Task 3

Data:

S	The set of all suppliers
H	The set of all hubs
P	The set of all plants

Decision variables:

X_{ih}	$The\ decision\ variable\ representing\ amount\ of\ biomass\ to\ transport\ between\ i\ and\ h$	$i \in S \quad h \in H$
Y_{hj}	$The\ decision\ variable\ representing\ amount\ of\ biomass\ to\ transport\ between\ h\ and\ j$	$h \in H \quad j \in P$
Z_h	$The\ decision\ variable\ representing\ the\ amount\ of\ third\ party\ biomass\ transported\ to\ h$	$h \in H$
SC_i	The capacity of any given supplier	$i \in S$
HC_h	The capacity of any given hub	$h \in H$
PC_j	The capacity of any given plant	$j \in P$
TP_{ih}	The cost of transportation between i and h, given in \$ per Mg per kilometer of biomass. The total cost of a trip is thus $TP_{ih} * X_{ih}$	$i \in S \quad h \in H$
RP_{hj}	The cost of transportation between h and p, given in \$ per Mg per kilometer of biomass. The total cost of a trip is thus $RP_{hj} * Y_{hj}$	$h \in H \quad j \in P$
D	The total demand, which is 800,000,000 liters of bio-ethanol, requires 3,448,275 Mg of biomass	
LT	The cost of loading and unloading a truck, given as a constant 10000	
RT	The cost of loading and unloading a train, given as a constant 60000	
IP_j	The investment cost for each plant	$j \in P$
IH_h	The investment cost for each hub	$h \in H$
B_j	A binary variable that represents whether or not we've invested in a plant	$B \in \{0,1\} \quad j \in P$
B_h	A binary variable that represents whether or not we've invested in a hub	$B \in \{0,1\} \quad h \in H$
CP_j	The conversion capacity of each plant	$j \in P$
CH_h	The conversion capacity of each hub	$h \in H$
R	The constant conversion rate of bioethanol per Mg of biomass, which is 232 liters/Mg.	
TPR	The constant price of an Mg of third party biomass, given as \$2000	

Objective function:

$$Minimize\ Z = \sum_{i \in S} \sum_{h \in H} (TP_{ih} * X_{ih}) + \sum_{h \in H} \sum_{j \in P} (RP_{hj} * Y_{hj}) + \sum_{h \in H} (Z_h * TPR) + \sum_{j \in P} (IP_j * B_j) + \sum_{h \in H} (IH_h * B_h)$$

Constraint to:

$\sum_{h \in H} \sum_{j \in P} Y_{hj} \geq D$ $\quad The\ sum\ of\ flow\ between\ all\ h's\ and\ j's\ meets\ the\ production\ goal$

$\sum_{i \in S} \sum_{h \in H} X_{ih} \leq SC_i$ $\quad The\ sum\ of\ the\ outgoing\ flow\ from\ each\ supplier\ is\ less\ than\ or\ equal\ to\ its\ available\ supply$

$\sum_{h \in H} \sum_{j \in P} Y_{hj} \leq PC_j$ $\quad The\ sum\ of\ incoming\ flow\ to\ each\ plant\ is\ less\ than\ or\ equal\ to\ its\ capacity$

$(\sum_{h \in H} \sum_{i \in S} X_{ih}) + \sum_{h \in H} Z_h \leq HC_h$ $\quad The\ sum\ of\ the\ incoming\ flow\ to\ each\ hub\ is\ less\ than\ or\ equal\ to\ its\ capacity$

$\sum_{i \in S} \sum_{h \in H} X_{ih} = \sum_{h \in H} \sum_{j \in P} Y_{hj}$ $\quad The\ sum\ of\ the\ incoming\ flow\ to\ each\ hub\ is\ equal\ to\ its\ outgoing\ flow$

$\sum_{i \in S} \sum_{j \in P} X_{ij} = \sum_{h \in H} \sum_{j \in P} Y_{ij}$ $\quad The\ sum\ of\ outgoing\ flow\ from\ all\ suppliers\ equals\ the\ ingoing\ flow\ to\ all\ plants$