ASGM BASELINE PRACTICE EXERCISE

In this exercise, we give an example set from the fictional community of Goldougou. The data set is representative to that which an inventory officer might collect from the field for a theoretical site. In some cases, the averages calculated from information gathered in the field are included rather than the raw data to save time; however, it is important that trainees understand that calculating averages is a key step, and all data included in these average calculations should be reviewed to assure only quality data is incorporated into the data set. From this example data set we ask trainees to produce inventory estimates based on the information acquired.

Goldougou is a large, active, mining community, with a single mining style practiced throughout (manual extraction, downhole pit, hard rock mining). There is one (1) site boss (concession holder), and individual teams of pit workers dedicated to their specific pits. All processing is conducted using an identical processing workflow, in which a mill reduces grain size of raw ore to a sand, this milled ore is sluiced to produce a concentrate, and this concentrate is amalgamated using mercury. Amalgamation is completed by the individual pit bosses responsible for producing the ore. The revenue of the mineral operations is distributed such that each gold miner receives 2-4% of the total production, pit bosses receive 10 %, and the rest goes to the site owner. The site owner is responsible for paying all operational costs, as well as paying processing fees.

To gather the data included in **Table 1**, the inventory officer visited the site and spent two (2) days interviewing various stakeholders such as miners, processors, pit bosses, the mine owner (concession holder), gold buyers on site, and local authorities in the region. Additionally, various physical measurements, counts and observations were conducted to gain further information and to verify data received during stakeholder interviews. Additional information from regional or national sources is also included for comparison. The national government of this fictional country has distributed miner cards in an attempt to formalise the sector, and has a baseline set of data for the community of Goldougou.

Table 1. Given Data:

Info Source	Information	Estimate and units	Additional Notes
Pit boss 1	production estimate	25 bags/day/pit	Has been working on site since the opening of the mine. Lead for 1 pit.
Pit boss 1	population estimate	6 guys in his pit	
Pit boss 1	Revenue Distribution	20 % of all gold goes to miners, 10 % to him	
Pit boss 2	production estimate	15 bags/day	Single pit leader. Has been working on site for 2 years. This pit 4 months.
Miner 1	production estimate	20 bags/pit/day	
Miner 1	Purity	19 k	
Miner 1	population estimate	5 workers in his pit	
Miner 1	Earnings	0.5 g/d	

Miner 1	Grade	1 g / bag	
Miner 1	Days Active	300 / yr	
Miner 2	production estimate	20 bags/pit/day	
Miner 2	population estimate	7 workers in his pit	
Miner 2	Purity	17 k	
Miner 2	Earnings	0.5 g/d	
Miner 2	Grade	25 g/T	
Miner 3	production	75 bags/pit/day	New to mine site, only worked a few shifts
Physical Measurement	Weight of 1 bag	50 kg	Weighed 10 bags using bathroom scale and took the average
Physical Count	Total number of pits	150 pits total, 75 active pits	Community leader took inventory expert around site showing all pits. Expert noted if active or not.
Physical Count	Total active processing systems	50	
Mine Owner	Total number of pits	80 active pits	
Mine Owner	Revenue Distribution	20% goes to miners; 10 % to pit boss; rest to site owner	Reported sharing of profits
Average of stakeholder surveys	Days worked per year	300 days/year	Took average of reported worked days per year from various stakeholders
Average of stakeholder surveys	Recoverable gold grade	20 g/T	Took average gold grade estimates from various stakeholders
Average of physical measurements	Gold Karatage	18 k	Measured 5 batches of gold for karatage using density techniques and took average
Processor 1	Throughput	3 bag/hour	8 hrs/day
	Processor/system	2	
	Earnings	Paid $2 per bag	
	Days Active	275	
Processor 2	Throughput 1	20 bag/day	
	Throughput 2	4 bag/hour	8 hr/day
	Processor/system	2	
	Days Active	325	
Processer 3	Throughput	30 bag/day	
	Processor/system	2	
Physical Measurement	Mercury use	Mercury added = 500 g Mercury recovered = 425 g Gold produced = 50 g	Information collected during a physical measurement of an amalgamation and burn

Goals:

- **Determine total gold production for the site using multiple techniques and cross checks.**
- **Determine total mercury usage for the site.**
- **Determine total miner population for site using multiple techniques and cross check.**

Questions:

1 – Determine total annual 24K gold production for the site using the extraction based method.

a) **Determine average daily ore extraction per pit.**
b) **Determine total daily ore extraction per site.**
c) **Determine total daily gold production.**
d) **Daily gold production per site as corrected to 24 k.**
e) **Total annual 24 k gold production for the site.**

2 – Determine total annual 24 k gold production for the site using the processing based method.

a) **Calculate average daily processing throughput for individual systems.**
b) **Calculate daily throughput in T/d per system.**
c) **Calculate daily processing capacity for the site.**
d) **Calculate total daily gold production for the site.**
e) **Correct for 24 k.**
f) **Calculate total annual 24 k gold production.**

3 – Determine total worker population for the site (miners, processors and bosses).

a) **Determine extracting worker population.**
b) **Determine pit boss population.**
c) **Determine total processor population.**
d) **Determine total worker population.**

4 – Determine total annual 24 k gold production using the earnings based method.

a) **Determine total annual earnings for all miners.**
b) **Determine total annual earnings for all miners in 24K gold.**
c) **Determine total site production from miner earnings and miner share of profits.**

5 – Cross check total production calculations from various sources and compare with other available data. Discuss.

6 – Calculate Hg:Au ratio.

7 – Determine total Hg use on the site.

Answers:

1 – Determine total annual 24 k gold production for the site using the extraction based method.

    a) Determine average daily ore extraction per pit:

$$daily\ ore\ extraction\ per\ pit = \frac{25\frac{bag}{day} + 15\frac{bag}{day} + 20\frac{bag}{day}}{3} = 20\ bag/day$$

Note: The Miner 3 estimate was NOT used as it was found to be notably higher than other estimates, and the miner was new to site with limited experience. Therefore, this miner likely did not truly know daily extraction rates.

    b) Determine total daily ore extraction per site:

$$Daily\ ore\ extraction\ (bags)\ per\ site = 20\frac{bag}{pit}x\ 75\ pits = 1500\ bag/day$$

$$Daily\ ore\ extraction\ (Tonnes)\ per\ site = 1500\frac{bag}{day}x\ 50\frac{kg}{bag}\ x\ \frac{1\ T}{1000\ kg} = 75\ T/day$$

    c) Determine total daily gold production.

$$Daily\ gold\ production\frac{g}{day} = 75\frac{T}{day}x\ 20\frac{g}{T} = 1500\ g\ Au/day$$

    d) Daily gold production per site as corrected to 24 k.

$$Daily\ 24\ k\ gold\ production = 1500\frac{g}{day}\ x\frac{18}{24} = 1125\ g/day$$

    e) Total annual 24 k gold production for the site.

$$Annual\ 24\ k\ gold\ production = 1125\frac{g}{day}x\ 300\frac{d}{year}\ x\ 1\frac{kg}{1000}g = \mathbf{337.5\ kg/yr}$$

2 – Determine total 24 k gold production using the processing based method.

    a) Calculate average daily processing throughput for individual systems.

Note: Must first standardize units of throughput estimates.

Processor 1:

- $3\frac{bag}{hr}x\ 8\frac{hr}{day} = \mathbf{24\frac{bag}{day}}$

Processor 2:

Note: As processor 2 gave two conflicting estimates when using different units, we take the average of these estimates.

- $20 \frac{bag}{day}$
- $4 \frac{bag}{hr} x\, 8 \frac{hr}{day} = 32 \frac{bag}{day}$
- $Average\ of\ processor\ 2\ esitmates = \frac{10\frac{bag}{day} + 20\frac{bag}{day}}{2} = \mathbf{26 \frac{bag}{day}}$

Processor 3:

- $\mathbf{30 \frac{bag}{day}}$

We now calculate the average of these 3 processors estimates:

$$Average\ daily\ throughput\ capacity\ per\ system = \frac{24\frac{bag}{day} + 26\frac{bag}{day} + 30\frac{bag}{day}}{3} = \mathbf{26.66 \frac{bag}{day}}$$

b) **Calculate daily throughput in T/d per system.**

- $26.66 \frac{bag}{day} x\, 0.05 \frac{T}{bag} = \mathbf{1.33 \frac{T}{day}}$

c) **Calculate daily processing capacity for the site.**

$$Daily\ processing\ capacity\ for\ the\ site\ (T) = 1.33 \frac{T}{\frac{day}{system}} x\, 50 \frac{system}{site} = \frac{66.67\ T}{\frac{day}{site}}$$

d) **Calculate total daily gold production for the site.**

$$Daily\ gold\ production = 66.67 \frac{T}{day} x\, 20 \frac{g}{T} = 1333\ g\ Au/day$$

e) **Correct for 24 k.**

$$Daily\ 24\ k\ gold\ production = 1333 \frac{g}{day} x\, 0.75 = 1000\ g/day$$

f) **Calculate total annual 24 k gold production.**

$$Annual\ 24\ k\ gold\ production = 1000 \frac{g}{day} x\, 300 \frac{d}{year} x\, 1 \frac{kg}{1000}g = \mathbf{300\ kg/yr}$$

3 – Determine ASGM Workforce population.

e) **Determine extracting worker population.**

$$Total\ extracting\ miner\ population = \left(6 \frac{miner}{pit}\right) * 75\ pits = 450\ miners$$

f) Determine pit boss population.

$$Total\ pit\ boss\ population = \left(1\frac{boss}{pit}\right) * 75\ pits = 75\ pit\ workers$$

g) Determine total processor population.

$$Total\ processing\ population = 2\frac{processors}{system} * 50\ systems = 100\ processors$$

h) Determine total worker population.

$$Total\ worker\ population = 100\ processors + 450\ miners + 75\ pit\ bosses = 625\ workers$$

4 – Earnings based production estimate.

d) Determine total annual earnings for all miners**.**

$$Total\ annual\ earnings\ per\ miner = 450\ miners\ x\ 0.5\frac{\frac{g}{miner}}{day}\ x\ 300\frac{days}{year} = 67500\ g\ per\ year$$

e) Determine total annual earnings for all miners 24 k**.**

$$Total\ 24\ k\ gold\ earnings\ to\ miners = 67500\frac{g}{year}\ x0.75 = 50625\ g\ 24\ k\ gold$$

f) Determine total site production from miner earnings and miner share of profits.

Note: Here we use the fact that 20% of all gold production goes to extracting miners coupled with total miner earnings to calculate total production.

$$Total\ 24\ kgold\ production = \frac{50625\ g\ to\ miners}{0.2\ to\ miners} = 253125g = 253.12\ kg$$

5 – Cross check total production calculations from various sources and compare with other available data. Discuss.

6 – Calculate Hg:Au ratio.

7 – Determine total Hg use on the site.