QUESTION 1

PART A

SCENARIO 1

Decision Variables

x_1 = # ASLAVs
x_2 = # Bushmasters
x_3 = # M113s

Objective Function

Maximise $20x_1 + 22x_2 + 18x_3$

Constraints

Crew: $2x_1 + x_2 + 2x_3 \leq 33$

Soldiers: $7x_1 + 9x_2 + 11x_3 \leq 165$

Fleet: $x_1 + x_2 + x_3 \leq 25$

Nonnegativity: $x_1, x_2, x_3 \geqslant 0$

SCENARIO 2

Same as above, with additional constraint:

$x_2 = 5$

PART B

See spreadsheet.

PART C

optimal solution for scenario 1:

x1 = 12, x2 = 9, x3 = 0

area coverage = 438 sqkm

optimal solution for scenario 2:

x1 = 14, x2 = 5, x3 = 0

area coverage = 390 sqkm

QUESTION 2

PART A

x_{ij} = travel from i to j

obj function = Minimise travel time

$$= 8x_{12} + 13x_{13} + 15x_{14} + 10x_{15} + 5x_{23} + 15x_{27} + 5x_{36} + 4x_{45} + 3x_{46} + 12x_{59} + 4x_{67} + 2x_{68} + 5x_{69} + 2x_{78} + 4x_{710} + 5x_{89} + 7x_{810} + 5x_{98} + 5x_{910}$$

I eliminated some route segments that will never be on an optimal path, in order to save computation time.

Constraints

Start node: $x_{12} + x_{13} + x_{14} + x_{15} = 1$
End node: $x_{710} + x_{810} + x_{910} = 1$

Net flows: Node 2: $x_{12} - x_{23} - x_{27} = 0$
3: $x_{13} + x_{23} - x_{36} = 0$
4: $x_{14} + x_{54} - x_{46} = 0$
5: $x_{15} + x_{45} - x_{54} - x_{59} = 0$
6: $x_{36} + x_{46} - x_{67} - x_{68} - x_{69} = 0$
7: $x_{27} + x_{67} - x_{78} - x_{710} = 0$
8: $x_{68} + x_{78} + x_{98} - x_{89} - x_{810} = 0$
9: $x_{59} + x_{69} + x_{89} - x_{98} - x_{910} = 0$

Nonnegativity: $x_{ij} \geq 0$
Binary: $x_{ij} \in \{0, 1\}$

PART B

See spreadsheet.

Optimal path is: 1, 5, 4, 6, 7, 10

PART C

Shortest travel time = 25

QUESTION 3

PART A

x_{ij} = # cars sent from i to j

Objective function = Minimise transportation cost

$$= 250x_{15} + 1300x_{18}$$
$$+ 700x_{23} + 800x_{25} + 800x_{27}$$
$$+ 800x_{32} + 1000x_{37} + 1200x_{38}$$
$$+ 400x_{42} + 1900x_{43} + 450x_{45} + 800x_{47}$$
$$+ 600x_{52} + 900x_{57} + 1800x_{58}$$
$$+ 900x_{65} + 1500x_{68}$$
$$+ 1000x_{72} + 900x_{73} + 800x_{75} + 1100x_{78}$$
$$+ 1400x_{82} + 1500x_{85} + 1300x_{87}$$

Constraints.

Node

Supply 1 $x_{15} + x_{18} = 80$

Demand 2 $x_{32} + x_{42} + x_{52} + x_{72} - x_{23} - x_{25} - x_{27} \leq 80$

Demand 3 $x_{23} + x_{43} + x_{73} + x_{83} - x_{32} - x_{37} - x_{38} \leq 70$

Supply 4 $x_{42} + x_{43} + x_{45} + x_{47} = 100$

Demand 5 $x_{15} + x_{25} + x_{45} + x_{65} + x_{75} + x_{85} - x_{52} - x_{57} - x_{58} \leq 70$

Supply 6 $x_{65} + x_{68} = 60$

Demand 7 $x_{27} + x_{37} + x_{47} + x_{57} + x_{87} - x_{72} - x_{73} - x_{75} - x_{78} \leq 40$

Demand 8 $x_{18} + x_{38} + x_{58} + x_{68} + x_{78} - x_{83} - x_{15} - x_{17} \leq 40$

$x_{ij} \geq 0$

$x_{ij} \in$ Integers

PART B

See spreadsheet.

Minimum transportation cost = \$176,000

PART C

Number of cars transported out of ports:

Syd to Can = 80

Mel to Adel = 90

Mel to Alice = 10

Bris to Can = 20

Bris to Dar = 40

Number of cars transported out of demand cities:

Adel to Per = 10

Can to Alice = 30