UNITED STATES MARINE CORPS
ENGINEER EQUIPMENT INSTRUCTION COMPANY
MARINE CORPS DETACHMENT
686 MINNESOTA AVE
FORT LEONARD WOOD, MISSOURI 65473-5850

LESSON PLAN

ESTIMATING FOR MISSION REQUIREMENTS

LESSON ID: NCOO-A04

ENGINEER EQUIPMENT OPERATORS NCO

A16ACX1

REVISED 01/11/2012

APPROVED BY _____ **DATE** _____

(ON SLIDE #1)

INTRODUCTION **(10 Min)**

1. GAIN ATTENTION: There are two goals to Marine Corps leadership. One is mission accomplishment, the second is troop welfare. Inadequate production estimation and estimates for logistical support requirements will lead to a failure of both goals. Not knowing how much material is required and what equipment you will need to move it as well as Marines without chow and water will eventually fail to accomplish a mission and will result in a demoralized unit. The same applies to equipment, without fuel and proper maintenance it will fail to perform its intended functions.

(ON SLIDE #2)

2. **OVERVIEW**: Good morning/afternoon, my name is _____. The purpose of this lesson is to familiarize you, the student, with preparing estimations for project production and logistical requirements to support mission requirements.

INSTRUCTOR NOTE
Introduce the learning objectives.

(ON SLIDE #3)

3. **LEARNING OBJECTIVE(S)**:

INSTRUCTOR NOTE
Have students read learning objectives to themselves.

a. TERMINAL LEARNING OBJECTIVES:

(1) Provided a horizontal construction mission, resources, and references, prepare estimations for project production and logistical requirements to support mission requirements per the references. (1345-XENG-2006)

b. ENABLING LEARNING OBJECTIVES:

(1) Given a horizontal construction directive, soil type, classification, state and moisture content, with the aid of references, identify weight of a specified volume per the FM 5-434.

(1345-XENG-2006a)

(2) Given a horizontal construction directive, engineer equipment quantities and types, soil weight, with the aid of references, calculate maximum load (volume and weight), per the FM 5-434. (1345-XENG-2006b)

(3) Given a horizontal construction directive, engineer equipment quantities and types, specified material and weight, and with the aid of references, calculate production rates per the reference FM 5-434.
(1345-XENG-2006c)

(4) Given a horizontal construction directive, production rates, with the aid of references, calculate the time requirement for mission completion per the FM 5-434. (1345-XENG-2006d)

(5) Given a horizontal construction directive, with the aid of references, identify the responsibilities of the NCO for logistical requirements to support a mission per the FM 5-35. (1345-XENG-2006e)

(ON SLIDE #4)

4. **METHOD/MEDIA**: This lesson will be presented by lecture, demonstration, and practical application. I will be aided by computer slides, and the dry erase board.

INSTRUCTOR NOTE
Explain Instructional Rating Forms and Safety Questionnaire to students.

(ON SLIDE #5)

5. **EVALUATION**: There will be three written/performance examinations utilizing references and notes covering basic mathematics operations and formulas, soil states and volumes, scraper production estimations, dozer production estimations, loader production estimations, dump truck production estimations, and logistical requirements estimations covered in this lesson and will be administered at specified points of training during this period of instruction.

(ON SLIDE #6-7)

6. **SAFETY/CEASE TRAINING (CT) BRIEF.** All instructors and students will use caution when walking around the equipment lot during equipment operations. Sun block should be used to avoid sunburn. Issue students bug spray if required. Encourage students to stay hydrated as temperatures can reach 100 degrees plus during the summer months. In the event of a casualty, emergency services (911) will be called and all students will move to the classroom and await further instruction.

TRANSITION: Are there any questions over what is going to be taught, how it will be taught, or how you the student will be evaluated? The first topic we will cover is the purpose of estimations and the states of soil.

_____
_____
_____

(ON SLIDE #8-12)

BODY **(77 HOURS 40 MIN)**

1. Estimations: (2 HRS)

Estimations is the art of determining the size of the job, equipment and personal required to perform the assigned mission and quantities of materials needed. To be able to complete these tasks you must first have an understanding of soil states and understanding of some basic formulas.

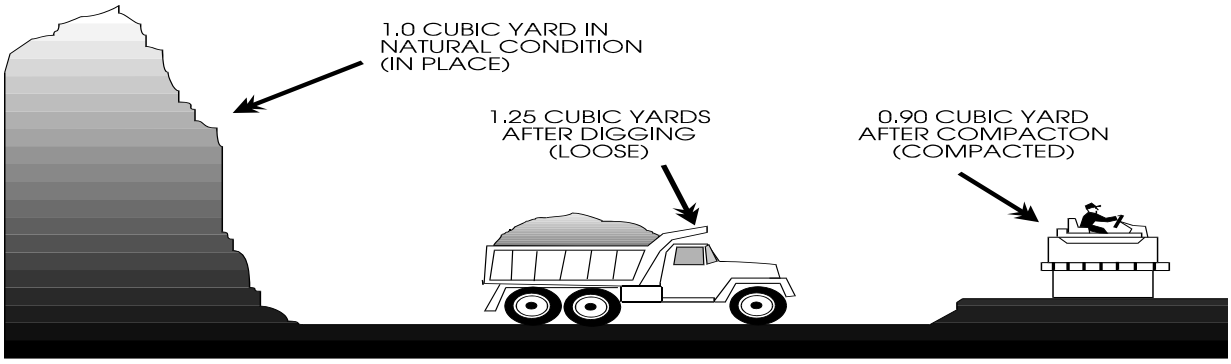
a. SOIL CONVERSION: Before we can estimate any equipment production we need to know what soil we are working with and what state it is in.

(1) Soil is found in THREE different **STATES** or **VOLUMES** 1) bank 2) loose 3) compacted. Sometimes it is necessary to convert from one volume to the other. To do this we use (TABLE# 1-1)

(a) **Bank Soil Volume:** is any soil that has not been disturbed from its natural state for at least ten years. This is also known as Bank Cubic Yards **(BCY).**

(b) **Loose Soil Volume:** is any soil that has been disturbed. Note: soil is always in a loose volume when being hauled, worked or stockpiled. This is also known as Loose Cubic Yards **(LCY).**

(c) **Compacted Soil Volume:** is any soil that has been compacted by artificial means. This is also known as Compacted Cubic Yards **(CCY).**



EXAMPLE FOR THE VARIOUS STATES OF COMMON EARTH

(2) Now that you understand that soil is found in three basic volumes, you must also know that we can convert from bank volume, to loose volume, to compacted volume. This can be done by using table #1-1.

(3) Due to the volume change of material in different states, it is necessary to use a conversion factor to determine the correct amount of material needed for a project. These factors are in Table #1-1. The conversion chart has five columns. The first is the type of soil that is being worked with. The second column identifies the initial soil condition as being either Bank, Loose, or Compacted. Columns three through five identify the conversion factor used to convert the volume of the soil from its initial condition to another form. An asterisk indicates a soil condition, which is the same as the initial soil condition.

(ON SLIDE #13)

TABLE #1-1 SOIL CONVERSION FACTORS

SOIL	CONVERTED FROM:	BANK	LOOSE	COMPACTED
SAND OR GRAVEL	BANK	*	1.11	.95
	LOOSE	.90	*	.86
	COMPACTED	1.05	1.17	*
LOAM	BANK	*	1.25	.90
	LOOSE	.80	*	.72
	COMPACTED	1.11	1.39	*
CLAY	BANK	*	1.43	.90
	LOOSE	.70	*	.63
	COMPACTED	1.11	1.59	*
ROCK (BLASTED)	BANK	*	1.50	1.30
	LOOSE	.67	*	.87
	COMPACTED	.77	1.15	*
CORAL COMPARABLE TO LIMESTONE	BANK	*	1.50	1.30
	LOOSE	.67	*	.87
	COMPACTED	.77	1.15	*

INTERIM TRANSITION: Thus far we have discussed soil conversion. Do you have any questions? Let's move on to the demonstration.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)

Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

(ON SLIDE #14,15)

EXAMPLE

If we needed to make a road that is **1500' long** with a **3" lift** of **gravel** and **24' wide,** it would be necessary to compute the volume first in compacted cubic yards and then convert it to a Loose state. This determines how much material our haul units would have to move. This is done by multiplying the volume of the compacted material by a conversion factor.

INSTRUCTOR NOTE

Ensure the students understand the conversion from inches to feet.

NOTE: When working with inches you must convert inches to feet, ie: 3" ÷ 12" = .25'

1500' (L) X .25' (H) X 24' (W) = 9000 ÷ 27 = 333.33 OR, *334 (CCY)*

334 (CCY)
X 1.17 CONVERSION FACTOR
390.78 OR **391 LCY**

NOTE: ROUND UP TO THE NEXT FULL CUBIC YARD WHEN DEALING WITH SOIL NEEDED OR TO BE REMOVED.

INTERIM TRANSITION: Thus far we have discussed soil conversion. Do you have any questions about the soil conversion demonstration? Let's move on to the practical application.

_____
_____
_____

INSTRUCTOR NOTE

Introduce the following practical application (1). Have the students do the problems 1 and 2.

PRACTICAL APPLICATION (1). (30 MIN) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems convert basic dimensions to cubic yards.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief**: There are no safety concerns.
2. **Supervision & Guidance**: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.

3. Debrief: Are there any questions or comments concerning the conversion of basic dimensions to cubic yards? In order to progress further, you must have an understanding of the conversion.

(ON SLIDE #16,17)

PROBLEM #1: Your crew is tasked to dig a trench which is 300 feet long, 9 feet wide, and 6 feet deep. The material that you are working with is earth loam, dry, and the soil has been undisturbed for more than 10 years. Using a 420 backhoe, how many loose cubic yards **(LCY)** of soil will you remove?

$$\frac{300' \times 9' \times 6'}{27} = 600 \text{ BCY}$$

600 BCY
1.25 CONV FACT
750 LCY

PROBLEM #2: In Problem #1 you removed 750 loose cubic yards of soil. However your requirement for a road you are working on is 16,600 compacted cubic yards (CCY). Will you have enough soil to do the road? If yes, how much over? If not, how much under?

750 LCY
x.72 conv fact
540 CCY

16,600 Volume Req
- 540 CCY
16,060 CCY Needed

INTERIM TRANSITION: Are there any questions or comments concerning the conversion of basic dimensions to cubic yards? Let's move on to basic production time.

_____
_____
_____

(ON SLIDE #18-20)

b. PRODUCTION TIME

a. Even though each item of equipment has different formulas to arrive at production times, the basic principal needs to be talked about before we can move into equipment production.

(1) **CUBIC YARDS PER HOUR (CYPH)** All equipment productions are based on this simple principal, Cubic Yards Per Hour (CYPH), whether it be

Loose Cubic Yards Per Hour **(LCYPH)**

Bank Cubic yards Per Hour **(BCYPH)**

Compacted Cubic Yards Per Hour **(CCYPH)**

(2) **CUBIC YARDS PER DAY (CYPD)** Daily production can simply be found by multiplying the total cubic yards moved per hour by the total hours worked per day.

EXAMPLE:

100 ***CYPH*** **X** 8 **HR WORK/DAY =** 800 ***CYPD***

NOTE: ROUND DOWN CYPD

(3) **TOTAL PRODUCTION DAYS:** Can be found by taking the total requirement of cubic yards needed and dividing it by the total CYPD moved.

EXAMPLE:

16,600 ÷ 800 = 20.75 OR 21
REQ CY **÷** ***CYPD*** **=** ***DAYS NEEDED TO MOVE REQ*** **CY**

NOTE: ROUND UP DAYS TO NEXT FULL DAY

INTERIM TRANSITION: Thus far we have discussed production time. Do you have any questions? Let's move on to the practical application.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (2). Have the students do the problems 1 and 2.

PRACTICAL APPLICATION (2). (30 MIN) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining basic production per hour and per day.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief:** Are there any questions or comments concerning the conversion of basic dimensions to cubic yards? In order to progress further, you must have an understanding of basic production.

(ON SLIDE #21-24)

WHAT HAVE YOU LEARNED?

PROBLEM #1: It has been determined that you are moving 150 LCYPH and you're working 5 hours per day, due to bad weather. The requirement to be moved is 17,000 LCY. How much material is being moved per day and how many days will it take to move the required amount of material?

150 LCYPH
x 5 hrs/day
750 LCYPD

17,000 Req LCY
÷ 750 LCYPD
22.67 or 23 days

PROBLEM #2: It has been determined that you are moving 250 LCYPH and that you're working 8 hours per day. The requirement to be moved is 18,000 LCY. How much material is being moved per day, and how many days will it take to move the required amount of material?

250 LCYPH
x 8 Hrs/day
2,000 LCYPD

18,000 Req LCY
÷ 2,000 LCYPD
9 Days

(ON SLIDE #25-27)

TRANSISTION: Are there any questions or comments concerning basic production for hours and days?

_____
_____
_____

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. What is estimating?

The art of determining the size, equipment, personal, and quantities needed for a project.

b. What are the three states of soil?

Bank, Loose, Compacted

c. What does CCYPH mean?

Compact Cubic Yards Per Hour (CCYPH)

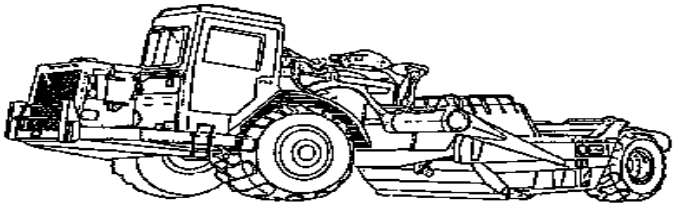
(BREAK – 10 Min)

TRANSISTION: Are there any questions or comments concerning basic production for hours and days? Let's now move on to actual Scraper estimations, first starting with its basic functions and capabilities.

_____
_____
_____

(ON SLIDE #28-35)

SCRAPERS



2. INTRODUCTION TO SCRAPERS. (1 HR)

Scrapers are designed for loading, hauling, and dumping on long-haul earth moving operations. The scraper has three basic operational parts; the bowl, the apron, and the ejector. The bowl, which is equipped with a cutting edge on the front bottom, is the loading and carrying component. The apron is the front wall of the bowl, and can be raised and lowered independently of the bowl. The ejector is the rear wall of the bowl. It is moved back to load, and forward to discharge materials.

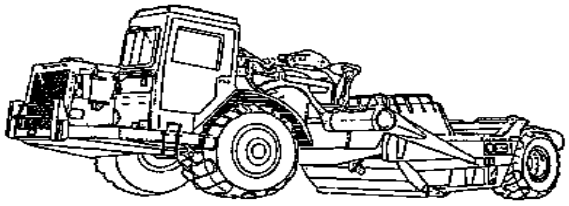
a. **USE**. In the field of heavy construction, tractor-scrapers serve the primary purpose of loading, and hauling material. The distinct advantage of the tractor-scraper, in earth moving, is the ability to load, haul, and spread in one continuous cycle. The tractor-scraper is capable of working alone for leveling operations, but is supplemented with push-tractors for cut and fill operations.

b. **CLASSIFICATION**: Tractor-scrapers are classified according to load capacity, and rated load. Capacity is measured in heaped and struck capacity. A heap load is the maximum load of the machine, and a struck load is the minimum effective load.

c. **CHARACTERISTICS:** Tractor-scrapers are wheeled vehicles characterized by a tractor and scraper. They serve as prime earth movers in cut and fill operations and in bringing elevations to rough, final grades. Since scraper bowls are of open design, they can also be loaded from above, with a shovel or a bucket. Scrapers have three types of cutting edges; straight, which is most effective for smooth grade finishing; curved, which provides better penetration than a straight edge; and the three-piece cutting edge, where the center piece (called a

stinger) is held ahead of the two side pieces for better penetration. **The 621B has a rated load weight of 48,000 lbs.**

d. **OPERATION:** Scrapers are hydraulically operated and powered by a tractor. The tractor-scraper is most efficient during downhill loading. Other methods that will increase production include straddle loading, and pump loading. Straddle loading is most effective in stripper operations and will gain time on every third trip because the center strip has less resistance than a full cut. Pump loading is a technique used in sand, and gravel, where material is heaped in front of the bowl and when the pusher lugs down, the bowl is raised and lowered to create a pumping effect. All loading should be accomplished with a pusher, within (1) minute, and within (100) feet of travel. Longer loading times and distance are justified only when hauling fewer loads over long hauling distances offsets such efforts. It is important to remember that whenever soil is hauled in a haul unit, it is considered to be loose soil. Haul units, particularly scrapers, are generally said to have **TWO (2) VOLUME CAPACITIES, STRUCK AND HEAP LOADS.**



(1) **Struck load** : Is when the unit is loaded with soil until the material is approximately even with the top of the side boards. The capacity of the 621B Scraper, when struck loaded is ***14 loose cubic yards***.

(2) **Heap load**. Is when the unit is loaded to its maximum capacity and the material is overflowing the side boards. The capacity of the 621B Scraper when heap loaded is ***18 loose cubic yards***.

NOTE: The 621B cannot efficiently self load to a heap capacity.

e. These terms are used as a general reference to load size. **Actual load size** will vary considerably, being somewhere between struck & heap due to variables such as soil weight, moisture content, and the manner in which the scraper is being loaded. For example, if a TRAM with a 2 1/2 cubic yard bucket were load-

ing the 621B, the volume of the load would be some multiple of 2.5.

(ON SLIDE #36)

TRANSISTION: Are there any questions or comments concerning the introduction to the 621B Scraper?

_____
_____
_____

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. How are scrapers classified?

According to load capacity, and rated load.

b. What are the two volume capacities?

Struck and Heap

c. What is the Scraper's rated load weight?

48,000 lbs

(BREAK – 10 Min)

TRANSITION: Now that we have covered the use, classification, characteristics and operations of the scraper, are there any questions? Let's move right into scraper production.

_____
_____
_____

(ON SLIDE #37-51)

3. **PRODUCTION: (14 HRS)**

There are **15** steps to determine scraper production, starting with soil weight.

a. **STEP #1: ACTUAL SOIL WEIGHT**

To determine the **actual soil weight** per cubic yard, start by taking the soil weight from (Table #2-2).

EXAMPLE:

EARTH LOAM DRY IS *2200 lbs*. PER CUBIC YARD

TABLE #2-2
APPROXIMATE WEIGHT OF SOIL

TYPE OF SOIL	POUNDS PER (CY)	TYPE OF SOIL	POUNDS PER (CY)
CINDERS	1200 LBS.	***LIMESTONE***	2500 LBS.
CLAY, DRY	2000 LBS.	***SANDSTONE***	2200 LBS.
CLAY, WET	3000 LBS.	***SAND, DRY***	2900 LBS.
CLAY & GRAVEL,	2700 LBS.	***SAND, WET***	3100 LBS.
GRAVEL, DRY	3000 LBS.	***SHALE & SOFT ROCK***	2700 LBS.
GRAVEL, WET	3100 LBS.	***SLAG, BANK***	1940 LBS.
EARTH LOAM, DRY	2200 LBS.	***SLATE***	2500 LBS.
EARTH LOAM, WET	3200 LBS.	***TRAP ROCK***	3500 LBS.
HARDPAN	3100 LBS.	***CORAL (HARD)***	2440 LBS.
		CORAL (SOFT)	2030 LBS.

(1) Now that you know how to get your soil weight per cubic yard, Step 2 adds the weight of the moisture to the soil weight. This is called moisture content. This factor must be taken into consideration when determining the weight of the load. Notice that in Table #2-2, the approximate weights of many different types of soil are listed. For many of the soils listed, a weight is given for both wet and dry materials. For most general applications, these weights may be used to estimate the weight of the soil being worked with. However, there will be times that a more specific weight is needed, and then the moisture content of the soil must be taken into consideration. Soil analysis personnel are trained to determine the moisture content, and the weight of this moisture must be calculated and added to the weight of the **DRY** soil. This moisture will be expressed as a percentage of the weight of the dry soil.

(2) To determine the weight of the moisture, multiply the dry weight by the percentage of the moisture content then add the result to the dry weight to determine the actual weight of the soil. If the weight of dry earth loam is 2200 lbs. per cubic yard, then 2200 lbs. is 100% of the original weight. The initial moisture content is 7% of the original weight. Therefore, the actual soil weight is 107% of the original weight. 107% converted to a decimal is 1.07. Now by multiplying the

original weight of 2200 lbs. by 1.07, we will get the end result of 2354 lbs.

NOTES: ***If you are given a wet soil,*** **take the weight of the wet soil off of the chart.**

If you are not given either wet or dry condition**, take the weight of dry soil off of the chart**

If you are given a wet soil and moisture content**, take the weight of dry soil and multiply the moisture content.**

EXAMPLE:

You have Dry Earth Loam with a 7% moisture content. What is your Actual Soil Weight (ASW)?

2200	**WEIGHT OF DRY EARTH LOAM PER CY FROM TABLE 2-2**
X 1.07	**100% OF SOIL WEIGHT + 7% MOISTURE**
2354	***ACTUAL SOIL WEIGHT*** **(ASW)**

NOTE: NEVER ROUND OFF ASW.

b. **STEP #2: CUBIC YARDS OF A LOAD:**

Remembering that you want to keep the weight of the load under 48,000 lbs, determine how many cubic yards can be hauled without exceeding 48,000 lbs. To do this, divide 48,000 by the actual soil weight per cubic yard.

48,000	**LBS (RATED CAPACITY)**
÷ 2,354	**LBS (ACTUAL SOIL WEIGHT)** FROM STEP# 1
20.39	**CY NO MORE THAN 18 CY**

If the resulting figure is over 18 cubic yards, you must go with 18. It is the maximum cubic yards that the 621B can haul. If the resulting figure is less than 18, use that entire number as it appears on the adding machine in step 3.

NOTE: ROUND DOWN TO 18 IF MORE THAN THE MAXIMUM CAPACITY.

c. **STEP #3: (If Needed) BUCKETS LOADED:**

To determine the number of **buckets loaded** that is equal to or less than the figure determined in step #2. Divide that figure, in this case 18, by the size of each bucket load which for the TRAM is 2 1/2 or 2.5.

Note: if the scraper is being self loaded or push loaded go to step #5

18	**CUBIC YARDS**
÷ 2.5	**CUBIC YARDS (BUCKET SIZE FROM TABLE)**
7.2	**BUCKETS OR 7 BUCKETS LOADED**

NOTE: ROUND DOWN TO WHOLE BUCKETS LOADED.

TABLE #3-2

BUCKET SIZE

TRAM 624KR	**2 1/2 or 2.5 CY**
MC1155E	**1 3/4 or 1.75 CY**
MAC-50 CLAMSHELL	**1 ¼ OR 1.25 CY**
420D FRONT BUCKET	**1 ¼ or 1.25 CY**
420D BACKHOE BUCKET	**¼ or .25 CY**

d. **STEP #4 ACTUAL LOAD SIZE:**

To determine the volume of the load, take the answer from Step #3, 7 buckets per load, multiplied by the bucket size 2.5 for a TRAM.

7	**# OF BUCKETS**
X 2.5	**TRAM BUCKET SIZE**
17.5	***ACTUAL LOAD SIZE*** **(ALS)** ***NOTE: NEVER ROUND OFF ALS***

e. **STEP #5 LOAD WEIGHT (LW):**

To determine the Load Weight, multiply ASW and ALS. Regardless of how much volume that you may be able to haul, you should try to keep your load weight under 48,000 pounds. Table #2-2 shows the weight of Cinders as 1200 pounds per loose cubic yard. A struck load would weigh 16,800 pounds, while the heap load would weigh 21,600 pounds. These weights would be easily hauled, but it is a different story with other materials. Take a look at Earth Loam, Wet for instance:

TABLE #2-2
APPROXIMATE WEIGHT OF SOIL

TYPE OF SOIL	POUNDS PER (CY)	TYPE OF SOIL	POUNDS PER (CY)
CINDERS	1200 LBS.	***LIMESTONE***	2500 LBS.
CLAY, DRY	2000 LBS.	***SANDSTONE***	2200 LBS.
CLAY, WET	3000 LBS.	***SAND, DRY***	2900 LBS.
CLAY & GRAVEL,	2700 LBS.	***SAND, WET***	3100 LBS.
GRAVEL, DRY	3000 LBS.	***SHALE & SOFT ROCK***	2700 LBS.
GRAVEL, WET	3100 LBS.	***SLAG, BANK***	1940 LBS.
EARTH LOAM, DRY	2200 LBS.	***SLATE***	2500 LBS.
EARTH LOAM, WET	3200 LBS.	***TRAP ROCK***	3500 LBS.
HARDPAN	3100 LBS.	***CORAL (HARD)***	2440 LBS.
		CORAL (SOFT)	2030 LBS.

3,200 Weight of Earth loam WET, PER/CY
X 14 (LCY) Struck
44,800 LBS. STRUCK LOADED

3,200 Weight of Earth loam WET, PER/CY
X 18 (LCY) Heaped
57,600 LBS. HEAPED LOADED

(1) As you can see, the struck load weighs less than the rated capacity, but **the heaped load is over the 48,000 pound limit** by 9,600 pounds. Therefore, if you are going to be hauling this type of material, and you are self loading, you should plan on hauling a struck load. However, if you are loading the scraper with another piece of equipment, such as a scoop loader, you must determine how many loads the loader can put on the scraper and still keep the weight of the load within the acceptable weight limits.

(2) Each cubic yard weighs 2354 lbs (Step #1), and you are hauling 17.5 cubic yards. Therefore, the weight of your load will be 41,195 lbs.

INTERIM TRANSITION: Thus far we have discussed scraper production. Do you have any questions? Let's move on to the demonstration.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE:

2354	**ASW**
X 17.5	**ALS**
41,195	***LOAD WEIGHT (LW)*** NOT OVER THE 48,000 LBS MAX. LOAD WEIGHT

NOTE: NEVER ROUND OFF LOAD WEIGHT

f. **STEP #6: SHORT TONS:**

Are found by dividing the gross weight by 2,000 lbs. (the weight of one ton)

Example:

66,590	**LBS.**	**TR. WT.**
+ 41,195	**LOAD**	**WT. (from step #5)**
107,785	**LBS.**	**GROSS WEIGHT**
÷ 2,000		**Weight of One Ton**
53.89	**ST**	***SHORT TONS (ST) (CLEAR CALCULATOR)***

Now take the Short Tons to steps 7 & 8

NOTE: NEVER ROUND OFF SHORT TONS (ST)

INTERIM TRANSITION: Are there any questions over the first six steps of scraper production? Now let's move into some practical application on these steps.

_____

_____

_____

(ON SLIDE #53)

INSTRUCTOR NOTE

Introduce the following practical application (3).

PRACTICAL APPLICATION (3). (2 HRS) Have the students complete the problems in the student handout.

PRACTICE: There are three problems in the student handout for the students to complete. The problems are determining the first six steps of scraper production.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief:** Are there any questions or comments concerning the first six steps of scraper production? In order to progress further, you must have an understanding of basic production.

(ON SLIDE #54-58)

WHAT HAVE YOU LEARNED

PROBLEM #1: If the soil analysis team told you that the Gravel being hauled by a 621B scraper had an initial moisture content of 12%, what would the **weight of each CY** be?

3000	Dry Gravel Weight
x 1.12	Moisture Content
3,360	Actual Soil Weight (ASW)

PROBLEM #2: When hauling this Gravel in a 621B loaded with a TRAM 624KR, what would the **load weight** be?

48,000	MAX CAP
÷ 3,360	ASW
14.29	CY OF LOAD
÷ 2.50	BUCKET SIZE
5.72	
OR 5	BUCKETS LOADED

5	BUCKETS LOADED
x 2.5	BUCKET SIZE
12.50	ALS
x 3,360	ASW
42,000	LW

PROBLEM #3: If the 621B has a load weight of 46,590 pounds, what **would your short tons be?**

	48,000	LW
+	66,590	TW
	113,180	GW
÷	2,000	1 TN
	56.59	SHORT TN

(BREAK 10 MIN)

INTERIM TRANSITION: Are there any questions over the first six steps of scraper production? Let's move on to rolling resistance.

_____

_____

_____

(ON SLIDE #59-61)

g. STEP #7 ROLLING RESISTANCE:

Is the resistance of movement to wheeled vehicles over a haul surface caused by irregularities in the surface such as compacting and displacement of material, caused by the flexing of tire side walls on the roadway. Rolling resistance is measured by the rim pull in pounds per short ton required to overcome resistance. This resistance effects the cycle time.

To do this multiply **SHORT TONS** (from step #6) by the **ROLLING RESISTANCE FACTOR (RRF)** found in (TABLE #4-2). The resulting answer will be your **ROLLING RESISTANCE (RR)**

TABLE #4-2
ROLLING RESISTANCE FACTORS

HARD, SMOOTH, STABILIZED ROADWAY WITHOUT PENETRATION UNDER LOAD (CONCRETE OR BLACKTOP) (WATERED, MAINTAINED)	40 LBS. A TON
FIRM, SMOOTH-ROLLING ROADWAY FLEXING SLIGHTLY UNDER LOAD 1" PENETRATION (GRAVEL TOPPED ROAD) (MAINTAINED FAIRLY REGULARY, WATERED)	65 LBS. A TON
RUTTED DIRT ROADWAY, FLEXING CONSIDERABLY UNDER LOAD 2" TO 3" PENETRATION (HARD CLAY ROAD)(LITTLE MAINTENANCE, NO WATERING)	100 LBS. A TON
RUTTED DIRT ROADWAY, NO STABILIZATION UNDER LOAD 4" TO 6" PENETRATION (SOFT CLAY ROAD) (NO MAINTENANCE, NO STABILIZATION)	150 LBS A TON
NO STABILIZATION 7" OR GRATER PENETRATION (SOFT, MUDDY, RUTTED ROADWAY, OR IN SAND) (NO MAINTENANCE)	400 LBS A TON

INTERIM TRANSITION: Thus far we have discussed rolling resistance. Do you have any questions? Let's move on to the demonstration.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)

Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: Determine the rolling resistance for a 621B scraper traveling over a **firm, smooth-rolling roadway flexing slightly under load 1" penetration.** The weight of the soil in the scraper is 41,195 pounds.

53.89	**(ST)** Short Tons
X 65	**(RRF)** Rolling Resistance Factor
3502.85 OR 3503	**(RR)** Rolling Resistance

NOW TAKE RR TO STEP #9

NOTE ROUND OFF RULE: (ROUND UP 5 OR GREATER, ROUND DOWN 4 OR LESS.) FOR (RR).

(ON SLIDE #62)

INTERIM TRANSITION: Are there any questions over rolling resistance? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (4).

PRACTICAL APPLICATION (4). (1HR 30MIN) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining rolling resistance for the scraper.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief**: There are no safety concerns.
2. **Supervision & Guidance**: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief**: Are there any questions or comments concerning rolling resistance? In order to progress further, you must have an understanding of basic production.

(ON SLIDE #63-66)

WHAT HAVE YOU LEARNED

PROBLEM #1: Figure **Rolling Resistance** for the following situation.

Caterpillar 621B Scraper

Struck loaded- (Self Load)

Hard pan

Rutted, dirt roadway, flexing considerably under load with 2" to 3" penetration.

3,100	ASW
X 14	ALS
43,400	LW

43,400	LW
+66,590	TW
109,990	GW

109,990	GW
÷ 2,000	1 TN
55.00	ST

55.00	ST
X 100	RRF
5,500	RR

PROBLEM #2: Figure **Rolling Resistance** for the following situation.

Caterpillar 621B Scraper

Loaded with a TRAM (2 1/2 CY Bucket)

Trap rock

Hard, smooth, stabilized roadway without penetration

48,000	MAX LOAD
÷ 3,500	ASW
13.71	CY OF A LOAD
13.71	CY OF A LOAD
÷ 2.5	BUCKET SIZE
5.48	OR 5 BUCKETS
5	LW
x 2.5	TW
12.50	ALS
12.50	ALS
÷ 3,500	ASW
43,750	LW
43,750	LW
+66,590	TW
110,340	GW
110,340	GW
÷ 2000	1 TN
55.17	ST
55.17	ST
X 40	RRF
2206.80	OR 2207 RR

INTERIM TRANSITION: Are there any questions over rolling resistance? Let's move on to grade resistance/grade assistance.

_____

_____

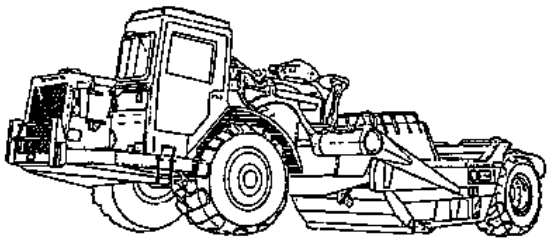
_____

(ON SLIDE #67-73)

h. **STEP #8: GRADE RESISTANCE (GR) OR GRADE ASSISTANCE (GA):**

Grade Resistance or Grade Assistance is the addition, or decrease, in the amount of pounds of pull required as the result of adverse or favorable grades on haul roads. Rules of thumb generally accepted as reliable measures of the effect of grades are as follows:

1. Each 1 percent of (uphill) grade increases the resistance by 20 pounds per short ton pull of gross vehicle weight.



The Formula:

Short Tons x 20 (constant) x % of Grade = Grade Resistance or Grade Assistance
Note: ROUND UP 5 OR GREATER, ROUND DOWN 4 OR LESS

INTERIM TRANSITION: Are there any questions over grade resistance/grade assistance? Let's move on to the next two demonstrations.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: The total weight of the loaded scraper on the haul is 107,785 lbs.
Calculate the grade resistance factor for climbing a (+2) uphill grade.

53.89	**X**	**20**	**X**	**2**	**=**	**2155.60 or +2156**
Short Tons	**X**	**20**	**X**	**% GRADE**	**=**	***Grade Resistance (GR)***

NOTE: ***ROUND UP 5 OR GREATER ROUND DOWN 4 OR LESS (GR/GA).***

2. Each 1 percent of (downhill) grade decreases the amount of pull required by 20 pounds per short ton of gross vehicle weight.

INSTRUCTOR DEMONSTRATION (5 min)

Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: For the return, the tractor is empty so the total weight is 66,590 lbs.

Calculate the grade assistance factor for (-2) downhill grade.

Note: An empty scraper has a constant 33.30 for short tons.

33.30	X	20	X	2	=	- 1,332
Short Tons empty	**X**	**Constant**	**X**	**% GRADE**	**=**	***Grade Assistance (GA)***

NOTE: ROUND UP 5 OR GREATER ROUND DOWN 4 OR LESS (GR/GA).

(ON SLIDE #74)

INTERIM TRANSITION: Are there any questions over grade assistance/resistance? Now let's move into some practical application on these steps.

_____

_____

_____

INSTRUCTOR NOTE

Introduce the following practical application (5).

PRACTICAL APPLICATION (5). (1HR 30MIN) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining grade assistance for the scraper.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. Safety Brief: There are no safety concerns.
2. Supervision & Guidance: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to walk through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. Debrief: Are there any questions or comments concerning grade assistance? In order to progress further, you must have an understanding of basic production.

(ON SLIDE #75-81)

WHAT HAVE YOU LEARNED

PROBLEM #1 Determine **Grade Resistance** for a 621B Scraper with the following factors.

Struck load

Sand

7% Initial moisture

3% uphill grade

2,900	DRY SAND
x 1.07	MOISTURE
3,103	ASW
3,103	ASW
÷ 14	ALS
43,442	LW
43,442	LW
+66,590	TW
110,032	GW
110,032	GW
÷ 2,000	1 TN
55.02	ST
55.02	ST
X 20	CONSTANT
X 3	GRADE

3,301	GR

PROBLEM #2: Determine **Rolling and Grade Resistance** for a 621B on the haul with the following factors.

Heap load

Sandstone

Rutted, dirt roadway, no stabilization under load 4" to 6" penetration.

6% uphill grade

2,200	ASW
x 18	ALS
39,600	LW
43,442	LW
+66,590	TW
106,190	GW
106,190	GW
÷ 2,000	1 TN
53.10	ST

HAUL		**RETURN**	
53.10	ST	33.10	ST
X 150	RRF	X 150	RRF
7,965	RR	4995	RR
53.10	ST	33.30	ST
X 20	CONSTANT	X 20	CONSTANT
X 6	GRADE	X - 6	GRADE
6,372	GR	- 3996	GA

(BREAK 10 MIN)

INTERIM TRANSITION: Are there any questions over grade assistance/resistance? Let's move on to required pounds of pull.

_____

_____

_____

(ON SLIDE #82-85)

i. **STEP #9: REQUIRED POUNDS OF PULL (REQPP):**

Is the total power required to move a unit. We can find our ***REQPP*** by adding ***GR*** with ***RR*** for uphill or subtracting ***GA*** from ***RR*** for downhill. **When on level terrain, your *RR* is your *REQPP*.**

EXAMPLE 1. *When traveling **uphill** a vehicle must overcome both rolling resistance and grade resistance.*

```
  3503      (RR)
+ 2156      (+GR)
  5659   = (REQPP)
```

Using Table 5-2, you can see that the scraper will not give you enough Rim Pounds Pull (RPP) in 8th or 7th gear, but in 6th gear you have enough RPP. The *travel speed is **14 MPH***

EXAMPLE 2 *When traveling **downhill** a vehicle must overcome rolling resistance less grade Assistance.*

```
  2165      (RR)
- 1332      (-GA)
   833   = (REQPP)
```

Using Table 5-2, we see that 8th gear gives you 3,393 pounds of pull, but you only need 833, so 8th gear will give you more than enough. The *travel speed is **26 MPH.***

EXAMPLE 3. *When traveling over **level terrain**, a vehicle must overcome rolling resistance only.*

```
   3503     RR = (REQPP)
```

SUB STEP: TRAVEL SPEED: To get your travel speed you first must make a gear selection.

Gear selections for the 621B is easy now that you know how much REQPP are needed to go uphill, downhill, or on level terrain. By looking at the table below, we can use the rim pounds of pull compared to the required pounds of pull to get our gear and travel speed. For example, you used 6th gear to go up and 8th to come down.

TABLE #5-2
POWER CHARACTERISTICS OF 621B SCRAPER

AVAIL (RPP)	*35,062*	*23,375*	*16,187*	*13,148*	*9,146*	*6,657*	*5,008*	*3,393*
GEAR:	1st	2nd	3rd	4th	5th	6th	7th	8th
(TS)SPEED MPH	**2 MPH**	**4 MPH**	**6 MPH**	**8 MPH**	**11 MPH**	**14 MPH**	**19 MPH**	**26 MPH**

NOTE: If the TM doesn't have this table you can use this formula to get your (RPP) table.

$$\frac{\textbf{375 X ENGINE HP X 80\% EFFICIENCY}}{\textbf{TRAVEL SPEED IN MPH}} = \textbf{RIM POUNDS PULL (RPP)}$$

(ON SLIDE #86-91)

INTERIM TRANSITION: Are there any questions over required pounds of pull? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE

Introduce the following practical application (6).

PRACTICAL APPLICATION (6). (2 HRS) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining travel speed.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief**: There are no safety concerns.
2. **Supervision & Guidance**: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief**: Are there any questions or comments concerning the travel speed? In order to progress further, you must have an understanding of basic production.

WHAT HAVE YOU LEARNED

PROBLEM #1: Determine **TRAVEL SPEED** with the following factors.

Caterpillar 621B Scraper

Struck load

Earth loam

10% Initial moisture

Hard, smooth roadway with
no penetration under load.

4% downhill grade

2,200	DRY EARTH LOAM
x 1.10	MOISTURE
2,420	ASW

2,420	ASW
x 14	ALS
33,880	LW

33,880	LW
+66,590	TW
100,470	GW

100,470	GW
÷ 2,000	1 TN
50.24	ST

	HAUL		**RETURN**	
	50.24	ST	33.10	ST
	X 40	RRF	X 40	RRF
	2,010	RR	1,332	RR
	50.24	ST	33.30	ST
	X 20	CONSTANT	X 20	CONSTANT
	X - 4	GRADE	X 4	GRADE
	- 4,019	GA	2664	GR
8TH GEAR	2,010	RR	1,332	RR **7TH GEAR**

26 MPH	- 4,019	GA	+ 2,664	GR	**19 MPH**
	- 2,009	RPP	3,996	RPP	

PROBLEM #2: Determine TRAVEL SPEED with the following factors.

Caterpillar 621B Scraper

Struck load

Clay and gravel

3% Initial moisture

Rutted, dirt roadway, no stabilization
under load, 4" to 6" penetration.

6% uphill grade

2,700	DRY EARTH LOAM
x 1.03	MOISTURE
2,781	ASW

2,781	ASW
x 14	ALS
38,934	LW

38,934	LW
+66,590	TW
105,524	GW

105,524	GW
÷ 2,000	1 TN
52.76	ST

HAUL		**RETURN**	
52.76	ST	33.10	ST
X 150	RRF	X 150	RRF
7,914	RR	4,995	RR
52.76	ST	33.30	ST
X 20	CONSTANT	X 20	CONSTANT
X 6	GRADE	X - 6	GRADE
6,331	GR	- 3996	GA

3RD GEAR	7,914	RR	4,995	RR	**8TH GEAR**
6 MPH	+ 6,331	GR	- 2,664	GA	**26 MPH**
	14,245	RPP	- 999	RPP	

(ON SLIDE #92-93)

INTERIM TRANSITION: Are there any questions over travel speed? Let's move on to the demonstration of rolling resistance.

_____
_____
_____

RETURN

The return is done by repeating steps 6-9 and using empty vehicle weight to get the short tons

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE :

STEP #6 *SHORT TONS* ***(ST)*** *WITH EMPTY VEHICLE WEIGHT*

66,590
÷ 2,000
33.30 **(ST,** CONSTANT FOR A EMPTY 621B)

STEP #7 *ROLLING RESISTANCE* ***(RR)***

33.30 (ST)
X 65 **(RRF)** ROLLING RESISTANCE FACTOR
2,164.50 or 2,165 **(RR)**

STEP # 8 *GRADE RESISTANCE* / GRADE ASSISTANCE

33.30 (ST) X 20 X -2 = 1,332 **(-GA)**

STEP #9 *REQUIRED POUNDS OF PULL (RPP) TRAVEL SPEED MPH.*

2,165 (RR)
-1,332 (-GA)

833 (RPP)

(ON SLIDE #94-99)

j. ***STEP #10 CYCLE TIME:***

Is the time required to LOAD, HAUL, SPREAD, and RETURN. This is figured by adding ***Fixed Time (Fix-T)*** *and* ***Travel Time (TT)*** *to get* ***cycle time (CT).***

a. **Fixed Time:** is the time spent during an equipment cycle other than hauling and returning. This includes positioning, loading, unloading, turning, accelerating and decelerating all of which are fairly constant or fixed. Fixed times are determined from Table #6-2. To use Table 6-2, start with the gear you are hauling in.

TABLE #6-2
FIXED TIME

EQUIPMENT LOADING SCRAPER	**1ST GEAR HAUL 2ND GEAR HAUL 3RD GEAR HAUL**		**4TH GEAR HAUL**		**5TH GEAR HAUL 6TH GEAR HAUL 7TH GEAR HAUL 8TH GEAR HAUL**	
	STRUCK	HEAP	STRUCK	HEAP	STRUCK	HEAP
SCRAPER LOADING ITSELF	2.5O	N/A	2.8O	N/A	3.O	N/A
1155E	7.O	9.O	7.3O	9.3O	7.5O	9.5O
TRAM	6.O	7.O	6.3O	7.3O	6.5O	7.5O
ATC CLAMSHELL	16.O	19.O	16.3O	19.3O	16.5O	19.5O
SCRAPER PUSH LOADED	1.43	1.71	1.73	2.01	1.93	2.21

NOTE: These are average fixed times only and are based on and average operator who is familiar with the attachments and equipment operation. These times are basic starting points only. Actual fixed times can vary considerably due to varying conditions. Timing of several actual fixed cycles is necessary in order to obtain a more realistic fixed time average for the particular job being performed. **FOR CLASS ROOM PURPOSES IF THE LOAD FALLS SOMEWHERE IN BETWEEN STRUCK AND HEAP LOADS. USE THE HEAP LOAD TIME FOR THE FIXED TIME.**

b. **Travel Time:** is the time spent on the haul road transporting material and returning empty. Travel Time depends on: (1) Size of hauling unit (2) Rolling resistance (3) Grade resistance and Distance traveled. All of which have already been

figured to get your gear selection and speed to put into the cycle time formula.

c. To figure **Cycle Time (CT)** you first must figure Travel Time (TT). To get Travel Time divide the distance in feet of the haul or return road by the sum of the travel speed (TS) in mph multiplied by 88. Do this for the haul and return. The Total Travel Time plus Fixed Time will equal **Total Cycle Time.**

NOTE: 88 is the conversion factor to change the speed in MPH to feet traveled per minute.

Example #1: A Caterpillar 621B Scraper, hauling 17.5 CY of material, travels 7500 feet to the fill area using 6th gear and returns empty by a different route of 8200 feet in 8th gear. What is the total cycle time, if a Tram is loading the 621b?

$$\frac{\textbf{haul distance in feet: } 7500}{14 \text{ TS} \times 88 \text{ (from step 9)}} = 6.09 \quad \textbf{HAUL Time (HT)}$$

$$\frac{\textbf{return distance in feet: } 8200}{26 \text{ TS} \times 88 \text{ (from step 9)}} = 3.58 \quad \textbf{RETURN Time (RT)}$$

6.09 (HT) + 3.58 (RT) + 7.5 Fixed Time (FT) = 17.17 *CYCLE TIME* (CT) MIN.
(Table 6-2)

NOTE: NEVER ROUND OFF TIME.

(ON SLIDE #100-104)

INTERIM TRANSITION: Are there any questions over cycle time? Now let's move into some practical application on these steps.

INSTRUCTOR NOTE
Introduce the following practical application (7).

PRACTICAL APPLICATION (7). (1 HR 30 MINS) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining cycle time for the scraper.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief:** Are there any questions or comments concerning the cycle time? In order to progress further, you must have an understanding of basic production.

WHAT HAVE YOU LEARNED

PROBLEM #1: Figure total **CYCLE TIME**.

Caterpillar 621B Scraper, self loaded

Haul distance - 8250'

Return distance - 7125'

Haul gear - 4th

Return gear - 8th

8,250 HD
8 X 88 = 11.72 HAUL TIME (HT)

7,125 RD
26 X 88 = 3.11 RETURN TIME (RT)

11.72	+	3.11	+	2.80	=	17.63
HAUL TIME		RETURN TIME		FIXED TIME		CYCLE TIME

PROBLEM #2: Figure total **CYCLE TIME**.

Caterpillar 621B Scraper, self loaded

Haul distance - 9000'

Return distance - 9176'

Haul gear - 6th

9,000 HD
14 X 88 = 7.31 HAUL TIME (HT)

9,176 RD
26 X 88 = 4.01 RETURN TIME (RT)

7.31	+	4.01	+	3.00	=	14.32
HAUL TIME		RETURN TIME		FIXED TIME		CYCLE TIME

(BREAK 10 MIN)

INTERIM TRANSITION: Are there any questions over cycle time? Let's move on to rolling resistance.

_____
_____
_____

(ON SLIDE #105)

k. ***STEP #11 TRIPS PER HOUR:*** *To determine Trips Per Hour (TPH) divide the working minutes per hour (normally a 60-minute work hour) by the cycle time.*

MIN. WORKED PER/HR
CYCLE TIME **=** ***TRIPS PER HOUR (TPH)***

NOTE: NEVER ROUND OFF TPH

INTERIM TRANSITION: Are there any questions before we move in to the next four demonstrations.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: How many trips per hour can a 621B make during a 60-minute work hour, if it has a cycle time of 17.17 minutes?

$$\frac{60}{17.17\ CT} = 3.49\ TPH$$

(ON SLIDE #106-107)

1. **STEP #12 BASIC PRODUCTION RATE (LCYPH):** *To determine the basic Production Rate, you must know the Actual Load Size (in LCY), the number of Trips per Hour, and the Efficiency Factor of the operator and equipment.*

TPH (from step #11)	X	**ALS**	X	**EFFICIENCY FACTOR** (from step #4)	=	**LCYPH**

NOTE: ALWAYS ROUND DOWN LCYPH

TABLE #7-2 EFFICIENCY FACTOR

TYPE UNIT	OPERATOR	DAY	NIGHT
WHEELED	EXCELLENT	1.00	.67
	AVERAGE	.60	.40
	POOR	.50	.33

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: What is the basic production rate for a 621B with an average operator, working a day shift, making 3.49 TPH, with a load of 17.5 LCY?

3.49 X 17.5 X 0.60 = 36.65 OR 36

TPH X ALS X EFFICIENCY FACTOR = (LCYPH)

NOTE: ROUND DOWN (LCYPH)

(ON SLIDE #108)

m. ***STEP #13 SOIL CONVERSION (SC) (IF NEEDED) :*** *In some cases the basic production rate may be needed in compacted cubic yards (CCY) for a road or runway.*

_____ X _____ = _____
LCYPH X *CONVERSION FACTOR* = (____CYPH)

NOTE: ROUND DOWN CYPH

TABLE #1-1 SOIL CONVERSION FACTORS

SOIL	CONVERTED FROM:	BANK	LOOSE	COMPACTED
SAND OR GRAVEL	BANK LOOSE COMPACTED	* .90 1.05	1.11 * 1.17	.95 .86 *
LOAM	BANK LOOSE COMPACTED	* .80 1.11	1.25 * 1.39	.90 .72 *
CLAY	BANK LOOSE COMPACTED	* .70 1.11	1.43 * 1.59	.90 .63 *
ROCK (BLASTED)	BANK LOOSE COMPACTED	* .67 .77	1.50 * 1.15	1.30 .87 *
CORAL COMPARABLE TO LIMESTONE	BANK LOOSE COMPACTED	* .67 .77	1.50 * 1.15	1.30 .87 *

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: What is the production rate in (CCY) for a 621B with a basic production rate of 36 LCYPH, working in Earth Loam, Dry?

36 X .72 = 25.92 OR **25** **(C CYPH)**

LCYPH X CONVERSION FACTOR = ***NOTE: ROUND DOWN (__CYPH)***

(ON SLIDE #109)

n. ***STEP #14 TOTAL HOURS REQUIRED TO COMPLETE MISSION:*** *To determine the total time required to complete the mission, you must know the total volume to be moved, the basic production rate, and the number of scrapers you will use on the job.*

$$\frac{\text{VOLUME NEEDED (-CY)}}{(\_\text{CYPH}) \times \#\text{ OF SCRAPERS}} = \text{TOTAL HOURS REQUIRED}$$

NOTE: NEVER ROUND OFF TIME

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: Your requirement is 19,440 CCY. You have 3 scrapers available that have a 25 CCYPH capability. How many hours will it take to complete this mission?

$$\frac{19{,}940 \text{ CCY}}{25 \text{ CCYPH} \times 3 \text{ SCRAPERS}} = 259.20 \text{ HOURS REQUIRED}$$

(ON SLIDE #110)

o. ***STEP #15 TOTAL PRODUCTION (DAYS)*** *To get the production days required to complete the mission, divide total hours required by the hours worked per day, which will equal the total number of days required.*

HOURS REQUIRED ÷ HOURS WORKED A DAY = DAYS REQUIRED

NOTE: ROUND UP DAYS TO THE NEXT FULL DAY

EXAMPLE: If you are working 8 hour a days, how many days will it take if your estimation is 259.20 total hours required?

259.20 ÷ 8 = 32.40 OR 33 DAYS

(ON SLIDE #111-117)

INTERIM TRANSITION: Are there any questions over the last five steps of scraper production? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (8).

PRACTICAL APPLICATION (8). (3 HRS) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining total production days (all 15 steps).

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. Safety Brief: There are no safety concerns.
2. Supervision & Guidance: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. Debrief: Are there any questions or comments concerning the 15 step scraper production estimation? In order to progress further, you must have an understanding of basic production.

WHAT HAVE YOU LEARNED

PROBLEM #1: Figure total number production days with the following factors.

Three Caterpillar 621B Scrapers

Struck loaded, loam

7 hour production day

Excellent Operator

13.08 minute cycle time

Compacted volume required for job - 250,000 CY

Working 60 minutes per hour

60	MIN WORKED PER HOUR
÷ 13.08	CT
4.59	TPH
14	ALS
x 1.00	EFF FACTOR
64.26	
OR 64	LCYPH
x .72	CON FACTOR
46.08	
OR 46	CCYPH

250,000	VOL NEEDED
÷ (46 x 3)	PRODUCTION
1,811.59	THR
÷ 7	HRS PER DAY
258.80	
OR 259	DAYS

PROBLEM #2: A project requires you to build a parking lot using gravel. How many work nights, at 8 hours per night, are required to complete the project? You are working only during the hours of darkness. The job conditions are as follows. Show and label all figures and formulas.

Compacted fill required	150,000 CY
Class of earth	Gravel
Initial moisture content	14%
Average haul distance	7000 ft
Return by same route	
Grade of haul road	6% downhill

5 - 621B's/Struck loaded

Average operators/Working 60 mins/hr.

Rutted, dirt roadway, with no stabilization under load 4" to 6" penetration.

3000	DRY GRAVEL				
x 1.14	MOISTURE				
3420	ASW				
x 14	ALS				
47,880	LW				
+ 66,590	VW				
114,470	GW				
÷ 2,000	1 TN				
57.24	ST (HAUL)		33.30	ST (RETURN)	
x 150	RRF		x 150	RRF	
8,586	RR (HAUL)		4,995	RR (RETURN)	
57.24	ST		33.30	ST	
20	CONSTANT		20	CONSTANT	
x - 6			x 6		
-6,868.8			**3,996**	**GR**	
OR -6,869	**GA**				
8,586	RR		4,995	RR	
- 6,869	GA		+ 3,996	GR	
1,717	8TH GEAR/26 MPH		8,991	5TH GEAR/11 MPH	

7,000 HD
26 X 88 = 3.06 HAUL TIME (HT)

7,000 RD
11 X 88 = 7.23 RETURN TIME (RT)

3.06	+	7.23	+	3.00	=	13.29
HAUL TIME		RETURN TIME		FIXED TIME		CYCLE TIME

60	MIN/HR
÷ 13.29	CT
4.51	TPH
4.51	TPH
14	ALS
x .4	EF

```
  25.26
  OR 25   LCYPH

     25   LCYPH
x   .86   CONV FACTOR
  21.50
  OR 21   CCYPH


   150,000   VOL REQUIRED
÷ (21 x 5)   PRODUCTION
   1428.57   THR
÷          8   HRS/NIGHT
    178.57
   OR  179   NIGHTS
```

(ON SLIDE #118-119)

TRANSITION: Are there any questions over the last five steps of Scraper estimations? Let's move on to push loading.

_____
_____
_____

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. How many steps are there in Scraper production?

15

b. When do you round off time?

NEVER

c. What does TPH mean?

Trips Per Hour (TPH)

(BREAK – 10 Min)

TRANSITION: Now that we have covered the use, classification, characteristics and operations of the scraper, are there any

questions? Let’s move right into scraper production.

_____

_____

_____

(ON SLIDE #120-121)

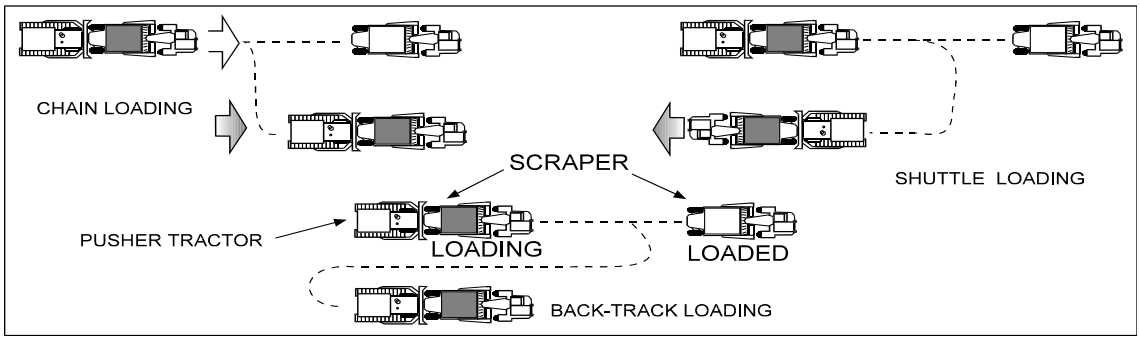
3. **PUSH LOADING (1 HR)**

a. Push loading a scraper is one of the most effective methods of loading a scraper. A self loaded Scraper may require twice the time and distance than one being assisted by a push tractor, thus effecting the cycle times and production throughout the project. The MCT is the only dozer in the Marine Corps with a reinforced blade for push loading.

b. Load time should be one minute or less. The optimum loading distance is around 90' to 125'. The optimum depth of cut for a push loaded scraper is 4 to 6 inches. The type of soil, its moisture content, laudability, operator efficiency, actual load size, and the method of equipment employment will govern these.

c. Normally the gear used during push loading is equivalent to second gear in the old D7G, for the MCT it is in RPM’s and first for the 621B Scraper. The MPH listed in Table #5-2 for the scraper reflect the maximum and/or average speed in miles per hour. When push loading is employed, the maximum MPH will not be the loaded MPH reflected in the Table, therefore, for **CLASSROOM PURPOSES USE 2 MPH WHEN PUSH LOADING.**

d. There are three types of push loading. They are, Chain Loading, Shuttle Loading and Back-Track Loading. Chain Loading and Shuttle Loading is the most efficient at keeping the dozer from excess movement. Back-Track Loading is the most inefficient method of push loading. It takes more movement by the dozer, but it is still useful if the work area allows no other type of operation.



NUMBER OF PUSH TRACTORS REQUIRED

e. To get the number of Push Tractors (PT) required, we must go through 6 steps starting with load time.

(ON SLIDE #122-127)

(1) **STEP #1 LOAD TIME.** Load time is the time required to load the haul unit during which the dozer is in contact with the push block of the scraper. Load Time is figured by using the formula below. NOTE: USE 2 MPH FOR CLASSROOM PURPOSES.

$$\frac{\text{LENGTH OF CUT}}{\text{MPH} \times 88} = \text{LOAD TIME (LT) in min.}$$

NOTE: NEVER ROUND OFF TIME

Example:

$$\frac{\text{150' feet length of cut}}{\text{2 mph X 88 con factor}} = .85 \text{ min. LOAD TIME (LT)}$$

Note: 2 X 88 is a constant.

(2) **STEP #2 BOOST TIME TRAVEL TIME.** Boost time is the time expended after the scraper is loaded during which the push tractor assists the scraper in attaining momentum. (For Boost time use a constant of 0.25).

(3) **STEP #3 RETURN TIME.** Return time is the time required for the push tractor to return to the starting point. This portion of the cycle time will be greatly reduced by "chain" or "shuttle" loading. To get Return Time use the formula below.

LOAD TIME (LT) X 1.4 = RETURN TIME (RT)

NOTE: NEVER ROUND OFF TIME

(NOTE: 1.4 IS A CONSTANT)

Example:

.85 load time X 1.4 = 1.19 min. RETURN TIME. (RT)

(4) **STEP # 4 FORMULATE CYCLE TIME.**

(LOAD TIME X 1.4) + BOST TIME = PT CYCLE TIME (CT)

Example:

(LT)		(Constant)		(BT)
(.85	X 1.4) +	.25	= 1.44 min. PT CT	

NOTE: NEVER ROUND OFF TIME

(5) **STEP #5 NUMBER OF SCRAPERS A PUSH-TRACTOR CAN SUPPORT:** This is found by dividing scraper cycle time by the push-tractor time .

$$\frac{\text{Scraper CT (min)}}{\text{push-Tractor CT (min)}} = \text{Number of scrapers a push-tractor can support}$$

(NOTE: Always round down)

Example: How many scrapers can a single push-tractor support if the scraper cycle time is 4 minutes and the push-tractor cycle time is 1.3 minutes?

$$\frac{4 \text{ min}}{1.3 \text{ min.}} = 3.1$$

Scrapers, rounded down to 3 Scrapers

(6) **STEP #6 NUMBER OF PUSH TRACTORS REQUIRED**: This is found by dividing the number of scrapers on the job by the number of scrapers a push tractor can support.

$$\frac{\text{Number of scrapers on job}}{\text{Number of scrapers a push-tractor can support}} = \text{Number of Push-Tractors required}$$

(NOTE: ROUND UP # OF PUSH TRACTORS REQUIRED)

Example: How many push-tractors are required on a job that has nine 621-B scrapers, if a single push-tractor can support three scrapers?

$$\frac{\text{9 scrapers}}{\text{3 scrapers per push-tractor}} = \text{3 Push- Tractors Required}$$

(ON SLIDE #128-137)

INTERIM TRANSITION: Are there any questions over the push tractor required estimations? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (9).

PRACTICAL APPLICATION (9). (2 HRS) Have the students complete the problems in the student handout.

PRACTICE: There are three problems in the student handout for the students to complete. The problems are determining push tractors required.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief**: There are no safety concerns.
2. **Supervision & Guidance**: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief**: Are there any questions or comments concerning push tractor required estimations? Now we have completed scaper production estimations.

WHAT HAVE YOU LEARNED

PROBLEM #1: Figure the number of push tractors required for (4) 621B's, with a 12.58 minute cycle time. The length of cut is 150 feet.

$$\frac{150}{2 \times 88} = .85 \text{ CT}$$

(.85 x 1.4) + .25 = 1.44 PT. CT

$$\frac{12.58}{1.44} = 8.74 \text{ OR } 8 \text{ SCRAPERS 1 PT CAN SUPPORT}$$

$$\frac{4 \text{ SCRAPERS ON JOB}}{8 \text{ SCRAPERS 1 PT CAN SUPPORT}} = .5 \text{ OR } 1 \text{ PT REQUIRED}$$

PROBLEM #2: Figure the number of push tractors required for (7) 621B's, with an 8.92 minute cycle time. The length of cut is 125 feet.

$$\frac{125}{2 \times 88} = .71 \text{ CT}$$

(.71 x 1.4) + .25 = 1.24 PT. CT

$$\frac{8.92}{1.24} = 7.19 \text{ OR } 7 \text{ SCRAPERS 1 PT CAN SUPPORT}$$

$$\frac{7 \text{ SCRAPERS ON JOB}}{7 \text{ SCRAPERS 1 PT CAN SUPPORT}} = 1 \text{ PT REQUIRED}$$

WHAT HAVE YOU LEARNED

PROBLEM #3: A project requires you to build a road using clay and gravel with an 8% moisture content. The borrow pit area allows you to push load the 621Bs with D7G. How many days are required, at 10 hours per day, to complete the project? Also figure the total number of push tractors required. The job conditions are as follows. Show and label all figures and formulas. If you need help, raise your hand.

Compacted fill required 175,000 CY

Use clay and gravel for Soil Conversion Factor

Initial moisture content
8%

Average haul distance 6600
ft

Return route 6600
ft

Grade of haul road 7 % Up-
hill

Rutted, dirt roadway, flexing considerably under load

621B's
6

Push loaded by MCT/Struck loaded

Average operators

Working 60 min/hr.

Length of cut
80'

2,700	SOIL		48,000	MAX LOAD	
x 1.08	MOISTURE		÷ 2,916	ASW	
2,916	ASW		16.46	MLS	
x 14	ALS				
40,824	LW				
+ 66,590	VW				
107,414	GW				
÷ 2,000	1 TN				
53.71	ST	(HAUL)	33.30	ST	(RETURN)
x 100	RRF		x 100	RRF	
5,371	RR	(HAUL)	3,330	RR	(RETURN)
57.24	ST		33.30	ST	
20	CONSTANT		20	CONSTANT	
x 7			x -7		
7,519.4			**- 4,662**	**GR**	
OR 7,519	**GR**				

5,371	RR		3,330	RR	
- 7,519	GA		- 4,662	GR	
12,890	4TH GEAR/8 MPH		- 1,332	8TH GEAR/26 MPH	

6,600 HD
8 X 88 = 9.38 HAUL TIME (HT)

6,600 RD
26 X 88 = 2.88 RETURN TIME (RT)

9.38	+	2.88	+	1.73	=	13.99
HAUL TIME		RETURN TIME		FIXED TIME		CYCLE TIME

60	MIN/HR
÷ 13.99	CT
4.29	TPH

4.51	TPH
14	ALS
x .60	EF
36.03	
OR 36	LCYPH

36	LCYPH
x .63	CONV FACTOR
22.68	
OR 22	CCYPH

175,000	VOL REQUIRED
÷ (22 x 6)	PRODUCTION
1,325.76	THR
÷ 10	HRS/NIGHT
132.58	
OR 133	NIGHTS

PUSH TRACTORS REQUIRED

80 / 2 x 88 = .45

(.45 x 1.4) + .25 = .88 PT CT

$\frac{13.99}{.88}$ CT = 15.90 OR 15 1 PUSH TRACTOR CAN SUPPORT

$\frac{6}{15}$ = .4 OR 1 PT REQUIRED

(ON SLIDE #138,139)

TRANSITION: Are there any questions over basic scraper production?

_____
_____
_____

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. What is the only dozer in the Marine Corps that can be used as a push tractor?

Medium Crawler Tractor (MCT)

b. What are the three types of push loading??

Chain Loading, Shuttle Loading, Backtrack loading

c. What should the load time be?

One minute or less

(BREAK – 10 Min)

TRANSITION: Are there any questions over basic scraper production? Now let's move into crawler tractor estimations.

_____
_____
_____

(ON SLIDE #140-145)

4. **CRAWLER TRACTORS (6 HRS)**

a. Dozers and scrapers are the most common pieces of equipment on a project. It is important to be able to properly use these prime earth movers to get maximum production, to establish production estimation rates, and to insure the prompt completion of an earth moving task.

b. **USE:** In the field of heavy construction, crawler tractors serve many purposes. They may be used as prime movers for pushing or pulling loads, as power units for winches and hoists, and as moving mounts for dozer blades. They are used primarily where it is advantageous to obtain high drawbar pull and traction. The crawler tractor is the most suitable piece of equipment for pushing or pulling loads through marshy areas.

c. **CLASSIFICATION:** Crawler tractors are classified according to weight. They are classified for easy identification as light, medium, and heavy. For example, the 1150E and the 1155 are in the light class, the MCT is in the medium class, and the D8 is in the heavy class.

d. **CHARACTERISTICS**: Crawler tractors are tractors, which are supported on the ground by track assemblies. Commonly called "bulldozers", they are the work horses of construction. Due to their versatility, they are usually the first piece of machinery on a construction job, and often the last to leave. They are used to cut haul roads, move dirt, trees, and rocks, and are used on many other jobs. A bulldozer is simply a crawler tractor with a blade mounted on the front, which is used for pushing objects or materials. Once the blade is removed and the machine is used as a towing unit, it is referred to as a tractor. Since the track sections support the weight of the machine, the crawler tractor has great traction pull. The ability to "lock" one side section of track while pulling with the other one enables the crawler tractor to pull itself out of material that would easily cause a wheeled machine to become stuck.

e. **OPERATION**: These tractors are equipped with a diesel engine rated from 85 to 202 brake horsepower, and either 4 or 6 cylinders, depending on the make and model. The all-terrain versatility of the crawler tractor is due to its' low ground bearing pressure, varying from 6 to 9 pounds per square inch, which gives it a distinct "flotation" advantage. Crawler tractors are capable of operating in muck or water as deep as the height of the track. Crawler tractors can move from jobsite to jobsite under their own power at slow speeds, however, this tends to shorten their operational life. For this reason, trailer should transport them if a long distance is involved. A paved or finished surface may also suffer extensive damage from the tracks.

(ON SLIDE #146, 147)

(1) BASIC PRODUCTION RATE: Dozer production can be estimated using the production from Table #9-3, and then adjusting the table with five (5) correction factors.

FACTOR 1 X FACTOR 2 X FACTOR 3 X FACTOR 4 X FACTOR 5 X FACTOR 6 = LCYPH

NOTE: ROUND DOWN LCYPH

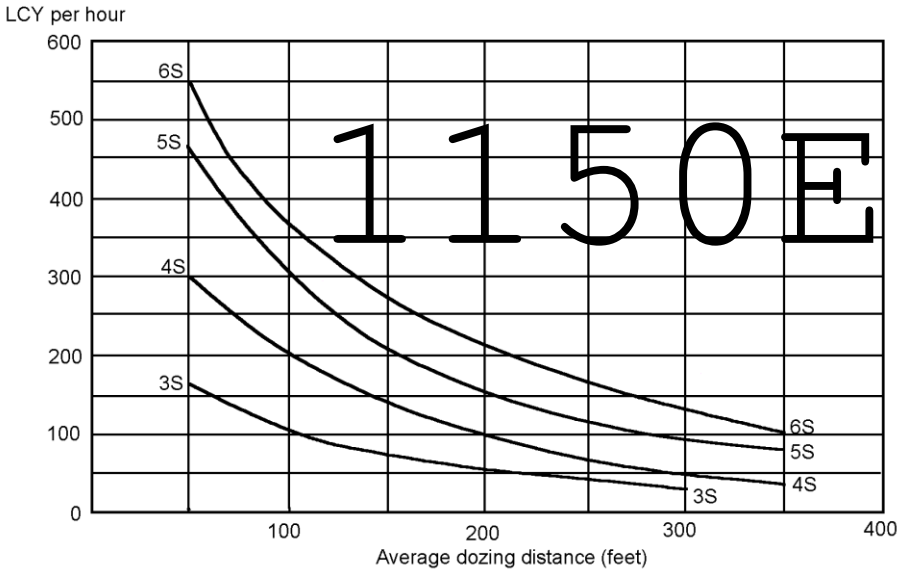
NOTE: For classroom purposes, if you are not given the information for any factor, that factor will be N/A

(ON SLIDE #148-157)

(a) FACTOR #1: MAXIMUM BASIC PRODUCTION. Use (Table #9-3) to determine Maximum Basic Production. First find the av-

erage dozing distance line on the bottom of the scale, read up until you intercept the production curve for the dozer you are using, then read to the left to get the production rate in LCYPH.

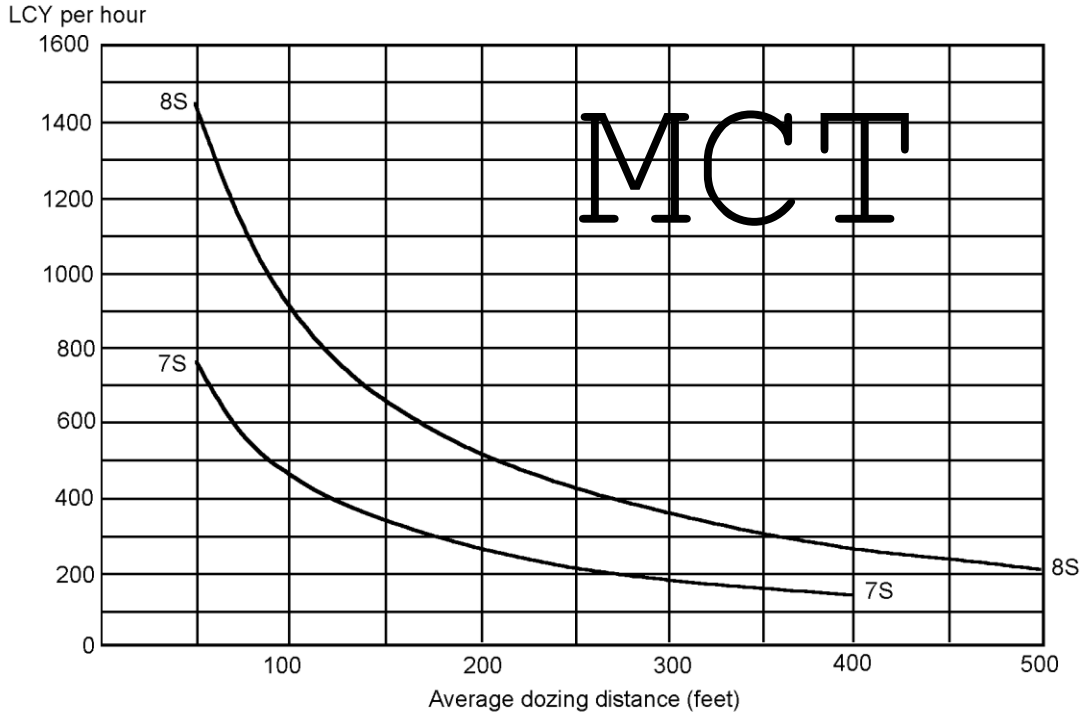
TABLE #9-3



NOTE: The "4s" represents an 1150E.

NOTE: Each LCY/hr is in increments of 50.

TABLE #9-3



NOTE: The 7S is a MCT*

NOTE: Each LCY/hr is in increments of 100.

NOTE: For classroom purposes round down to the next factor line if it falls in between.

INTERIM TRANSITION: Are there any questions over crawler tractors? Let's move on to some demonstrations of push tractor required estimations.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)

Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

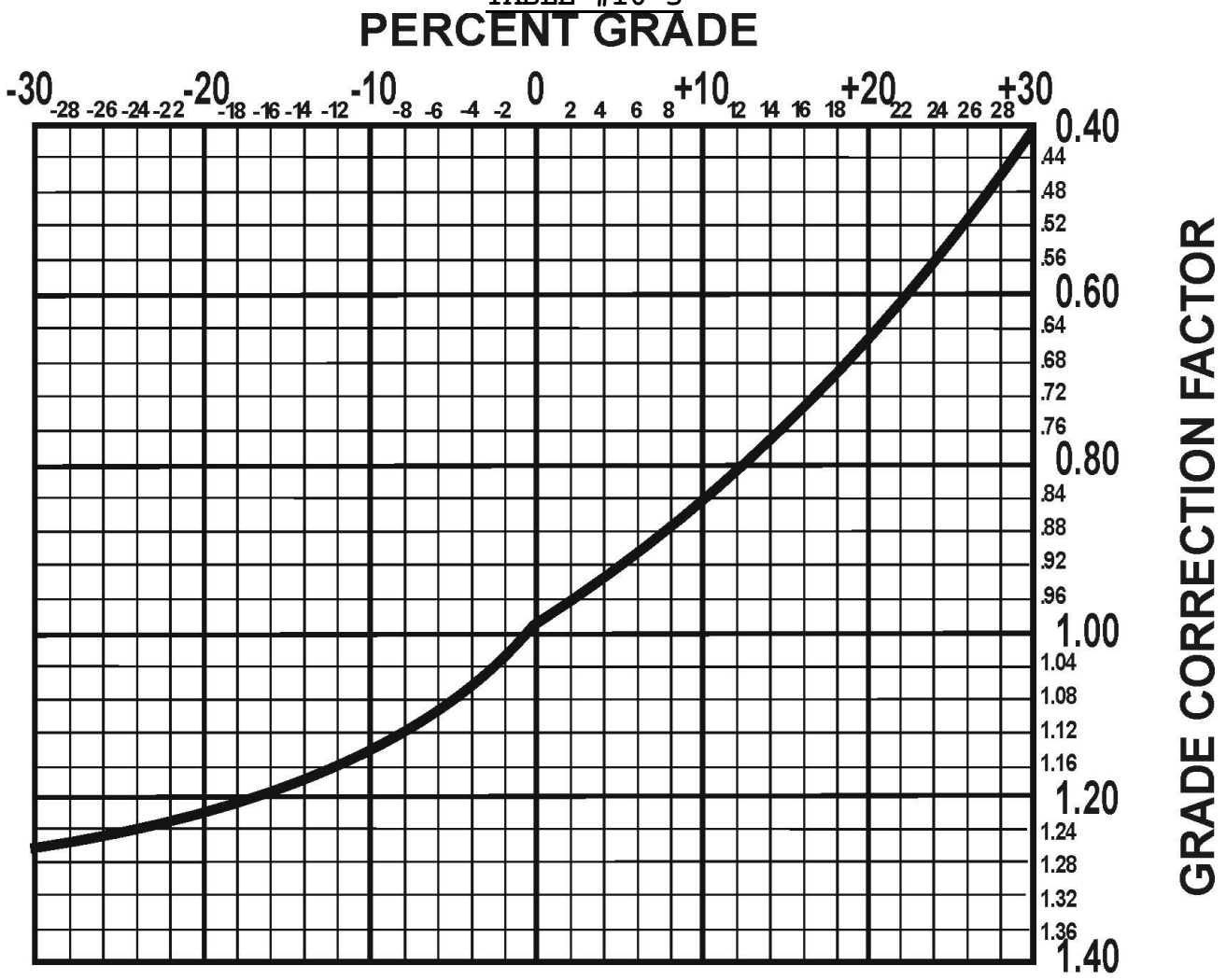
EXAMPLE: Determine the Maximum Basic Production for a MCT with an average dozing distance of 200 feet.

200 LCYPH

(b) **FACTOR #2: GRADE CORRECTION FACTOR.** Determine the **Grade Correction Factor** using (Table #10-3). Find the % of grade (-) Favorable or (+) unfavorable on the top of the scale, read down until you intercept the grade correction curve, then read to the right to determine the grade correction factor. Each vertical line on this scale represents multiple of two. Each horizontal line represents 0.04.

NOTE: For classroom purposes round down the chart, to the closest factor line if it falls in between.

TABLE #10-3



Grade correction factor

NOTE: % GRADE IS IN INCREMENTS OF 2
NOTE: FACTORS ARE IN INCREMENTS OF .04

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: Move the material up a 2% grade (+). **Grade correction factor = .96**

(c) **FACTOR #3: SOIL WEIGHT CORRECTION FACTOR**. Using Table #2-2 find the listed soil weight for the type soil you are working in. Add the moisture content to determine the actual soil weight for that soil. Divide 2,300 LBS/CY by the actual soil weight to find the correction factor. (2,300 LB'S is a constant, which is the weight of soil used to determine Table #9-3)

$$\frac{\text{2300 constant}}{\text{ACTUAL SOIL WEIGHT}} = \text{SOIL WEIGHT CORRECTION FACTOR}$$

NOTE: NEVER ROUND OFF

INSTRUCTOR NOTE
2300 is the industry standard for material unit weight per CY.

TABLE #2-2

TYPE OF SOIL	POUNDS PER (CY)	TYPE OF SOIL	POUNDS PER (CY)
CINDERS	1200 LBS.	***LIMESTONE***	2500 LBS.
CLAY, DRY	2000 LBS.	***SANDSTONE***	2200 LBS.
CLAY, WET	3000 LBS.	***SAND, DRY***	2900 LBS.
CLAY & GRAVEL,	2700 LBS.	***SAND, WET***	3100 LBS.
GRAVEL, DRY	3000 LBS.	***SHALE & SOFT ROCK***	2700 LBS.
GRAVEL, WET	3100 LBS.	***SLAG, BANK***	1940 LBS.
EARTH LOAM, DRY	2200 LBS.	***SLATE***	2500 LBS.
EARTH LOAM, WET	3200 LBS.	***TRAP ROCK***	3500 LBS.
HARDPAN	3100 LBS.	***CORAL (HARD)***	2440 LBS.
		CORAL (SOFT)	2030 LBS.

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: What is the soil weight correction factor for clay with 5% moisture content ?

2,000	lbs. Clay
X 1.05	% of Moisture
2,100	Actual Soil Weight

2,300 Constant
2,100 Actual Soil Weight = 1.10 CORRECTION FACTOR

NOTE: NEVER ROUND OFF

(d) **FACTOR #4: SOIL TYPE CORRECTION FACTOR.** The dozer blade is designed to cut the material and give it a rolling effect for a production factor of 1.00. Material found in different states will effect dozer production as follows.

TABLE # 11-3
SOIL CORRECTION FACTOR

SOIL TYPE	FACTOR
LOOSE, STOCKPILE	1.2O
HARD TO CUT (WITH TILT CYLINDER)	O.80
HARD TO CUT (WITHOUT TILT CYLINDER)	O.70
HARD TO DRIFT (STICKS TO BLADE)	O.80
ROCK, RIPPED OR BLASTED	O.60

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: Hard packed clay is Hard to drift (sticks to blade) =

.80

(e) **FACTOR #5: Determine Equipment / Operator Efficiency Correction Factor**.

TABLE #7-2 EQUIPMENT OPERATOR EFFICIENCY FACTOR

TYPE UNIT	OPERATOR	DAY	NIGHT
TRACKED	EXCELLENT	1.OO	0.75
	AVERAGE	.75	.56
	POOR	.60	.45

NOTE: These factors include operator efficiency and visibility (dust, rain, snow, fog and darkness) with a job efficiency of a 60-minute hour.

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: Operator and equipment efficiency factors are average, working daylight = **.75**

(f) **FACTOR #6: Determine the Management Technique correction factor:**

TABLE # 12-3

MANAGEMENT TECHNIQUE	FACTOR
SLOT DOZING	1.2O
SIDE BY SIDE DOZING	1.15

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: Slot Dozing is being Employed = **1.20**
NOTE: If management factor is not given, then it is N/A.

(ON SLIDE #158)

(2) **STEP #1: Production Calculation:**

FACTOR 1 X FACTOR 2 X FACTOR 3 X FACTOR 4 X FACTOR 5 X FACTOR 6 = _____ LCYPH

NOTE: ROUND DOWN LCYPH

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: 200 LCYPH X .96 X 1.10 X .80 X .75 X 1.20 = 152.06 or 152 LCYPH

(ON SLIDE #159)

(3) **STEP # 2: Soil Conversion Factor (IF REQUIRED):**

Material conversion factor, if required.

TABLE #1-1 SOIL CONVERSION FACTORS

SOIL	CONVERTED FROM:	BANK	LOOSE	COMPACTED
SAND OR GRAVEL	BANK LOOSE COMPACTED	* .90 1.05	1.11 * 1.17	.95 .86 *
LOAM	BANK LOOSE COMPACTED	* .80 1.11	1.25 * 1.39	.90 .72 *
CLAY	BANK LOOSE COMPACTED	* .70 1.11	1.43 * 1.59	.90 .63 *
ROCK (BLASTED)	BANK LOOSE COMPACTED	* .67 .77	1.50 * 1.15	1.30 .87 *
CORAL COMPARABLE TO LIMESTONE	BANK LOOSE COMPACTED	* .67 .77	1.50 * 1.15	1.30 .87 *

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: If your requirement is 4,500 compacted cubic yards and you are moving 228 loose cubic yards per hour, you must convert the loose cubic yards per hour to compacted cubic yards per hour.

152 x .63 = 95.76 or 95 (C CYPH)

(LCYPH) **X** CON FACTOR (TABLE #1-1)= ***SOIL CONVERTED (____CYPH)***

ROUND DOWN (CYPH)

(ON SLIDE #160)

(4) **STEP #3: Total Hours Required:**

(a) Quantity to be moved divided by the hourly production rate multiplied by the number of dozers you have employed equals the total time in hours to complete the job.

(b) The formula:

$$\frac{\textbf{Quantity to be moved (\quad CYPH)}}{\textbf{Hr Production rate (\_\_\_CYPH) X Number of dozers}} = \textbf{THR}$$

NOTE: NEVER ROUND OFF TIME

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: How long would it take to move 4,500 CCY of clay, using 3 MCT's with a production rate of 95 CCYPH.

$$\frac{\textbf{4,500}}{\textbf{95 x 3}} = \textbf{15.79 HRS}$$

(ON SLIDE#161)

(5) **STEP #4: Total Production (DAYS)**

(a) Total hours required divided by the number of hours worked in that day/night will give you the total production days.

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE:

15.79 ÷ 8 = 1.97 OR 2 DAYS

ROUND DAYS TO NEXT FULL DAY

(ON SLIDE# 162)

(6) **STEP#5: Total Number Of Dozers Required**

(a) Quantity of material to be moved divided by the basic production rate per hour multiplied by the number of hours you have to complete the job. Use the formula below to formulate.

$$\frac{\text{Quantity to be moved}}{\text{Basic Production rate Per Dozer} \times \text{Required Completion time in hours}} = \text{Total \# of Dozers Required}$$

NOTE: ALWAYS ROUND UP NUMBER OF DOZERS REQUIRED

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: How many D7G's (with a production rate of 143 CCYPH) would be needed to move 4500 CCY of Loam in 5 hours?

$$\frac{\text{4500 CCY Required}}{\text{143 CCYPH x 5 Hrs}} = \text{6.29 or 7 D7G's}$$

(ON SLIDE#163-166)

INTERIM TRANSITION: Are there any questions over the push tractor required estimations? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (10).

PRACTICAL APPLICATION (10). (2 HRS) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining push tractors required.
PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief:** Are there any questions or comments concerning push tractor required estimations? Now we have completed crawler tractor production estimations.

WHAT HAVE YOU LEARNED

PROBLEM #1: Using the following information, determine how long it will take two (2) MCT Tractors to complete the job ?

Average Dozing Distance.....150 ft
Average % of Grade.....+2%
Quantity of Soil to be Moved.....1548 CCY
Material type... .....Clay with 2% Moisture Content
Material Type Factor.....Hard to Drift (sticks to blade)
Operator Efficiency Factor.....Poor/Night
Blade-to-Blade Dozing is Employed
Equipment Available.....(2) MCT

SOLUTION:

300 x .96 x 1.13 x .80 x .45 x 1.15 = 134.73 or 134 LCYPH

134 x .63 = 84.42 or 84 CCYPH

$$\frac{1548}{(84 \times 2)} = 9.20 \text{ THR}$$

PROBLEM #2: Using the following information, determine how many MC1150E Tractors are required to complete this job in five (5) hours?

Average dozing distance	100 ft.
Average % of grade	+6%
Quantity of soil required	2976 LCY
Material type	Sandstone
Material type factor	Hard to Cut (with tilt cylinder)
Operator efficiency factor	Excellent/Daylight
Slot Dozing is Employed	
Equipment available	(6) MC1150E Tractors

SOLUTION:

200 x .92 x 1.05 x .80 x 1.00 x 1.20 = 185.47 or 185 LCYPH

$$\frac{2976}{(185 \times 5)} = 3.22 \text{ or } 4 \text{ Dozers Required}$$

TRANSITION: Are there any questions over the crawler tractor estimations? Now let's move into scoop loader estimations.

_____
_____
_____

(ON SLIDE #167)

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. What is the most common piece of construction equipment on a project?

Dozers and Scrapers

b. How many factors are there to determine the basic production rate?

Six

c. If you are not given or cannot find any factors, what do you do?

Mark it as N/A and move to the next factor

(BREAK – 10 Min)

TRANSITION: Are there any questions over basic crawler tractor estimations? Now let's move into scoop loaders estimations.

_____
_____
_____

(ON SLIDE # 168-176)

5. SCOOP LOADERS (7 HRS)

INTRODUCTION

a. Loaders are available in varied sizes and bucket capacities. Loaders have a hinged frame, which provides the steering; this steering method is referred to as articulated, and provides greater maneuverability. Articulated steering provides zero clearance for personnel at the point of articulation. Most loaders have a towing pintle for towing small trailers. Special caution should be exercised when the bucket is fully raised, because the chances of rollover or tipping are greatly increased.

b. **USE:** The primary use of the front-end loader is lifting and loading. It is also used for excavating, snow removal, and back filling. The loader is capable of many other operations with the proper attachments such as (forks, sweeper, snowplow, and multi-segmented bucket.) Loaders are used in and around rock quarries, when equipped with rock-type tread tires. Loaders

are used in various tasks, including, stripping overburden, charging hoppers, and carrying materials.

c. **CLASSIFICATION:** Loaders are classified according to bucket size. The normal buckets are 2 1/2 and 5 cubic yards; however, the buckets are available in many sizes, both larger and smaller.

d. **CHARACTERISTICS:** Loaders are wheeled vehicles characterized by an attachment for lifting and loading. The most common scoop loader attachments are the shovel-type bucket and the forklift. The loaders hydraulic system provides the power for these attachments. The bucket is available in two types, the general purpose and the multi-segmented bucket. The general-purpose bucket is a one-piece bucket made of heavy duty all welded steel. The multi-segmented bucket is a hinged jaw bucket, commonly referred to as a clamshell. It has bolted or welded replaceable cutting edges and bolt on teeth for excavation. The two-piece bucket has many capabilities not available to the single-piece bucket. These include clamshell, dozer, and scraper operations.

e. **OPERATION:** Loaders are hydraulically operated and powered by a diesel engine. The loader is extremely versatile and capable of many different operations. When working in a stockpile, the bucket should be parallel to the ground when loading, and raised after penetration of the material. Crowding the material will prevent spilling, and maximize loading. When loading trucks from a bank or stockpile with a single loader, the "V" method should be used. This method will produce the best production, because the angle and the moving distance are kept to a minimum. A loader can dig excavations such as defilades and gun emplacements. When digging the excavation, a ramp should be constructed prior to the emplacement. This provides an area where the material can be removed from the hole. Material that is difficult to excavate should be broken up or loosened for greater effectiveness.

f. **PRODUCTION:** Scoop loaders are affected by numerous factors, which must be considered prior to their employment. Among these factors are operator skill, extent of prior loosening of the material, weight and volume of the material, slope of the operating area, height of the material, climatic conditions, and management factors.

(1) The Marine Corps currently has two scoop loaders in the system, the MC1155E, and the 624KR Tram. The front bucket on

the 420DV Backhoe Loader can also be used to perform limited scoop loader operations.

(2) Scoop loader production can be estimated by using the following steps.

(ON SLIDE# 177)

(a) **STEP #1: DETERMINE BASIC PRODUCTION**

$$\frac{\text{BUCKET SIZE (IN CY) X MIN WORKED PER HOUR X 60 SEC}}{\text{LOADER CYCLE TIME (IN SECONDS)}} = \text{BASIC PRODUCTION (LCYPH)}$$

Note: Always round down LCYPH

Note: You can find the seconds you are working per hour by multiplying the minutes you are working per hour by 60.

TABLE #3-2
BUCKET SIZE

TRAM 624KR	**2 1/2 or 2.5 CY**
MC1155E	**1 3/4 or 1.75 CY**
MAC-50 CLAMSHELL	**1 ¼ OR 1.25 CY**
420D FRONT BUCKET	**1 ¼ or 1.25 CY**
420D BACKHOE BUCKET	**¼ or .25 CY**

INTERIM TRANSITION: Are there any questions over scoop loaders? Let's move on to some demonstrations of scoop loader estimations.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: What is the basic production in LCYPH of a 2 1/2 cubic yard scoop loader working a 60-minute hour, with a cycle time of 35 seconds?

$$\frac{2.5 \text{ X } 3{,}600}{}$$

35 = 257.14 OR 257 LCYPH

NOTE: ALWAYS ROUND DOWN LCYPH

(ON SLIDE# 178-181)

(b) **STEP #2: DETERMINE EFFICIENCY FACTOR (Table 17-5)**

Efficiency depends on both job conditions and management conditions. To arrive at an efficiency factor, these conditions must be subjectively evaluated.

JOB FACTORS: *Job factors are the physical conditions that affect the production rate of specific jobs, other than the type of material to be handled. They include:*

** Topography and work dimensions, including depth of cut and amount of movement required.*
** Surface and weather conditions, including the season of the year and drainage conditions.*
** Specifications that control handling of work or indicate the operational sequence.*
** Equipment maintenance and repair.*

MANAGEMENT FACTORS: *Management factors are:*

** Planning, organizing, and laying out the job; supervising and controlling the operation.*
** Selecting, training, and directing personnel.*

TABLE # 17-5
MANAGEMENT FACTORS

JOB FACTORS	EXCELLENT	GOOD	FAIR	POOR
EXCELLENT	.84	.81	.76	.70
GOOD	.78	.75	.71	.65
FAIR	.72	.69	.65	.60
POOR	.63	.61	.57	.52

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: If the job factor is good and the management factor is fair, the efficiency factor would be 0.71

(ON SLIDE# 182)

(c) **STEP #3: DETERMINE NET PRODUCTION (LCYPH):** To determine the net production in LCYPH, multiply the basic production in LCYPH by the efficiency factor.

BASIC PRODUCTION (LCYPH) X EFF FACTOR = NET PRODUCTION (LCYPH)

NOTE: ALWAYS ROUND DOWN LCYPH

INSTRUCTOR DEMONSTRATION (5 min)

Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: What is the net production in LCYPH of a scoop loader with a basic production rate of 257 LCYPH, and an efficiency factor of .71?

257 (LCYPH) x .71 = 182.47 or 182 LCYPH

NOTE: ALWAYS ROUND DOWN LCYPH

(ON SLIDE 183)

(d) **STEP #4: SOIL CONVERSION (IF NEEDED):** If your requirement, or quantity to be moved, is expressed in either CCY or BCY, you must use the following formula to convert your net production.

NET PRODUCTION (LCYPH) x SOIL CON FACTOR (Table # 1-1) = CONVERTED CYPH

NOTE: ROUND DOWN CYPH

TABLE #1-1 SOIL CONVERSION FACTORS

SOIL	CONVERTED FROM:	BANK	LOOSE	COMPACTED
SAND OR GRAVEL	BANK LOOSE COMPACTED	* .90 1.05	1.11 * 1.17	.95 .86 *
LOAM	BANK LOOSE COMPACTED	* .80 1.11	1.25 * 1.39	.90 .72 *
CLAY	BANK LOOSE COMPACTED	* .70 1.11	1.43 * 1.59	.90 .63 *
ROCK (BLASTED)	BANK LOOSE COMPACTED	* .67 .77	1.50 * 1.15	1.30 .87 *
CORAL COMPARABLE TO LIMESTONE	BANK LOOSE COMPACTED	* .67 .77	1.50 * 1.15	1.30 .87 *

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: If you are loading clay, and your net production is 280 LCYPH, how many CCYPH are you loading?

280 x .63 = 176.40 or 176 CCYPH

NOTE: ROUND DOWN CYPH

(ON SLIDE# 184)

(e) **STEP #5: TOTAL TIME REQUIRED (HRS)***:* To determine the total time required to complete the mission, utilize the following formula.

$$\frac{\text{QUANTITY TO BE MOVED}}{\text{HOURLY PRODUCTION RATE x \# OF SCOOP LOADERS}} = \text{TOTAL TIME (HRS)}$$

NOTE: NEVER ROUND OFF TIME

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: If your scoop loaders have an hourly production rate of 380 LCYPH each, how long will it take 3 scoop loaders to move 13250 LCY of material?

$$\frac{13250}{380 \times 3} = 11.62 \text{ HRS}$$

(ON SLIDE# 185)

(f) **STEP #6: *TOTAL # OF DAYS REQUIRED*:** To determine the total number of days that a project will take, use the following formula.

$$\frac{\text{\# HOURS REQUIRED}}{\text{\# HOURS WORKED PER DAY}} = \text{\# OF DAYS REQUIRED}$$

NOTE: ROUND UP TO NEXT FULL DAY

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: You have estimated that it will take you 263.87 hours to complete a project, how many days will this project take if you are working 7.5 hours per day?

$$\frac{263.87}{7.5} = 35.18 \text{ OR } 36 \text{ DAYS}$$

(ON SLIDE#186-188)

INTERIM TRANSITION: Are there any questions over the scoop loader estimations? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (11).

PRACTICAL APPLICATION (11). (2HRS 30MIN) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are determining scoop loader estimations.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief:** Are there any questions or comments concerning scoop loader estimations? Now we have completed scoop loader production estimations.

WHAT HAVE YOU LEARNED?

PROBLEM #1: Determine the production rate in CCYPH, for a Tram 624KR with the following factors.

Cycle Time	120 seconds
Job Factor	Fair
Management Factor	Fair
Type of Material	Earth Loam, Dry

Working a 60 minute work hour

SOLUTION:

2.5	BUCKET SIZE
x 3,600	SEC/HR WORKED
9,000	
÷ 120	LOADER CYCLE TIME
75	LCYPH
x .65	EFF FACTOR
48.75	
OR 48	LCYPH

```
     48  LCYPH
x   .72  CONV FACTOR
  34.56
  OR 34  CCYPH
```

PROBLEM #2: Determine the production rate in LCYPH, for an MC1155E with the following factors.

Cycle Time	90 seconds
Job Factor	Poor
Management Factor	Poor
Type of Material	Limestone

Working a 45 minute work hour

SOLUTION:

```
    1.75  BUCKET SIZE
x  2,7000  SEC/HR WORKED
   4,725
÷     90  LOADER CYCLE TIME
   52.50
   OR 52  LCYPH
```

```
     52  LCYPH
x   .52  EFF FACTOR
  27.04
  OR 27  LCYPH
```

(ON SLIDE#189-193)

INTERIM TRANSITION: Are there any questions over scoop loader estimations? Now let's move into ratio of loading units to hauling units.

_____

_____

_____

g. **Ratio of Loading Units to Hauling Units**

(1) For the cycle time to be of any value, you have to have enough loaders. There is no time computed into the cycle time for the scrapers to wait due to the loader's inability to keep up. Therefore, you have to have the proper ratio of loading units to hauling units.

(2) Utilize the formula below to figure out how many haul units (1) loader can handle with no waiting.

HAUL UNIT CYCLE TIME = **# HAUL UNITS THAT (1) LOADING UNIT**
LOAD TIME (TABLE #18-5) **CAN HANDLE WITH NO WAITING**

NOTE: ROUND DOWN # OF HAUL UNITS

TABLE # 18-5
LOADING TIME

LOADING EQUIPMENT	621B STRUCK LOADED	621B HEAP LOADED
1155E	6 MIN.	8 MIN.
TRAM 624KR	5 MIN.	6 MIN.
420D 4 in 1 Bucket GP Bucket	 11 MIN. 15 MIN.	 15 MIN. 21 MIN.
MAC-50 - Clamshell	15 MIN.	18 MIN.

Note #1: If the actual load size falls between a struck load and a heap load, use the heap load time for the load time.

Note #2: These are average fixed times only and are based on an average operator who is familiar with the attachments and equipment operation. These times are a basic starting point only. Actual fixed times can vary considerably due to varying conditions. Timing of several actual cycles is necessary in order to obtain a more realistic fixed time average for the particular job being performed.

INTERIM TRANSITION: Are there any questions over ratio of loading units to hauling units? Let's move on to some demonstrations.

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: How many haul units can (1) Tram 624KR handle, if the haul units are hauling 15 CY of material and their cycle time is 14.5 minutes?

$$\frac{14.5}{6} = 2.42 \text{ or } 2$$

NOTE: ROUND DOWN # OF HAUL UNITS

After figuring out how many haul units (1) loading unit can handle, the next step is to determine how many loading units you will need to keep the haul units busy.

h. **Total Number of Loading Units Needed**

Use the following formula to determine the number of loading units that are required on the project.

HAUL UNIT CYCLE TIME = # LOADING UNITS NEEDED

 # HAUL UNITS ÷ LOAD TIME (TABLE #18-5)

NOTE: ROUND UP # LOADING UNITS

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example: On your job project you have (5) 621B's being loaded by MC1155E's to a heap load. If the scrapers cycle time is 17 minutes, how many loading units do you need to keep the scrapers busy?

$$5 \div \frac{17}{8} = 2.35 \text{ or } 3$$

NOTE: ROUND UP # LOADING UNITS

$$\frac{17}{8} = 2.13 \qquad \frac{5}{2.13} = 2.35$$

(ON SLIDE #194-196)

INTERIM TRANSITION: Are there any questions over loading units to haul units or number of load units needed? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (12).

PRACTICAL APPLICATION (12). (2 HRS 30 MIN) Have the students complete the problems in the student handout.

PRACTICE: There are two problems in the student handout for the students to complete. The problems are loader and haul unit required.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.
3. **Debrief:** Are there any questions or comments concerning loader and haul unit required? Now we have completed scoop loader estimations.

PROBLEM 1: How many haul units can (1) Tram 624KR handle, if the haul units are hauling 12.5 CY of material and their cycle time is 8.42 minutes?

SOLUTION:

$$\frac{8.42}{5}\ \frac{\text{HU CT}}{\text{LOAD TIME}} = 1.68 \text{ OR } 1 \text{ HAUL UNIT}$$

PROBLEM 2: On your job project you have (7) 621B's being loaded by MC1155E's to a struck load. If the scrapers cycle time is 33 minutes, how many loading units do you need to keep the scrapers busy?

SOLUTION:

$$7 \div \frac{33}{6} = 1.27 \text{ OR } 2 \text{ LOADERS NEEDED}$$

TRANSITION: Are there any questions over loader and haul unit required? Now let's move into the last estimations topic you will receive, the dump truck.

_____
_____
_____

(ON SLIDE #197,198)

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. What is the primary use of front end loaders?

Lifting and Loading

b. How many front end loaders does the Marine Corps have?

Three

c. What are they?

624KR TRAM, 420E Backhoe, and the MC1150E

(BREAK – 10 Min)

TRANSITION: Are there any questions over basic scoop loader production? Now let's move into dump trucks estimations.

_____
_____
_____

(ON SLIDE# 199)

6. DUMP TRUCKS (11 HRS)

(ON SLIDE#200-209)

NOTE: THE MOST COMMON HAULING EQUIPMENT USED FOR MILITARY PURPOSES ARE THE 2-1/2, 5, 7 TON (MK29-MK30), 15 TON AND 20-TON DUMP TRUCKS. THE 2 1/2 TON TRUCK IS CAPABLE OF HAULING 2 1/2 CUBIC YARDS OF MATERIAL. THE 5-TON TRUCK IS CAPABLE OF HAULING 5 CUBIC YARDS. THE 7 TON 6.5 CUBIC YARDS. THE 20-TON TRUCK, WIDELY USED IN QUARRY OPERATIONS, CARRIES 12 CUBIC YARDS. **SPECIAL ATTENTION MUST BE PAID TO THE WEIGHT OF SOIL LOADED SO AS NOT TO EXCEED THE WEIGHT LIMITATIONS OF THE VEHICLE**.

a. USE: Dump trucks are the most common hauling equipment for the engineers. Their primary purpose is to haul and deliver material. Dump trucks are also used to transport troops and equipment in support of the unit mission. The trucks are equipped with a towing hook and are a tremendous asset for moving equipment and trailers. Trucks equipped with winches are valuable for recovery operations.

b. CLASSIFICATION: Dump trucks are classified by the weight they carry in tons, by the truck volume in cubic yards, or by the heaped capacity in cubic yards. For example, a 5 ton truck

is capable of carrying 5.88 cubic yards of loose dry clay weighing 1,700 pounds per loose cubic yard but is restricted to the 5 cubic yard capacity. Wet clay weighing 3200 pounds per cubic yard, for instance, would be restricted to the 5 ton capacity.

c. CHARACTERISTICS: Dump trucks are characterized by a hydraulic lift cylinder that is used to raise and lower a bed. Most trucks are capable of all wheel drive that permits operation in different terrains. The raised bed can create problems when operated around overhead utilities. The bed also becomes top heavy when fully raised, so caution should be exercised when operating on side slopes. For the safest operation, the assistant operator should dismount the truck and ground guide the operator.

d. OPERATION: Dump trucks are hydraulically operated and powered by a diesel engine. Haul at the highest safe speed (without speeding) and in the proper gear. Speeding is unsafe and hard on the equipment. When several trucks are hauling, it is essential to maintain the proper speed to prevent hauling delays or bottlenecks at the loading or dumping site. Slow trucks, as well as speeding ones, disrupt normal traffic patterns. Until the maintenance crew can repair a sluggish truck, replace it with a standby truck. Lay out traffic patterns in loading and dumping sites to minimize backing, passing, and cross traffic. Keep truck bodies clean and in good condition. Accumulations of rust, dirt, dried concrete or bituminous materials hamper dumping operations. The time spent cleaning and oiling truck bodies must be considered in computing transportation requirements. The 900 series dumps cannot raise the bed and move forward at the same time. Whereas the 800 series, and the MK29/MK30 can; allowing them to spread the loaded material. Capacities of dump trucks are expressed two ways.

(1) TONS (USE TABLE 23-9, 1-3.1 AND 1-12.1 OR CHECK DATA PLATE FOR LOAD WEIGHT.)

(2) CUBIC YARDS (USE TABLE 23-9 FOR CY OR CALL MOTOR TRANSPORT)

TABLE 23-9 TRUCK VOLUMES

TYPE OF TRUCK	LOAD CAPACITY IN POUNDS	STRUCK VOLUME IN LCY	HEAP VOLUME IN LCY
2 1/2 TON	5,000	call MT for volume	call MT for volume
5 TON	10,000	5 LCY	7.5 LCY
20 TON	40,000	call MT for volume	call MT for volume

NOTE: TABLE 23-9 INFORMATION COMES FROM TM 9 2320-260-10 AND TM 9 2320-2720-10

TABLE 1-3.1 Weights – MK29 and MK30

Item	Specification
Weight of MTVR w/Empty Dump MK29 (w/o winch)	29,938 lbs (13,592 kg)
MK30 (w/winch)	30,618 lbs (13,901 kg)
Weight of MTVR w/Full Dump Body	58,618 lbs (26,613 kg)
Weight of Payload (Permissible Capacity) Hwy	28,000 lbs (12,712 kg)
C/C	12,200 lbs (5,539 kg)
Maximum weight of Dump Body and Payload Hwy	58,618 lbs (26,613 kg)
C/C	42,818 lbs (19,439 kg)

TABLE 1-12.1 Dump Body (MK29 and MK30)

Item	Specification
Struck Payload Capacity – Paved Surface	21,060 lbs (9,561 kg)
Heaped Payload Capacity – Paved Surface	28,000 lbs (12,712 kg)
Struck or Payload Capacity – Cross Country	14,200 lbs (6,447 kg)
Recommended Personnel Capacity	16 (NOTE: Also Refer to paragraph 2-31 for warning information)

NOTE: TABLE 1-3.1 AND 1-12.1 INFORMATION COMES FROM TM 10629-10B

*****FOR CLASSROOM PURPOSES DO NOT EXCEED 10CY (20,000LBS) CAPACITY***** (OUTSIDE THE CLASSROOM, NOTE THE TYPE OF SURFACE YOU ARE TRAVELING ON, THIS WILL CHANGE THE CAPACITY)

(ON SLIDE #209)

e. PRODUCTION: Other than scrapers, dump trucks are the primary haul units for earth work in the military inventory. Primarily, dump trucks are used for hauling, dumping, spreading base course and surfacing materials, hauling other material incident to construction, and for general hauling where distance is greater than 5000 feet. There are twelve steps to calculating dump truck production, starting with soil weight.

(ON SLIDE #210)

(1) STEP #1 ACTUAL SOIL WEIGHT: To determine the actual soil weight per cubic yard, take the dry soil weight from (Table #2-2).

INTERIM TRANSITION: Are there any questions? Now I will give you several demonstrations on the first eleven steps of dump truck estimations?

_____
_____
_____

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE:

EARTH LOAM DRY IS *2200 lbs*. PER CUBIC YARD

TABLE #2-2
APPROXIMATE WEIGHT OF SOIL

SOIL	CONVERTED FROM:	BANK	LOOSE	COMPACTED
SAND OR GRAVEL	BANK	*	1.11	.95
	LOOSE	.90	*	.86
	COMPACTED	1.05	1.17	*
LOAM	BANK	*	1.25	.90
	LOOSE	.80	*	.72
	COMPACTED	1.11	1.39	*
CLAY	BANK	*	1.43	.90
	LOOSE	.70	*	.63
	COMPACTED	1.11	1.59	*
ROCK (BLASTED)	BANK	*	1.50	1.30
	LOOSE	.67	*	.87
	COMPACTED	.77	1.15	*
CORAL COMPARABLE TO LIMESTONE	BANK	*	1.50	1.30
	LOOSE	.67	*	.87
	COMPACTED	.77	1.15	*

(a) **MOISTURE CONTENT**

Initial soil weight x moisture content = actual soil weight

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE:

2200	**LBS. WEIGHT OF DRY EARTH LOAM PER CY FROM TABLE 2-2**
X 1.07	**100% OF SOIL WEIGHT + 7% MOISTURE**
2354	**LBS. *ACTUAL SOIL WEIGHT* (ASW)**

(ON SLIDE # 211)

(2) **STEP #2: CUBIC YARDS OF A LOAD:** Remembering that you want to keep the weight of the load under 20,000 lbs, determine how many cubic yards can be hauled without exceeding 20,000 lbs. To do this, divide 20,000 by the listed soil weight per cubic yard.

20,000	**LBS (RATED CAPACITY)**
÷ 2,354	**ASW FROM STEP #1**
8.50	***CY OR NO MORE THAN 10 CY***

(a) ***If the resulting figure is over 10 cubic yards,*** you must go with 10. It is the maximum cubic yards that the MTVR series can haul. If the resulting figure is less than 10, use that figure in step 3. (***NOTE: NO MORE THAN MAX VOLUME OF TRUCK***)

(ON SLIDE # 212)

(3) **STEP #3: BUCKETS LOADED:** To Determine the number of buckets loaded that is equal to or less than the figure determined in step #2. Divide that figure, in this case 4.25, by the size of each bucket load which for the TRAM is 2 1/2 or 2.5.

8.50	**CUBIC YARDS**
÷ 2.5	**CUBIC YARDS (BUCKET SIZE FROM TABLE)**
3.40	**OR 3 *BUCKETS LOADED***

NOTE: ROUND DOWN TO WHOLE BUCKETS.

TABLE #3-2
BUCKET SIZE

TRAM 624KR	2 1/2 or 2.5 CY
MC1155E	1 3/4 or 1.75 CY
MAC-50 CLAMSHELL	1.25 CY
420D FRONT BUCKET	1 ¼ or 1.25 CY
420D BACKHOE BUCKET	¼ or .25 CY

(ON SLIDE # 213)

(4) **STEP #4 ACTUAL LOAD SIZE OR VOLUME:** To determine the volume of the load take the answer from Step #3, 1 bucket per load, and multiply by the bucket size (2.5 for a TRAM).

3 # OF BUCKETS
x 2.5 **TRAM BUCKET SIZE**
7.5 ***ACTUAL LOAD SIZE (ALS)***

NOTE: NEVER ROUND OFF LOAD SIZE OR VOLUME.

(ON SLIDE # 214)

(5) **STEP #5 LOAD WEIGHT:** Regardless of how much volume that you may be able to haul, you should try to keep your load weight under 10,000 pounds. Table #2-2 shows the weight of cinders as 1200 pounds per loose cubic yard. A struck load would weigh 6,000 pounds, while the heap load would weigh 9,000 pounds. These weights would be easily hauled, but it is a different story with other materials. Take a look at Earth Loam, Wet for instance:

TABLE #2-2

TYPE OF SOIL	POUNDS PER (CY)	TYPE OF SOIL	POUNDS PER (CY)
CINDERS	1200 LBS.	***LIMESTONE***	2500 LBS.
CLAY, DRY	2000 LBS.	***SANDSTONE***	2200 LBS.
CLAY, WET	3000 LBS.	***SAND, DRY***	2900 LBS.
CLAY & GRAVEL	2700 LBS.	***SAND, WET***	3100 LBS.
GRAVEL, DRY	3000 LBS.	***SHALE & SOFT ROCK***	2700 LBS.
GRAVEL, WET	3100 LBS.	***SLAG, BANK***	1940 LBS.
EARTH LOAM, DRY	2200 LBS.	***SLATE***	2500 LBS.
EARTH LOAM, WET	3200 LBS.	***TRAP ROCK***	3500 LBS.
HARDPAN	3100 LBS.	***CORAL (HARD)***	2440 LBS.
		CORAL (SOFT)	2030 LBS.

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: OF OVERLOADING

3,200 Weight of Earth loam WET, PER/CY
X 10 (LCY) Struck
32,000 LBS. STRUCK LOADED

3,200 Weight of Earth loam WET, PER/CY
X 14 (LCY) Heaped
44,800 LBS. HEAPED LOADED

a. As you can see, the struck load and the heaped load are over the 20,000-pound limit. Therefore, if you are going to be hauling this type of material, you must determine how many loads the loader can put on the dump and still keep the weight of the load within the acceptable weight limits.

b. Each cubic yard weighs 2354 lbs (Step #1) and you are hauling 7.5 cubic yards. Therefore the weight of your load will be 17,655 lbs.

2354	**ASW (FROM STEP #1)**
x 7.5	**ALS**
17,655	***LOAD WEIGHT (LW)***

NOTE: NOW THAT YOU KNOW THAT YOU ARE NOT OVERLOADED, YOU CAN CALCULATE YOUR CYCLE TIME.

(ON SLIDE # 215-217)

(6) **STEP #6: CYCLE TIME: To get your travel speed look at the table below, (This Table is for classroom purposes only).**

TABLE 24-9 TRAVEL SPEED

LOADED	**35 MPH**
EMPTY	**50 MPH**

The following table contains the maximum allowable speed for the MK29 and MK30. They have to be set according to the type of terrain.

TABLE 2-9 Maximum Allowable Speed

Terrain setting	Max. Allowable Speed	Driveline Lock Configuration
Highway	65 mph (105 km/h)	No Driveline lock
Cross Country	40 mph (64 km/h)	No Driveline lock
Mud/Sand/Snow	15 mph (24 km/h)	T-Case and Inter-axle
Emergency	5 mph (8 km/h)	T-Case and Inter-axle, and Rear Intra-axle

NOTE: TABLE 2-9 INFORMATION COMES FROM TM 10629-10B PAGE 2-174

(1) To figure Cycle Time (CT) you first must figure Travel Time (TT). To get Travel Time divide the sum of the Travel Speed (TS) in MPH multiplied by 88. Do this for haul and return. The Total Travel Times equal Total Cycle Time.

NOTE: 88 is the conversion factor to change the speed in MPH to feet traveled per minute.

HAUL :

$$\frac{\text{Distance in feet}}{\text{MPH TS X 88}} = \text{HAUL Time (HT)}$$

RETURN :

$$\frac{\text{Distance in feet}}{\text{MPH TS X 88}} = \text{RETURN Time (RT)}$$

$$\frac{\quad}{\text{HT}} + \frac{\quad}{\text{RT}} + \frac{2}{\text{2 MIN FXT}} = \frac{\quad}{\text{CT}}$$

NOTE: USE 2 MIN. AS A CONSTANT FIXED TIME FOR DUMP TRUCKS IN THE CLASS ROOM.

INSTRUCTOR DEMONSTRATION (5 min)

Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

Example #1: A dump truck travels 7500 feet to the fill area at 35 mph and returns by a different route of 8200 feet at 50 mph. What is the total cycle time?

HAUL :

$$\frac{\text{Distance in feet: 7500 ft.}}{\text{35 TS X 88}} = 2.44 \text{ HAUL Time (HT)}$$

***RETURN* :**

$$\frac{\text{Distance in feet: 8200 ft}}{\text{50 TS X 88}} = 1.86 \text{ RETURN Time (RT)}$$

$$\frac{2.44}{\text{HT}} + \frac{1.86}{\text{RT}} + \frac{\text{2 MIN}}{\text{2 MIN FXT}} = \frac{6.30}{\text{CT}}$$

(ON SLIDE # 218)

(7) STEP #7 TRIPS PER HOUR: To determine Trips Per Hour (TPH) divide the working minutes per hour by the cycle time.

WORKING MIN. PER/HR
CYCLE TIME **= *TRIPS PER HOUR (TPH)***

NOTE: NEVER ROUND OFF TPH

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: How many trips per hour can a dump truck make during a 60-minute work hour and a cycle time of 6.30 min/trip?

60 MIN. PER/HR
6.30 CT **=** 9.52 TPH ***NOTE: NEVER ROUND TPH***

(ON SLIDE # 219)

(8) STEP #8 PRODUCTION RATE: To determine the Production Rate, you must know the size of the load, the Number Of trips Per Hour, and the Efficiency of the operator.

	x		x		=	
TPH	**X**	**ALS**	**X**	**EFFICIENCY FACTOR**	**=**	**(LCYPH)**

TABLE #7-2 EFFICIENCY FACTOR

TYPE UNIT	OPERATOR	DAY	NIGHT
TRACKED	EXCELLENT	1.00	0.75
	AVERAGE	.75	.56
	POOR	.60	.45
WHEELED	EXCELLENT	1.00	.67
	AVERAGE	.60	.40
	POOR	.50	.33

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: What is the basic production rate of a dump truck with an average operator, working a day shift, making 9.52 TPH, with a load of 2.5 LCY?

9.52	X	7.5	X	0.60	=	42.84 OR 42
TPH	**X**	**ALS**	**X**	**EFFICIENCY FACTOR**	**=**	**(LCYPH)**

NOTE: ROUND DOWN (LCYPH)

(ON SLIDE #220)

(9) **STEP #9 SOIL CONVERSION (IF NEEDED):** In some cases basic production rate may be needed in compacted cubic yards (CCY) for a road or runway.

	X		=	
(LCYPH)	**X**	***CONVERSION FACTOR***	**=**	**(____CYPH)**

TABLE #1-1
SOIL CONVERSION FACTORS

SOIL	CONVERTED FROM	BANK(IN PLACE)	LOOSE	COMPACTED
SAND OR GRAVEL	BANK	*	1.11	.95
	LOOSE	.90	*	.86
	COMPACTED	1.05	1.17	*
LOAM	BANK	*	1.25	.90
	LOOSE	.80	*	.72
	COMPACTED	1.11	1.39	*
CLAY	BANK	*	1.43	.90
	LOOSE	.70	*	.63
	COMPACTED	1.11	1.59	*
ROCK(BLASTED)	BANK	*	1.50	1.30
	LOOSE	.67	*	.87
	COMPACTED	.77	1.15	*
CORAL COMPARABLE TO LIMESTONE	BANK	*	1.50	1.30
	LOOSE	.67	*	.87
	COMPACTED	.77	1.15	*

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE: What is the production rate in (CCY) for a dump with a basic production rate of 14 lcy/hr, working in loam.

42	**X**	**.72**	**=**	**30.24 OR 30**
LCYPH	**X**	***CONVERSION FACTOR***	**=**	**(C CYPH)**

NOTE: ROUND DOWN (__CYPH)

(ON SLIDE #221, 222)

(10) **STEP #10 RATIO OF TRUCKS TO SCOOP LOADER**

a. The number of trucks to keep one scoop loader moving with no down time is found in the formula below (Ref FM 5-434/PG 10-4).

TCT (Tractor Cycle Time) *FROM STEP 6
LCT (Loader Cycle Time) + 1 = Trucks Req

b. To get the Loader cycle time use the below formula.

(Bucket Cycle Time x Number of Buckets) ÷ 60 seconds = Loader Cycle Time
(Given) (From Step 3) (constant)

(ON SLIDE #223)

(11) **STEP #11 TOTAL HOURS REQUIRED TO COMPLETE MISSION:** To determine the total time required to complete the mission, you must know the total volume to be moved, the basic production rate, and the number of trucks you will use on the job.

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE:

1,900 **(**C **CY)**				
30 **(**C **CYPH)**	**X**	3 **DUMP TRUCKS**	**=**	21.11 **(hr) REQUIRED**

NOTE: NEVER ROUND OFF TIME.

(ON SLIDE # 224)

(12) **STEP #12: TOTAL PRODUCTION (DAYS):** To get the production days required to complete the mission, divide total time required by the hours worked per day, which will equal the total number of days required.

TOTAL HOURS REQUIRED ÷ HOURS WORKED PER DAY = TOTAL PRODUCTION DAYS

INSTRUCTOR DEMONSTRATION (5 min)
Present the below example, reference the students to the power point and white board. Ensure this is explained step by step.

EXAMPLE:

$$\frac{63.33}{8} = 7.92 \text{ OR } 8 \text{ TOTAL DAYS}$$

NOTE: ROUND UP DAYS TO THE NEXT FULL DAY.

(ON SLIDE #225-229)

INTERIM TRANSITION: Are there any questions over the first eleven steps of dump truck estimations? Now let's move into some practical application on these steps.

_____
_____
_____

INSTRUCTOR NOTE
Introduce the following practical application (13).

PRACTICAL APPLICATION (13). (2 HRS) Have the students complete the problems in the student handout.

PRACTICE: There is one problem in the student handout for the students to complete. The problems are the first eleven steps of dump truck production.

PROVIDE-HELP: Instructor will answer questions as they arise and assist students having difficulty.

1. Safety Brief: There are no safety concerns.

2. Supervision & Guidance: Instructors will walk around the classroom and answer questions as they may arise. Instructor may use the dry-erase board to wall through the problems. Upon completion instructors will progress to the next power point slide which contains the answers for the problems in the student handout. Clarify understanding of the material and answer any questions.

3. Debrief: Are there any questions or comments concerning first eleven steps of dump truck production? Now we have continue with dump truck production estimations

WHAT HAVE YOU LEARNED?

PROBLEM: A project requires you to build a road using clay and gravel with an 8% moisture content. How many days are required, at 10 hours per day, to complete the project? Also, figure the total number of 7 ton dump trucks needed. The job conditions are as follows. Show and label all figures and formulas.

COMPACTED FILL REQUIRED ---------- 170,000 CY

CLASS OF EARTH FOR SOIL CONVERSION---------- CLAY

INITIAL MOISTURE CONTENT ---------- 8%

AVERAGE HAUL DISTANCE ---------- 6600 FT

AVERAGE RETURN DISTANCE---------- 6600 FT

AVERAGE OPERATORS---------- WORKING 60 MIN/HR

TRUCKS ARE LOADED BY TRAM WITH 2 1/2 CY BUCKET

TRAM CYCLE TIME IS 30 SECONDS

JOB AND MNGT. FACTORS ARE GOOD.

SOLUTION:

2,000	DRY CLAY
x 1.08	MOISTURE
2,160	ASW

20,000	MAX LOAD SIZE
÷ 2,160	ASW
9.26	CY OF THE LOAD

9.26	CY OF THE LOAD
÷ 2.5	BUCKET SIZE
3.70	
OR 3	BUCKETS LOADED
x 2.5	ALS
7.5	ALS

2,160	ASW
x 7.5	ALS
16,200	LW

6,600 HD
35 X 88 = 2.14 HAUL TIME (HT)

6,600 RD
50 X 88 = 1.50 RETURN TIME (RT)

2.14	+	1.50	+	2.00	=	5.64
HAUL TIME		RETURN TIME		FIXED TIME		CYCLE TIME

60	MIN/HR
÷ 5.64	CT
10.64	TPH

10.64	TPH
7.5	ALS
x .6	EF
47.88	
OR 47	LCYPH

47	LCYPH
x .63	CONV FACTOR
29.31	
OR 29	CCYPH

5.64	TCT
÷ .50	LCT
11.28	
+ 1.00	
12.28	
OR 12	TRUCKS REQUIRED

170,000	FILL REQUIRED
÷ (29 x 12)	
488.51	THR
488.51	
÷ 10	
48.85	
OR 49	DAYS REQUIRED

TRANSITION: Now that we have completed all the steps required for dump truck estimations, are there any questions?

_____
_____
_____

(ON SLIDE #230, 231)

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

a. What factors need to be considered when loading a dump truck?

Weight of the soil, condition of the traveling surface, experience of the operator, to name a few.

b. What is the loaded MAX speed?

35 MPH

c. What is the empty MAX speed?

50 MPH

(BREAK – 10 Min)

TRANSITION: Are there any questions over basic dump truck production? If not let's move into logistical estimations.

_____
_____
_____

(ON SLIDE #232-233)

7. **TASKS/RESPONSIBILITIES BY RANK: (1 HR 30 MIN)**

Before any logistical estimation can be done certain questions must be answered. Responsibilities for gaining this information and performing these tasks are broken down by rank.

(ON SLIDE #234-237)

a. Although there are responsibilities by rank, everyone in the

chain must know what the others are doing. The first check list is for the engineer officer. The list is as follows and is only a guide. This list may be added to or taken away from depending on the extent of the mission. More information on engineer planning can be found in FM-FM 4-4 Par 706. Engineer responsibilities are found in FM 5-35, page 18-11.

CHECK LIST FOR THE ENGINEER OFFICER:

START	COMPLETE	TASK
		CONDUCT SITE RECONNAISSANCE
		ORDER SURVEY
		ORDER SOIL ANALYSIS
		ORDER ENVIRONMENTAL IMPACT STUDY
		ORDER GRADE STAKES TO BE PLACED AND ENVIRONMENTAL AREAS MARKED
		SUPPLY BLUE PRINT AND ENVIRONMENTAL STUDY TO CHIEFS
		HAVE EACH CHIEF MAKE WRITTEN ESTIMATIONS FOR EACH AREA OF CONCERN.
		COLLECT DATA FROM ALL CHIEFS AND FORMULATE TOTAL ESTIMATION
		IDENTIFY CONSTRUCTION REQUIREMENTS/LIMITATIONS/ RESTRICTIONS
		CRITICAL PATH METHOD
		ISSUE THE ORDERS TO THE CHIEFS TO CONDUCT THE MISSION

EXPLANATION OF OFFICERS CHECK LIST:

(1) **CONDUCT SITE RECONNAISSANCE**: Conduct site reconnaissance of area if possible. If not possible, collect data by way of maps and/or by topographical observation platoon (TOPO). The mission of TOPO is to give satellite imagery of an area. This imagery can be made into three dimensional maps that may be used to estimate mission requirements. More information on engineer reconnaissance is found in FM 5-35, page 18-10.

(2) **ORDER SURVEY:** A survey of an area is very important to the mission, if it entails detail work such as roads and runways. It is next to impossible for a carpenter to build without a blue print. The same goes for the engineer equipment officer. Survey teams are organic to most engineer units. More information on surveying, maps, and aerial photography, can be found in FM-3-35, page 17-1.

(3) **ORDER SOIL ANALYSIS:** Soil analysis is needed to determine several factors in the estimation. The soil classification is done by a soil analysis team. More information on how soils are classified can be found in FM 5-35, page 4-1.

(4) **ORDER ENVIRONMENTAL IMPACT STUDY:** Environmental studies can be attained through the environmental protection agency (EPA).

(5) **GRADE STAKES TO BE PLACED AND ENVIRONMENTAL ARE MARKED:** The survey team will place the grade stakes and mark environ-mental areas.

(6) **SUPPLY BLUE PRINT AND ENVIRONMENTAL IMPACT STUDY TO CHIEF:** The chief needs to have the blue print and all studies to estimate the mission. Without the prints and studies, a chief cannot make an accurate estimation.

(7) **ORDER EACH CHIEF TO MAKE A WRITTEN ESTIMATION FOR EACH AREA OF CONCERN:** Most engineer units are broken down into sections and have an equipment chief, a technical engineer chief, an utilities chief, etc. Each has a specific area of responsibility and knowledge of those areas.

(8) **COLLECT DATA FROM ALL CHIEFS AND FORMULATE TOTAL ESTIMATION:** To formulate data you need to know some formulas they are as follows. Starting with fuel consumption, this formula computation comes from FM 101-10-1 page 2-18.

(9) **IDENTIFY CONSTRUCTION REQUIREMENTS /RESTRICTIONS / LIMITATIONS:** After receiving the written estimation from the chiefs make one last check for any requirement that may have been over looked. For example, if working at night, is a floodlight going to be used? This is the catch all check.

(10) **CRITICAL PATH METHOD (CPM):** Is now made from Chiefs estimation. It is next to impossible to do the CPM without estimations. Work with the Chiefs to complete the CPM.

(11) **ISSUE THE ORDER:** To the Chiefs with the CPM.

ENGINEER CHIEF CHECK LIST:

START	COMPLETE	TASK
		CONDUCT SITE RECONNAISSANCE
		READ SURVEY (BLUE PRINT)
		GET SOIL ANALYSIS INFORMATION
		VIEW ENVIRONMENTAL IMPACT STUDY
		PLAN ORDER OF WORK
		MAKE ESTIMATIONS OFF OF MEASUREMENTS GIVEN IN BLUE PRINT
		MAKE MATHEMATICAL ESTIMATION FOR EQUIPMENT, PERSONNEL, TIME, MATERIALS
		RETURN WRITTEN ESTIMATION TO PROJECT OFFICER
		ISSUE THE ORDER TO THE NCO's TO EMPLOY EQUIPMENT

EXPLANATION OF CHIEF'S CHECK LIST

(ON SLIDE #238-241)

(1) **CONDUCT SITE RECONNAISSANCE:** After receiving the blue prints, you need to look at the area if possible to get a better idea of what equipment is needed to meet the mission. Also look for things that are not shown on the blue prints, trees, large boulders, and things that will slow production.

(2) **READ SURVEY (BLUE PRINT):** Read the blue print very carefully. Look for lines that may be barred like power lines, phone lines, sew-age lines, and so on.

(3) **GET SOIL ANALYSIS INFORMATION:** Most of the formulas use the information found in the soil analysis report. If you do not know what type of soil you are working in, it is next to impossible to determine what equipment will be used or the amount of time it will take to meet mission.

(4) **VIEW ENVIRONMENTAL IMPACT STUDY:** Make sure that everyone knows the areas that are protected. There are all kinds of

plant and endangered species that depend on us doing our job correctly.

(5) **MAKE WRITTEN ESTIMATIONS OFF OF MEASUREMENTS GIVEN IN BLUE PRINT:** Making a written estimation is done with the formulas previously shown in this class and in the production estimation class. If a formula is needed that was not in this class, you can fine other formulas in FM 5-434; when performing estimations, remember to view TE/LM2 reports, to determine what available equipment. If external sup-port is needed, request external report. Order all supplies that may be needed.

(6) **RETURN WRITTEN ESTIMATION TO PROJECT OFFICER:** This can also be asked for in brief form, so be ready to make a presentation with the appropriate media.

(7) **PLAN ORDER OF WORK WITH THE CPM:** Look at mission requirements and restrictions of job site. Plan the work as to where it can be conducted without confusion or unsafe working conditions. Make daily schedules and bar charts at this point off of CPM or GANT Chart. Ensure to plan routes of travel.

(8) **ISSUE THE ORDER TO THE NCO's TO EMPLOY EQUIPMENT:** Once the order has been given by the officer, the chief relays the order to begin work. Remember to give a safety brief and map the way to the project.

NCO'S RESPONSIBILITIES:

START	COMPLETE	TASK
		REQUEST THE SUPPORT OF FUEL, OILS, AND OTHER REQUIREMENTS NEEDED.
		EMPLOY EQUIPMENT TO JOB SITE
		PERIODICALLY SUPERVISE CREWS AND TEAMS

(ON SLIDE #242)

EXPLANATION OF NCO's CHECK LIST

(1) **REQUEST THE SUPPORT OF FUEL, OIL, AND OTHER REQUIREMENTS NEEDED:** The formulas to get this information are at the end of

this handout.

(2) **EMPLOY EQUIPMENT TO THE JOB SITE:** Moving the equipment is very dangerous. Be watchful of anything that may endanger personnel or damage the equipment. After all, you do not need to start behind schedule or get someone hurt. Also make sure that tools, fuel, oil, and water that may be needed are taken.

(3) **PERIODICALLY SUPERVISE CREWS AND TEAMS:** Supervision is the NCO's main mission on the job site. He/she is the one who insures everything runs smoothly and safely.

(ON SLIDE #243)

TRANSITION: So far we have covered conducting the site billet responsibilities. Are there any questions?

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

Q. Who is responsible for conducting the site survey?

A. Equipment/project officer

Q. Who is responsible for conducting the mathematical estimations?

A. Engineer Equipment Chief

(BREAK – 10 Min)

TRANSITION: Each billet in a typical engineer equipment platoon has responsibilities that pertain to conducting logistical estimations. Now that we have discussed those billet responsibilities, let's get into the actual mathematical process for conducting logistical estimations.

_____
_____
_____

(ON SLIDE #244)

8. LOGISTICAL ESTIMATIONS: (2 HRS 15 MIN)

(ON SLIDE #245)

a. Logistical estimations can be made up from check lists that are broken down into areas of responsibility by rank. When all the questions from the check lists are answered, there are formulas to work out to determine quantity requirements.

(ON SLIDE #246)

FUEL CONSUMPTION FORMULA

QTY OF EQUIPMENT X GALS/HR X HOURS/DAY X # OF DAYS = TOTAL GALS

(ON SLIDE #247, 248)

NOTE: To get the gals/hour refer to the equipment TM for fuel consumption or to FM 5-35 par. 3-4. **FOR CLASS ROOM PURPOSES USE TABLE #1.**

TABLE #1 FUEL CONSUMPTION

EQUIPMENT	TYPE OF FUEL	GALS/HOUR
LOADER 624KR	DIESEL	6.00
MAC 50 (ATC)	DIESEL	6.00
GRADER (120M)	DIESEL	4.00
COMPACTOR(563D)	DIESEL	4.00
SCRAPER (621B)	DIESEL	10.00
DOZER (1150E)	DIESEL	6.00
DOZER (1155E)	DIESEL	6.00
DOZER (MCT)	DIESEL	8.00
BACKHOE (420E)	DIESEL	4.00

INTERIM TRANSITION: Now that you understand the formula for estimating fuel consumption, follow along with the example in your student handout during the demonstration.

_____
_____
_____

(ON SLIDE # 249)

INSTRUCTOR NOTE
Introduce the following demonstration (1).

DEMONSTRATION (1): (20MIN) Have the students follow along as you (the instructor) demonstrates how to put the formula in a table for each piece of equipment and totals the estimated fuel requirement at the bottom of the table.

STUDENT ROLE: Students will observe the instructor and follow along with the example in the student handout. Students are encouraged to ask questions.

INSTRUCTOR(S) ROLE: The instructor will draw a table on the dry erase board. Fill in the formula at the top of the table and list all equipment from the example in the table.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Students will perform each step as it is completed by the instructor. Ensure students are recording their data.
3. **Debrief:** Now that you've seen the process, you can complete the "What Have You Learned" problem in the book.

EXAMPLE: Total fuel consumption for 3 scrapers (621b) working 12 hr/day for 10 days and 2 loaders (624KR)working 12 hr/day for 4 days, and 2 graders (120M) working 12 hr/day for 13 days.

(ON SLIDE #250)

Solution:

QTY OF EQUIP	X GALS/HOUR	X HOURS/DAY	X NUMBER OF DAYS	= TOTAL GALS
621B	3 **X**	10 **X**	12 **X**	10	= **3600**
624KR	2 **X**	6 **X**	12 **X**	4	= **576**
120M	2 **X**	4 **X**	12 **X**	13	= **1,248**
				TOTAL GALS = **5,424** **gals**

(Same example problem as in the demonstration box.)

INTERIM TRANSITION: You have now seen how to put the formula into a table format. Now, solve the "What Have You Learned" problem in the student handout.

_____
_____
_____

INSTRUCTOR NOTE

Introduce the following practical application (14).

PRACTICAL APPLICATION (14). (45 MIN) Have the students complete the "What Have You Learned" problem in the student to determine the fuel required for 3 dozers (MCT) working 10 hr/day for 8 days, 2 tractors (420) working 10 hr/day for 3 days, and 1 scraper (621B) is working 10 hr/day for 2 days.

PRACTICE: Students will solve the "What Have You Learned" problem in the student handout for practice using the fuel estimation formula. Upon completion review the practical application with the students.

PROVIDE-HELP: Observe the students and answer questions.
1. Safety Brief: No safety concerns for this exercise.
2. Supervision & Guidance: Be sure to follow the step by step directions covered in your student outline along with the instructor's supervision.
3. Debrief: Are there any questions or comments about estimating fuel requirements for various equipment. Accurate estimations for fuel and other logistical requirements for a successful mission will save, time, money and effort in ordering excess fuel (or not enough)and paying for fuel not used, plus effort and space required to transport unused fuel back to your shop.

(ON SLIDE #251)

WHAT HAVE YOU LEARNED?

PROBLEM: Figure the total fuel consumption for 3 dozers (MCT) working 10 hr/day for 8 days, 2 backhoes' (420) working 10 hr/day for 3 days, and 1 scraper (621B) working 10 hr/day for 2 days.

(ON SLIDE #252)

QTY OF EQUIPMENT	X	GALS/HOUR	X	HOURS/DAY	X	NUMBER OF DAYS	=	TOTAL GALS
3	X	8	X	10	X	8	=	1,920
2	X	4	X	10	X	3	=	240
1	X	10	X	10	X	2	=	200
							TOTAL	2,360 GALS
QTY OF EQUIPMENT	X	GALS/HOUR	X	HOURS/DAY	X	NUMBER OF DAYS	=	TOTAL GALS

INTERIM TRANSITION: Now that we have covered the formula for determining fuel requirements. Let's get into the other logistical requirements such as P.O.L.'s, water, and chow.

_____
_____
_____

(ON SLIDE #253)

b. **Petroleum, oil, and lubricant (POL)**

Once the total gallons of fuel have been determined using the previous fuel consumption formula, all POL requirements can be estimated using the fuel estimation as a guideline.

PETROLEOUM OIL LUBRICATES (POL) CONSUMPTION FORMULAS

(Information for POL is found in FM 101-10-1 page 2-11.)

(ON SLIDE #254)

STEP #1: 10WT THROUGH 50WT FORMULA

X =

.02 X TOTAL GALS OF FUEL EST = TOTAL OIL ENGINE (OE)

(ON SLIDE #255)

STEP #2: 80WT THROUGH 90WT FORMULA

X =

.005 X TOTAL GALS OF FUEL EST = TOTAL GEAR OIL (GO)

(ON SLIDE #256, 257)

STEP #3: GREASE

EST METER HOURS / 8 X .25 = POUNDS OF GREASE

NOTE: The 8 stands for 8 hr on the meter, not hrs of day, the .25 stands for 1/4 lbs of grease for every 8 meter hours. To get the estimate hour meter hours, use this formula.

NUMBER OF EQUIPMENT X HR/DAY X NUMBER OF DAYS = EST METER HRS

NOTE: TO MAKE THINGS SIMPLE TOTALS ARE PUT IN THE CHART

ROUND OFF GALLONS BEFORE PUTTING IN TABLE

STEP #4: TOTALS

	10WT	30WT	40WT	50WT	80WT	90WT	GAA		
624KR									
ATC 50									
120M									
563D									
621B									
1150E									
1155E									
MCT									
420									
TOTALS									

INTERIM TRANSITION: You have now seen how formulate fuel consumption. Now, follow along with the demonstration.

_____
_____
_____

(ON SLIDE #258)

INSTRUCTOR NOTE

Introduce the following demonstration (2).

DEMONSTRATION (2): (20 MIN) Have the students follow along as you (the instructor) demonstrates how to put the formula in a table for each piece of equipment and totals the estimated fuel requirement at the bottom of the table.

STUDENT ROLE: Students will observe the instructor and follow along with the example in the student handout. Students are encouraged to ask questions.

INSTRUCTOR(S) ROLE: The instructor will draw a table on the dry erase board. Fill in the formula at the top of the table and list all equipment from the example in the table.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Students will perform each step as it is completed by the instructor. Ensure students are recording their data.
3. **Debrief:** Now that you've seen the process, you can complete the "What Have You Learned" problem in the book.

(ON SLIDE #259)

EXAMPLE: Estimate the total petroleum oil lubricant (POL) required for two graders (120M) with an estimated fuel consumption of 1,248 gals for 13 days of operations. The graders will be working 12hrs per day.

STEP #1

.02 X *1,248* EST FUEL NEEDED = ***24.96* OR *25* GALS OF 30 WT *OE***

STEP #2

.005 X *1,248* EST FUEL NEEDED = ***6.24* OR *7* GALS OF 90 WT *GO***

STEP #3

$$\frac{\text{EST METER HOURS}}{8} \text{ X } .25 = 9.75 \text{ OR } 10 \text{ POUNDS OF GREASE}$$

2 GRADER X *12* HR/DAY X *13* # OF DAYS = ***312* EST METER HRS**

INTERIM TRANSITION: You have just walked through the process of estimating fuel. Now, solve the "What Have You Learned" problem in the student handout.

_____
_____
_____

(ON SLIDE #260)

INSTRUCTOR NOTE
Introduce the following practical application (15).

PRACTICAL APPLICATION (15). (45 MIN) Have the students complete the "What Have You Learned" problem in the student handout to estimate the total POL required for 3- loaders (624KR) with a estimated fuel consumption of 3,500 gals, and 2 tractors (420) with fuel consumption of 1,200 gals. The equipment will be working for 8 days at 7 hrs per day.

PRACTICE: Students will solve the "What Have You Learned" problem in the student handout for practice using the fuel estimation formula. Upon completion review the practical application with the students.

PROVIDE-HELP: Observe the students and answer questions.
1. Safety Brief: No safety concerns for this exercise.
2. Supervision & Guidance: Be sure to follow the step by step directions covered in your student outline along with the instructor's supervision.
3. Debrief: Are there any questions or comments about estimating POL requirements for various equipment. Accurate estimations for POL requirements, as with fuel, will ensure a successful mission by saving time, money and effort by ordering appropriate amounts of POL's, and effort and space required to transport unused POL's back to your shop.

WHAT HAVE YOU LEARNED

PROBLEM: Estimate the total POL required for 3- loaders (624KR) with a estimated fuel consumption of 3,500 gals, and 2 tractors (420) with fuel consumption of 1,200 gals. The equipment will be working for 8 days at 7 hrs per day.

(ON SLIDE #261-263)

3 TRAMS (624KR)

.02 X 3,500 EST FUEL NEEDED = 70 GALS OE

.005 X 3,500 EST FUEL NEEDED = 17.5 OR 18 GALS OE

3 TRAMS X 7 HRS/DAY X 8 DAYS = 168 EST METER HRS

EST METER HRS

$$\frac{168}{8} \quad X .25 = 5.25 \text{ OR } 6 \text{ LBS GAA}$$

2 420D

.02 X 1,200 EST FUEL NEEDED = 24 GALS OF OE

.005 X 1,200 EST FUEL NEEDED = 6 GALS OF GO

2 420E X 7 HR/DAY X 8 DAYS = 112 EST METER HRS

EST METER HRS

$$\frac{112}{8} \quad X .25 = 3.5 \text{ OR } 4 \text{ LBS GAA}$$

	10WT	30WT	40WT	50WT	80WT / 90WT	GAA		
624KR	70	70			18	6		
ATC 50								
120M								
563D								
621B								
1150E								
1155E								
MCT								
420	24	24			6	4		
TOTALS	94	94			24	10		

INTERIM TRANSITION: Now that we have covered the formula for determining POL requirements. Now let's take a look at estimating for water consumption.

_____
_____
_____

(ON SLIDE #264)

c. **WATER CONSUMPTION:** There are two categories to estimate for water consumption.

(1) Potable water: Fresh water that is used for drinking, personnel hygiene, laundry, and showers.

(2) Non-Potable water: Fresh water that is used for soil preparation / dust control and equipment.

(Note: Salt water can be used in some circumstances, however, salt water will cause equipment to rust more rapidly and may have adverse effects on soil preparation, particularly if combine with admix chemicals.)

(ON SLIDE #265)

TABLE #2 WATER CONSUMPTION GAL. PER PERSON/DAY OR EQUIPMENT/DAY

USES	***HOT***	***TEMPERATE***	***COLD***
DRINKING	3.0	1.5	2.0
LAUNDRY	2.1	2.1	2.1
SHOWERS	1.0	1.0	1.0
PERSONNAL HYGEINE	1.7	1.7	1.7
SOIL PREPARATION	1.0 GAL/SQ.YD	1.0 GAL/SQ.YD	1.0 GAL/SQ.YD
EQUIPMENT	1.0	1.0	1.0

NOTE: INFORMATION TAKEN FROM FM 101-10-1 TABLE 2-5 AND FM 5-434 TABLE 11-1. ***LAUNDRY TOTALS ARE BASED ON 1 LAUNDRY EXCHANGE/WEEK AND 1 SHOWER/DAY. THESE ARE MINIMAL USAGE REQUIREMENTS.***

(ON SLIDE #266)

FORMULAS

FOR SOIL PREPARATION AND DUST CONTROL (NON POTABLE WATER)

			X		X	=
TOTAL COMPACTED SQ YD (SQ.Y)	X	1 GAL/SQ YD	X	1.10 WASTE	=	GALS REQ

(ON SLIDE #267)

FOR EQUIPMENT (*NON POTABLE WATER)*

			X		X		X	=
# OF EQUIPMENT	X	1 GAL/DAY	X	EST DAYS	X	1.10 WASTE	=	GALS REQ

(ON SLIDE 268)

SHOWERS (*POTABLE WATER)*

		X		X		X	=

OF PERSONNEL X TABLE 2 X # OF DAYS X 1.10 WASTE = GALS REQ

(ON SLIDE #269)

LAUNDRY *(POTABLE WATER)*

	X	X	X	=	

OF PERSONNEL X TABLE 2 X # OF DAYS X 1.10 WASTE = GALS REQ

(ON SLIDE #270)

PERSONNAL HYGEINE *(POTABLE WATER)*

	X	X	X	=	

OF PERSONNEL X TABLE 2 X # OF DAYS X 1.10 WASTE = GALS REQ

(ON SLIDE #271)

DRINKING WATER *POTABLE WATER*

	X	X	X	=	

OF PERSONNEL X TABLE 2 X DAYS X 1.10 WASTE = GALS REQ

INTERIM TRANSITION: You have seen how to estimate for the various water consumptions. Now, follow along with the instructor's demonstration.

_____
_____
_____

(ON SLIDE #272)

INSTRUCTOR NOTE
Introduce the following demonstration (3).

DEMONSTRATION (3): (20 MIN) Have the students follow along as you (the instructor) demonstrates how to put the formula in a table for water requirements of each usage type.

STUDENT ROLE: Students will observe the instructor and follow along with the example in the student handout. Students are encouraged to ask questions.

INSTRUCTOR(S) ROLE: The instructor will use the dry erase board to formulate each equation as a display for the students to read and understand.

1. **Safety Brief:** There are no safety concerns.
2. **Supervision & Guidance:** Students will perform each step as it is completed by the instructor. Ensure students are recording their data.
3. **Debrief:** Now that you've seen the process, you can complete the "What Have You Learned" problem in the book.

EXAMPLE: Estimate the water consumption for 250 personnel working for 28 days in a hot climate. Each marine will take four showers and have their laundry cleaned four times during the 28-day operation. Compute the water requirement for 50 vehicles. You will be working on a road that is 4,000' long and 28' wide from ditch to ditch.

(ON SLIDE #273)

STEP #1 SOIL PREPARATION (NON POTABLE WATER):

A: ESTIMATE THE SQ YD OF THE ROAD.

$$\frac{4{,}000'\text{L} \times 28'\text{ W}}{9} = \textbf{12,444.44 OR 12,445 SQ.YD}$$

Round Up

B: FORMULATE

12,445 SQ.YD. X 1 GAL X 1.10 WASTE = **13,689.50**
OR 13,690 GAL

(ON SLIDE #274)

STEP #2 EQUIPMENT (NON POTABLE WATER):

50 VEHICLES X 1 GAL/DAY X 28 DAYS X 1.10 WASTE = **1,540 GAL**

(ON SLIDE #275)

STEP #3 SHOWERS (POTABLE WATER):

SHOWERS 250 MEN X 1.0 (TABLE 2) X 4 DAYS X 1.10 WASTE =
1,100 GAL

STEP #4 LAUNDRY (POTABLE WATER):

LAUNDRY 250 MEN X 2.1 (TABLE 2) X 4 DAYS X 1.10 WASTE = **2,310 GAL**

(ON SLIDE #276)

STEP #5 PERSONNAL HYGEINE (POTABLE WATER)

HYGEINE 250 MEN X 1.7(TABLE 2) X 28 DAYS X 1.10 WASTE = **13,090 GALS**

(ON SLIDE #277)

STEP #5 DRINKING WATER (POTABLE WATER):

250 MEN X 3 GAL/MAN X 28 DAYS X 1.10 WASTE = **23,100 GAL**

(ON SLIDE #278)

	POTABLE WATER	***NON POTABLE WATER***
SOIL PREPARATION		**13,690**
EQUIPMENT		**1,540**
LAUNDRY	**2,310**	
SHOWERS	**1,100**	
HYGEINE	**13,090**	
DRINKING WATER	**23,100**	
TOTAL	**39,600**	**15,230**

INTERIM TRANSITION: We have just completed the example problem for estimating water requirements. Now, practice what you have learned in this practical application.

_____
_____
_____

(ON SLIDE #279)

INSTRUCTOR NOTE
Introduce the following practical application(16).

_____

PRACTICAL APPLICATION 16). (30 MIN) Have the students complete the "What Have You Learned" problem in the student handout to estimate the water consumption for 75 personnel working for 60 days in a hot climate. During the 60-day operation showers will

go once a day and laundries will be done 1x/week. Compute the requirement for 25 vehicles. You will be moving 4,500 SQY.

PRACTICE: Students will solve the "What Have You Learned" problem in the student handout for practice using the fuel estimation formula. Upon completion review the practical application with the students.

PROVIDE-HELP: Observe the students and answer questions.
1. Safety Brief: No safety concerns for this exercise.
2. Supervision & Guidance: Be sure to follow the step by step directions covered in your student outline along with the instructor's supervision.
3. Debrief: Are there any questions or comments about estimating water requirements for equipment or personnel. Accurate estimations for water requirements will ensure a successful mission largely in part due to the medicinal effects of cleanliness and hydration, but also a better construction product through compaction efforts.

PROBLEM: Estimate the water consumption for 75 personnel working for 60 days in a hot climate. During the 60-day operation showers will go once a day and laundries will be done 1x/week. Compute the requirement for 25 vehicles. You will be moving 4,500 SQY.

Compacted road measurements are:
6,099' LONG
24' WIDE
10" HIGH

(ON SLIDE #280-286)

SOIL PREP

$$\frac{6{,}099' \text{ L} \times 24' \text{ W}}{9} = 16{,}264 \text{ SQ YD}$$

16,264 SQ YD X 1 GAL X 1.10 WASTE = 17,891 GALS

EQUIPMENT

25 VEHICLES X 1 GAL/DAY X 60 DAYS X 1.10 = 1,650 GALS

LAUNDRY

60 DAYS ÷ 7 DAYS = 8.57 ROUND DOWN TO 8 LAUNDRY DAYS

75 PERSONNEL X 2.1 GAL X 8 DAYS X 1.10 = 1,386 GAL

SHOWERS

75 PERSONNEL X 1 GAL X 60 DAYS X 1.10 = 4,950 GAL

PERSONAL HYGIENE

75 PERSONNEL X 1.7 GAL X 60 DAYS X 1.10 = 8,415 GAL

DRINKING

75 PERSONNEL X 3 GAL/MAN X 60 DAYS X 1.10 = 14,850 GALS

	POTABLE WATER	***NON POTABLE WATER***
SOIL PREPARATION		17,891
EQUIPMENT		1,650
LAUNDRY	1,386	
SHOWERS	4,950	
HYGEINE	8,415	
DRINKING WATER	14,850	
TOTAL	29,601	19,541

INTERIM TRANSITION: Are there any questions or comments concerning the practical application. Now we will look at a very simple formula for determining the required number of meals ready to eat (MREs) for an operation.

_____
_____
_____

(ON SLIDE #287)

d. **Estimating for Meals Ready To Eat (MRE)**

(1) MRE's are the most common form of sustenance for troops in the field. Estimating for meals will ensure enough food for Marines while conducting field operations and are easy to transport.

(ON SLIDE #288)

FORMULA FOR MEALS READY TO EAT

X X =

PERSONNEL X 3 MEALS/DAY X NUMBER OF DAY = TOTAL NUMBER OF MEALS

÷ =

TOTAL NUMBER OF MEALS ÷ 12 TO A CASE = TOTAL NUMBER OF CASES.

(ON SLIDE #289)

EXAMPLE: The unit's size is 175 personnel. Working 60 days, determine the quantity of meal ready-to-eat, by the cases.

(ON SLIDE #290)

175 PERSONNEL X 3 MEALS/DAY X 60 DAYS = **31,500** TOTAL NUMBER OF MEALS

TOTAL NUMBER OF MEALS 31,500 ÷ 12 TO A CASE = **2,625** TOTAL NUMBER OF CASES

(ON SLIDE #291, 292)

PROBLEM: The unit's size is 30 personnel. Working 20 days, determine the quantity of meal ready-to-eat, by the cases.

- **30 PERSONNEL X 3 MEALS/DAY X 20 DAYS = 1800 TOTAL MEALS**
- **1,800 TOTAL MEALS / 12/CASE = 150 CASES**

INTERIM TRANSITION: We have just finished covering logistical estimations. Now, complete practical application worksheets 1, 2, and 3

_____
_____
_____

(ON SLIDE #293)

INSTRUCTOR NOTE

Introduce the following practical application (17).

PRACTICAL APPLICATION (17). (2 HRS 30 MIN) Have the students complete the worksheets #1,2,and 3. These worksheets are an accumulation of all logistical estimations for fuel consumption, POL, water usage, and MRE's.

PRACTICE: Students will complete the worksheet assignments.

PROVIDE-HELP: Observe the students and answer questions.
1. Safety Brief: No safety concerns for this exercise.
2. Supervision & Guidance: Observe the students, answer questions, and give guidance.
3. Debrief: Are there any questions or comments about estimating for logistical requirements. Accurate estimations ensures mission accomplishment, builds confidence in leaders through successful planning, and raises moral by providing logistical support to your Marines in forms of plenty of chow, drinking water, and showers.

(ON SLIDE #294)

TRANSITION: Are there any questions or comments concerning logistical estimations? If not I have some questions for you.
_____
_____
_____

OPPORTUNITY FOR QUESTIONS:

1. QUESTIONS FROM THE CLASS

2. QUESTIONS TO THE CLASS:

Q. What must be determined before POL consumption can be estimated?

A. Estimated fuel consumption

Q. What are the two classifications of water?

A. Potable and Non-potable

(ON SLIDE #295)

SUMMARY **(5 MIN)**

During this period of instruction, we have covered Production estimations for the scraper, crawler tractor, scoop loader, and

dump truck as well as how to estimate for fuel, potable water, non-potable water, petroleum, oils, and lubricants, and meals. Accurate estimations for these essential items ensures mission accomplishment, builds junior Marines confidence in leaders through successful planning, and raises moral by providing logistical support to your Marines in the form of chow, drinking water, and showers and also allows for the equipment to continue running effectively throughout the project construction.

INSTRUCTOR NOTE

Ensure to collect all IRF's and safety questionnaires handed out.

(BREAK – 10 Min)

REFERENCES:

ROUND OFF RULES FOR CLASSROOM PURPOSES	
ROUND UP * DAYS TO THE NEXT FULL DAY * CUBIC YARDS TO THE NEXT FULL CUBIC YARD WHEN MEASURING THE AMOUNT OF SOIL NEEDED OR TO BE REMOVED	***ROUND DOWN*** * BUCKETS TO THE NEXT FULL BUCKET * LCYPD CCYPD BCYPD LCYPH CCYPH BCYPH
ROUND OFF ***5 OR GREATER ROUND UP*** ***4 OR LESS ROUND DOWN*** * ROLLING RESISTANCE * GRADE RESISTANCE * GRADE ASSISTANCE	***NEVER ROUND OFF*** * CONVERTING INCHES INTO FEET * WEIGHT / SHORT TONS * MPH * SIZE OF THE LOAD * TIME

MCRP 4-11A, Vol 1 CSS Field Reference Guide

FM 5-434 Earthmoving Operations

FMFM 4-4 Engineer Operations

FM 5-34 Engineering Field Data

MCRP 4-11-8A Marine Corps Field Feeding Program

FM 5-430-00-1 Planning and Design of roads, airfields, and heliports in the theater of operations- Road Design

FM 101-10-1 Staff Officer's Field Manual