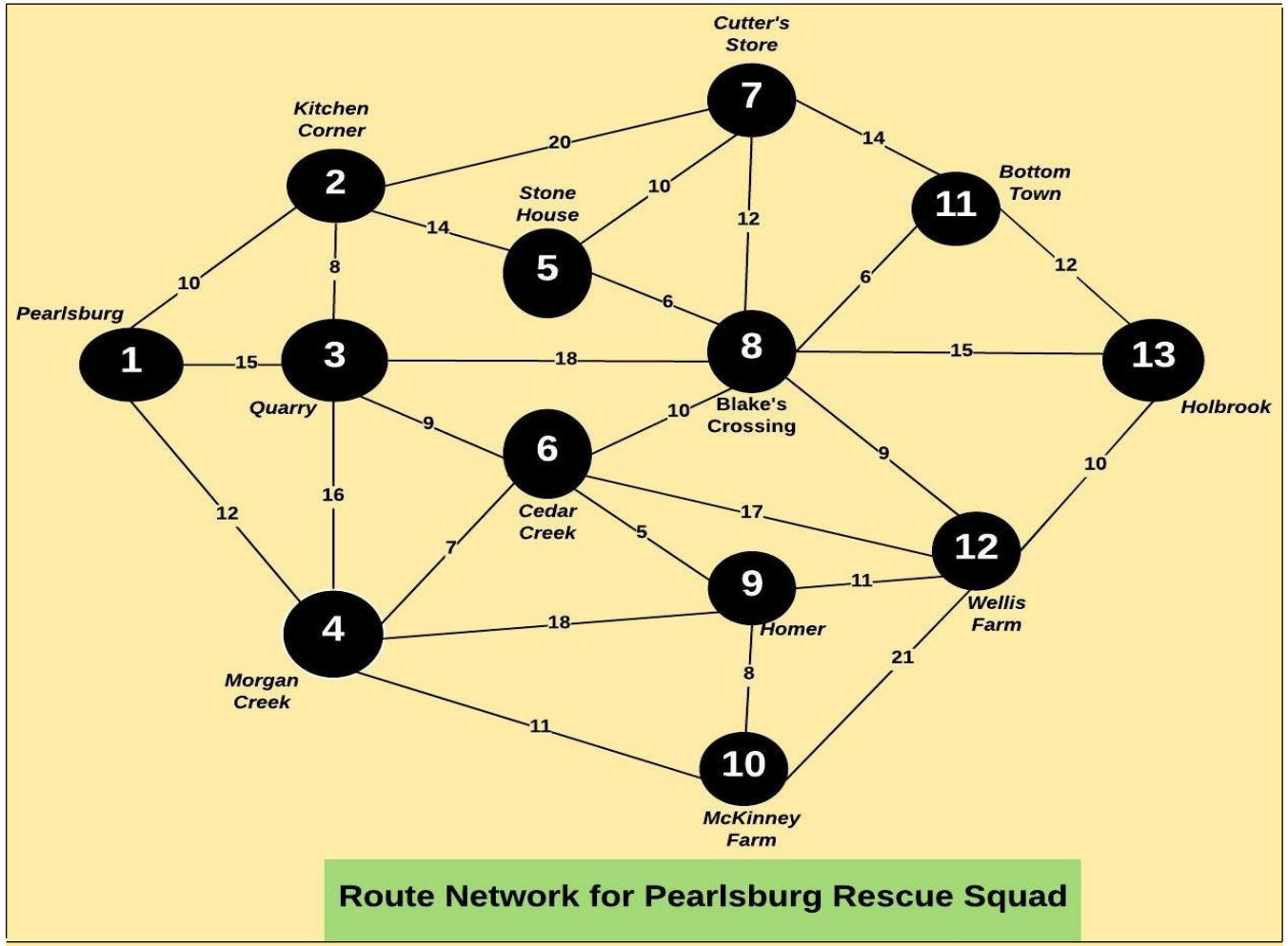
Case Study

The Pearlsburg Rescue Squad

PROBLEM DEFINITION

The Pearlsburg (West Virginia) Rescue Squad serves a mountainous, rural area in southern West Virginia. The only access to the homes, farms, and small crossroad communities and villages is a network of dirt, gravel, and poorly paved roads. They want to determine the shortest routes from Pearlsburg to all the different communities and farms visited by the rescue squad which means it is a time minimization problem represented as follows through the Objective Function:

$$\textbf{\textit{Minimize Z}} = 10N_{1,2} + 15N_{1,3} + 12N_{1,4} + 8N_{2,3} + 14\,N_{2,5} + 20N_{2,7} + 9N_{3,6} + 18N_{3,8} + 16N_{4,3} + 7N_{4,6} + 18N_{4,9} + 11N_{4,10} + 10N_{5,7} + 6N_{5,8} + 10N_{6,8} + 5N_{6,9} + 17N_{6,12} + 12N_{7,8} + 14N_{7,11} + 6N_{8,11} + 9N_{8,12} + 15N_{8,13} + 8N_{9,10} + 11N_{9,12} + 21N_{10,12} + 12N_{11,13} + 10N_{12,13}$$



The diagram shows the time taken to travel between different communities by the Pearlsburg Rescue Squad

CONSTRAINTS FACED BY THE RESCUE SQUAD

Let Node 1 = Pearlsburg, Node 2 = Kitchen Corner, Node 3 = Quarry, Node 4 = Morgan Creek, Node 5 = Stone House, Node 6 = Cedar Creek, Node 7 = Cutter's Store, Node 8 = Blake's Crossing, Node 9 = Homer, Node 10 = McKinney Farm, Node 11= Bottom Town, Node 12 = Wellis Farm, Node 13 = Holbrook

Node	Network Flow	Description
1	1	All possible outflows from starting Node 1 (Pearlsburg)
2	0	Net flow through Node 2 (Kitchen Corner)
3	0	Net flow through Node 3 (Quarry)
4	0	Net flow through Node 4 (Morgan Creek)
5	0	Net flow through Node 5 (Stone House)
6	0	Net flow through Node 6 (Cedar Creek)
7	0	Net flow through Node 7 (Cutter's Store)
8	0	Net flow through Node 8 (Blake's Crossing)
9	0	Net flow through Node 9 (Homer)
10	0	Net flow through Node 10 (McKinney Farm)
11	0	Net flow through Node 11 (Bottom Town)
12	0	Net flow through Node 12 (Wellis Farm)
13	1	All possible inflows to terminal Node 13 (Holbrook)

Must depart or return from Pearlsburg

Flows into each node must equal flows from each node (Net Flows = 0)

Must connect to Holbrook

SOLUTION SYNOPSIS: Shortest Routes to different locations

Pearlsburg 

Kitchen Corner

Pearlsburg 

Quarry

Pearlsburg 

Morgan Creek

Pearlsburg 

Stone House

Via Kitchen Corner

Pearlsburg 

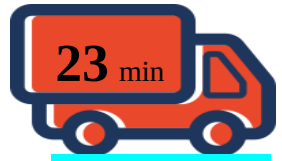
Cedar Creek

Via Morgan Creek

Pearlsburg 

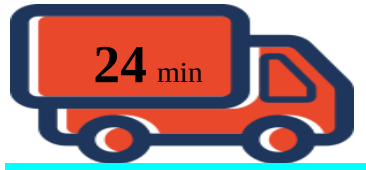
Cutter's Store

Via Kitchen Corner

Pearlsburg 

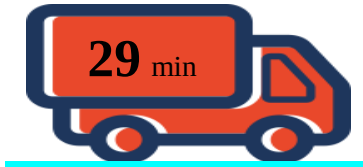
McKinney Farm

Via Morgan Creek

Pearlsburg 

Homer

Via Morgan Creek & Cedar Creek

Pearlsburg 

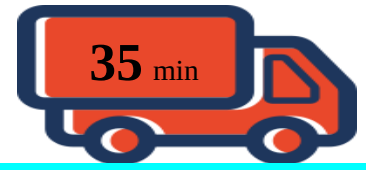
Blake's Crossing

Via Morgan Creek & Cedar Creek

Pearlsburg 

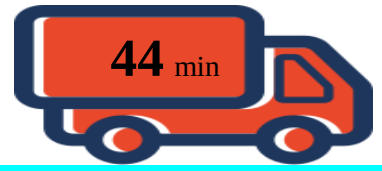
Bottom Town

Via Morgan Creek & Cedar Creek & Blake's Crossing

Pearlsburg 

Wellis Farm

Via Morgan Creek & Cedar Creek & Homer

Pearlsburg 

Holbrook

Via Morgan Creek & Cedar Creek & Blake's Crossing

RECOMMENDATIONS

- ***Common Route***: From the solution synopsis, we can see that the shortest rote to most destinations requires going via Morgan Creek and Cedar Creek. So, to reduce travel time Pearlsburg Rescue Squad should consider taking Morgan Creek & Cedar Creek on their way as per the route map to reach various communities in shortest time.

- ***Squad Station:*** Since Morgan Creek & Cedar Creek are common routes taken to reach further locations like Homer, Blake's Crossing, Bottom Town, Wellis Farm and Holbrook, so the rescue squad should consider having a team stationed at Morgan Creek & Cedar Creek to save additional 12 to 20 minutes approximately.

- ***Optimal Time***: The Rescue Squad can reach Holbrook (furthest community) from Pearlsburg in 44 minutes which is the minimum time if it follows this route:

Pearlsburg —**12 min**→ *Morgan Creek* —**7 min**→ *Cedar Creek* —**10 min**→ *Blake's Crossing* —**15 min**→ *Holbrook*

If there is a team stationed at Morgan Creek, then travel time to reach Holbrook will be 32 minutes which means they are saving additional 12 minutes.

If there is a team stationed at Cedar Creek, then the rescue squad can reach Holbrook in 25 minutes and hence, saving 19 minutes.