x40	10.000	40	6.000	0.687	0.37	92	53	25	6.3
S10x35	10.000	35	5.000	0.500	0.62	65	88	25	5.3
S10x25	10.000	25	4.625	0.500	0.31	55	46	25	4.9
W10x21	9.875	21	5.750	0.312	0.25	48	36	25	6.1
W10x59	9.250	59	9.500	0.687	0.43	132	56	25	10.0
S9x25	9.500	25	4.500	0.500	0.31	51	43	24	4.8
S9x50	9.000	50	7.000	0.812	0.37	103	45	23	7.4
S8x35	8.000	35	6.000	0.625	0.31	65	34	20	6.3
S8x28	8.000	28	5.000	0.562	0.31	49	35	20	5.3
W8x31	8.000	31	8.000	0.437	0.31	61	33	20	8.4
W8x44	7.875	44	7.875	0.625	0.75	81	40	20	8.3
W7x35	7.125	35	7.125	0.562	0.37	58	37	18	7.5
W6x31	6.250	31	6.250	0.562	0.37	45	31	16	6.6

Table F-5. Wheeled- and tracked-vehicle moment (M_{LL} in kip-ft)

MLC	Wheeled/ Tracked	Span Length (feet) 4	6	8	10	12	14	16	18	20	25	30
4	W	4.96	7.44	9.92	12.40	14.88	17.92	21.40	25.60	30.00	41.00	52.20
	T	2.64	6.00	9.92	14.00	18.00	22.10	25.90	29.90	34.00	44.00	54.00
8	W	10.96	16.44	21.90	27.40	32.90	38.30	43.60	49.30	54.80	71.00	93.60
	T	4.88	11.04	19.04	27.00	35.00	43.10	50.90	59.00	66.80	87.00	106.80
12	W	16.00	24.00	32.00	40.00	48.00	56.00	64.00	72.00	80.80	112.50	145.20
	T	5.44	12.00	21.30	33.00	44.90	57.10	69.10	81.00	92.80	123.00	153.00
16	W	20.00	30.00	40.00	50.00	60.00	70.00	80.00	92.50	105.20	144.00	184.20
	T	7.12	15.96	28.50	44.00	60.00	75.90	91.80	108.00	124.00	164.00	204.00
20	W	22.00	33.00	44.00	55.00	70.80	87.40	104.00	121.00	137.60	188.50	241.00
	T	8.88	20.00	35.50	55.00	74.90	94.90	114.90	135.00	154.80	205.00	255.00
24	W	24.00	36.00	48.00	64.00	83.30	102.80	122.60	142.20	162.00	223.00	285.00
	T	10.64	24.00	42.70	66.00	90.00	114.00	137.90	162.00	186.00	246.00	306.00
30	W	26.70	40.40	53.90	70.40	91.70	113.10	134.70	156.60	178.00	246.00	316.00
	T	10.88	24.50	43.70	68.20	97.40	127.40	157.40	187.60	218.00	293.00	367.00
40	W	34.00	51.00	68.00	85.00	108.30	133.80	159.40	185.00	210.00	277.00	359.00
	T	13.36	30.00	53.30	83.40	120.00	158.90	200.00	240.00	280.00	380.00	480.00
50	W	40.00	60.00	80.00	100.00	125.00	154.30	183.70	213.00	243.00	320.00	415.00
	T	15.36	34.60	61.60	96.20	138.50	187.60	237.00	288.00	338.00	463.00	587.00
60	W	46.00	69.00	92.00	115.00	138.00	170.00	205.00	240.00	276.00	365.00	474.00
	T	17.12	38.50	68.60	107.20	154.30	210.00	270.00	330.00	390.00	540.00	690.00
70	W	51.00	76.40	101.90	127.40	157.90	198.20	239.00	280.00	322.00	426.00	557.00
	T	18.64	42.00	74.70	116.60	168.00	229.00	298.00	368.00	438.00	613.00	787.00
80	W	56.00	84.00	112.00	140.00	180.50	227.00	273.00	320.00	368.00	486.00	636.00
	T	20.00	45.00	80.00	125.00	180.00	245.00	320.00	400.00	480.00	680.00	880.00
90	W	60.00	90.00	120.00	151.80	203.00	225.00	308.00	360.00	414.00	547.00	716.00

Table F-5. Wheeled- and tracked-vehicle moment (M_{LL} in kip-ft) (continued)

MLC	***Wheeled/ Tracked***	***Span Length (feet)***										
		4	***6***	***8***	***10***	***12***	***14***	***16***	***18***	***20***	***25***	***30***
90	T	21.20	47.60	84.60	132.40	190.60	259.00	339.00	427.00	518.00	743.00	967.00
100	W	64.00	96.00	128.00	160.00	203.00	259.00	317.00	375.00	434.00	581.00	765.00
	T	22.20	50.00	89.00	138.80	199.90	272.00	356.00	450.00	550.00	800.00	1,050.00
120	W	72.00	108.00	144.00	180.00	243.00	311.00	380.00	450.00	520.00	697.00	918.00
	T	24.00	54.00	96.00	150.00	216.00	294.00	384.00	486.00	600.00	900.00	1,200.00
150	W	84.00	126.00	168.00	210.00	253.00	331.00	410.00	491.00	572.00	777.00	1,032.00
	T	25.00	56.30	100.00	156.20	225.00	306.00	400.00	506.00	625.00	975.00	1,350.00

MLC	***Wheeled/ Tracked***	***Span Length (feet)***									
		35	***40***	***45***	***50***	***55***	***60***	***70***	***80***	***90***	***100***
4	W	63.70	75.20	86.40	97.00	108.90	120.00	142.80	164.80	187.20	210.00
	T	63.70	73.80	83.70	94.00	103.40	114.00	134.40	153.60	174.60	194.00
8	W	116.20	138.40	161.10	183.00	206.00	228.00	273.00	318.00	364.00	408.00
	T	126.70	147.20	167.40	187.00	207.00	227.00	267.00	307.00	347.00	386.00
12	W	180.60	218.00	256.00	293.00	331.00	368.00	444.00	518.00	592.00	668.00
	T	182.70	213.00	243.00	273.00	303.00	332.00	393.00	453.00	513.00	572.00
16	W	229.00	275.00	321.00	367.00	414.00	460.00	552.00	645.00	736.00	830.00
	T	244.00	284.00	324.00	364.00	404.00	444.00	524.00	603.00	684.00	764.00
20	W	299.00	359.00	419.00	479.00	539.00	599.00	718.00	838.00	958.00	1,078.00
	T	305.00	355.00	405.00	455.00	505.00	554.00	655.00	755.00	855.00	954.00
24	W	353.00	422.00	492.00	562.00	633.00	702.00	843.00	982.00	1,121.00	1,262.00
	T	366.00	426.00	486.00	546.00	606.00	666.00	785.00	906.00	1,026.00	1,146.00
30	W	398.00	482.00	567.00	652.00	737.00	822.00	991.00	1,162.00	1,130.00	1,500.00
	T	442.00	518.00	592.00	667.00	743.00	817.00	967.00	1,117.00	1,267.00	1,418.00
40	W	442.00	553.00	671.00	788.00	905.00	1,022.00	1,257.00	1,493.00	1,728.00	1,962.00
	T	580.00	680.00	780.00	880.00	980.00	1,080.00	1,280.00	1,480.00	1,679.00	1,880.00

Table F-5. Wheeled- and tracked-vehicle moment (M_{LL} in kip-ft) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)									
		35	40	45	50	55	60	70	80	90	100
50	W	511.00	656.00	800.00	945.00	1,090.00	1,235.00	1,525.00	1,814.00	2,100.00	2,390.00
	T	713.00	838.00	962.00	1,087.00	1,212.00	1,338.00	1,588.00	1,837.00	2,090.00	2,340.00
60	W	584.00	740.00	914.00	1,089.00	1,263.00	1,438.00	1,786.00	2,140.00	2,490.00	2,840.00
	T	840.00	990.00	1,140.00	1,290.00	1,440.00	1,590.00	1,890.00	2,190.00	2,490.00	2,790.00
70	W	688.00	856.00	1,057.00	1,257.00	1,458.00	1,658.00	2,060.00	2,460.00	2,870.00	3,270.00
	T	963.00	1,138.00	1,312.00	1,478.00	1,662.00	1,837.00	2,190.00	2,540.00	2,890.00	3,240.00
80	W	786.00	936.00	1,103.00	1,332.00	1,561.00	1,790.00	2,250.00	2,710.00	3,170.00	3,630.00
	T	1,080.00	1,280.00	1,480.00	1,680.00	1,880.00	2,080.00	2,480.00	2,880.00	3,280.00	3,680.00
90	W	884.00	1,053.00	1,242.00	1,499.00	1,757.00	2,010.00	2,530.00	3,050.00	3,560.00	4,080.00
	T	1,193.00	1,418.00	1,643.00	1,867.00	2,090.00	2,320.00	2,770.00	3,220.00	3,670.00	4,120.00
100	W	953.00	1,140.00	1,328.00	1,543.00	1,828.00	2,110.00	2,690.00	3,260.00	3,830.00	4,410.00
	T	1,300.00	1,550.00	1,800.00	2,050.00	2,300.00	2,550.00	3,050.00	3,550.00	4,050.00	4,550.00
120	W	1,143.00	1,368.00	1,593.00	1,851.00	2,195.00	2,540.00	3,230.00	3,910.00	4,600.00	5,290.00
	T	1,500.00	1,800.00	2,100.00	2,400.00	2,700.00	3,000.00	3,600.00	4,200.00	4,800.00	5,400.00
150	W	1,297.00	1,562.00	1,827.00	2,092.00	2,405.00	2,830.00	3,670.00	4,520.00	5,560.00	6,210.00
	T	1,725.00	2,100.00	2,478.00	2,850.00	3,230.00	3,600.00	4,350.00	5,100.00	5,850.00	6,600.00
MLC	**Wheeled/ Tracked**	**Span Length (feet)**									
		110	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
4	W	233	254	278	270	321	346	367	389	414	448
	T	213	233	255	274	294	314	333	353	391	428
8	W	453	499	543	588	633	678	724	767	813	880
	T	427	468	507	546	588	627	666	706	775	852
12	W	744	818	892	969	1,044	1,117	1,193	1,267	1,341	1,416
	T	634	694	754	812	873	934	993	1,051	1,136	1,248
16	W	922	1,015	1,108	1,198	1,293	1,386	1,476	1,570	1,661	1,752

Figure F-5. Wheeled- and tracked-vehicle moment (M_{LL} in kip-ft) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)									
		110	120	130	140	150	160	170	180	190	200
16	T	845	924	1,004	1,084	1,164	1,245	1,323	1,404	1,516	1,664
20	W	1,199	1,318	1,438	1,557	1,677	1,798	1,918	2,040	2,160	2,280
	T	1,054	1,154	1,256	1,355	1,455	1,555	1,656	1,753	1,896	2,080
24	W	1,401	1,543	1,682	1,823	1,962	2,100	2,240	2,380	2,520	2,660
	T	1,265	1,385	1,505	1,627	1,746	1,866	1,986	2,110	2,280	2,500
30	W	1,670	1,841	2,010	2,180	2,350	2,520	2,690	2,860	3,030	3,200
	T	1,566	1,718	1,867	2,020	2,170	2,310	2,470	2,620	2,790	3,070
40	W	2,200	2,430	2,670	2,900	3,140	3,370	3,610	3,840	4,080	4,310
	T	2,080	2,280	2,480	2,680	2,880	3,080	3,280	3,480	3,680	4,050
50	W	2,680	2,970	3,260	3,550	3,840	4,130	4,420	4,710	5,000	5,290
	T	2,590	2,840	3,090	3,340	3,590	3,840	4,090	4,340	4,590	5,020
60	W	3,190	3,540	3,880	4,230	4,580	4,930	5,280	5,630	5,990	6,330
	T	3,090	3,390	3,690	4,000	4,290	4,590	4,890	5,190	5,490	5,970
70	W	3,670	4,070	4,470	4,880	5,280	5,680	6,080	6,490	6,890	7,290
	T	3,590	3,940	4,290	4,640	4,990	5,340	5,690	6,040	6,390	6,900
80	W	4,090	4,550	5,010	5,460	5,930	6,380	6,840	7,300	7,760	8,820
	T	4,080	4,480	4,880	5,280	5,680	6,080	6,480	6,880	7,280	7,810
90	W	4,600	5,110	5,630	6,150	6,670	7,180	7,700	8,220	8,730	9,250
	T	4,570	5,020	5,470	5,920	6,370	6,820	7,270	7,720	8,170	8,700
100	W	4,980	5,560	6,130	6,710	7,280	7,860	8,430	9,000	9,580	10,160
	T	5,050	5,550	6,050	6,550	7,050	7,550	8,050	8,550	9,050	9,570
120	W	5,980	6,670	7,360	8,050	8,740	9,430	10,120	10,810	11,500	12,180
	T	6,000	6,600	7,200	7,800	8,400	9,000	9,600	10,200	10,800	11,400
150	W	7,060	7,910	8,760	9,600	10,450	11,300	12,150	13,000	13,850	14,700
	T	7,350	8,100	8,850	9,600	10,350	11,100	11,850	12,600	13,350	14,100

Figure F-5. Wheeled- and tracked-vehicle moment (M_{LL} in kip-ft) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)									
		210	220	230	240	250	260	270	280	290	300
4	W	491	532	579	619	665	733	799	868	934	1,002
	T	466	502	538	586	645	707	767	823	887	948
8	W	966	1,052	1,136	1,224	1,310	1,414	1,550	1,686	1,821	1,956
	T	924	1,003	1,076	1,162	1,285	1,404	1,523	1,641	1,763	1,884
12	W	1,491	1,593	1,734	1,877	2,020	2,160	2,310	2,450	2,660	2,890
	T	1,361	1,474	1,587	1,704	1,855	2,040	2,220	2,400	2,580	2,750
16	W	1,848	1,958	2,130	2,390	2,490	2,660	2,840	3,020	3,290	3,570
	T	1,814	1,967	2,120	2,270	2,480	2,710	2,950	3,200	3,430	3,680
20	W	2,400	2,540	2,770	3,000	3,230	3,460	3,690	3,920	4,270	4,630
	T	2,270	2,460	2,650	2,840	3,100	3,400	3,690	3,990	4,290	4,600
24	W	2,800	2,970	3,240	3,500	3,700	4,040	4,310	4,580	4,990	5,410
	T	2,720	2,950	3,170	3,400	3,720	4,070	4,430	4,790	5,160	5,510
30	W	3,370	3,590	3,910	4,240	4,570	4,890	5,220	5,550	6,020	6,530
	T	3,350	3,630	3,910	4,200	4,510	4,960	5,410	5,860	6,310	6,760
40	W	4,550	4,780	5,140	5,590	6,040	6,490	6,940	7,400	7,850	8,310
	T	4,430	4,800	5,180	5,560	5,940	6,520	7,120	7,720	8,320	8,920
50	W	5,580	5,870	6,370	6,930	7,480	8,030	8,590	9,150	9,710	10,270
	T	5,490	5,950	6,430	6,900	7,380	8,040	8,790	9,540	10,290	11,040
60	W	6,680	7,030	7,410	8,070	8,740	9,410	10,050	10,760	11,430	12,110
	T	6,530	7,090	7,650	8,220	8,800	9,510	10,410	11,310	12,210	13,110
70	W	7,690	8,100	8,500	9,260	10,030	10,800	11,570	12,350	13,130	13,910
	T	7,550	8,200	8,860	9,530	10,200	10,940	11,990	13,040	14,090	15,140
80	W	8,680	9,140	9,600	10,180	11,060	11,940	12,830	13,720	14,610	15,500

Figure F-5. Wheeled- and tracked-vehicle moment (M_{LL} in kip-ft) (continued)

MLC	*Wheeled/ Tracked*	*Span Length (feet)*									
		210	***220***	***230***	***240***	***250***	***260***	***270***	***280***	***290***	***300***
80	T	8,550	9,300	10,060	10,810	11,580	12,340	13,520	14,720	15,920	17,120
90	W	9,770	10,290	10,810	11,450	12,450	13,440	14,430	15,440	16,440	17,440
	T	9,530	10,380	11,220	12,080	12,940	13,800	15,010	16,360	17,710	19,060
100	W	10,730	11,300	11,880	12,450	13,480	14,580	15,690	16,800	17,910	19,030
	T	10,500	11,440	12,380	13,330	14,280	15,230	16,450	17,950	19,450	21,000
120	W	12,870	13,570	14,260	14,940	16,170	17,490	18,820	20,200	21,500	22,800
	T	12,380	13,500	14,630	15,760	16,910	18,050	19,200	21,000	22,800	24,600
150	W	15,550	16,400	17,250	18,100	19,300	20,900	22,500	24,200	25,800	27,500
	T	14,910	16,320	17,720	19,140	20,600	22,000	23,400	24,700	27,200	29,400

Notes:
If the span length falls between two lengths listed in this table, use the column pertaining to the longer of the two.
If the moment value (in kip-feet) falls between two MLC rows, use the row pertaining to the lower and therefore more conservative MLC.

Table F-6. Wheeled- and tracked-vehicle sheer (V_{LL} in kips)

MLC	Wheeled/ Tracked	Span Length (feet) 4	6	8	10	12	14	16	18	20	25
4	W	5.00	5.00	5.26	5.60	5.84	6.28	6.62	6.88	7.10	7.48
	T	2.66	4.00	5.00	5.60	6.00	6.28	6.50	6.66	6.80	7.04
8	W	11.00	11.00	11.00	11.00	11.00	11.00	11.26	12.00	12.60	13.68
	T	4.92	7.38	9.50	10.80	11.66	12.28	12.76	13.12	13.40	13.92
12	W	16.00	16.00	16.00	16.00	16.66	17.14	18.26	19.12	19.80	21.04
	T	5.34	8.00	10.66	13.20	15.00	16.28	17.24	18.00	18.60	19.68
16	W	20.00	20.00	20.00	20.80	21.66	22.28	23.50	24.44	25.20	26.56
	T	7.12	10.66	14.22	17.60	20.00	21.72	23.00	24.00	24.80	26.24
20	W	22.00	22.66	25.50	27.20	28.34	29.14	30.76	32.00	33.00	34.80
	T	8.88	13.34	17.78	22.00	25.00	27.14	28.76	30.00	31.00	32.80
24	W	24.00	26.66	30.00	32.00	33.34	34.28	36.26	37.78	39.00	41.20
	T	11.06	16.00	21.34	26.40	30.00	32.56	34.50	36.00	37.20	39.36
30	W	27.00	29.34	33.00	35.20	36.66	37.72	40.00	41.78	43.20	45.76
	T	10.92	16.36	21.82	27.28	32.50	36.44	39.38	41.66	43.50	46.80
40	W	34.00	34.66	39.00	41.60	43.34	44.58	45.50	47.78	49.60	53.44
	T	13.34	20.00	26.66	33.34	40.00	45.72	50.00	53.34	56.00	60.80
50	W	40.00	40.00	45.00	48.00	50.00	51.42	52.50	55.12	57.20	63.20
	T	15.38	23.08	30.76	38.46	46.16	53.56	59.38	63.88	67.50	74.00
60	W	46.00	46.00	49.50	54.00	57.00	59.14	60.76	62.88	65.40	71.04
	T	17.14	25.72	34.28	42.86	51.44	60.00	67.50	73.34	78.00	86.40
70	W	51.00	51.00	57.76	63.00	66.50	69.00	70.88	73.50	76.66	82.32
	T	18.66	28.00	37.34	46.66	56.00	65.34	74.38	81.66	87.50	98.00
80	W	56.00	56.00	66.00	72.00	76.00	78.86	81.00	84.00	87.60	94.08
	T	20.00	30.00	40.00	50.00	60.00	70.00	80.00	88.88	96.00	108.80
90	W	60.00	63.00	74.26	81.00	85.50	88.72	91.12	94.50	98.56	105.84
	T	21.18	31.76	42.36	52.94	63.52	74.12	84.70	95.00	103.50	118.80

Table F-6. Wheeled- and tracked-vehicle sheer (V_{LL} in kips) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)									
		4	6	8	10	12	14	16	18	20	25
100	W	64.00	64.00	75.00	84.00	90.00	94.28	97.50	100.00	105.00	114.00
	T	22.22	33.34	44.44	55.56	66.66	77.78	88.88	100.00	110.00	128.00
120	W	72.00	72.00	90.00	100.80	108.00	113.14	77.00	120.00	126.00	136.80
	T	24.00	36.00	48.00	60.00	72.00	84.00	96.00	108.00	120.00	144.00
150	W	84.00	84.00	94.50	109.20	119.00	126.00	131.26	135.34	140.80	155.04
	T	25.00	37.50	50.00	62.50	75.00	87.50	100.00	112.50	125.00	156.00

MLC	Wheeled/ Tracked	Span Length (feet)										
		30	35	40	45	50	55	60	70	80	90	100
4	W	7.74	7.92	8.06	8.16	8.24	8.30	8.36	8.46	8.52	8.58	8.62
	T	7.20	7.32	7.40	7.46	7.52	7.56	7.60	7.66	7.70	7.74	7.76
8	W	14.40	14.92	15.30	15.60	15.84	16.04	16.20	16.46	16.66	16.80	16.92
	T	14.26	14.52	14.70	14.84	14.96	15.06	15.14	15.26	15.36	15.42	15.48
12	W	21.86	22.46	22.90	23.24	23.52	23.74	24.26	25.08	25.70	26.18	26.56
	T	20.40	20.92	21.30	21.60	21.84	22.04	22.20	22.46	22.64	22.80	22.92
16	W	27.46	28.12	28.60	28.98	29.28	29.52	29.74	30.68	31.48	32.08	32.58
	T	27.20	27.88	28.40	28.80	29.12	29.38	29.60	29.94	30.20	30.40	30.56
20	W	36.00	36.86	37.50	38.00	38.40	38.72	39.00	39.94	40.96	41.74	42.36
	T	34.00	34.86	35.50	36.00	36.40	36.72	37.00	37.44	37.76	38.00	38.20
24	W	42.66	43.72	44.50	45.12	45.60	46.00	46.34	46.92	48.06	48.94	49.64
	T	40.80	41.84	42.60	43.20	43.68	44.08	44.40	44.92	45.30	45.60	45.84
30	W	47.46	48.68	49.60	50.32	51.20	52.72	54.00	56.00	57.50	58.66	59.60
	T	49.00	50.56	51.76	52.66	53.40	54.00	54.50	55.28	55.88	56.34	56.70
40	W	57.86	61.02	63.40	65.24	66.72	68.84	70.94	74.22	76.70	78.62	80.16
	T	64.00	66.28	68.00	69.34	70.40	71.28	72.00	73.14	74.00	74.66	75.20
50	W	69.34	73.72	77.00	80.62	84.16	87.06	89.46	93.26	96.10	98.32	100.08
	T	78.34	81.44	83.76	85.56	87.00	88.18	89.16	90.72	91.88	92.78	93.50

Table F-6. Wheeled- and tracked-vehicle sheer (V_{LL} in kips) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)										
		30	**35**	**40**	**45**	**50**	**55**	**60**	**70**	**80**	**90**	**100**
60	W	79.86	84.18	90.90	94.58	97.52	99.92	102.86	108.18	112.16	115.24	117.72
	T	92.00	96.00	99.00	101.34	103.20	104.72	106.00	108.00	109.50	110.66	111.20
70	W	91.94	98.80	103.96	107.96	111.16	113.78	116.44	122.80	127.58	131.28	134.26
	T	105.00	110.00	113.76	116.66	119.00	120.92	122.50	125.00	126.88	128.34	129.50
80	W	98.40	106.52	113.20	118.40	122.56	125.96	128.80	133.26	139.40	144.36	148.32
	T	117.34	123.44	128.00	131.56	134.40	136.72	138.66	141.72	144.00	145.78	147.20
90	W	110.70	119.82	127.36	133.20	137.88	141.70	144.90	149.92	156.82	162.40	166.86
	T	129.00	136.28	141.76	146.00	149.40	152.18	154.50	158.14	160.88	163.00	164.70
100	W	120.04	129.14	138.00	144.88	150.40	154.90	158.66	164.58	169.38	176.12	181.50
	T	140.00	148.56	155.00	160.00	164.00	167.28	170.00	174.28	177.50	180.00	182.00
120	W	144.04	154.98	165.60	173.86	180.48	185.88	190.40	197.48	203.20	211.40	217.80
	T	160.00	171.42	180.00	186.66	192.00	196.36	200.00	205.80	210.00	213.40	216.00
150	W	165.96	171.32	178.90	191.52	202.40	210.80	218.00	229.40	243.20	254.00	262.60
	T	180.00	197.14	210.00	220.00	228.00	234.60	240.00	248.60	255.00	260.00	264.00

MLC	Wheeled/ Tracked	Span Length (feet)									
		110	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
4	W	8.66	9.04	9.66	10.26	10.78	11.22	11.62	11.98	12.30	12.58
	T	7.88	8.54	9.12	9.60	10.02	10.40	10.72	11.02	11.28	11.52
8	W	17.02	17.50	18.56	19.80	20.88	21.82	22.66	23.40	24.06	24.66
	T	15.66	16.94	18.10	19.08	19.94	20.70	21.36	21.96	22.48	22.96
12	W	26.88	27.14	27.54	28.42	30.26	32.08	33.72	35.18	36.48	37.66
	T	23.04	24.40	26.20	27.78	29.12	30.30	31.34	32.26	33.10	33.84
16	W	33.00	33.30	33.78	34.82	37.10	39.34	41.38	43.18	44.82	46.28
	T	30.70	32.54	34.96	37.02	38.82	40.40	41.78	43.02	44.12	45.12

Table F-6. Wheeled- and tracked-vehicle sheer (V_{LL} in kips) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)									
		110	120	130	140	150	160	170	180	190	200
20	W	42.88	43.30	43.90	45.26	48.24	51.16	53.78	56.14	58.24	60.12
	T	38.38	40.66	43.70	46.28	48.54	50.50	52.24	53.78	55.16	56.40
24	W	50.22	50.70	51.42	53.02	56.56	59.96	63.02	65.74	67.34	70.36
	T	46.06	48.80	52.44	55.54	58.24	60.60	62.68	64.54	66.18	67.68
30	W	60.36	61.00	61.90	63.82	67.84	71.96	74.72	79.06	82.06	84.76
	T	57.00	59.10	63.70	67.72	71.20	74.26	76.94	79.34	81.48	83.40
40	W	81.42	82.46	83.36	85.72	88.48	93.50	98.72	103.68	108.12	112.12
	T	75.64	77.78	83.70	89.14	93.86	98.00	101.64	104.88	107.78	110.40
50	W	101.52	102.74	103.76	106.92	110.58	116.80	123.20	129.24	134.66	139.52
	T	94.08	96.16	103.08	110.00	116.00	121.26	125.88	130.00	133.68	137.00
0	W	119.74	121.42	122.86	124.82	127.14	134.36	141.98	149.48	156.34	162.52
	T	112.36	114.28	121.84	130.28	137.60	144.00	149.64	154.66	159.16	163.20
70	W	136.70	138.72	140.44	142.70	147.76	153.30	161.98	170.62	178.62	185.78
	T	130.46	132.22	140.00	150.00	158.66	166.26	172.94	178.88	184.20	189.00
80	W	151.56	154.26	156.56	158.52	163.42	168.70	175.90	185.24	194.86	203.60
	T	148.36	150.00	157.70	169.14	179.20	187.78	195.54	202.40	208.60	214.20
90	W	170.50	173.54	176.12	178.32	183.84	189.78	197.70	208.40	219.20	229.00
	T	166.08	167.64	175.12	187.72	199.20	209.20	218.20	226.00	233.00	239.40
100	W	185.90	189.58	192.70	195.36	200.00	207.00	213.80	224.40	235.80	247.00
	T	183.64	185.18	192.30	205.80	218.60	230.00	240.00	248.80	256.80	264.00
120	W	223.00	227.60	231.20	234.40	240.00	248.40	256.40	269.20	283.00	296.40
	T	218.20	220.00	226.20	240.00	256.00	270.00	282.40	293.40	303.20	312.00
150	W	269.60	275.40	280.40	284.60	289.60	299.60	309.60	320.60	336.40	352.60
	T	267.20	270.00	274.00	285.80	304.00	322.60	338.80	353.40	366.40	378.00

Table F-6. Wheeled- and tracked-vehicle sheer (V_{LL} in kips) (continued)

MLC	Wheeled/ Tracked	Span Length (feet)									
		210	220	230	240	250	260	270	280	290	300
4	W	12.84	13.08	13.40	13.92	14.44	14.94	15.38	15.80	16.18	16.54
	T	11.74	12.10	12.62	13.10	13.54	13.94	14.32	14.66	14.98	15.28
8	W	25.20	25.68	26.20	27.06	28.08	29.08	30.00	30.86	31.66	32.40
	T	23.40	24.06	25.10	26.04	26.92	27.74	28.48	29.18	29.84	30.44
12	W	38.72	39.70	40.58	41.38	42.12	43.00	44.30	45.82	47.34	48.76
	T	34.52	35.16	36.46	37.94	39.32	40.56	41.74	42.82	43.82	44.76
16	W	47.60	48.80	49.88	50.90	51.82	52.86	54.44	56.32	58.20	59.96
	T	46.02	46.86	48.62	50.60	52.42	54.10	55.64	57.08	58.42	59.68
20	W	61.82	63.38	64.80	66.10	67.30	68.64	70.72	73.16	75.60	77.88
	T	57.52	58.58	60.78	63.24	65.52	67.62	69.56	71.36	73.04	74.60
24	W	72.34	74.14	75.80	77.30	78.68	80.28	82.72	85.58	88.42	91.08
	T	69.02	70.30	72.94	75.90	78.62	81.14	83.46	85.62	87.64	89.52
30	W	87.20	89.42	91.44	93.30	95.00	96.96	99.82	103.20	106.68	109.92
	T	85.14	86.72	88.94	92.62	96.12	99.34	102.34	105.10	107.68	110.10
40	W	115.74	119.02	122.02	124.76	127.30	129.64	132.42	135.40	139.62	144.08
	T	112.76	114.90	117.40	122.00	126.72	131.08	135.12	138.86	142.34	145.60
50	W	143.92	147.92	151.58	154.94	158.02	160.86	164.38	168.22	173.46	178.96
	T	140.00	142.72	145.48	150.62	156.60	162.12	167.22	171.96	176.38	180.50
60	W	168.12	173.20	177.84	182.10	186.02	189.64	192.98	197.20	201.84	207.74
	T	166.86	170.18	173.30	178.58	185.76	192.46	198.66	204.40	209.80	214.80
70	W	192.26	198.16	203.60	208.40	213.00	217.20	221.20	226.00	231.20	237.80
	T	193.34	197.28	200.80	206.20	214.20	222.20	229.40	236.20	242.60	248.60
80	W	211.40	218.40	225.00	231.00	236.40	241.40	246.20	250.60	256.20	262.00
	T	219.20	224.00	228.20	233.40	242.00	251.00	259.60	267.40	274.80	281.60
90	W	237.80	245.80	253.20	259.80	266.00	271.60	277.00	281.80	288.20	294.80
	T	245.20	250.40	255.20	260.20	269.00	279.40	289.00	298.00	306.40	314.20

Table F-6. Wheeled- and tracked-vehicle sheer (V_{LL} in kips) (continued)

MLC	*Wheeled/ Tracked*	*Span Length (feet)*									
100	W	257.20	266.40	274.80	282.60	289.60	296.20	302.20	307.80	313.60	321.20
	T	370.40	276.40	281.80	287.00	295.40	307.00	317.80	327.80	337.20	346.00
120	W	308.60	319.60	329.80	339.00	347.60	355.40	362.80	369.40	376.40	385.40
	T	320.00	327.20	334.00	340.00	348.00	360.00	373.40	385.80	397.20	408.00
150	W	368.20	382.40	395.54	407.20	418.20	428.80	437.60	446.20	454.20	463.00
	T	388.60	398.20	407.00	415.00	422.60	432.60	446.80	462.80	478.00	492.00

Notes:
If the span length falls between two lengths listed in this table, use the column pertaining to the longer of the two.
If the shear value (in kips) falls between two MLC rows, use the row pertaining to the lower and therefore more conservative MLC.

Table F-7. Profile factors

Profile	***Factor***	***Remarks***
For span-to-rise ratio up to 4	1.0	For a given load, a flat arch of steeper profile (although it has a very large rise) may fail due to the crown's action as a smaller, flatter arch.
For span-to-rise ratio over 4	See figure F-16, page F-38.	

Table F-8. Arch factors

<table>
<tr><th colspan="3">Material Factors</th></tr>
<tr><th colspan="2">Type of Material</th><th>Factor</th></tr>
<tr><td colspan="2">Granite, white stone, or built-in course masonry</td><td>1.50</td></tr>
<tr><td colspan="2">Concrete or blue engineering bricks</td><td>1.20</td></tr>
<tr><td colspan="2">Good limestone masonry and building bricks</td><td>1.00</td></tr>
<tr><td colspan="2">Poor masonry or any kind of brickwork</td><td>0.50</td></tr>
<tr><th colspan="3">Joint Factors</th></tr>
<tr><th colspan="2">Type of Joint</th><th>Factor</th></tr>
<tr><td colspan="2">Thin joints, 1/10 inch or less in width</td><td>1.25</td></tr>
<tr><td colspan="2">Normal joints, width to 1/4 inch, pointed mortar</td><td>1.00</td></tr>
<tr><td colspan="2">Normal joints, mortar unpointed</td><td>0.90</td></tr>
<tr><td colspan="2">Joint over 1/4 inch, irregular good mortar</td><td>0.80</td></tr>
<tr><td colspan="2">Joint over 1/4 inch, mortar with voids deeper than 1/10 of the ring thickness</td><td>0.70</td></tr>
<tr><td colspan="2">Joints 1/2 inch or more, poor mortar</td><td>0.50</td></tr>
<tr><th colspan="3">Deformations</th></tr>
<tr><th>Condition</th><th>Adjustment</th><th>Note</th></tr>
<tr><td>The rise over the affected portion is always positive.</td><td>Span-to-rise ratio of affected portion to whole arch applied.</td><td rowspan="3">Arch ring deformation may be due to partial failure of the ring (usually accompanied by a sag in the parapet) or movement at the abutment.</td></tr>
<tr><td>Distortion produces a flat section of profile.</td><td>Maximum MLC = 12.</td></tr>
<tr><td>A portion of the ring is sagging.</td><td>Maximum MLC = 5 only if fill at crown > 18 inches.</td></tr>
<tr><th colspan="3">Abutment Size Factors</th></tr>
<tr><th>Type of Abutment</th><th>Factor</th><th>Note</th></tr>
<tr><td>Both abutments satisfactory</td><td>1.00</td><td rowspan="6">An abutment may be regarded as inadequate to resist the full thrust of the arch if—
• The bridge is on a narrow embankment, particularly if the approaches slope steeply up to the bridge.
• The bridge is on an embanked curve.
• The abutment walls are very short and suggest little solid fill behind the arch.</td></tr>
<tr><td>One abutment unsatisfactory</td><td>0.95</td></tr>
<tr><td>Both abutments unsatisfactory</td><td>0.90</td></tr>
<tr><td>Both abutments massive but a clay fill suspected</td><td>0.70</td></tr>
<tr><td>Arch carried on one abutment and one pier</td><td>0.90</td></tr>
<tr><td>Arch carried on two piers</td><td>0.80</td></tr>
</table>

Table F-8. Arch factors

<table>
<tr><th colspan="3">Abutment Fault Factors</th></tr>
<tr><th colspan="2">Type of Fault</th><th>Factor</th></tr>
<tr><td colspan="2">Inward movement of one abutment</td><td>0.50</td></tr>
<tr><td colspan="2">Outward spread of abutments</td><td>0.50</td></tr>
<tr><td colspan="2">Vertical settlement of one abutment</td><td>0.50</td></tr>
<tr><th colspan="3">Crack Factors</th></tr>
<tr><th>Type of Crack</th><th>Factor</th><th>Note</th></tr>
<tr><td>Longitudinal cracks within 2 feet of the edge of the arch; wider than ¼ inch and longer than 1/10 of the span, in bridges.
• Wider than 20 feet between parapets.
• Narrower than 20 feet between parapets.</td><td>1.00
0.70</td><td>This type of longitudinal crack is due to an outward force on the spandrel walls caused by a lateral spread of the fill.</td></tr>
<tr><td>Longitudinal cracks in middle third of the ridge with—
• One small crack under 1/8 inch wide and shorter than 1/10 of the span.
• Three or more small cracks as above.
• One large crack wider than ¼ inch and longer than 1/10 of the span.</td><td>1.00
0.50
0.50</td><td>This type of longitudinal crack is due to varying amount of subsiding along the length of the abutment. Large cracks are danger signs which indicate that the arch ring has broken up into narrower, independent rings.</td></tr>
<tr><td>Lateral and diagonal cracks less than 1/8 inch wide and shorter than 1/10 of the arch width</td><td rowspan="2">1.00</td><td rowspan="2">Lateral cracks, usually found near the quarter points, are due to permanent deformation of the arch, which may be caused by partial collapse of the arch or by abutment movement.
Diagonal cracks, usually starting near the sides of the arch at the springing and spreading toward the center of the arch at the crown, are probably due to subsiding at the sides of the abutment.</td></tr>
<tr><td>Lateral and diagonal cracks wider than ¼ inch and longer than 1/10 of the arch width: Restrict load classification to 12 or to the calculated classification using all other applicable factors, whichever is less.</td></tr>
<tr><td>Cracks between the arch ring and spandrel or parapet wall greater than 1/10 of the span due to fill spread</td><td rowspan="2">0.90</td><td rowspan="2">Cracks indicate that the bridge is in a dangerous condition due to spreading of the fill pushing the wall outward or movement of a flexible ring away from a stiff fill, so that the two act independently. The latter type of failure often produces cracks in the spandrel wall near the quarter points.</td></tr>
<tr><td>Cracks between the arch ring and spandrel or parapet wall due to a dropped ring: Reclassify from the nomograph, taking the crown thickness as that of the ring alone.</td></tr>
</table>

Table F-9. Minimum roadway widths

Roadway Width (meters)	*Bridge Classification*	
	One-Way	***Two-Way***
2.75 to 3.34	12	0
3.35 to 3.99	30	0
4 to 4.49	60	0
4.5 to 4.99	100	0
5 to 5.4	150	0
5.5 to 7.2	150	30
7.3 to 8.1	150	60
8.2 to 9.7	150	100
Over 9.8	150	150

Note. Minimum overhead clearance for all classes is 4.3 meters.

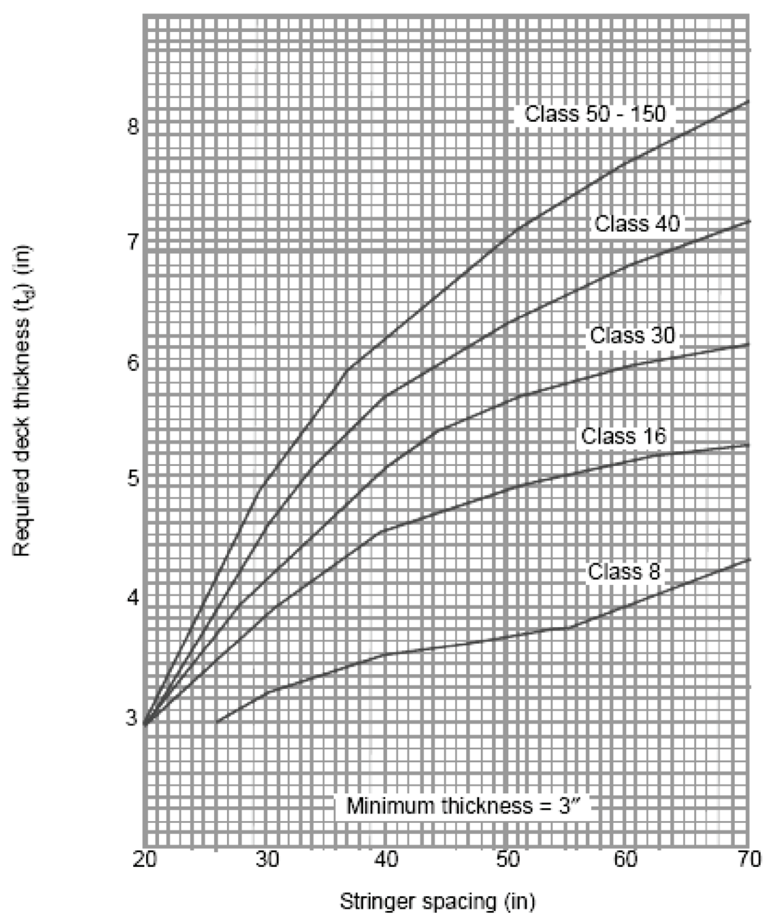


Figure F-12. Timber deck classification

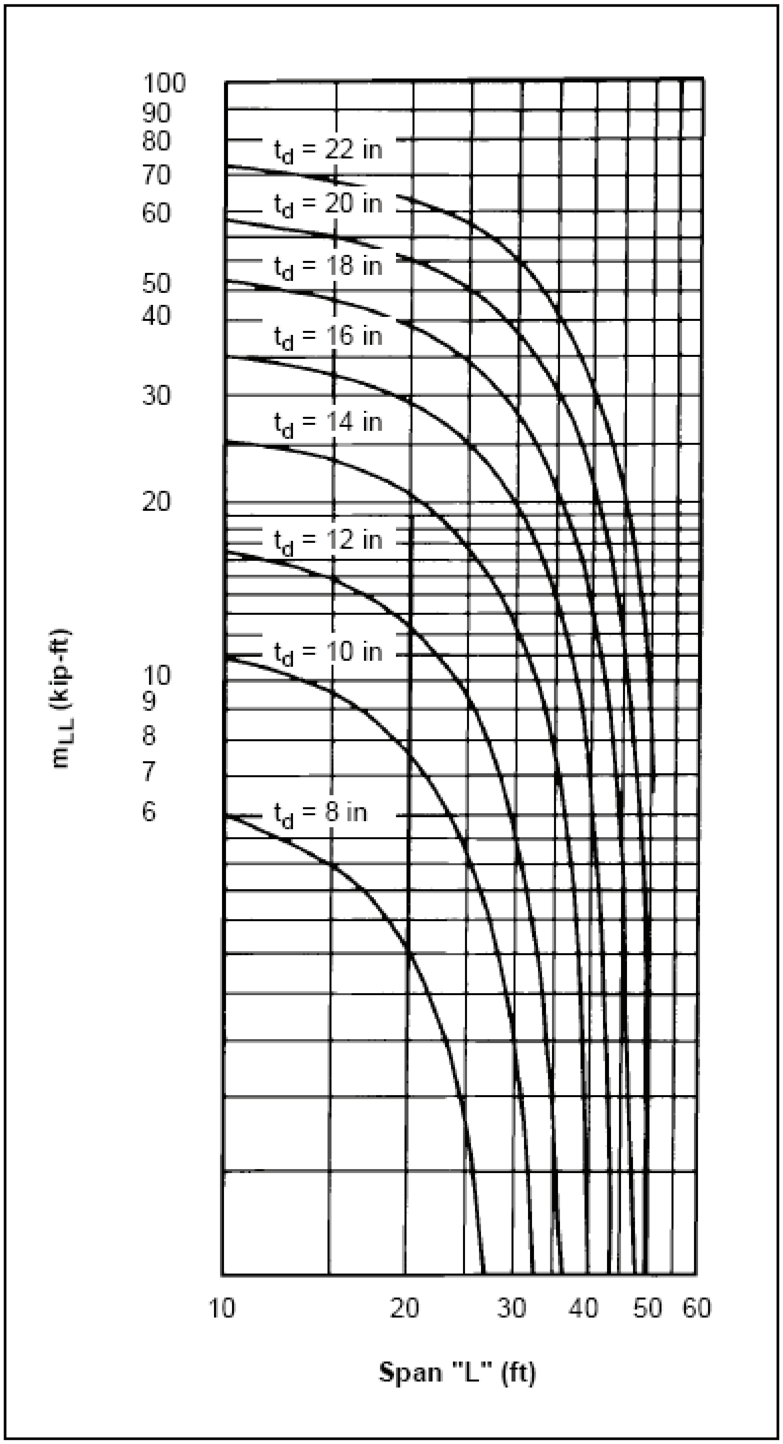


Figure F-13. Live-load moment for a 12-inch reinforced concrete strip

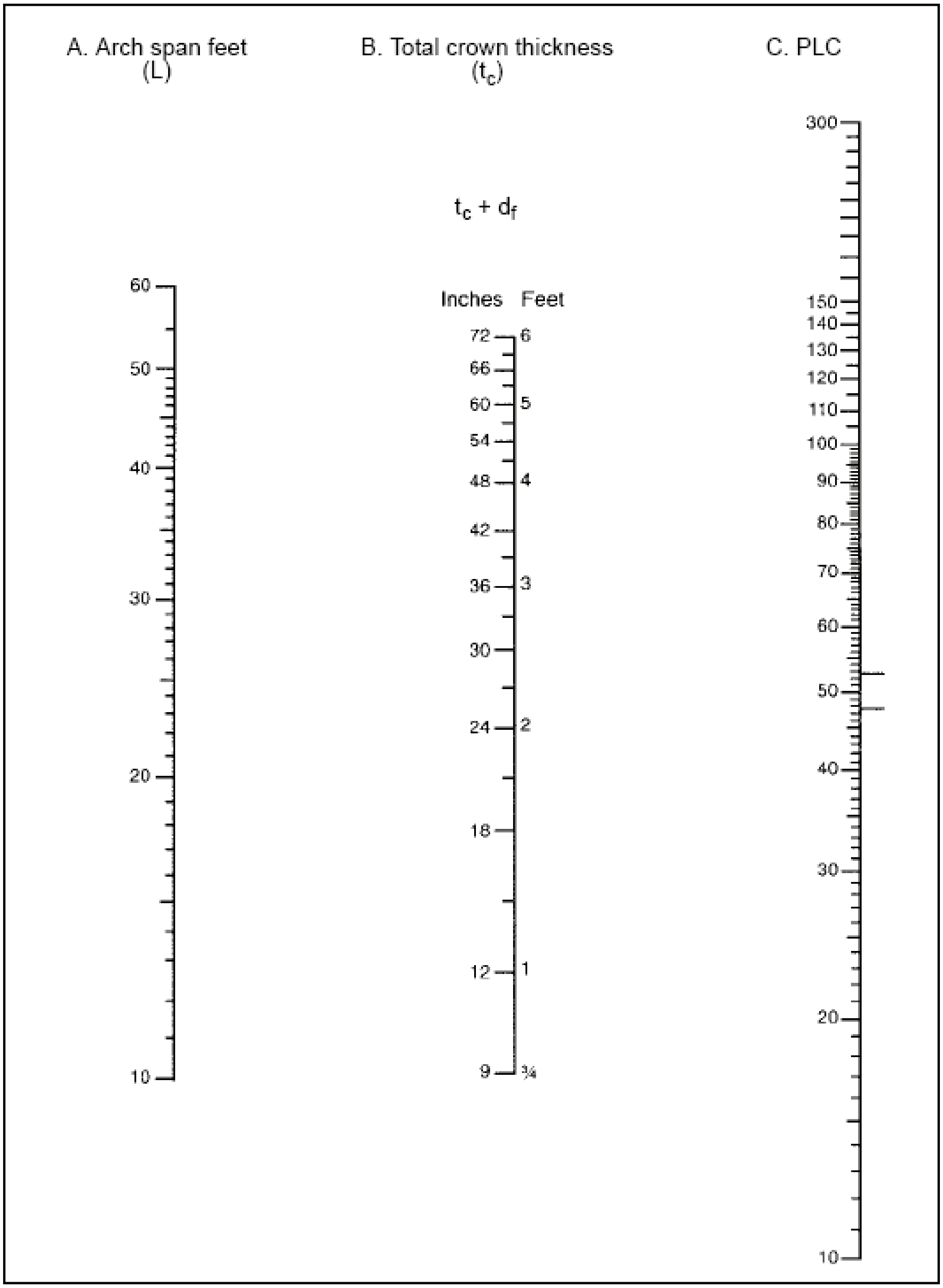


Figure F-14. Masonry arch PLC

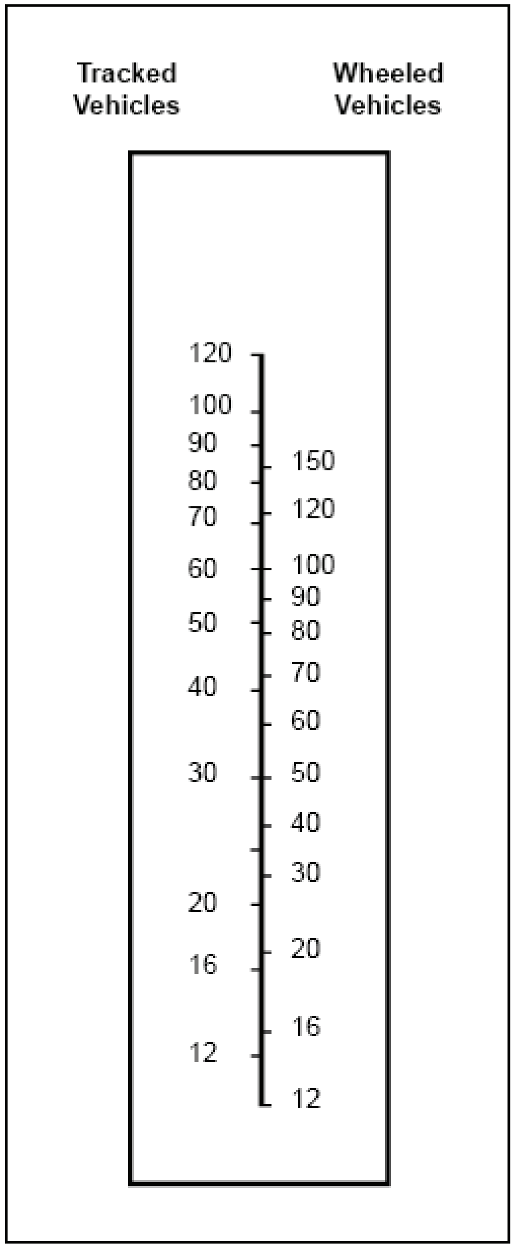


Figure F-15. Bridge classification

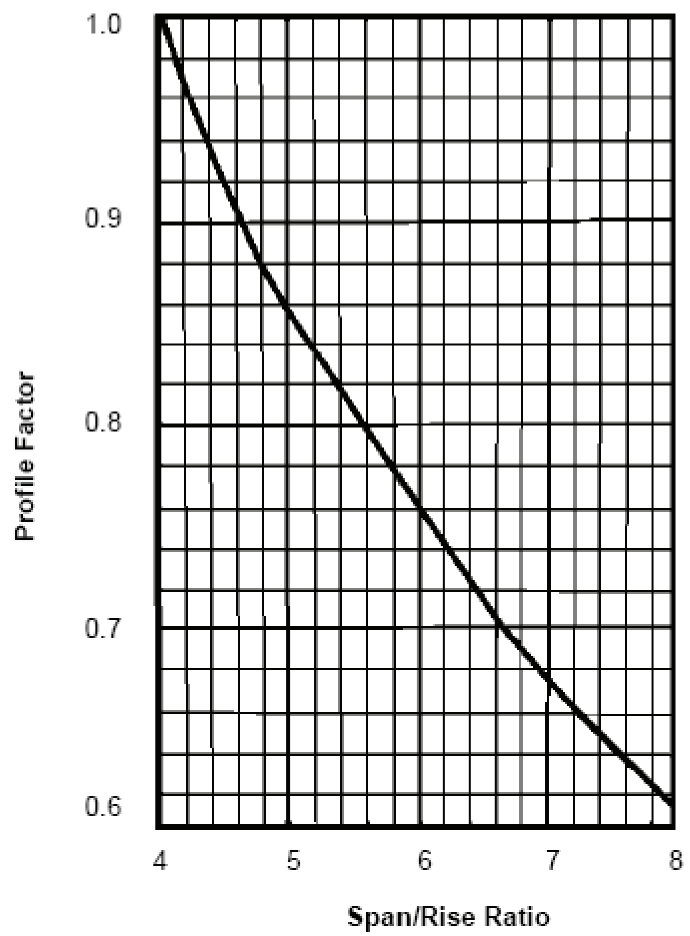


Figure F-16. Profile factors for arch bridges

Appendix G

Signs

Posting signs at bridges and at other constrictions or key locations along a route promotes efficient traffic control and limits the impact of hazardous areas along the route. Signs are used when it is necessary to identify special controls placed on a bridge or route section, to warn vehicle operators of hazardous areas or conditions, and to identify holding areas, turnouts for parking and unloading vehicles, and checkpoints. Procedures for posting military routes are standardized for the United States and Allied Nations. However, this system may be integrated into other road-sign systems in accordance with military requirements.

Note. This appendix implements STANAG 2454 and Allied Publication AMovP-1, *Road Movements and Movement Control*.

ROUTE SIGNS

G-1. There are three general types of standard route signs—hazard, regulatory, and guide. Table G-1 on page G-2 lists the way each type may be used. The size of these signs is not prescribed; however, they must be large enough to be easily read under poor lighting conditions. Exceptions to this rule are bridge classification signs for which dimensions are specified. As a guide, signs for civil international road use usually are not less than 16 inches square.

Table G-1. Typical hazard, regulatory, and guide signs

	Type		
	Hazard	***Regulatory***	***Guide***
Application	Advance warning of stop signs and traffic signals	No entry	Detour
	Changes in road width	One way	Detour begins
	Crossroad	Parking restrictions	Detour ends
	Curves	Specific regulations for vehicles	Directions
	Danger or hazard	Speed limit	Distances
	Dangerous corner	Stop	Information to help driver
	Dips	Bridge classification	Locations
	Junction T		Route number
	Junction Y		
	Level railroad crossing, advance warning		
	Men working		
	Railroad crossing		
	Road construction repairs		
	Road narrows		
	Slippery road		
	Steep grades		
	Steep hill		
	Turns		

HAZARD SIGNS

G-2. Hazard signs indicate traffic hazards and require coordination with civil authorities. Hazard signs are square and are installed in a diamond position (see figures G-1 and G-2). A military hazard sign has a yellow background with the legend or symbol inscribed in black. The wording on these signs is in the language or languages determined by the authority erecting the sign. (See FM 3-34.210 for information on explosive hazard signs.)

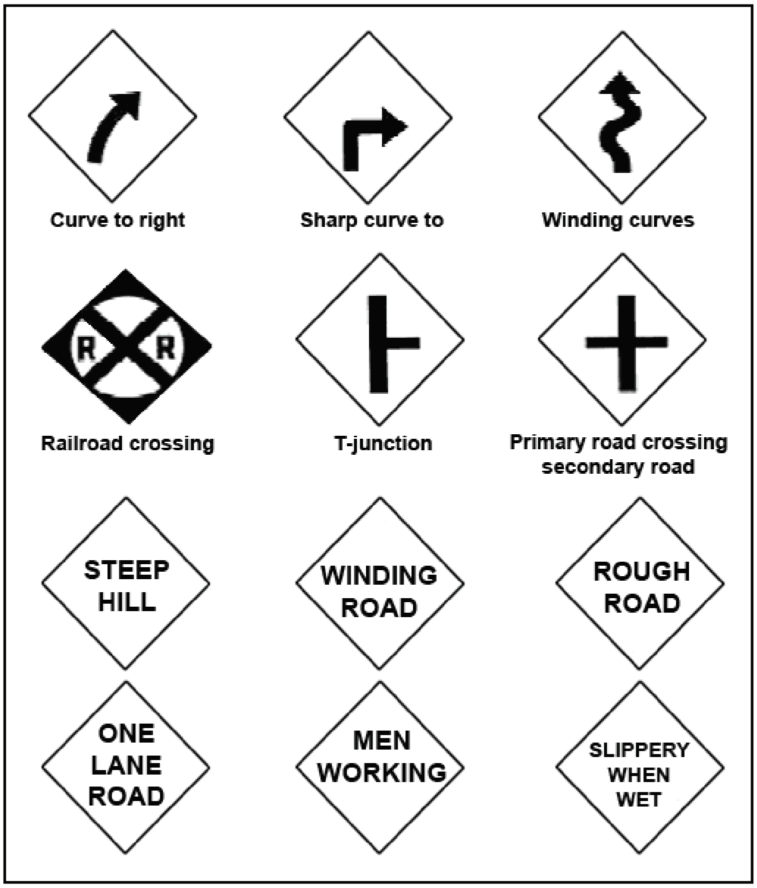


Figure G-1. Example of hazard signs not included in the Geneva Convention

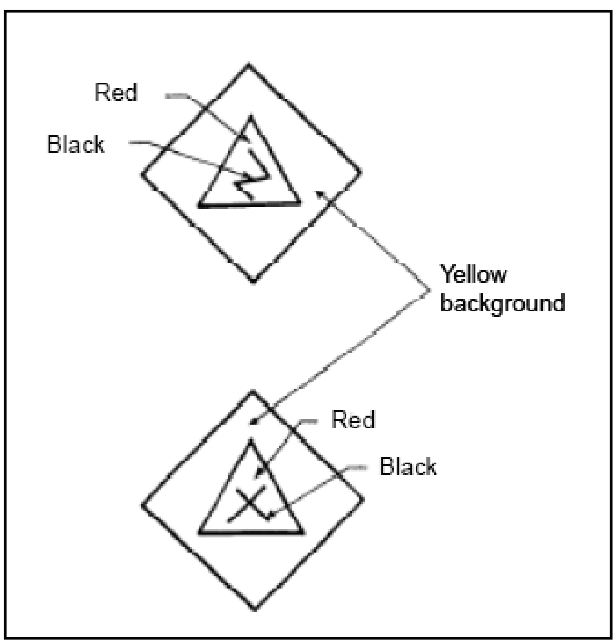


Figure G-2. Example of hazard signs included in the Geneva Convention

REGULATORY SIGNS

G-3. Regulatory signs regulate and control traffic. Regulatory signs include enforcement and warning signs. Warning signs are placed in advance of the enforcement sign to provide vehicle operators with advance notice of the enforcement area. Examples of regulatory signs include bridge classification signs, stop signs, no-entry signs, and signs that define the light line (the line where vehicles must use blackout lights at night). Regulatory signs have a black background on which the legend or symbol is superimposed in white.

> ***Note.*** Exceptions to these rules are bridge classification signs, stop signs, no-entry signs, and signs that apply to civil as well as military traffic. Check with civilian authorities to ensure compliance when erecting signs in areas with civilian traffic.

G-4. Example regulatory signs are shown in figure G-3. Two warning signs are located, according to the terrain, prior to the enforcement sign. Locate the first warning sign 200 to 500 meters before the regulatory sign.

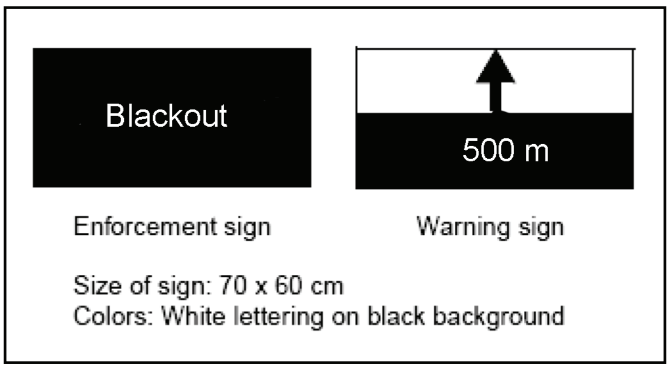


Figure G-3. Warning and enforcement signs

Bridge and Raft Signs

G-5. All classified vehicles and bridges in the theater of operations require classification signs. Bridge signs are circular with yellow background and black inscriptions. Sign diameters are a minimum of 40 centimeters for one-lane bridges and 50 centimeters for two-lane bridges. (See figure G-4.) A two-lane bridge has two numbers, side by side, on the sign.

- The number on the left is the bridge classification when both lanes are in use at the same time.
- The number on the right indicates the classification if the bridge is carrying one-way traffic and the vehicles proceed along the centerline of the bridge.

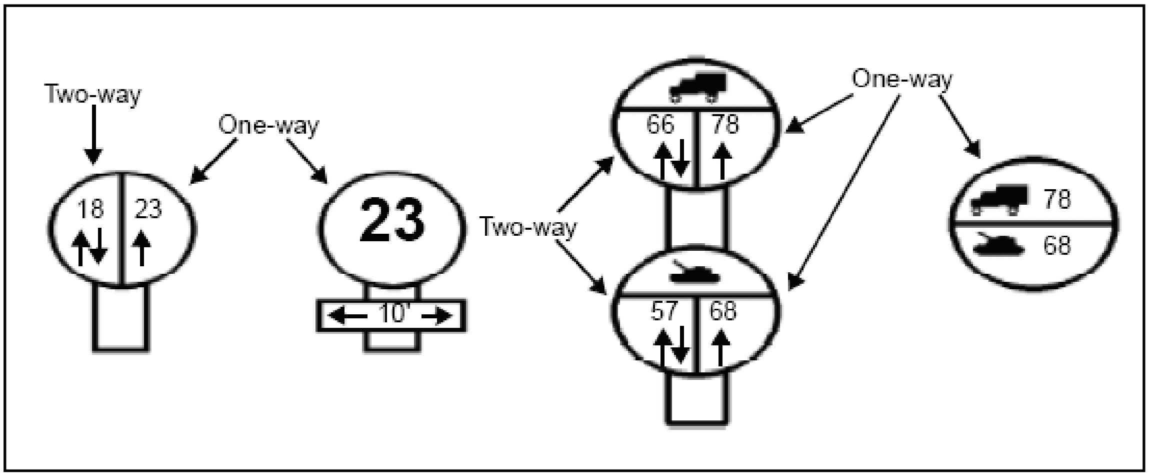


Figure G-4. Bridge signs

G-6. For bridges with separate classifications for wheeled and tracked vehicles (dual classification), use a special circular sign that indicates both classifications (only applicable if the classification is over 50) (see the right side of figure G-4). Use a separate rectangular sign, if necessary, to show the bridge's width limitations. For one-way or two-way traffic bridges, the sign is to be a minimum of 50 centimeters.

Rectangular Bridge Signs

G-7. Additional instructions and technical information are posted on rectangular signs, which are a minimum of 41 centimeters in height or width and have a yellow background with the appropriate letters and symbols in black. Write the figures as large as the sign permits. Theater commanders may make special arrangements to indicate vehicles of exceptional width or to indicate low overhead obstructions. Use separate signs to show width or height limitations (see figure G-6, page G-6) or technical information (see figure G-5). Width and height signs are not required on bridges where existing civilian signs are in place and sufficiently clear.

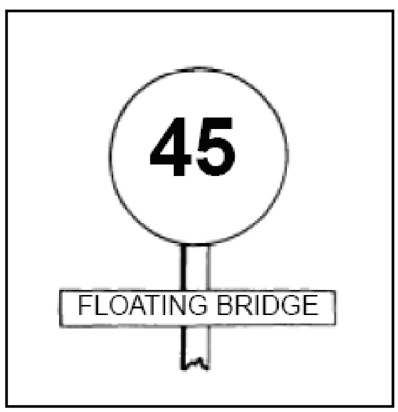


Figure G-5. Bridge sign containing technical information

Width and Height Restrictions

G-8. Table F-9, page F-34, lists minimum roadway width restrictions for given bridge classifications. If a one-lane bridge does not meet width requirements, post a rectangular warning sign under the classification sign showing the actual clear width (see figure G-6, page G-6). If this is a route restriction, annotate it in the route classification formula. For a two-lane bridge, downgrade the two-way classification to the highest class for which it does qualify (one-way class is not affected). Post a limited-clearance sign if the overhead clearance is less than 4.3 meters. These signs must be a minimum of 3 to 5 meters in height or width, with a yellow background, and the appropriate description in black letters. Separate rectangular signs are used if necessary to denote width limitations, height limitations, or other technical information. The same signs are used for tunnels, if applicable.

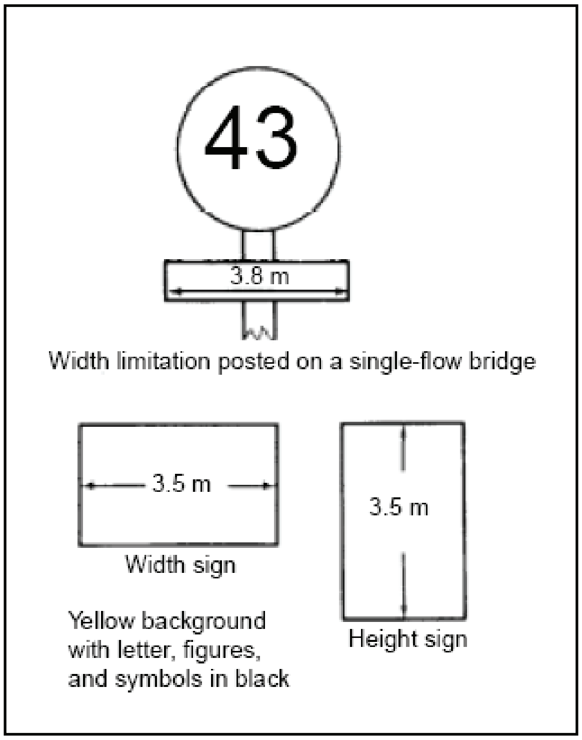


Figure G-6. Width and height signs

Multilane Bridge Signs

G-9. Bridges of three or more lanes are special cases that require individual consideration; the minimum widths for respective load classifications (see table F-9, page F-34) are used. In some cases, heavier loads can be carried on a restricted lane rather than on the other lanes (see figure G-7 and figure G-8). Under such circumstances, post standard bridge-classification signs for each lane and mark the restricted lanes with barricades, painted lines, or studs.

Bridge Sign Placement

G-10. Ensure that signs are placed properly (as listed below) to maintain uninterrupted traffic across a bridge.

- The bridge classification sign is placed at both ends of the bridge in a position that is clearly visible to all oncoming traffic.
- Rectangular signs, other than those indicating height restrictions, are placed immediately below the bridge classification (circular) signs.
- Signs that indicate height restrictions are placed centrally on the overhead obstruction.
- Special classification numbers are never posted on standard bridge-marking signs.
- Appropriate advance warning signals are placed on bridge approaches, as required.

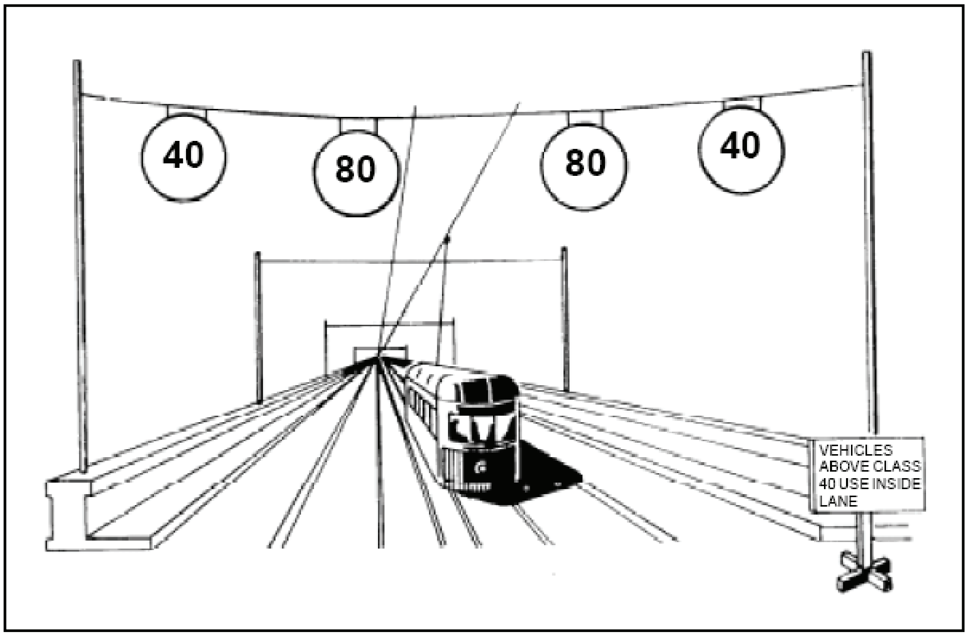


Figure G-7. Typical multilane bridge classification

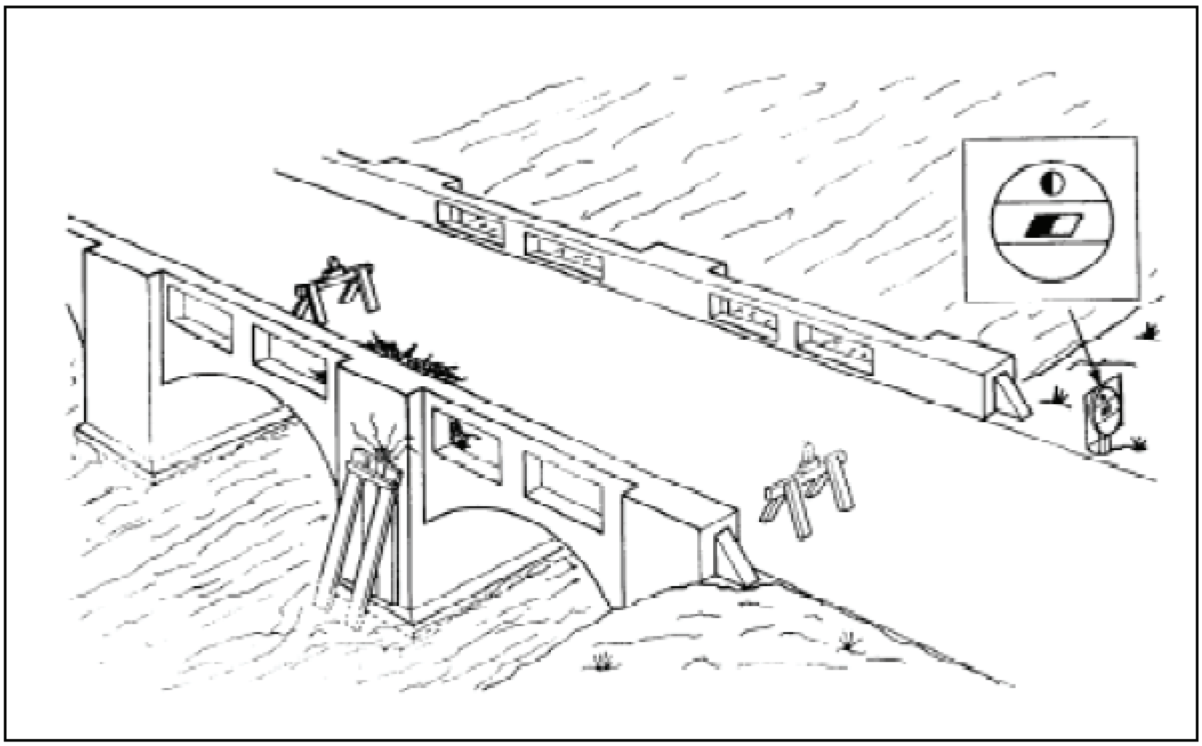


Figure G-8. Example of posting a damaged bridge

GUIDE SIGNS

G-11. Guide signs indicate direction or location. These signs consist of the military route number and the appropriate directional disk. If standard signs are not available, construct military route guide signs by placing a directional disk over a rectangular panel upon which the route number is inscribed (see figure G-9).

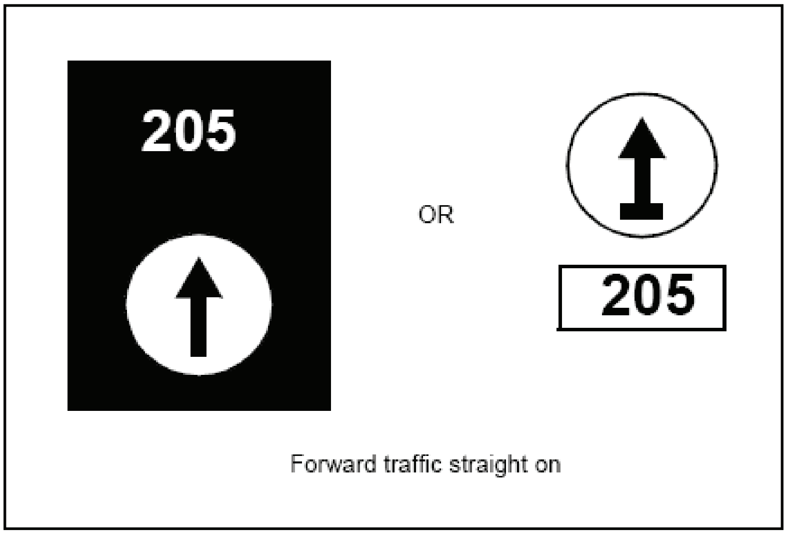


Figure G-9. Military route guide signs for axial routes

Directional Disks

G-12. A directional disk consists of a fixed black arrow, with or without a bar, on a white background. Eight equally spaced holes around the edges of the circumference allow the disk to be nailed with the arrow pointing in the desired direction. These disks are no smaller than 12 inches in diameter (see figure G-10). They are used as standard guide signs to indicate military axial and lateral routes. Directional disks may be used together with unit signs to indicate direction to locations of major units (groups and above). Smaller units may not use directional disks. However, any arrow sign that provides a different shape and color from the standard direction disks can be used to indicate smaller units.

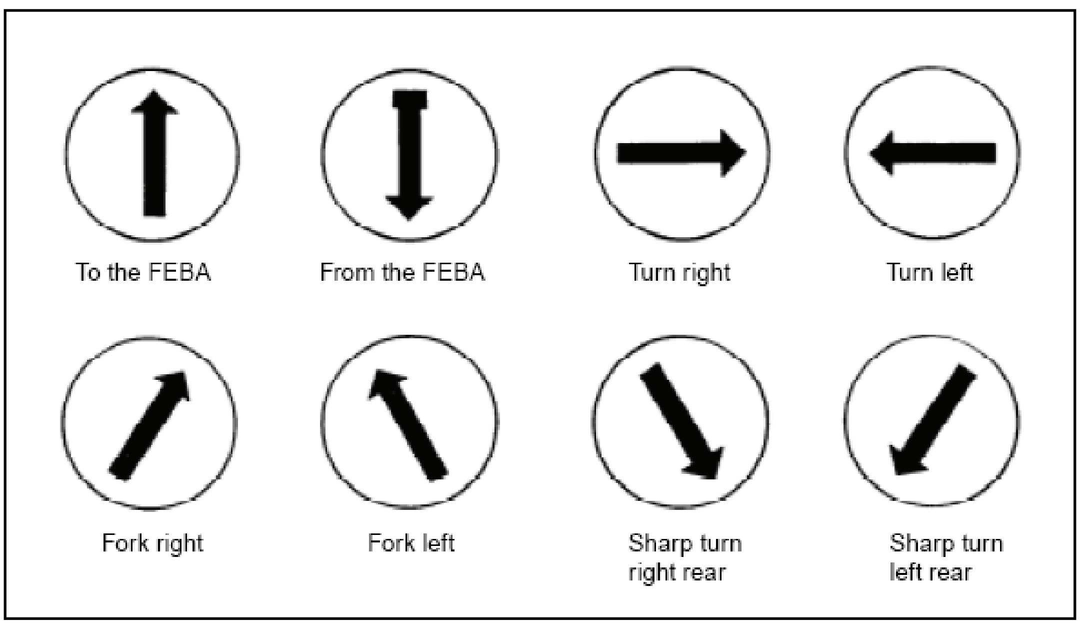


Figure G-10. Example of directional arrow disks

Headquarters and Logistical Signs

G-13. Use these signs to mark a headquarters and logistical installation. Use the appropriate military symbol (see FM 1-02). The inscription is black on a yellow background. This symbol may be supplemented by national distinguishing symbols or abbreviations. For division headquarters and above, nationality is always indicated. Colors other than black or yellow are prohibited except for national distinguishing symbols.

Casualty Evacuation Route Signs

G-14. Indicate casualty evacuation routes on rectangular signs (see figure G-11). The signs have a white background with red inscriptions of a directional arrow, a red cross (red crescent for Turkey), and a unit or subunit designation (if required). An alternate sign may be made from a white disk with four segments cut out to give an X shape. The inscriptions are shown in red.

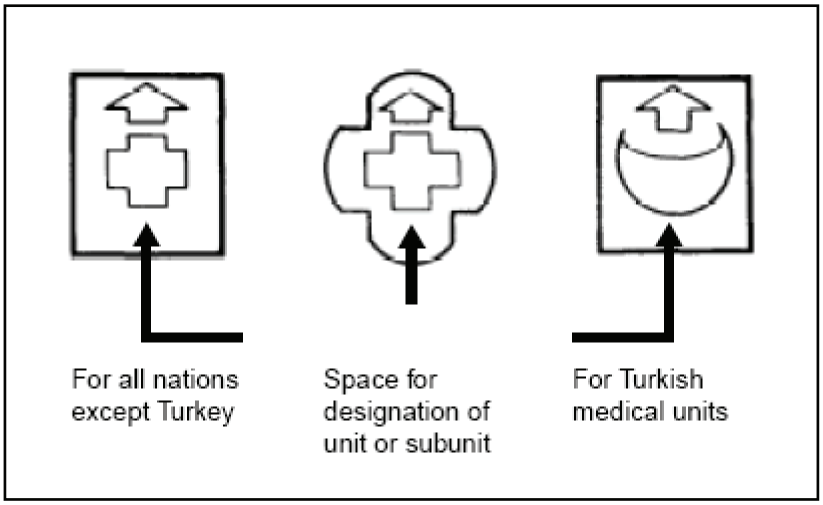


Figure G-11. Example of guide signs for casualty evacuation routes

Unit Direction Arrow

G-15. Use temporary unit direction arrows to mark march routes (see figure G-12). In addition to the direction arrow, include the unit identification symbol as part of the inscription. Unit route signs are placed in advance of the moving column and are picked up by a trail vehicle.

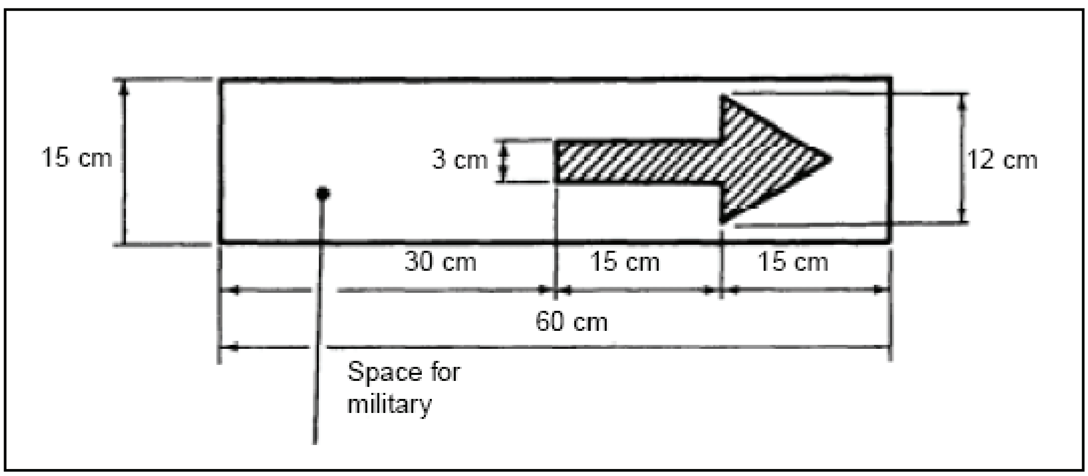


Figure G-12. Unit direction arrow

Military Detour Signs

G-16. Detour signs consist of a white arrow superimposed on a blue square. Place the sign in a diamond position (see figure G-13). Show the number of the diverted route by placing the number on the square over the arrow or placing the number on a small panel under the square.

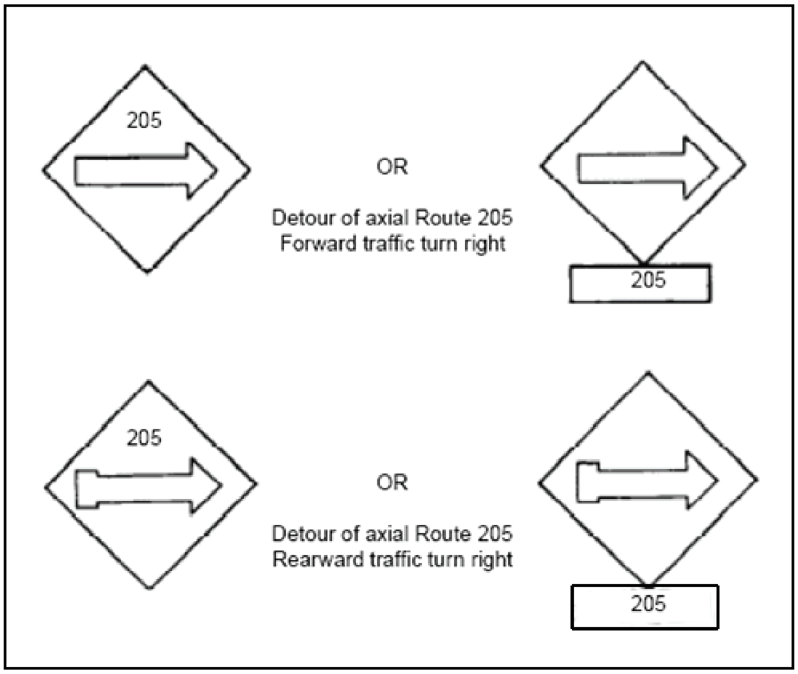


Figure G-13. Example of detour signs

ROAD MARKERS IN AREAS OF HEAVY SNOW

G-17. Posting road signs in areas of heavy snowfall requires special attention. Ensure that the markers are placed evenly on both sides of the traveled way. In open country, use poles of appropriate height with direction markers, snow markers, or flags. Erect markers at least one meter off the traveled way to avoid traffic damage. If you cannot completely mark a road, erect arrow signs at prominent points to indicate road direction. Road markers and signs used for long periods of time in areas of heavy snow should be checked frequently to ensure that their positions have not altered. In areas with prolonged conditions of snow, yellow (international orange) may be substituted for white on all standard military route signs.

VEHICLE SIGNS

G-18. There are two types of vehicle signs: front and side.

- Use front signs on all vehicles, except trailers, to show the classification of the laden vehicle.
- Use side signs on towing vehicles and trailers only to show the classification of the laden towing vehicles or trailers by themselves.

G-19. Both signs are circular and marked in contrasting colors consistent with camouflage requirements. Black figures on a yellow background may be used.

- The front sign is 23 centimeters in diameter. Place or paint the front sign on the front of the vehicle, above or on the bumper, and below the driver’s line of vision. When possible, place it on the right side, facing forward. .
- The side sign is 15 centimeters in diameter. Place or paint the side sign on the vehicle’s right side facing outward.

G-20. Make the inscription on the sign as large as the sign allows.

- The front sign—except on towing vehicles and tank transporters—indicates the vehicle's laden solo class. On towing vehicles, the front sign indicates the train's combined load class. Above this number, write the letter C to distinguish the vehicle as a towing vehicle (see figure G-14). On tank transporters and similar type vehicles, the fixed front sign shows the maximum classification of the laden vehicle. In addition, one alternative front sign may be carried. Place it so that it covers the fixed front sign, when necessary, to show the class of the vehicle when unladen.
- The side sign (used only by prime movers of combination vehicles and trailers) indicates the laden solo class of the prime mover or trailer.

G-21. Single vehicles (including tank transporters) carry the front sign only, towing vehicles carry both front and side signs, and trailers carry side signs only. Mark all vehicles as given above. (See appendix E for details on determining a vehicle's MLC.) Marking the following vehicles is optional:

- Vehicles of a gross weight of 3.048 tons or less.
- Trailers with a rated capacity of 1.524 tons or less.

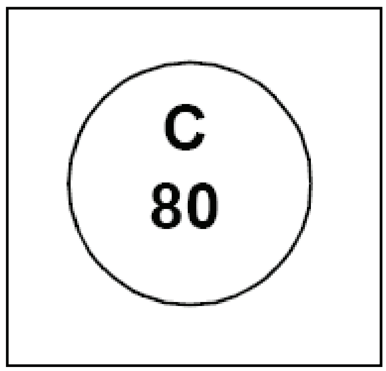


Figure G-14. Front sign

SIGN LIGHTING

G-22. The appropriate military authority in the area specifies which signs are to be illuminated. Primary considerations go to hazard and direction signs. The system of lighting must remain operational for a minimum of 15 hours without refueling or changing batteries. Consider the following:

- Under normal conditions, each armed force is responsible for ensuring that standard signs are visible at night and other periods of reduced visibility. Take necessary precautions in tactical situations.
- Under reduced lighting conditions, the positioning of the signs and the methods adopted to make them visible (illumination or reflection) must enable personnel to see them from vehicles fitted with reduced lighting or filtering devices.
- In a blackout zone, signs are equipped with upper shields that prevent light from being directly observed from the air. The light illuminating the sign is of such low intensity that it is not possible to locate the sign from the air at altitudes greater than 150 meters by its reflection off the road surface. Illumination devices are positioned so they can be recognized by oncoming vehicles at a road distance of 100 meters and read at a distance of 80 meter.

Appendix H
Technical Tools and Resources

This appendix highlights some of the most useful and primary support tools for engineers performing general engineering operations. These tools include the USAES, the USACE Engineer Research and Development Center (ERDC), USACE Protective Design Center (PDC), USACE TEOC, Prime Power, Water Resource Detection Team (WRDT), AARK, Defense Environmental Network and Information Exchange (DENIX), and USACHPPM. This type of reach-back capability is one of the characteristics of FFE. The Air Force and Navy provide some of the same type of capabilities and support through the AFCESA and the NAVFAC. (See FM 3-34 for further information.)

UNITED STATES ARMY ENGINEER SCHOOL

H-1. The doctrine division (DD) of the USAES manages engineer doctrine within the United States Army Training and Doctrine Command (TRADOC) doctrine development cycle. As part of this process, DD assesses, plans, develops, produces, and disseminates engineer doctrine that is synchronized with allied, multinational, joint, multi-Service, and combined arms doctrine. DD supports the development of nonengineer doctrinal products by providing subject matter expertise for review and coordination. DD also supports the Engineer Regiment by managing the Center for Engineer Lessons Learned and by providing information and analysis as needed.

ENGINEER RESEARCH AND DEVELOPMENT CENTER

H-2. The U.S. Army ERDC is one of the most diverse engineering and scientific research organizations in the world. It consists of seven laboratories at four geographical sites in Vicksburg, MS; Champaign, IL; Hanover, NH; and Alexandria, VA; employing more than 2,000 engineers, scientists, and support personnel.

H-3. ERDC research and development supports the DOD, other federal agencies, and the nation in military and civilian projects. Its primary mission areas include the following.

- Warfighter support.
- Installations.
- Environment.
- Water resources.
- Information technology.

H-4. Research projects include facilities, airfields and pavements, protective structures, sustainment engineering, environmental quality, installation restoration (cleanup), compliance and conservation, regulatory functions, flood control, navigation, recreation, hydropower, topography, mapping, geospatial data, winter climatic conditions, oceanography, environmental impacts, and information technology.

UNITED STATES ARMY CORPS OF ENGINEERS PROTECTIVE DESIGN CENTER

H-5. The U.S. Army Corps of Engineers PDC is the Army's Center of Expertise for structures hardened to resist weapons effects and in security engineering. The PDC employees are considered world-class experts in their specialties.

H-6. The PDC co-chairs the committee that wrote the DOD minimum antiterrorism construction standards and that writes many of the DOD security engineering UFC documents. These UFC present design guidance for protective systems against aggressor tactics including—

- Vehicle improvised explosive devices.
- Indirect weapons fire.
- Direct weapons fire.
- CBRNE.

H-7. The PDC has experience assisting units with vulnerability assessments and using software and other tools to determine where facility hardening is required. Their engineers can identify vulnerabilities and recommend mitigating measures including vehicle barriers to achieve standoff distance and structural hardening to resist weapons effects.

TELEENGINEERING OPERATIONS CENTER

DESCRIPTION

H-8. The TEOC provides a reach-back engineering capability that allows DOD personnel deployed worldwide to talk directly with experts in the United States when a problem in the field needs quick resolution. Deployed troops can be linked to subject matter experts (SMEs) within the USACE (or comparable Air Force and Navy organizations), private industry, and academia to obtain detailed analysis of complex problems that would be difficult to achieve with the limited expertise or computational capabilities available in the field.

CAPABILITIES

H-9. TEOC staff members respond to incoming information requests and provide detailed analyses of problems—such as flooding potential due to dam breaches, load-carrying capacities of roads and bridges, field fortifications and protection, evaluation of transportation networks, and water resource data. The TEOC has access to the USACE Transportation System Center, which includes SMEs on airfields, roadways, and railroads.

SUPPORTING TECHNOLOGY

H-10. TeleEngineering communication equipment provides reach-back capability using off-the-shelf communications equipment with encryption added. Video teleconferences and data transfers can be conducted from remote sites where other similar means of communications are nonexistent or unavailable.

H-11. The TeleEngineering toolkit (TETK) is a software product that provides a valuable analysis tool to personnel on the ground or going into an AO. By annotating an area of interest, a small reference file can be sent back to the SMEs to provide requests for a variety of information to include cross-country mobility analysis, flood analysis, and vegetation information. The response can then be sent back and graphically displayed using the TETK. (For more information on TeleEngineering, contact the ERDC at teoc@usace.army.mil.)

PRIME POWER OPERATIONS

H-12. Engineer prime power units conduct prime power operations, a subset of the general engineering function of the engineer regiment (see FM 3-34.480). They provide an essential continuity between power from tactical generators (TACGENS) and commercial sources (see figure H-1). Prime power units provide technical assistance and staff planning to support development of electrical power solutions for military operations. Prime power units also possess a limited organic capability to provide interim contingency power to satisfy the critical electrical requirements above the capability of TACGENS and below the availability of commercial power or to augment the power available from either source. The portion of the continuum that is exclusively prime power represents power generation and distribution accomplished by prime power units with their organic equipment. The intersections of TACGENS and commercial power with prime power represent areas of shared responsibility.

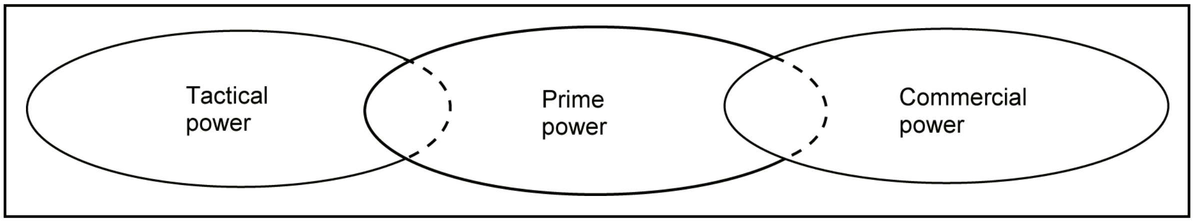


Figure H-1. The power continuum

H-13. Engineer prime power units support theaterwide general engineering efforts by providing advice and technical assistance on all aspects of electrical power and distribution systems in support of military operations. They are also capable of providing limited, interim contingency power generation to critical facilities. This mission statement spans the range of military operations to include combat (offense and defense), stability and support operations, and civil support operations. Prime power efforts and capabilities must be closely integrated and synchronized with the overall general engineering effort to achieve the effects intended in the theater ESP.

H-14. The prime power unit performs many technical power related tasks. A minimum of a two-Soldier and Marine team is required to perform each of the tasks. These tasks include—

- Providing power related planning and staff assistance.
- Conducting electrical load surveys.
- Analyzing and designing distribution systems.
- Constructing, maintaining, and repairing distribution systems.
- Performing damage assessment of distribution systems.
- Operating and maintaining industrial power systems and controls.
- Providing power related technical assistance to the contracting officer's representative.

H-15. Engineer prime power units can produce large quantities of reliable power with their organic generators. Each prime power platoon is equipped with four 840-kilowatt power units, giving the platoon a 3.36-megawatt total power production capability and 2.52-megawatts of normal operating continuous power production. They can also install, operate, and maintain nonstandard, power generation equipment and operate and maintain some fixed commercial power plants. This power generation capability can be used in a variety of military base camp configurations as well as ports, airfields, C2 nodes, and other critical facilities. The units' power generation capability also allows them to—

- Provide power to locations where another source is not available or is inadequate using organic or war reserve equipment.
- Operate, maintain, and perform damage assessments of fixed commercial diesel engine power plants.

WATER RESOURCE DETECTION TEAM

PURPOSE

H-16. The objective of the water resource detection team (WRDT) is to identify high-potential areas for the best quality of water, within available drilling equipment capability, to meet the water production requirements of the mission.

CAPABILITIES

H-17. WRDT expertise and studies are concentrated in four areas or elements: database, remote sensing, supporting specialists, and geophysics.

- Database. TEC produces and maintains a worldwide DOD Water Resources Database (WRDB) of available water supply and hydrologic data, including ground water resources. The WRDB is derived from classified and open-source data, maps, documents, and imagery. When specific missions/requests are received for areas where data are uncertain or inconclusive, the team will research additional sources and data unique to the area. The resulting WRDT product or report summarizes the information critical to planning a successful well—such as the hydrogeology, target depth, aquifer material, expected yield, and probable water quality. Office studies, based on research and analysis of existing data, are the most cost effective and timely WRDT approach and normally take hours to days to complete.
- Remote sensing. If databases and other supplemental information are inadequate, aerial or satellite imagery may be studied and analyzed for indications of groundwater. This source is especially useful in a hard-rock area, where siting wells on significant fractures and fracture intersections is the key to success. The acquisition and analysis of imagery increases the time and cost to complete an office study.
- Supporting specialists. If office studies including imagery analysis are inadequate, one or more supporting specialists may be deployed to the site. These specialists contact HN groundwater experts, collect and evaluate in-country data associated with existing or historic wells, and conduct hydrogeologic field reconnaissance of specific areas prior to drilling. They may also assist with interpreting well cuttings and down-hole electric logging during drilling. Field studies generally take days to weeks to complete.
- Geophysics. Should information gathered by supporting specialists be insufficient, additional local site investigation may be necessary using exploratory geophysics. Geophysicists may deploy to the site to conduct electrical resistivity, seismic refraction, or other on-site tests to better define the subsurface prior to drilling. Geophysical exploration and data analysis generally take weeks to complete. Costs are significantly higher than for office-based studies and are normally paid by the requester.

H-18. When activated, the WRDT does not automatically deploy to provide technical support for military operations. The starting point for each WRDT request is to identify high-potential areas by examining existing databases, followed by collecting and analyzing additional sources and imagery. In those rare cases when high-potential water sites cannot be identified from source data and imagery, teams from the supporting specialists and/or geophysics elements can be deployed for on-site investigations. This should take place before well drillers arrive. If deployed to the theater of operations, the WRDT operates as a component of the ENCOM or senior engineer organization in theater. As with any USACE capability, activation of the WRDT for deployment is not automatic; it must be requested through the supporting ENCOM in theater or through other appropriate command channels to TEC. The commander provides/arranges for the WRDT logistics and administrative support necessary for mission accomplishment.

AUTOMATED ROUTE RECONNAISSANCE KIT

PURPOSE

H-19. An automated route reconnaissance kit (ARRK) provides military units with an adaptable, easy-to-use reconnaissance package that allows an ERT or other engineer reconnaissance element to rapidly collect and process reconnaissance (all types but generally route) information.

CAPABILITIES

H-20. The ARRK uses a field-ready laptop computer to continuously collect reconnaissance information without stopping or leaving the vehicle for routine calculations. Time, security, and accuracy issues normally associated with a route reconnaissance are reduced. The ARRK collects pictures, voice recordings, GPS locations, accelerometer, and gyroscope data streams in three dimensions. Unlike the traditional, manually recorded route reconnaissance efforts, the ARRK allows an operator with minimum training experience to collect, process, and export the route information. The ARRK accommodates a chronological, picture replay of the route and geo-referenced display of major features that affect the classification and usage of the road or route. The viewer of the data can scroll through the stored data types to instantly locate specific features along the route. Data includes automated determination of slope, radius of curvature, and ride quality. The reconnaissance data collected from the ARRK is quickly converted by the operator to a preformatted report that is according to the requirements of this manual. Planned improvements for the system include integration of a laser range finder and digital scale reference guide. The system will be developed as a stand-alone data collection tool and a fully interoperable data collection platform for dissemination and repository of route information.

DEFENSE ENVIRONMENTAL NETWORK AND INFORMATION EXCHANGE

PURPOSE

H-21. The Defense Environmental Network and Information Exchange (DENIX) is an electronic environmental bulletin board accessible throughout the DOD that gives DOD environmental, safety, and occupational health managers a central communications platform to gain timely access to vital environmental information.

CAPABILITIES

H-22. DENIX (based on the Army's Defense Environmental Electronic Bulletin Board System) gives users the ability to—

- Read online environmental publications (proprietary or DOD specific).
- Send/receive mail electronically on the DENIX host computer or across the internet.
- Exchange environmental information via managed discussion forums based on a subject area.
- Send/receive required reporting data through the chain of command.
- Peruse and request environmental training courses and seminars.
- Access the DENIX directory service database.
- Upload and download files from DENIX to and from a personal computer.

UNITED STATES ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

PURPOSE

H-23. The United States Army Center for Health Promotion and Preventive Medicine (USACHPPM) has a mission to provide worldwide technical support for implementing preventive medicine, public health, and health promotion/wellness services into all aspects of America's Army and the Army community. It anticipates and rapidly responds to operational needs and adapts to a changing world environment. The USACHPPM organization is headquartered at Aberdeen Proving Ground, Maryland, with subordinate commands in Landstuhl, Germany, and Sagami, Japan. USACHPPM also maintains subordinate commands at three locations in the United States: Fort Meade, MD; Fort McPherson, GA; and Fort Lewis, WA.

CAPABILITIES

H-24. The USACHPPM is a linchpin of medical support to combat forces and of the military managed-care system. It provides worldwide scientific expertise and services in clinical and field preventive medicine, environmental and occupational health, health promotion and wellness, epidemiology and disease surveillance, toxicology, and related laboratory sciences. It supports readiness by keeping Soldiers and Marines fit to fight, while also promoting wellness among their families and the Federal civilian workforce. Professional disciplines represented include chemists, physicists, engineers, physicians, optometrists, epidemiologists, audiologists, nurses, industrial hygienists, toxicologists, entomologists, and many others, as well as subspecialties within these professions.

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Source Notes

This section lists sources by page number. Where material appears in a paragraph, both the page number and paragraph number are listed. Boldface indicates titles of vignettes.

1-1 “Nothing is more worthy of attention…”: Niccolo Machiavelli, *The Military Quotation Book*, (edited by James Charlton, Thomas Dunne Books, February 2002; St. Martin’s Press, 175 Fifth Avenue, New York, New York 10010), 87.

2-1 “Make your plans fit the circumstances.”: General George S. Patton, Jr., [Online]. Available: http://www.geocities.com/heartland/fields/5248/quotes.html.

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4-1 “Tactics are the cutting edge of strategy,…”: Major General J.F.C. Fuller, *The Military Quotation Book*, (Thomas Dunne Books, February 2002; St. Martin’s Press, 175 Fifth Avenue, New York, New York 10010).

5-1 The art of war is, in the last result,…”: Xenophon, [Online]. Available: http://www.tankmastergunner.com/quote.htm.

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Glossary

SECTION I – ACRONYMS AND ABBREVIATIONS

Acronym	Definition
A	no limiting characteristics (road classification formula)
AAP	Allied Administrative Publication
AAV	amphibious assault vehicle
ACE	armored combat earthmover
ADR	airfield damage repair
AEODP	Allied Explosive Ordnance Disposal Publication
AFCESA	Air Force Civil Engineering Support Agency
AGS	armored gun system
AHD	antihandling device
AO	area of operations
AOR	area of responsibility
AP	antipersonnel
AR	Army regulation
ARAT	Abrams reactive armor title
ARRK	automated route reconnaissance kit
ART	Army tactical task
ASCC	Army service component commander
AT	antitank
ATEC	all terrain crane
ATLAS	all terrain lifter, Army system
AVLB	armored vehicle-launched bridge
B	one or more limiting characteristics (road-classification formula)
BCT	brigade combat team
bn	battalion
BP	battle position
BSTB	brigade special troops battalion
C	distance from the centerline of the road to the centerline of the road at the outer extremities of the curve (formula method for measuring curves)
C2	command and control
CA	civil affairs
CASEVAC	casualty evacuation
CAT	Caterpillar®
CBR	California Bearing Ratio
CBRN	chemical, biological, radiological, and nuclear
CBRNE	chemical, biological, radiological, nuclear, and high yield explosives

CCD	camouflage, concealment, and deception
CCE	combat construction equipment
CCIR	commander's critical information requirements
CCN	combination class number
CEA	captured enemy ammunition
C-HET	commercial-heavy equipment
CMO	civil-military operations
COA	course of action
COE	common operational environment
COP	common operational picture
CP	command post
CREST	contingency real estate support team
CTOP	common topographic operating picture
DA	Department of the Army
DD	Doctrine Division
DED	diesel engine driven
DENIX	Defense Environmental Network and Information Exchange
DHS	Department of Homeland Security
DOD	Department of Defense
DP	decision point
DRS	Digital Reconnaissance System
DS	direct support
DSN	defense switched network
DTG	date-time group
EI2RC	Engineering Infrastructure Intelligence Reachback Center
EA	engagement area
EBS	environmental baseline survey
ECOA	enemy course of action
ECR	environmental conditions report
EEFI	essential elements of friendly information
EH	explosive hazard
EHSA	environmental health site assessment
EHT	explosive hazards team
EMST	essential mobility and survivability task
ENCOM	engineer command
ENCOORD	engineer coordinator
ENVST	environmental support team
EOCA	explosive hazard clearance agent
EOD	explosive ordnance disposal
ERDC	Engineer Research and Development Center
ERT	engineer reconnaissance team

ESMP	explosive standoff minefield breacher
ESP	engineering support plan
ESV	engineer squad vehicle
ETO	effects tasking order
EWG	effects working group
F	Fahrenheit
FAASV	field artillery ammunition support vehicle
FACE	forward aviation combat engineering
FARP	forward arming and refueling point
FCO	federal coordinating officer
FEMA	Federal Emergency Management Agency
FEST	forward engineer support team
FEST-A	forward engineer support team-advanced
FEST-M	forward engineer support team-main
FFE	field force engineering
FFIR	friendly force information requirement
FM	field manual
FMI	field manual interim
FMTV	family of medium tactical vehicles
FSCM	fire support coordinating measure
FSCOORD	fire support coordinator
FSCS	fire control support system
FST	fire support task
ft	feet
FTP	file transfer protocol
G-2	component intelligence staff officer
G-3	component operations staff officer
G-9	component civil-military operations officer
GEOINT	geospatial intelligence
GI&S	geospatial information and services
GIG	Global Information Grid
GPS	global positioning system
GS	general support
HAZMAT	hazardous materials
HBCT	heavy brigade combat teams
H_d	horizontal distance (determining the percent of slope)
HDSB	heavy dry support bridge
HEMAT	heavy expanded mobility ammunition trailer
HEMTT	heavy expanded mobile tactical truck
HET	heavy equipment transporter
HM	hazardous material

HMMWV	high mobility multipurpose wheeled vehicle
HN	host nation
HNS	host nation support
HUMINT	human intelligence
HW	hazardous waste
HYEX	hydraulic excavation
IAT	infrastructure assessment team
IBCT	infantry brigade combat teams
IED	improvised explosive device
IGEO	International Geospatial
IM	information management
IMG	international military and government
IMINT	imagery intelligence
in	inch
IP	intermediate point
IPB	intelligence preparation of the battlefield
IR	information requirements
ISM	intelligence synchronization matrix
ISR	intelligence, surveillance, and reconnaissance
J-9	civil-military operations officer
JD	John Deere™
JERRV	joint explosive ordnance disposal rapid response vehicle
JP	joint publication
JTF	joint task force
kg	kilogram
km	kilometer
LAN	local area network
LAV	light armored vehicle
LD	line of departure
LET	light equipment transporter
LHS	load hauling system
LMTV	light to medium tactical vehicle
LOA	limit of advance
LOC	line of communications
LOGPAC	logistics package
LRP	logistics release point
LTIOV	latest time the information is of value
LZ	landing zone
m	meter
M	perpendicular distance from the center of the tape to the centerline of the road (formula method for measuring curves)

MBPL	nodular base petroleum laboratory
MC	mortar carrier
M/CM/S	mobility, countermobility, and survivability
MCJSB	Military Committee Joint Standardization Board
MCRP	Marine Corps reference publication
MCV	mortar carrier vehicle
MCWP	Marine Corps warfighting publication
MDMP	military decision-making process
MED	medium
MET	medium equipment transport
METT-T[C]	mission, enemy, terrain and weather, troops and support available, time available, [Army adds "civil considerations"]
MEV	medical evaluation vehicle
MGS	mobile gun system
MHC	material handling crane
MHE	materials handling equipment
MI	military intelligence
MLC	military load classification
MLRS	multiple launch rocket system
mm	millimeter
MOG	maximum (aircraft) on the ground
MP	military police
MRAP	mine resistant ambush protected
MRBC	multirole bridge company
MSR	main supply route
MTD	mounted
MTV	medium tactical vehicle
NAI	named area of interest
NATO	North Atlantic Treaty Organization
NAVFAC	Naval Facilities Engineering Command
NGO	nongovernmental organization
NSN	National Stock Number
o	intersection (triangulation method for measuring curves)
O&M	operation and maintenance
O/I	operations and intelligence
OB	obstructions to traffic flow (route-classification formula)
OBSTINTEL	obstacle intelligence
OE	operational environment
OGA	other governmental agency
OP	observation post
OPCON	operational control

OPLAN	operation plan
OPORD	operation order
PC	point of curvature (triangulation method for measuring curves)
PCC	project coordination cell
PDC	Protective Design Center
PGM	precision guided munitions
PIR	priority intelligence requirements
PL	phase line
PLC	provisional load class
PLS	palletized load system
POL	petroleum, oils, and lubricants
Prime BEEF	Prime Base Engineer Emergency Force
psi	pounds per square inch
PSYOPS	psychological operations
PT	point of tangency (triangulation method for measuring curves)
QM	quartermaster
r	surface material (road classification formula)
R	distance (triangulation method for measuring curves); radius of curve (formula method for measuring curves)
RCT	regimental combat team
RDSP	rapid decision-making and synchronization process
recon	reconnaissance
RED HORSE	Rapid Engineers Deployable Heavy Operations Repair Squadron, Engineers
RFI	request for information
RI	relevant information
ROE	rules of engagement
RO/RO	roll-on/roll-off
ROPS	Rollover protective structures
RP	release point
RRR	rapid runway repair
RTCH	rough terrain container handler
S-1	personnel staff officer
S-2	intelligence staff officer
S-3	operations staff officer
S-4	logistics staff officer
S-9	civil-military operations officer
SAK	Simula Armor Kit
SBCT	Stryker brigade combat team
SCATMINE	scatterable mine
Seabee	Navy construction engineer
SHAPE	Supreme Headquarters Allied Powers, Europe

SIG	signal intelligence
SINCGARS	Single-Channel, Ground-to-Air Radio System
SIPRNET	SECRET Internet Protocol Router Network
SIR	specific information requirement
SLOT	self-load/off-load
SME	subject matter expert
SOP	standing operating procedure
SP	start point
SSN	Social Security number
STANAG	standardization agreement (NATO)
SU	situational understanding
SWEAT-MSO	sewage, water, electricity, academics, trash, medical, safety, and other considerations
T	snow blockage (route classification formula)
TACGENS	tactical generators
TAI	targeted area of interest
TEC	Topographic Engineering Center
TEOC	TeleEngineering Emergency Operations Center
TETK	TeleEngineering toolkit
TF	task force
TGD	Theater Geospatial Database
TIM	toxic industrial material
TLP	troop-leading procedure
TM	technical manual
TOC	tactical operations center
TOE	table of organization and equipment
TP	turn point
TRADOC	United States Army Training and Doctrine Command
TUSK	tank urban survivability kit
TV	television
U.S.	United States
UAS	unmanned aircraft system
UFC	Unified Facilities Criteria
UO	urban operations
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USAES	United States Army Engineer School
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
UXO	unexploded explosive ordnance

VBIED	vehicle-borne improvised explosive device
V_d	vertical distance (determining the percent of slope)
W	flooding (route classification formula)
WARNORD	warning order
WF	wide flange
WRDB	water resources database
WRDT	water resource detection team
X	all-weather route
XO	executive officer
Y	limited, all-weather route
Z	fair-weather route

SECTION II – TERMS

area clearance

In land operations, the detection and if found, the identification, marking and neutralization, destruction, or removal of mines or other explosive ordnance, improvised explosive devises, and booby traps in a defined area to allow a military operation to continue with reduced risk.

***assessment**

A judgment about something based on a technical understanding of the situation. Within the range of technical reconnaissance, an assessment takes less time and technical expertise to perform than a survey but provides less technical detail than a survey. Reconnaissance elements do not require specialized technical expertise to perform an assessment. They conduct assessments following the same basic formats a survey would use.

assured mobility

Actions that give the force commander the ability to maneuver where and when desired without interruption or delay to achieve the mission. (FM 3-34)

booby trap

An explosive or nonexplosive device or other material deliberately placed to cause casualties when an apparently harmless object is disturbed or a normally safe act is performed. (FM 1-02)

breach

(Army) A tactical mission task in which a unit employs all available means to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. (Marine Corps) The employment of any means available to break through or secure a passage through an obstacle. (FM 1-02)

captured enemy ammunition

Captured enemy ammunition is all ammunition products and components produced for or used by a foreign force that is hostile to the United States (that is or was engaged in combat against the United States) in the custody of a United States military force or under the control of a Department of Defense component. The term includes confined gaseous, liquid and solid propellants, explosives, pyrotechnics, chemical and riot-control agents, smokes and incendiaries (including bulk explosives), chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components of the above. (FM 3-34.210)

combined arms

The synchronized or simultaneous application of several arms—such as infantry, armor, field artillery, engineers, air defense, and aviation—to achieve an effect on the enemy that is greater than if each arm were used against the enemy in sequence. (FM 1-02)

command

(DOD only) The authority that a commander in the Armed Forces lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources to plan for employing, organizing, directing, coordinating, and controlling military forces to accomplish assigned missions. It also includes responsibility for health, welfare, morale, and discipline of assigned personnel. (FM 6-0)

command and control

(Army) The exercise of authority and direction by a properly designated commander over assigned and attached forces to accomplish a mission. Commanders exercise command and control through a command and control system. (FM 6-0)

control

(Army) Within command and control, the regulation of forces and other battlefield operating systems to accomplish the mission in accordance with the commander's intent. It includes collecting, processing, displaying, storing, and disseminating relevant information for creating the common operational picture and using information during the operations process. (FM 6-0)

engagement area

An area where the commander intends to contain and destroy an enemy force with the massed effects of all available weapons and supporting systems. Also called an **EA**. (FM 3-90)

engagement criteria

Protocols that specify those circumstances for initiating engagement with an enemy force. (FM 3-90)

essential elements of friendly information

(DOD) Key questions likely to be asked by adversary officials and intelligence systems about specific friendly intentions, capabilities, and activities so they can obtain answers critical to their operational effectiveness. (Army) The critical aspects of a friendly operation that, if known by the enemy, would subsequently compromise, lead to failure, or limit success of the operation, and, therefore, must be protected from enemy detection. (FM 3-13) (Marine Corps) Specific facts about friendly intentions, capabilities, and activities needed by adversaries to plan and execute effective operations against our forces. Also called **EEFI**. (FM 1-02)

essential mobility and survivability task

A mobility, countermobility, or survivability task identified as critical to the combined arms mission. Like other essential tasks, these tasks are identified from the specified and implied tasks listed during mission analysis. Although the task may be executed by a combined-arms element, staff elements typically identify and propose the essential mobility and survivability tasks to the commander. Also called **EMST**. (FM 3-34)

explosive hazard

Any hazard containing an explosive component. All explosive hazards currently encountered on the battlefield can be broken down into five categories: unexploded ordnance, booby traps, improvised explosive devices, captured enemy ammunition, and bulk explosives. (FM 3-34.210)

explosive ordnance disposal

(DOD, NATO) The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of unexploded ordnance. It may also include explosive ordnance which has become hazardous by damage or deterioration. Also called **EOD**. See FM 5-250. (FM 1-02)

friendly force information requirements

Information the commander and staff need about the forces available for the operation. Also called **FFIR**. (FM 6-0)

improvised explosive device

A device placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic, or incendiary chemicals and designed to destroy, incapacitate, harass, or distract. It may incorporate military stores but is normally devised from nonmilitary components. Also called **IED**. (JP 3-07.2)

***infrastructure reconnaissance**

A multidiscipline variant of reconnaissance to collect technical information on various categories of the public systems, services, and facilities of a country or region. This task may take the form of either an assessment or a survey and develops the situational understanding of the local capability to support the infrastructure requirements of the local populace and/or military operations within a specific area.

***military load classification**

A standard system in which a route, bridge, or raft is assigned class number(s) representing the load it can carry. Vehicles are also assigned number(s) indicating the minimum class of route, bridge, or raft they are authorized to use. Also called **MLC**.

military search

The management and application of systematic procedures and appropriate detection equipment to locate specified targets. (FM 3-34.210)

neutralize

(DOD) To render safe mines, bombs, missiles, and booby traps. See FM 5-250. (FM 1-02)

obstacle

(DOD) Any obstruction designed or employed to disrupt, fix, turn, or block the movement of an enemy force, and to impose additional losses in personnel, time, and equipment on the enemy. Obstacles can be natural, manmade, or a combination of both. See FM 90-7. (FM 1-02)

***obstacle intelligence**

Those collection efforts to detect the presence of enemy (and natural) obstacles, determine their types and dimensions, and provide the necessary information to plan appropriate combined arms breaching, clearance, or bypass operations to negate the impact on the friendly scheme of maneuver. Also called OBSTINTEL.

operational environment

(DOD) A composite of the conditions, circumstances, and influences which affect the employment of military forces and bear on the decisions of the unit commander. Some examples are as follows: a. **permissive environment—**Operational environment in which host country military and law enforcement agencies have control as well as the intent and capability to assist operations that a unit intends to conduct. b. **uncertain environment**—Operational environment in which host government forces, whether opposed or receptive to operations that a unit intends to conduct, do not have totally effective control of the territory and population in the intended operational area. c. **hostile environment—**Operational environment in which hostile forces have control and the intent and capability to effectively oppose or react to the operations a unit intends to conduct. See FM 3-07. (FM 1-02)

priority intelligence requirement

(Joint) Those intelligence requirements for which a commander has an anticipated and stated priority in his task of planning and decision making. Also called **PIRs**. (JP 1-02)

reachback

(DOD) The process of obtaining products, services, and applications, or forces, or equipment, or material from organizations that are not forward deployed. (Army/Marine Corps) The ability to exploit resources, capabilities, expertise, and so forth not physically located in the theater or a joint operations area when established. (FM 1-02)

reconnaissance

A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy or to secure data concerning the meteorological, hydrographical, or geographical characteristics and the indigenous population of a particular area. (FM 3-0)

reconnaissance objective

A terrain feature, geographical area, or an enemy force about which the commander wants to obtain additional information. (FM 3-90)

reduce

One of the five breaching fundamentals. The creation of a lane through, over, or around an obstacle. In the case of minefields, refers to destroying, neutralizing, removing, or bypassing mines. (FM 3-34.2)

render safe

Those particular courses or modes of action taken by explosive ordnance disposal personnel for access to, diagnosis, rendering safe, recovery, and final disposal of explosive ordnance or any hazardous material associated with an explosive ordnance disposal incident. The render safe procedures include the portion of the explosive ordnance disposal procedures involving the application of special explosive ordnance disposal methods and tools to provide for the interruption of functions or separation of essential components of unexploded ordnance to prevent an unacceptable detonation. (FM 3-34.210)

***route classification**

Classification assigned to a route using factors of minimum width and worst route type; least bridge, raft, or culvert military load classification; and obstructions to traffic flow.

route clearance

In land operations, the detection and if found, the identification, marking, neutralization, destruction or removal of explosive hazards and other obstacles along a defined route to allow a military operation to continue with reduced risk. (FM 3-34.2)

situational understanding

The product of applying analysis and judgment to the common operational picture to determine the relationships among the factors of mission, enemy, terrain and weather, troops and support available, time available, civil considerations. (FM 3-0)

surveillance

(DOD, NATO) The systematic observation of airspace, surface, or subsurface areas by visual, auditory, electronic, photographic, or other means. (FM 1-02)

***survey**

Looks at or considers something closely, especially to form a technical opinion. Within the range of technical reconnaissance, a survey requires more time and technical expertise than an assessment to perform but subsequently provides the most technical detail. Specific technical expertise is required to conduct a survey.

task

(Army) A clearly defined and measurable activity accomplished by individuals and organizations. Tasks are specific activities that contribute to the accomplishment of encompassing missions or other requirements. (FM 7-0)

unexploded explosive ordnance

(DOD, NATO) Explosive ordnance which has been primed, fused, armed, or otherwise prepared for action, and which has been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material and remains unexploded either by malfunction or design or for any other cause. Also called **UXO**. See FM 21-16. (FM 1-02)

warfighting function

A group of tasks and systems (people, organizations, information, and processes) united by a common purpose that commanders use to accomplish missions and training objectives. (FM 3-0)

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DOCUMENTS NEEDED

These documents must be available to the intended users of this publication.

None

READINGS RECOMMENDED

These readings contain relevant supplemental information.

None

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FM 3-34.170/MCWP 3-17.4
25 March 2008

By order of the Secretary of the Army:

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