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TECHNICAL MANUAL

CENTRAL VEHICLE WASH FACILITIES

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CHAPTER 1
INTRODUCTION

1-1. Purpose

This manual provides a comprehensive reference source for planning, and designing a central vehicle wash facility (CVWF) at U. S. Army installations. The CVWF provides a rapid, economical method for washing tracked and wheeled tactical vehicles. The design elements provide for water pollution control, solid waste disposal, and conservation of manpower and water.

1-2. Scope

This manual is limited to wash facilities and wastewater treatment for cleaning vehicle exteriors only; this design information does not pertain to facilities for treating wastewater from maintenance cleaning activities.

1-3. References

The following documents form a part of this manual to the extent referenced:

TM 5-820-1	Surface Drainage Facilities for Airfields and Heliports

Standard Methods for Examination of Water and Wastewater (1987), American Public Health Association, 1015 15th Street N.W., Washington. D.C. 20005; American Water Works Association, 6666 S. Quincy Avenue, Denver, CO 80235; and Water Pollution Control Federation, 2626 Pennsylvania Avenue, Washington, D.C. 20037

Elements of Water Supply and Wastewater Disposal, edited by G.M. Fair, J.C.D. Geyer, and D.A. Okun, Second Edition (1971), John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158

1-4. Applicability

Information in this manual applies to all CONUS Army installations that maintain a fleet of vehicles for which there is a consistent washing requirement demanding cost-effective, on-post facilities.

1-5. Explanation of terms and abbreviations

Terms and abbreviations used in the manual are explained in the glossary.

1-6. Background

The Army has unique vehicle cleaning requirements in terms of numbers, types of vehicles, washing time, and degree to which washing is critical. Civilian technologies for cleaning Army off-road tactical vehicles and treating the wastewater created by this washing are not recommended. However, civilian technology may apply to facilities for washing vehicles in a transportation motor pool (TMP), most of which are the wheeled, on-road type such as sedans and buses. Figure 1-1 shows the recommended washing sequence for tactical vehicles. For installations where specific conditions require that a prewash be constructed, the washing procedure is shown in figure 1-2. The central vehicle wash facility is designed to provide expedient, cost-effective vehicle cleaning for tactical vehicles. The concept incorporates water conservation including recycle techniques and pollution control.

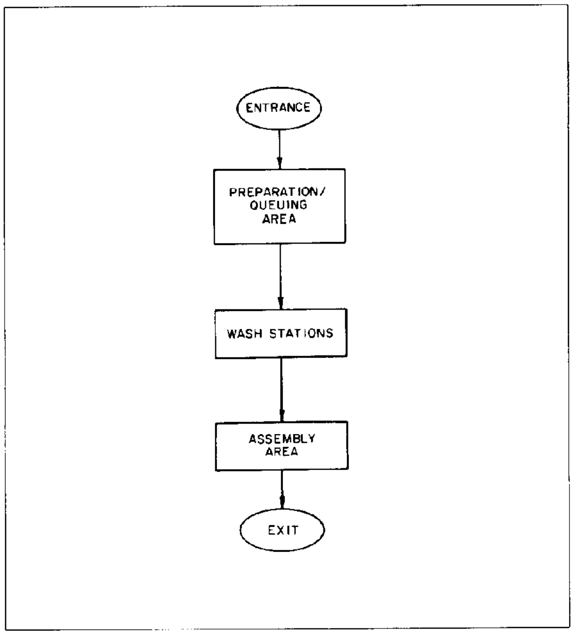

Figure 1-1. Standard washing sequence for tactical vehicles.

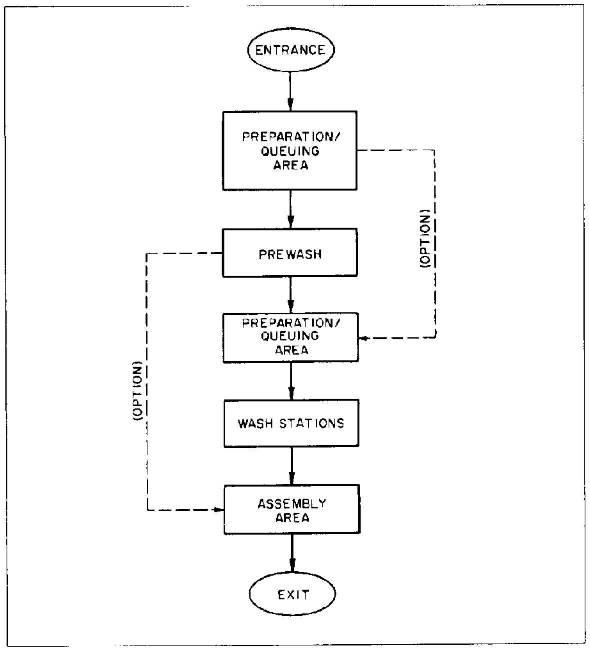

Figure 1-2. Washing procedure with optional prewash.

CHAPTER 2
CVWF DESIGN CONCEPT

2-1. Overview

The standard CVWF consists of a vehicle preparation area, wash stations, and vehicle assembly area (fig 24). However, the layout of a facility will be site-specific, based on the installation's mission and needs. Information on siting and master planning is found in chapter 3. A design example is provided in appendix A.

2-2. Prewash (optional)

At installations with heavy soiling conditions, high demands for washing, and/or limited washing times, a prewash system is recommended. Three types of prewash systems have been constructed for use in tactical vehicle washing: bath, spray stand, and automatic washer. The vehicle bath is the most effective prewash system for Army tactical vehicles. Figure 2-2 shows a typical CVWF plan with the CONUS approved bath prewash system for tactical vehicles. Commercial type, such as those in a Transportation Motor Pool (TMP), would utilize commercial automatic washers and not facilities described for the CVWF.

2-3. Wastewater treatment

A system for conveying and treating wastewater is included in the CVWF design, since water used to wash the vehicles will become contaminated with dirt, debris, and products related to vehicle operation such as oil and grease. All wastewater must receive primary treatment to remove settleable and floating materials. Following primary treatment, the wastewater is either released to a collection system or further treated onsite and stored for reuse during future washing operations. The water used to wash vehicles should be recycled whenever possible and feasible. However, even in a total recycle system, some of the wastewater may need to be released to a discharge system before or after receiving secondary treatment. This discharge is done to ensure that water quality and water balance are maintained. Measured makeup water is added to the recycle system to compensate for the volume of water carried off on the wet vehicles, released, and lost to evaporation.

a. Primary treatment. All wastewater must receive primary treatment. A sediment basin that provides primary treatment is required to allow most of the suspended solids to settle and to allow the free grease and oils to separate from the wastewater.

b. Secondary treatment. For the purposes of this manual, secondary treatment refers to intermittent sand filters, lagoons, or discharges to sanitary sewage systems. Two systems of onsite secondary treatment are used following primary treatment if the water is to be recycled. These methods include intermittent sand filters and lagoons. Lagoons are not the standard system but are included because they have been used as a wastewater treatment method for CVWFs. The third system of handling wastewater, discharge to sanitary sewer, may be available at an installation, but this method is not used in conjunction with a recycle system. In a discharge system, secondary treatment is done at the installation, local municipal, or regional sanitary wastewater treatment facility. Essentially, all recycle systems are partial treatment systems, as release of some wastewater may become necessary to maintain water quality and to allow discharge of excess storm water collected at the facility.

(1) *Intermittent sand filter system.* This secondary treatment system is comprised of an equalization basin and an intermittent sand filter. The equalization basin holds the wastewater after primary treatment and before it is applied to the filters to equalize flow rates by dampening the high and low-flow variations.

(a) A dosing tank may be provided after the flow equalization basin to provide a water volume of one charge or dose to a portion of the sand filter. The dosing tank is a designer's option which allows for flexibility in sizing the pumping facilities.

(b) Water quality testing and metering capabilities are recommended to be provided at a point following the intermittent sand filters to measure the quality and amount of the treated wastewater to be recycled. At this point, facilities should be provided which allow recirculating all or a portion of the filtered water back though filters via the equalization basin. The remaining filtered water flows into the water supply basin and is stored for reuse.

(c) Water overflow facilities to provide hydraulic protection for the secondary treatment process should be located at the water supply basin for emergency storm release. This overflow system should also be able to make controlled partial wastewater releases to further assist in maintaining the quality and quantity of the recycled water. Hydraulic protection should also be provided at the equalization basin as a backup. Chapter 6 presents details of the sand filter treatment system.

(2) *Lagoon system.* This secondary treatment system consists of a basin or a series of basins where the wastewater is held for an extended period of time to achieve the desired water quality. The treated water is allowed to flow to the water supply basin for reuse. Water quality testing and metering capabilities are recommended to be provided, as well as overflow protection. Chapter 6 explains the lagoon treatment system in greater detail.

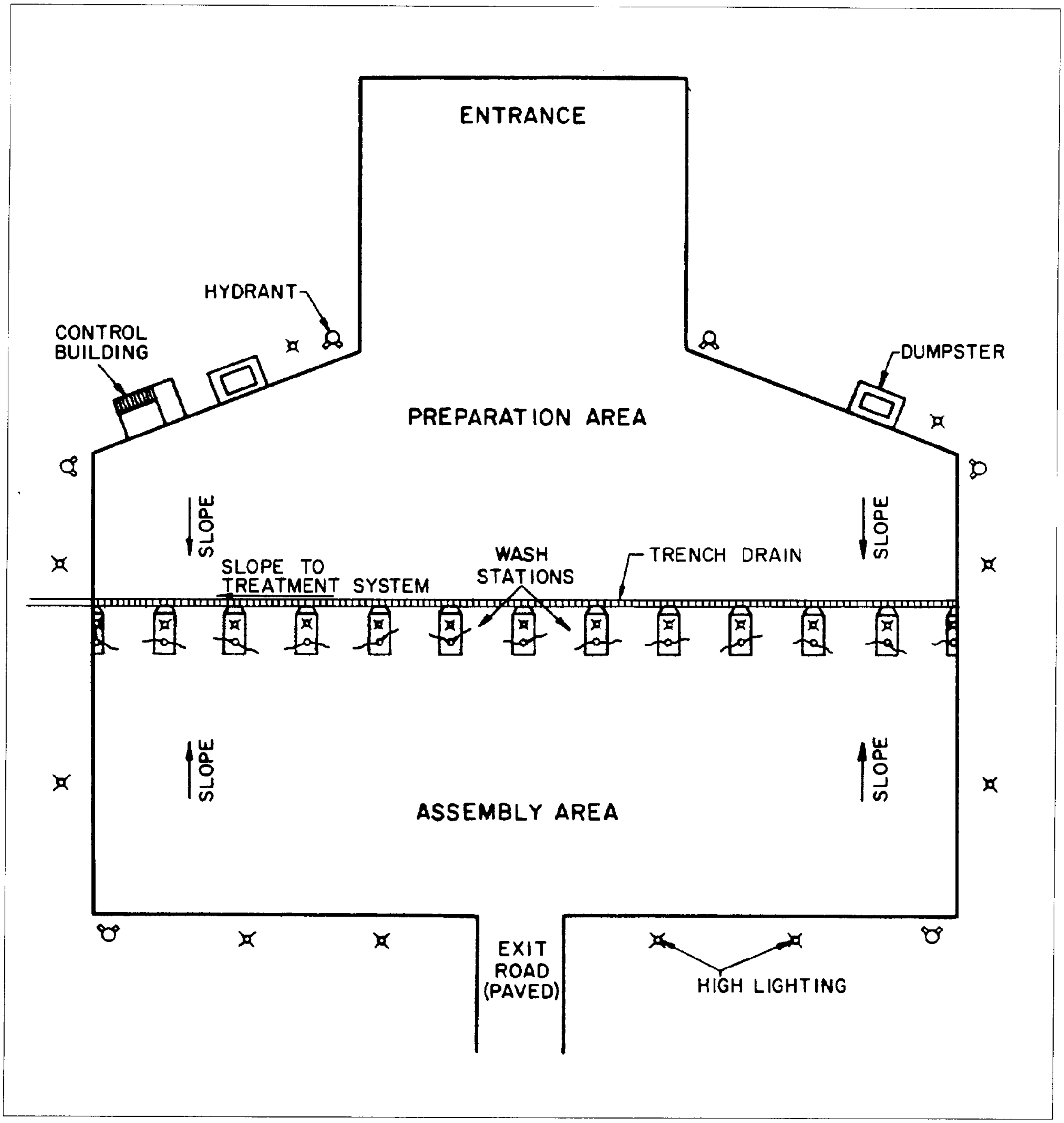

Figure 2–1. Standard central vehicle wash facility plan.

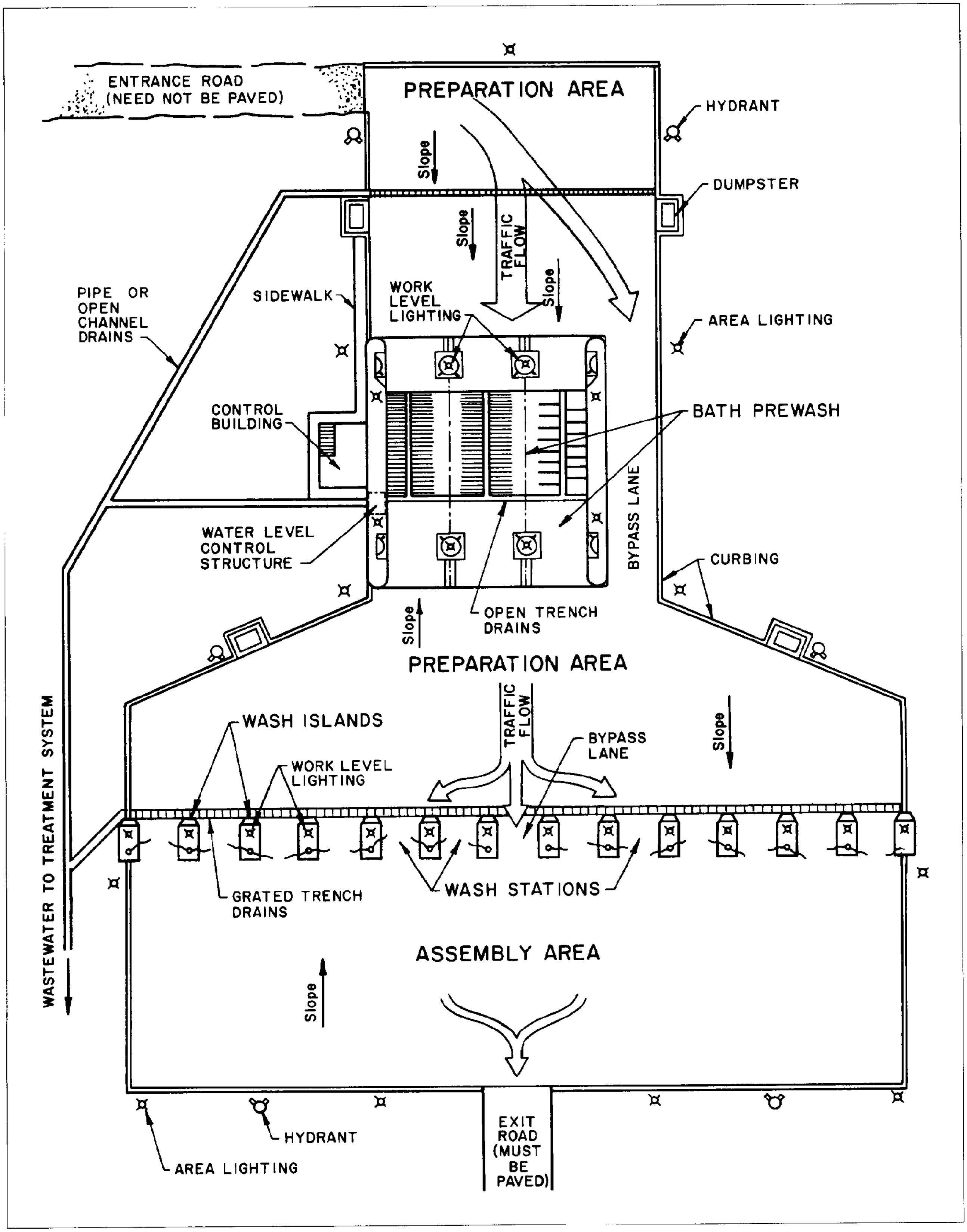

Figure 2-2. Central vehicle wash facility plan with bath prewash.

(3) *Discharge system.* If a recycle treatment system is not economically or technically feasible and/or operationally practical, and if wash water supply is available, wastewater from the CVWF may be discharged to a sanitary sewer system or some other conveyance for further treatment elsewhere. Primary treatment is the minimum level of treatment required to ensure that the wastewater discharged into a system is of a quality acceptable to the receiving authority. Quality, however, may not be the only criterion. The rate of discharge may also be a limiting factor, thus requiring an equalization basin prior to the point of release to the discharge system. The discharge-type treatment system is discussed in detail in chapter 6.

c. Water supply basin. After secondary treatment in a recycle system, the water is discharged to a water supply basin for reuse in the CVWF. In a system without recycling, the water supply basin is optional. If a reliable, consistent source of water is not available, a water supply basin may have to be constructed in a size large enough to hold the wash water volume required. This basin can be filled from the water source at a slower rate during nonpeak hours for the high demand required during the washing operations. The design must protect the water source through the use of air breaks or equipment to prevent backflow and back siphonage. In addition, makeup water that enters the water supply should be metered.

CHAPTER 3
MASTER PLANNING

3-1. Sizing

a. User input. The wash facility must be designed to meet the user's needs. The design will determine the type, size, and configuration of the wash facility and treatment system based on information supplied by the installation. Proper initial planning will result in the best final design. The planner will have to assemble data from many sources and use judgment in applying this data to the guidelines provided for sizing the facility components. Where data is not available, estimates must be made.

(1) *Military mission data.* The wash facility must sup--port the particular needs of the installation. Troop types, their vehicle types, and their training program, both current and future, must be considered. This includes resident troops as well as transient troops. The combination of numbers of vehicles, types of vehicles, and frequency of washing will determine the type and size wash facility required. A complete list of each military unit which will use the facility is required, along with its vehicular complement and the expected frequency each vehicle would be washed.

(2) *Wash frequency data.* Certain components of the wash facility will be sized based on long term or average numbers of vehicles washed. Other components are sized on short term or peak use numbers. In both cases, the mix of vehicle types is an important consideration.

(a) The average use of the facility should be provided by the user broken down as weekly or biweekly, monthly, and annually. Seasonal variations must also be a consideration. Where training programs are impacted by seasonal weather or where large numbers of transient units in a particular part of the year impact expected use, the average weekly or monthly numbers would not be a fixed ratio of the average annual numbers. Monthly average should be the average of the six highest use months; weekly should be the average of the ten highest use weeks.

(b) The peak use of the facility should be provided by the user as the largest number of vehicles to be washed in a continuous short term period. If night washing is to be designed for, the peak use may, for example, be a continuous three day (72 hour) period. The peak use will represent full utilization of the wash facility components for the chosen time period. The planner must consider the length of time it will take for all the vehicles scheduled to wash in this peak exercise to return to the cantonment area after training. The rate of movement of these vehicles will help determine the time period to allow for in the peak use operation. Ideally the CVWF would accommodate all units as they arrived, without excessive backup, and at a continuous full utilization of the washing components. It is important that the planner consider the frequency of the defined peak use; in some cases, a large-scale facility may not be justified based on the low frequency of this peak activity. The peak use should be a condition expected to occur at least three times per year.

(3) *Vehicle soiling data.* The types of soil found in the training ranges along with weather conditions are predictors for the amount of dirt which will have be to washed off of the vehicles. This will affect the type of washing components, the time required for washing, the amount of water used and the waste-water treatment components.

(a) A characterization of the soils is needed. A study of the installation maps showing soil types throughout the total training areas should be made to determine if sands, clays, or combinations of soils occur. Samples of Soils should be taken from the range areas, as well as samples taken directly from dirty vehicles returning to the cantonment area after a heavy rain. Separate samples should be collected for each identifiable soil type (3 to 5 gallons each) and analyzed in a soils laboratory. The laboratory should prepare a standard gradation curve of grain size distribution showing gravel, sand, silt, and clay utilizing both a mechanical analysis and a hydrometer analysis down to 0.001 mm diameter. Both a dispersed and a non-dispersed hydrometer analysis need to be performed. The dispersed, which breaks the particles into individual grains, is used for standard classification. This will be used to categorize the soiling expected on the vehicles. The dispersed, which assesses the agglomerated particles, is used in the treatment analysis (chap 6), since the washing operation does not totally disperse the soil. Figure 3-1 shows an example of a cohesive (silty clay) soil gradation curve both dispersed and dispersed. Figure 3-2 shows an example of a noncohesive (sandy) soil.

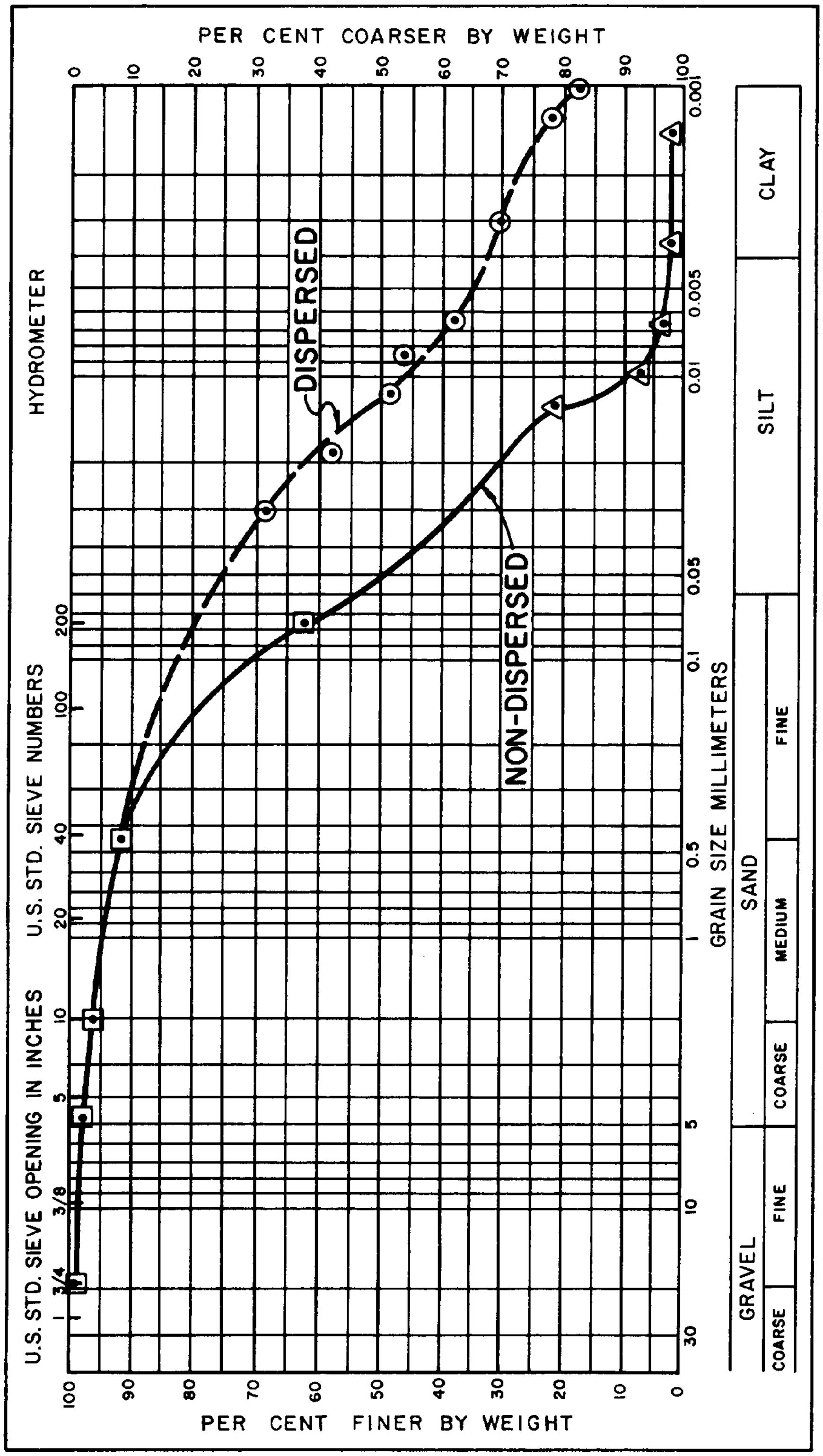

Figure 3-1. Cohesive soil gradation curve.

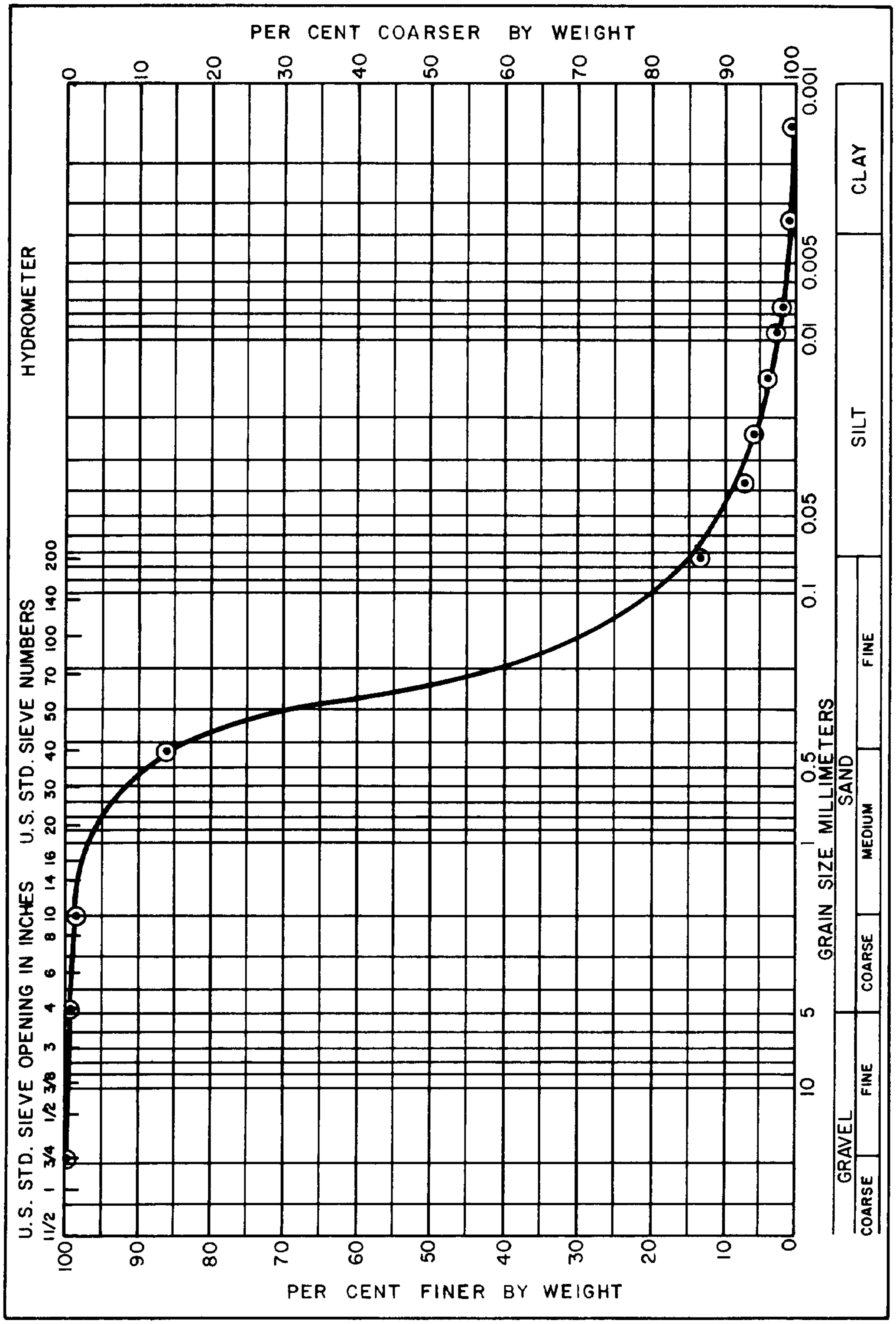

Figure 3-2. Noncohesive soil gradation curve.

(b) A classification of the soils expected to be on the vehicles is needed. By taking the particle size curve previously discussed and plotting the percentage of sand, silt, and clay (dispersed) on a triangular classification chart as shown on figure 3-3, a combined classification can be made. As an indicator of soiling potential expected on the vehicles, the chart is divided into 5 categories or soil type numbers (S_t) The sands and silty sands are given a type number of 1, being the least likely to soil a vehicle and being the easiest to clean. The clays are given a type number of 5, being the most likely to soil a vehicle and being the hardest to clean. Where a particular analysis may plot on the chart close to the line between two types, interpolation should be applied (i.e. a soil could be given a type number of 2.5). Where different soils occur in the training ranges, an average of those found may be used. The designer should use judgment when making this determination and give due consideration to the extreme adverse affects caused by high clay content soils.

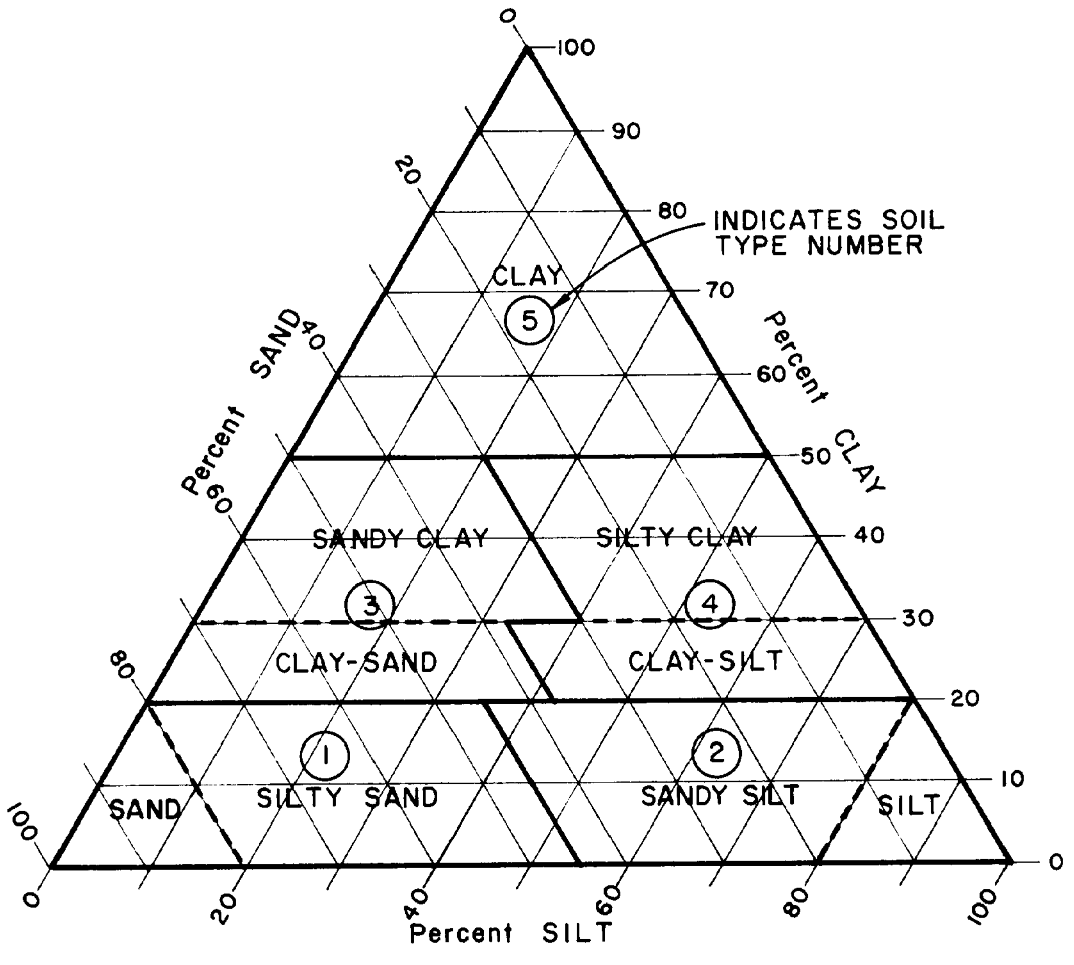

Figure 3-3. Soil classification and soil type number diagram.

(c) Actual soiling of vehicles is a function of both soil type and the amount of rain or wet conditions expected in the training areas. Therefore, climatic data must be provided in order to fully assess the potential for vehicle soiling. Arid regions would have minimum soiling potential where rainy regions would have maximum soiling potential. By assigning a climatic factor (Fc) to the area, ranging from 1 being arid to 2 being very rainy or wet, and multiplying this by the soil type number, a soiling index can be obtained for the installation. This is given by equation 3-1.

$$S_i = S_t x F_c \qquad \text{(eq 3-1)}$$

The soiling index will be used to predict times and determine the need for a prewash.

(4) *Climatic data.* As previously stated, climatic data at the installation is necessary. In addition to amount of rain, seasonal variations in moisture and temperature are needed. Areas with long periods of

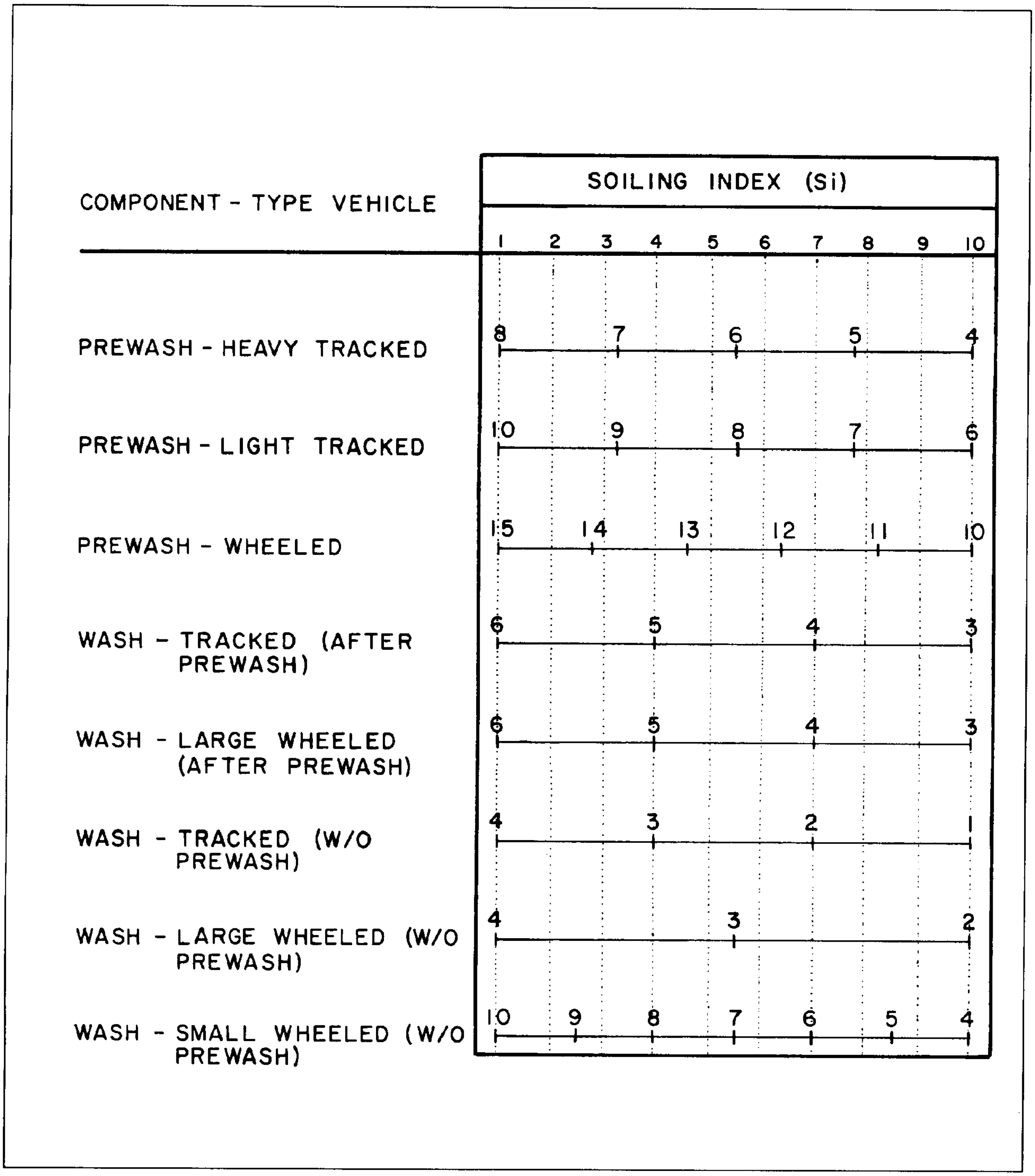

Figure 3-4. Vehicle processing rates.

freezing weather will require special design considerations to protect wash components, pumps and piping. Most of the wash components, particularly the prewash, may not be feasible to operate near freezing conditions because of the safety hazard caused by overspray freezing on the pavement. Enclosed facilities may be warranted, however, they are very expensive from both a capital and operations standpoint. Another climatic consideration in the design is the evaporation rate in the region. In an area with high evaporative losses and low rainfall, certain features of the CVWF may not be practical. For example, a spray stand creates large water losses due to overspray. Use of any prewash system increases the volume required in the treatment system; with the higher water volume, the surface area of the basins must be increased (particularly a lagoon treatment), which promotes evaporative losses even more. The designer must evaluate the potential evaporative loss as it affects the need for make-up water and weigh this against the benefits of either a recycle system or a discharge system.

b. Prewash. A prewash is used to reduce the time needed to wash vehicles, since it removes the bulk of the dirt in a timely, efficient way. Its function is to reduce the amount of time each vehicle must spend at the wash stations.

(1) *Bath prewash.* A bath prewash is currently the most efficient and effective method to remove dirt from the exteriors of tactical vehicles. A large volume of water is required to fill the bath, but because of the reduced wash time required, the overall water volume required for cleaning a large number of vehicles may be reduced. Lanes specifically designed for washing tracked vehicles can be provided; lanes which can accommodate both tracked and wheeled vehicles (referred to as dual purpose lanes) can also be provided. These are described further in chapter 5. Wheeled vehicles under 2.5 tons would not normally use the prewash bath.

(a) *Process Rate.* In a tracked bath lane, six to ten tracked vehicles per hour can be washed. In a dual-purpose lane, ten to fifteen wheeled vehicles per hour can be washed. The amount of soiling will determine the actual number of vehicles that can be processed through the facility; the heavier the soiling, the slower the vehicles can be processed. By using the Soiling Index (S_i) in conjunction with the processing rate chart shown on figure 3-4, the throughput rate can be determined for a particular design.

(b) *Number of lanes.* The number of lanes for the prewash will depend on two factors: The maximum number of vehicles that must be washed at the facility in a time specified by the installation (peak wash period) and the expected process rate through the facility. Equations 3-2 and 3-3 will help the designer determine the number of each type of lane needed for the prewash system. The installation's requirements will dictate how the result should be treated. If the maximum washing time is critical, the number should be rounded up; otherwise, the number of lanes should be rounded to the nearest whole number.

$$\text{No. tracked lanes} = \frac{\text{Max. no. tracked vehicles to be washed}}{(\text{Process rate x peak washing period})} \qquad \text{(eq 3-2)}$$

In equation 3-3, only the tracked and wheeled vehicles expected to use the dual-purpose lane should be considered in the equation. The number of tracked vehicles using the tracked vehicle lane should not be included, since they will not be washed twice in the prewash.

$$\text{No. dual-purpose lanes} = \frac{1}{\text{Peak wash period}} \text{ x } \frac{\text{No. tracked}}{\text{Process rate}} \text{ x } \frac{\text{No. wheeled}}{\text{Process rate}} \qquad \text{(eq 3-3)}$$

(c) An example will better explain how to use the equations. Consider an installation that needs to wash 42 heavy tracked vehicles, 88 light tracked vehicles, and 125 wheeled vehicles in the prewash during peak use. The installation requires that all of the vehicles be washed in 9 hours. Soils at the installation are extremely cohesive clays, so the process rates through the prewash are expected to be slow. The designer had determined that the soiling index (S_i) is 8 and from the chart (fig 3-4 estimates that five heavy tracked vehicles per hour can be washed in each lane; seven light tracked vehicles per hour per lane can be washed; and eleven wheeled vehicles per hour per lane can be washed in a dual-purpose lane. For initial calculations the following will be used.

$$\frac{\text{42 heavy tracked}}{\text{5 veh/hr/lane x 9 hr}} + \frac{\text{88 light tracked}}{\text{7 veh/hr/lane x 9 hr}} = 0.93 + 1.40$$

$$= 2.33 \text{ tracked lanes}$$

$$\frac{\text{125 wheeled vehicles}}{\text{11 veh/hr/lane x 9 hr}} = 1.26 \text{ dual-purpose}$$

The designer realizes that, with three tracked vehicle lanes and one dual-purpose lane, the tracked vehicles will be washed in less than 9 hours, but the wheeled vehicles will require more than 9 hours. To achieve a more even distribution of vehicle washing, the designer recalculates the number of lanes needed by assuming that some of the light tracked vehicles will use the dual-purpose lanes. The designer adjusts the process rate for the