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SYSTEMATIC ANALYSIS OF NONINFERIOR
TRANSFER ASSIGNMENTS

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Final Report
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ABSTRACT

The focus of this research was the development of a model for addressing the snow removal personnel reassignment problem for the La Porte District Office of the Indiana Department of Highways. The problem is one of assigning transfer personnel to winter snow removal routes so as to minimize the total distance that the workforce as a whole must travel to work during snow emergencies while keeping to a minimum the number of State-owned vehicles that must be issued for this purpose. During the course of this work, a third objective was identified which addressed the issue of equity in assignment strategy. A methodology was developed for determining a feasible assignment strategy that minimized the maximum distance that any individual would be required to travel to work.

This research has resulted in the development of a model called the **Systematic Analysis of Noninferior Transfer Assignments (SANTA)**. The model was used in making transfer assignments within the La Porte District for the 1984-85 winter season with dramatic results.

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1. THE PROBLEM

It is the responsibility of the Indiana Department of Highways (IDoH) to provide for the removal of snow and ice from the Indiana Interstate Highway System during the winter months. The goal of the Highway Department is to conduct snow removal as efficiently as possible while holding cost to a minimum. Efficiency is a function of the rapid and orderly mobilization of a fleet of snow removal vehicles (*snowplows*) and a force of trained drivers and radio operators.

Snow removal is administered through the maintenance division of each of the seven district offices of IDoH. Prior to the start of each snow season, available personnel are assigned to one of many *unit locations* for the duration of the winter months. Each unit location houses snow removal equipment and supplies necessary to maintain one or more *snow routes*. The number of workers required at each unit location depends on the number, length and priority of the snow routes maintained by that site.

The maintenance departments do not have a sufficient work force to provide drivers and radio operators to staff all site locations. However, other IDoH divisions, such as the construction division, do not have sufficient work during the winter months for their employees. Consequently, to avoid costly seasonal hirings and firings, IDoH *reassigns* summer construction workers to winter snow removal teams. A worker assigned to unit A for construction during the summer may be assigned to unit B for snow removal during the winter.

The efficiency of snow removal and the overall cost of the operation depend heavily on this reassignment profile. Assigning drivers to units which are geographically "close" to their residences means that the time to the initiation of snow removal is short. Furthermore, a shorter distance from home to work increases the chances that a driver will be able to report to work during a snow emergency.

Overall cost is also related to distance, but in a less obvious manner. It is the policy of IDoH that if a person's assignment is not to his nearest unit *and* that assignment is more than 15 miles from his home station, he/she must be given use of a state vehicle. By assigning workers to sites which do not require issuance of a vehicle, the cost for transportation is avoided.

The general snow removal personnel reassignment problem may now be stated:

"Find that strategy for the reassignment of summer personnel to snow removal units during the winter such that the total distance traveled by all workers to their respective job site is as small as possible while keeping the number of vehicles assigned to workers as small as possible."

It should be stated that the strategy which minimizes total distance will not, in general, be the same as the strategy which minimizes the assignment of vehicles. Most workers live more than 15 miles from most sites. The distance saved by assigning one worker to his closest site (thus avoiding issuance of a vehicle) is likely to be less than the added distance another person will have to travel to his original assignment.

The problem may be complicated by other factors. Some individuals may be better drivers than others. Some may have difficulty driving at night. Some may wish to be assigned in such a way that they are issued a vehicle. Some may not wish to be issued a vehicle. Some may feel that they have seniority. Some may be assigned units much further away than others living near the same place. Each of these factors and more, may need to be considered in developing an optimal reassignment strategy.

The purpose of this report is to develop a technique or set of techniques for solving the general snow removal personnel reassignment problem. The model developed to address this problem is described in detail in the following chapter of this report. Chapter 4 is included as a guide to the interpretation of model results and provides examples of how the model may be used to address more complex questions regarding transfer assignments. The final chapter discusses possible future computer implementation of the model. An Appendix of model solutions to date is included at the end of this report.

2. THE MODEL

A procedure has been developed for solving the snow removal personnel reassignment problem described in the first part of this report. The technique is a multiobjective version of the p-median problem. The model, which will generate the full and precise tradeoff curve for objectives of minimizing total travel distance and minimizing total assigned vehicles, has been named **Systematic Analysis of Noninferior Transfer Assignments (SANTA)**. The details of SANTA are discussed in this section of the report.

Consider the problem of assigning n workers to m site locations consistent with the discussion of the previous section. Let d_{ij} be the distance in miles from the residence of worker i to site location j along the route of shortest time-of-travel. Suppose that all d_{ij} values are known for all workers and all site locations. Let D be the maximum distance that any worker would be required to travel to his/her assigned site.

We may now define:

$$N_i = \{j \mid d_{ij} \leq D\}$$

The set N_i is the set of sites j to which worker i *can* be assigned. This set will be defined for each worker.

Now define:

T_j = The total number of transfer personnel needed at site j ; $j = 1, 2, \dots, m$

C = The total number of State vehicles available for winter assignment

$$X_{ij} = \begin{cases} 1, & \text{if worker } i \text{ is assigned to unit location } j; \forall i, j \in N_i \\ 0, & \text{otherwise} \end{cases}$$

$$A_{ij} = \begin{cases} 1, & \text{if the assignment of worker } i \text{ to site } j \text{ would require a vehicle; } \forall i, j \in N_i \\ 0, & \text{otherwise} \end{cases}$$

Note that the value of A_{ij} may be computed directly as both the distances and the rule for assigning vehicles are known.

An objective function which seeks the smallest total travel distance resulting from a particular strategy for assigning workers may be written as follows:

$$\text{Minimize } Z = \sum_i \sum_{j \in N_i} d_{ij} X_{ij} \quad (1)$$

Any distance d_{ij} will only be "counted" if worker i is assigned to unit j ; $X_{ij} = 1$. Total distance may be obtained by summing this term over all workers.

To avoid assigning a worker to more than one unit, we write the constraint:

$$\sum_{j \in N_i} X_{ij} \leq 1 \quad \forall i \quad (2)$$

The sum over all possible assignments may not exceed a value of 1. If the total number of personnel to be assigned is equal to the total requirement for workers, the operator in this equation may be an equality.

To insure that a sufficient number of workers is assigned to each unit location, a set of constraints of the following form must be included:

$$\sum_i X_{ij} \geq T_j \quad \forall j \quad (3)$$

Finally, to avoid assigning workers in such a way that insufficient vehicles will be available, we must add the following constraint:

$$\sum_i \sum_{j \in N_i} A_{ij} X_{ij} \leq C \quad (4)$$

A vehicle will be issued only if a worker is assigned to a site requiring a vehicle and the total must not exceed C. The total formulation is presented in Table 1.

The solution found by solving the model presented in Table 1 would be the assignment of workers to site locations such that the total (one-way) distance that all workers travel to work is as small as possible. Note that it is possible for the problem to terminate infeasible if, for example, not enough workers were available to meet total demand, or if there were insufficient vehicles available for assignment. However, if a feasible solution exists, an *optimal* assignment of workers to sites will be provided by the model. Furthermore, this solution will be the strategy which will require the largest number of vehicles to be assigned. The assignment of one additional vehicle will not reduce the total distance that workers travel.

A second objective embedded in the snow removal personnel reassignment problem as stated above is to keep the number of vehicles assigned as small as possible. One might ask the question: *What is the fewest number of vehicles that would have to be assigned given that no person will have to travel more than D miles to work?* A second model formulation is required to answer this question.

In the previous model formulation, Equation 4 was a constraint on the number of vehicles assigned. This constraint assured that the total number of vehicles assigned would not exceed C; the maximum number of vehicles available. If we remove the restriction on total number of vehicles we can write this equation as the objective function of a second model:

$$\text{Minimize } Z = \sum_i \sum_{j \in N_i} A_{ij} X_{ij} \quad (5)$$

This results in a model which seeks that assignment strategy which minimizes the total number of vehicles assigned. The solution to this model will also indicate the furthest total distance that would be traveled by all workers. That is, the solution which

Table 1: Model Formulation for Minimizing Total Distance

$$\text{Minimize } Z = \sum_i \sum_{j \in N_i} d_{ij} X_{ij} \quad (1)$$

$$\text{s.t. } \sum_{j \in N_i} X_{ij} \leq 1 \quad \forall i \quad (2)$$

$$\sum_i X_{ij} \geq T_j \quad \forall j \quad (3)$$

$$\sum_i \sum_{j \in N_i} A_{ij} X_{ij} \leq C \quad (4)$$

$$X_{ij} = \{0,1\} \quad \forall i, j \in N_i$$

where:

d_{ij} = The distance worker i would travel if assigned to unit location j (miles)

$N_i = \{j \mid d_{ij} \leq D\}$

D = Maximum allowable travel distance

T_j = Demand for workers at unit location j

C = Number of vehicles available for assignment

$$A_{ij} = \begin{cases} 1, & \text{if the assignment of worker } i \text{ to unit } j \text{ requires a vehicle} \\ 0, & \text{otherwise} \end{cases}$$

$$X_{ij} = \begin{cases} 1, & \text{if worker } i \text{ is assigned to unit } j \\ 0, & \text{otherwise} \end{cases}$$

minimizes the total number of vehicles that would have to be assigned is also the solution requiring workers to travel the furthest total distance. The availability of one less vehicle would not increase the total distance workers would have to travel. The complete model formulation for this problem is shown as Table 2.

Using the constraint method of multiobjective programming,¹ a tradeoff curve of the form shown in Figure 1 may be generated for the snow removal personnel reassignment problem. First, the model shown in Table 1 is solved as an integer program. The solution of this model corresponds to point B on the graph of Figure 1. This solution is the minimum distance solution and indicates the maximum number of cars that would ever be required for the given value of D. Call this number $L^{\max}$.

Next, the model presented in Table 2 is solved resulting in the solution requiring the least number of assigned vehicles; call this number $L^{\min}$. This solution is hypothetically shown as point A on the graph of Figure 1. Solution A also represents the greatest total distance that would be required for the given distance standard; D miles. Points A and B are the endpoints of a family of solutions which we refer to as the *noninferior set* of solutions to this problem.

To find the remaining noninferior solutions, we need yet another formulation. This "operational" formulation, which is presented in Table 3, is a modified version of the model shown in Table 1. Note that Equation 4 has been modified such that the total number of vehicles to be assigned is set equal to some value L. By ranging the value of L from $L^{\min}$ to $L^{\max}$ and resolving the problem, each solution will be a point on the noninferior set of solutions for the snow removal personnel reassignment problem. A solution is noninferior if there does not exist another solution which gives more of one objective without giving less of the other objective.

The tradeoff curve provides useful information regarding the two objectives being studied. Each point on the tradeoff curve represents a particular assignment of workers to site locations which is different from all other points on the curve. Furthermore, for each point on the curve, there does not exist a "better" solution in terms of the stated objectives. The curve is thus an explicit indication of what must be given up in terms of one objective for a gain in terms of the other. For example, if we consider two noninferior solutions C and D on the graph of Figure 1, we see precisely how much of the total distance objective we will gain by adding a proportional number of assigned vehicles in moving from point C to point D. Using this information, IDoH may make snow removal personnel reassignments in an efficient and cost effective manner.

1. For a complete discussion on Multiobjective Modeling, see: Cohon, Jared L., *Multiobjective Programming and Planning*, Academic Press, 1979.

Table 2: Model Formulation for Minimizing Assigned Vehicles

$$\text{Minimize } Z = \sum_i \sum_{j \in N_i} A_{ij} X_{ij} \quad (5)$$

$$\text{s.t. } \sum_{j \in N_i} X_{ij} \leq 1 \quad \forall i \quad (2)$$

$$\sum_i X_{ij} \geq T_j \quad \forall j \quad (3)$$

$$X_{ij} = \{0,1\} \quad \forall i, j \in N_i$$

where:

d_{ij} = The distance worker i would travel if assigned to unit location j (miles)

$$N_i = \{j \mid d_{ij} \leq D\}$$

D = Maximum allowable travel distance

T_j = Demand for workers at unit location j

$$A_{ij} = \begin{cases} 1, & \text{if the assignment of worker } i \text{ to unit } j \text{ requires a vehicle} \\ 0, & \text{otherwise} \end{cases}$$

$$X_{ij} = \begin{cases} 1, & \text{if worker } i \text{ is assigned to unit } j \\ 0, & \text{otherwise} \end{cases}$$

Figure 1. Tradeoff Curve Showing the Relationship Between Total Distance and Number of Vehicles Assigned.

Table 3: Operational Model Formulation

$$\text{Minimize } Z = \sum_i \sum_{j \in N_i} d_{ij} X_{ij} \quad (1)$$

$$\text{s.t. } \sum_{j \in N_i} X_{ij} \leq 1 \quad \forall i \quad (2)$$

$$\sum_i X_{ij} \geq T_j \quad \forall j \quad (3)$$

$$\sum_i \sum_{j \in N_i} A_{ij} X_{ij} = L \quad (6)$$

$$X_{ij} = \{0,1\} \quad \forall i, j \in N_i$$

where:

d_{ij} = The distance worker i would travel if assigned to unit location j (miles)

$N_i = \{j \mid d_{ij} \leq D\}$

D = Maximum allowable travel distance

T_j = Demand for workers at unit location j

L = Number of vehicles which will be assigned

Preliminary results from using SANTA to solve on the snow removal personnel reassignment problem indicate that the model is computationally very efficient. While the matrix is not unimodular, the model terminates with integer solutions "almost always". In cases where fractional solutions to result, only a small number of branch-and-bound iterations are required to secure an integer solution.

The next section of this report will describe the details of model results thus far and indicate how these results are properly interpreted.

3. INTERPRETATION OF MODEL RESULTS

SANTA has been used to solve the *CASE 1* problem; *All workers assigned to sites are qualified drivers without restrictions*. Some 89 workers were assigned to 19 site locations. A tradeoff curve for this scenario is shown as Figure 2.

Recall that each point on the tradeoff curve of Figure 2 is a unique assignment of workers to sites. Consequently, a great deal of information must be made available for each point on the curve. SANTA provides this information via three separate sheets of computer print-out. As an example, this information for the minimum distance solution--labeled as Point B on Figure 2--is presented in Tables 4a, 4b, and 4c. All other solutions have similar information with the same format and are included in the Appendix of this report.

Page one of each solution output gives a tabular and graphical summary of the solution. By inspecting Table 4a, we see that for the minimum distance solution, three separate report mechanisms are employed to give summary information about that solution. Along the left hand side of the graph is a column of tabular information concerning both the distance and vehicle objectives. For example, for this particular solution, total travel distance is 1846.6 miles, average distance is 20.7 miles, maximum distance is 66.0 miles, and the difference between the longest and shortest trip is 65.5 miles (indicating that the shortest assignment is, of course, .5 miles). Similarly, the summary for vehicles indicates that the total number of State vehicles utilized is 53 for this solution. For State vehicles only, the total distance traveled is 1578.8 miles with an average of 29.8 miles, while for private vehicles the total distance is 267.8 miles with a 7.4 mile average.

The graph shown on Table 4a is included to give an overall profile of this particular solution. The histogram indicates the number of workers traveling any particular distance range and whether or not they are issued a vehicle. For example, the minimum distance solution assigns 7 workers to sites 5 to 10 miles from their homes and no State vehicles are assigned to these people. All assignments greater than 10 miles require vehicles.

Along the bottom of the first page of output are listed alternate assignments. This information may be of direct use in the determination of the final assignments. The entries in this table indicate alternate assignments that *could* be made without changing total distance or number of assigned vehicles. For example, by inspecting Table 4a

Figure 2. Tradeoff Curves for D=80 and D=50 for the Case 1
Snow Removal Personnel Reassignment Problem.

Table 4a: Minimum Distance Solution: Solution Summary

D80.53

distance summary		one-way distance breakdown																
total distance =	1846.6																	
average distance =	20.7																	
maximum distance =	66.0																	
dev distance =	65.5																	
vehicle summary																		
state vehicles:																		
tot. allocated =	53.0																	
total distance =	1578.8																	
average distance =	29.8																	
privately owned:																		
total distance =	267.8																	
average distance =	7.4																	

alternate solutions																	
001to12	002to03	002to08	003to03	004to14	004to19	006to03	007to09	008to16	008to19	010to19	011to18						
014to01	015to14	016to03	017to03	018to17	020to14	021to18	022to03	022to18	023to07	024to08	025to09						
027to18	028to12	028to19	029to09	030to06	031to14	031to18	033to18	035to19	036to03	036to14	038to14						
040to14	043to03	043to18	044to13	045to18	046to03	047to13	048to05	049to14	052to14	054to02	055to14						
056to17	057to16	060to03	061to03	062to12	062to19	063to03	063to14	067to01	068to13	069to14	070to19						
072to02	074to13	075to03	076to07	078to07	078to18	080to19	081to19	082to12	083to18	084to18	085to19						
086to14	087to19	088to18	090to03	091to18	093to19	094to14	096to18	097to14	098to09	100to13	101to18						
103to13	104to18	105to18	106to14	107to14	108to03	110to08	111to08	112to19	113to19	114to09	116to19						

we find that worker number 001 could be assigned to site 12 instead of site 19 without changing total distance or total vehicles assigned. Of course, making this assignment would alter the overall pattern of assignments and would require another run of the model to accomplish.

The second page of output (Table 4b) displays the specific personnel assignments which SANTA has made corresponding to the current point on the tradeoff curve. Assignments which require the issuance of a State vehicle are also indicated.

Finally, the third page of output (Table 4c) provides a *site summary* indicating various distance and vehicle parameters for each site. This provides a convenient means of comparing assignment strategies by site location, and may provide useful information to each site manager.

Each set of output for a given solution is labeled with a reference number in the upper right and lower right corners of these three pages. For example, the three pages of output contained in Tables 4a, 4b, and 4c are each marked "D80.53" indicating that those results are for the solution requiring 53 vehicles and using a distance standard (D) of 80 miles.

For discussion purposes, the tradeoff curve using a distance standard of 50 miles has also been produced by SANTA; see Figure 2. Because the 50 mile standard imposes an additional constraint on the assignments which are possible, that curve lies "everywhere above" the D=80 curve consistent with intuition. Again, each point on this curve represents a unique assignment profile, the details of which are also included in the Appendix to this report.

The first page of output for the minimum assigned vehicles solution (corresponding to Point A on Figure 2) has been included as Table 5. For comparison, a summary showing the differences in actual assignments between these two solutions has been included as Table 6. The column at the left of Table 6 indicates if there was an increase, a decrease, or no change in distance assigned to a particular individual in going from the minimum distance solution to the minimum number of vehicles solution. For example, in the minimum distance solution (which required 53 assigned vehicles) employee number 1 was assigned to site 19; a distance of 24 miles from his home. This assignment required a vehicle as indicated by the asterisk. For the minimum assigned vehicles solution, employee number 1 is assigned to site 18 which is 43 miles away. Thus, he must travel further. On the other hand, there is a decrease in distance for worker number 2 in comparing these same two solutions to the point where a vehicle is "saved".

SANTA may also be used to address other issues which may be important to IDoH in making final reassignments. For example, consider the solution requiring 37 vehicles indicated as Point C on Figure 2. A summary of this solution is included as Table 7.

Table 4b: Minimum Distance Solution: Assignment Summary

employee	site	miles	employee	site	miles	employee	site	miles
* Anderson C	4701	19.0	* Heiser D	4301	22.1	Mielcarek C	4302	3.5
* Arens B	4701	30.0	* Heinrichs G	4701	53.0	* Miller M	4701	20.0
Atkinson T	4202	2.2	Henry L	4103	14.0	* Moore Dav	4502	22.0
Ballilleu R	4603	1.0	Horn C	4701	13.0	* Mouglin M	4302	33.0
* Bell B	4303	22.0	* Hudson J	4602	20.0	* Panos W	4701	42.0
Berg K	4102	11.0	* Hudson M	4102	41.0	* Paoletta M	4701	63.0
Bradfield R	4701	15.0	* Johnson B	4702	32.0	* Parker D	4701	42.0
* Brooks R	4702	39.0	* Judkins W	4203	24.0	* Poncher J	4701	25.0
* Burger M	4202	18.0	* Kinsey M	4202	3.0	* Pope J	4701	23.0
Dorkus E	4302	9.0	Kroening R	4103	1.2	Reynolds L	4701	2.0
Putzler D	4103	13.0	* Krutzick C	4102	34.0	* Rogers J	4701	20.0
Cain E	4401	12.0	Lamb M	4603	11.0	* Ropp W	4702	39.0
* Collins M	4702	24.0	Larson C	4702	0.5	* Rouch B	4202	21.0
* Corbin E	4501	38.0	* Leinbach E	4501	25.0	* Rowland D	4401	20.0
Crane S	4104	10.0	Lemons E	4701	10.0	Rundzaitis A	4502	5.0
Dalka C	4602	4.5	* Lestinsky S	4701	44.0	Scharf R	4104	0.5
Devitch J	4502	10.0	* Link H	4701	42.0	* Scribner M	4502	22.0
Donovan P	4302	2.0	* Lucterhand D	4702	43.0	Skaggs K	4302	13.0
Eckovich A	4502	15.0	Ludwig J	4502	22.0	* Spald G	4302	23.0
Egolf B	4403	7.0	Lynn W	4104	0.5	* Stigen L	4602	23.5
England W	4103	14.0	Mahoney S	4603	2.0	* Strom J	4701	16.2
Epley B	4502	5.0	* Mangus R	4303	19.0	* Tobey R	4301	25.5
* Galvas N	4302	20.0	Mantei M	4302	4.9	* Vermilyer R	4302	23.0
* Ginther K	4502	22.0	Marker T	4302	13.0	West R	4202	3.0
* Grubb J	4701	28.0	Martin R	4702	4.0	* White J	4602	17.0
* Gustafson G	4502	21.0	* Mathew J	4701	54.0	* Wilke T	4502	10.0
* Hammons J	4502	21.0	* Maywald E	4701	20.0	Woodward M	4502	10.0
Hannigan L	4701	13.0	* McCarver D	4302	21.0	* Yoder H	4701	54.0
* Harley J	4301	25.5	* McDonnell K	4701	42.0	* Zider M	4302	27.0
* Heldorn M	4702	66.0	* McGuire M	4502	26.0			

* state vehicle required

Table 4c: Minimum Distance Solution: Site Summary

D80. 53

OVERALL	1	4101	4102	4103	4201	4202	4203	4301	4302	4303	4401	4402	4403	4501	4502	4601	4602	4603	4701	4702
NUMBER	1	3	3	4	0	5	1	3	12	2	2	0	1	2	13	0	4	3	23	8
TOTAL MILES	1	11	86	42	0	47	24	73	192	41	32	0	7	63	211	0	65	14	690	248
AVG. MILES	1	4	29	11	0	9	24	24	16	21	16	0	7	32	16	0	16	5	30	31
MIN. MILES	1	1	11	1	0	2	24	22	2	19	12	0	7	25	5	0	5	1	2	1
MAX. MILES	1	10	41	14	0	21	24	26	33	22	20	0	7	38	26	0	24	11	63	66
STATE VEHICLES	1	0	2	0	0	2	1	3	6	2	1	0	0	2	7	0	3	0	18	6
NUMBER	1	0	75	0	0	39	24	73	147	41	20	0	0	63	156	0	61	0	637	243
TOTAL MILES	1	0	38	0	0	20	24	24	25	21	20	0	0	32	22	0	20	0	35	41
AVG. MILES	1	0	34	0	0	18	24	22	20	19	20	0	0	25	21	0	17	0	16	24
MIN. MILES	1	0	41	0	0	21	24	26	33	22	20	0	0	38	26	0	24	0	63	66
MAX. MILES	1	3	1	4	0	3	0	0	6	0	1	0	1	0	6	0	1	3	5	2
PERSONAL VEHICLES	1	11	11	42	0	8	0	0	45	0	12	0	7	0	55	0	5	14	53	5
NUMBER	1	4	11	11	0	3	0	0	8	0	12	0	7	0	9	0	5	5	11	2
TOTAL MILES	1	1	11	1	0	2	0	0	2	0	12	0	7	0	5	0	5	1	2	1
AVG. MILES	1	10	11	14	0	3	0	0	13	0	12	0	7	0	15	0	5	11	15	4
MIN. MILES	1	10	11	14	0	3	0	0	13	0	12	0	7	0	15	0	5	11	15	4
MAX. MILES	1	10	11	14	0	3	0	0	13	0	12	0	7	0	15	0	5	11	15	4

D80. 53

Table 6: Comparison of Minimum Distance with Minimum Assigned Vehicles Summary

CASE1 WITH 53 CARS				CASE1 WITH 34 CARS			
INC	E	1to19	24.0 *	E	1to18	43.0 *	
DEC	E	2to14	26.0 *	E	2to 8	15.0	
	E	3to 1	10.0	E	3to 1	10.0	
	E	4to16	4.5	E	4to16	4.5	
	E	6to14	10.0	E	6to14	10.0	
	E	7to 8	2.0	E	7to 8	2.0	
DEC	E	8to13	38.0 *	E	8to16	13.0	
	E	10to12	7.0	E	10to12	7.0	
	E	11to14	5.0	E	11to14	5.0	
	E	14to 8	20.0 *	E	14to 8	20.0 *	
DEC	E	15to18	28.0 *	E	15to14	11.0	
DEC	E	16to14	21.0 *	E	16to 3	14.0	
DEC	E	17to14	21.0 *	E	17to 3	14.0	
INC	E	18to 7	25.5 *	E	18to 9	41.5 *	
	E	20to18	42.0 *	E	20to18	42.0 *	
INC	E	21to19	43.0 *	E	21to18	64.0 *	
INC	E	22to14	22.0 *	E	22to18	43.0 *	
INC	E	23to17	2.0	E	23to 8	47.0 *	
DEC	E	24to 9	19.0 *	E	24to 7	9.0	
	E	25to 8	4.9	E	25to 8	4.9	
	E	27to19	4.0	E	27to19	4.0	
	E	28to18	54.0 *	E	28to18	54.0 *	
	E	29to 8	21.0 *	E	29to 8	21.0 *	
	E	30to 5	3.0	E	30to 5	3.0	
INC	E	31to 3	1.2	E	31to14	10.0	
	E	32to17	11.0	E	32to17	11.0	
	E	33to19	0.5	E	33to19	0.5	
	E	35to18	10.0	E	35to18	10.0	
	E	36to18	44.0 *	E	36to18	44.0 *	
DEC	E	38to18	25.0 *	E	38to14	14.0	
DEC	E	40to18	23.0 *	E	40to14	3.5	
	E	42to 5	21.0 *	E	42to 5	21.0 *	
INC	E	43to14	22.0 *	E	43to18	43.0 *	
	E	44to19	66.0 *	E	44to19	66.0 *	
INC	E	45to 7	22.1 *	E	45to18	75.0 *	
	E	46to18	53.0 *	E	46to18	53.0 *	
INC	E	47to16	20.0 *	E	47to18	80.0 *	
DEC	E	48to 2	41.0 *	E	48to 5	20.0 *	
DEC	E	49to19	32.0 *	E	49to16	4.0	
	E	52to 8	13.0	E	52to 8	13.0	
INC	E	54to16	23.5 *	E	54to19	64.5 *	
DEC	E	55to18	16.2 *	E	55to14	13.0	
DEC	E	56to 7	25.5 *	E	56to17	2.0	
INC	E	57to 2	34.0 *	E	57to19	64.5 *	
	E	60to 8	23.0 *	E	60to 8	23.0 *	
	E	61to14	10.0	E	61to14	10.0	
	E	62to18	54.0 *	E	62to18	54.0 *	
	E	63to18	42.0 *	E	63to18	42.0 *	
	E	67to18	42.0 *	E	67to18	42.0 *	
	E	68to18	63.0 *	E	68to18	63.0 *	
	E	69to18	42.0 *	E	69to18	42.0 *	
	E	70to18	13.0	E	70to18	13.0	
DEC	E	72to13	25.0 *	E	72to 2	10.0	
	E	73to 5	3.0	E	73to 5	3.0	

Table 6: Continued

INC	E 74to16	17.0	*	E 74to13	43.0	*
	E 75to14	10.0		E 75to14	10.0	
DEC	E 76to 8	27.0	*	E 76to 7	13.0	
DEC	E 78to 8	33.0	*	E 78to 7	13.0	
	E 80to18	2.0		E 80to18	2.0	
DEC	E 81to18	20.0	*	E 81to19	11.3	
	E 82to10	20.0	*	E 82to10	20.0	*
	E 83to14	5.0		E 83to14	5.0	
INC	E 84to14	22.0	*	E 84to18	42.0	*
	E 85to18	13.0		E 85to18	13.0	
INC	E 86to 3	14.0		E 86to18	43.0	*
DEC	E 87to18	20.0	*	E 87to19	5.0	
	E 88to 1	0.5		E 88to 1	0.5	
	E 90to 8	23.0	*	E 90to 8	23.0	*
DEC	E 91to19	39.0	*	E 91to16	16.0	
DEC	E 93to18	20.0	*	E 93to19	11.3	
	E 94to 3	14.0		E 94to 3	14.0	
	E 96to 1	0.5		E 96to 1	0.5	
	E 97to 8	13.0		E 97to 8	13.0	
	E 98to 8	3.5		E 98to 8	3.5	
	E100to 6	24.0	*	E100to 6	24.0	*
INC	E101to14	22.0	*	E101to18	42.0	*
INC	E103to 5	18.0	*	E103to13	55.0	*
DEC	E104to19	39.0	*	E104to 2	15.2	
	E105to14	15.0		E105to14	15.0	
	E106to 3	13.0		E106to 3	13.0	
DEC	E107to18	19.0	*	E107to14	4.2	
DEC	E108to18	30.0	*	E108to14	13.0	
	E109to 5	2.2		E109to 5	2.2	
	E110to17	1.0		E110to17	1.0	
	E111to 9	22.0	*	E111to 9	22.0	*
	E112to 2	11.0		E112to 2	11.0	
	E113to18	15.0		E113to18	15.0	
	E114to 8	9.0		E114to 8	9.0	
	E116to10	12.0		E116to10	12.0	
TOTALS		1846.6	53		1971.6	34

An alternate solution as indicated would be to assign worker 001 to site 12. SANTA can be used to "force" this assignment; the solution of which is shown as Table 8. Notice that the overall distance and vehicles assigned are the same, but other parameters have changed and the overall pattern of assignments has changed as well.

Suppose that an employee is not pleased with his/her assignment and feels that a globally "better" assignment would result from a different assignment for that person. For example, the solution shown in Table 7 would assign worker 047 to site 18. Suppose that he insisted on being assigned to site 16. Again, SANTA could force this assignment as shown in Table 9. The impact of this assignment can be seen by a comparison of Tables 7 and 9.

The use of SANTA in "justifying" assignments to disgruntled employees might better be seen via the following scenario. Suppose that the assignments are announced according to Table 7 and seven employees feel that each could be assigned to a closer site and a better solution for everybody would result. Forcing these solutions will give an assignment strategy shown in Table 10 and represented by Point D on Figure 2. Clearly, this solution is dominated by several other "better" solutions.

A variation of the procedure discussed in Chapter 2 (the basic formulation remains unchanged) addresses the issue of *equity* in personnel reassignments. Given that solutions exist for which sufficient vehicles are available, and assuming those solutions result in an acceptable distance measure, a third objective emerges: *Assign workers in such a way that the person traveling the greatest overall distance to work drives the shortest possible distance.* By "pushing down" on the distance traveled by the person traveling the furthest, the difference in travel distances of all workers is reduced as well.

This third objective does not require a reformulation of the model presented in Table 3. Rather, only the data set needs modification. By making the maximum allowable travel distance D as small as possible while still achieving a feasible solution, this objective is achieved.

The results of this methodology for the current data set is shown in Figure 3. The parenthetical entries adjacent to each solution indicate the number of vehicles needed for that particular solution.

Point A on Figure 3 represents a solution requiring 75 vehicles in which the total one-way distance traveled by all workers is 2017 miles with the maximum distance being 56 miles. In contrast, Point B represents a solution requiring only 48 vehicles with a total distance of only 1540 miles and a maximum distance of 30 miles. The distinction is dramatic. Significantly, Point A corresponds to the assignment strategy for the 1983-84 winter season, while Point B is the 1984-85 winter season.

Table 9: Solution Summary for D80.37 with 1 Assignment Set

Dset1

distance summary		one-way distance breakdown																									
		30																									
total distance =		1920.8																									
average distance =		21.6																									
maximum distance =		75.0																									
dev distance =		74.5																									
vehicle summary																											
state vehicles:																											
tot. allocated =		37.0																									
total distance =		1467.7																									
average distance =		39.7																									
privately owned:																											
total distance =		453.1																									
average distance =		8.7																									
alternate solutions		miles																									
001to12	002to14	003to14	004to14	005to02	007to09	008to13	010to18	011to18	014to01	015to13	016to14	017to14	018to17	019to13	020to01	021to19	022to14	023to17	024to09	025to09	026to08	027to18	028to19	029to09	030to06		
031to03	033to18	035to13	036to01	038to18	040to18	041to19	042to08	043to14	044to13	045to13	046to01	047to13	048to13	049to14	050to13	051to18	052to18	053to13	054to19	055to14	056to09	057to13	058to18	059to07	060to07		
060to14	061to03	061to18	062to19	063to14	064to01	068to13	069to14	070to19	074to18	075to03	076to08	077to18	078to18	080to19	081to18	082to19	083to18	084to01	085to19	086to14	087to18	088to18	089to18	090to07	091to14		
091to19	093to18	094to14	096to18	097to18	098to09	100to13	101to01	103to05	104to18	105to18	106to18	107to18	108to18	109to18	110to08	111to07	112to19	113to13	114to09	116to18							

Figure 3
Reassignment Strategies
TOTAL DISTANCE VS. MAXIMUM DISTANCE

4. COMPUTER IMPLEMENTATION OF SANTA

The SANTA model is written in the FORTRAN 77 programming language and was originally developed on a VAX 11/780 computer¹. In its original form, the model was actually comprised of four functionally separate modules, each designed to accomplish a single task. The reason for this was the immediacy of achieving an initial solution which could be implemented during the past season. No attempt was made to allow this version of the model to be transported to other computers.

During the past three months, SANTA has undergone substantial improvement in both design and function. It now exists as a fully integrated computer software system which may be transported (with little overall effort) to other computers having Standard FORTRAN 77 compilation capability. A detailed users manual for the system is being planned which could support remote access to SANTA on a central computer. Future research plans call for the development of a micro-computer system capable of accessing and running the model as well as aiding in the synthesis of results.

1. VAX is a Trademark of the Digital Equipment Corporation.

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APPENDIX

distance summary

```
total distance = 1516.7
```

average distance = 14.6

maximum distance = 35.0

dev distance = 34.5

vehicle summary

state vehicles:

tot. allocated = 46.0

```
total distance = 1073.3
```

average distance = 23.3

privately owned:

total distance = 443.4

average distance = 7.6

miles

alternate solutions

001t012	002*014	003to01	003to08	004to13	006tc18	007tc09	C1ctc12	011tc18	014tc07	014tc05	015to12
001t013	002*015	003to02	003to09	004to14	006tc19	007tc10	C1ctc13	011tc19	014tc08	014tc06	015to13
001t014	002*016	003to03	003to10	004to15	006tc20	007tc11	C1ctc14	011tc20	014tc09	014tc07	015to14
001t015	002*017	003to04	003to11	004to16	006tc21	007tc12	C1ctc15	011tc21	014tc10	014tc08	015to15
001t016	002*018	003to05	003to12	004to17	006tc22	007tc13	C1ctc16	011tc22	014tc11	014tc09	015to16
001t017	002*019	003to06	003to13	004to18	006tc23	007tc14	C1ctc17	011tc23	014tc12	014tc10	015to17
001t018	002*020	003to07	003to14	004to19	006tc24	007tc15	C1ctc18	011tc24	014tc13	014tc11	015to18
001t019	002*021	003to08	003to15	004to20	006tc25	007tc16	C1ctc19	011tc25	014tc14	014tc12	015to19
001t020	002*022	003to09	003to16	004to21	006tc26	007tc17	C1ctc20	011tc26	014tc15	014tc13	015to20
001t021	002*023	003to10	003to17	004to22	006tc27	007tc18	C1ctc21	011tc27	014tc16	014tc14	015to21
001t022	002*024	003to11	003to18	004to23	006tc28	007tc19	C1ctc22	011tc28	014tc17	014tc15	015to22
001t023	002*025	003to12	003to19	004to24	006tc29	007tc20	C1ctc23	011tc29	014tc18	014tc16	015to23
001t024	002*026	003to13	003to20	004to25	006tc30	007tc21	C1ctc24	011tc30	014tc19	014tc17	015to24
001t025	002*027	003to14	003to21	004to26	006tc31	007tc22	C1ctc25	011tc31	014tc20	014tc18	015to25
001t026	002*028	003to15	003to22	004to27	006tc32	007tc23	C1ctc26	011tc32	014tc21	014tc19	015to26
001t027	002*029	003to16	003to23	004to28	006tc33	007tc24	C1ctc27	011tc33	014tc22	014tc20	015to27
001t028	002*030	003to17	003to24	004to29	006tc34	007tc25	C1ctc28	011tc34	014tc23	014tc21	015to28
001t029	002*031	003to18	003to25	004to30	006tc35	007tc26	C1ctc29	011tc35	014tc24	014tc22	015to29
001t030	002*032	003to19	003to26	004to31	006tc36	007tc27	C1ctc30	011tc36	014tc25	014tc23	015to30
001t031	002*033	003to20	003to27	004to32	006tc37	007tc28	C1ctc31	011tc37	014tc26	014tc24	015to31
001t032	002*034	003to21	003to28	004to33	006tc38	007tc29	C1ctc32	011tc38	014tc27	014tc25	015to32
001t033	002*035	003to22	003to29	004to34	006tc39	007tc30	C1ctc33	011tc39	014tc28	014tc26	015to33
001t034	002*036	003to23	003to30	004to35	006tc40	007tc31	C1ctc34	011tc40	014tc29	014tc27	015to34
001t035	002*037	003to24	003to31	004to36	006tc41	007tc32	C1ctc35	011tc41	014tc30	014tc28	015to35
001t036	002*038	003to25	003to32	004to37	006tc42	007tc33	C1ctc36	011tc42	014tc31	014tc29	015to36
001t037	002*039	003to26	003to33	004to38	006tc43	007tc34	C1ctc37	011tc43	014tc32	014tc30	015to37
001t038	002*040	003to27	003to34	004to39	006tc44	007tc35	C1ctc38	011tc44	014tc33	014tc31	015to38
001t039	002*041	003to28	003to35	004to40	006tc45	007tc36	C1ctc39	011tc45	014tc34	014tc32	015to39
001t040	002*042	003to29	003to36	004to41	006tc46	007tc37	C1ctc40	011tc46	014tc35	014tc33	015to40
001t041	002*043	003to30	003to37	004to42	006tc47	007tc38	C1ctc41				

total distance =	1520.7
average distance =	14.6
maximum distance =	35.0
dev distance =	34.5

state vehicles:

tot. allocated =	45.0
total distance =	1060.3
average distance =	23.6
privately owned:	
total distance =	460.4
average distance =	7.8

m t e e

alternate solutions									
001t012	002t014	003t001	003t008	004t013	006t018	007t005	011tc12	011tc18	011tc02
017t014	018t007	020t001	021t010	022t001	023t007	024tc05	025tc05	027tc18	028tc11
029t006	029t008	030t005	031t014	032t005	033t018	035t019	036tc14	037tc19	038tc11
045t013	047t004	048t014	049t016	050t019	052t009	053tc19	054tc02	055tc14	057tc15
058t012	059t014	060t007	061t019	062t011	062t012	063t014	064tc05	067tc15	068tc02
059t001	072t013	073t006	074t004	075t018	076t008	077t018	078tc08	079tc14	081tc02
084t001	085t019	086t014	087t018	088t013	088t014	090t011	091tc02	092tc18	093tc19
096t013	096t014	097t009	098t009	101t019	103t014	104t015	104tc02	107tc14	108t006
113t007	111t007	112t013	113t019	114t019	116t012	117t015	118tc14	121tc15	122t015

total distance =	1514.9
average distance =	14.6
maximum distance =	39.0
dev distance =	38.5

vehicle summary -

state vehicles:

tot. allocated =	46.0
total distance =	1094.3
average distance =	23.8
privately owned:	
total distance =	420.6
average distance =	7.3

alternate solutions

001to12	002to14	003to01	003to08
017to14	018to07	020to01	021to11
029to06	029to08	030to05	031to18
042to07	043to01	043to03	046to13
056to07	057to15	057to16	058to12
057to13	067to14	068to02	069to01
080to19	081to19	083to18	084to01
093to18	094to03	095to19	096to13
107to14	108to03	109to06	110to07
120to07	121to19	122to02	122to15

010tc12 011tc18 C14tc07 C15tc18 018tc00
027tc09 025tc18 C27tc18 028tc15 038tc15
030tc07 026tc14 C24tc14 041tc07 043tc15
033tc19 027tc14 C25tc14 044tc14 055tc14
036tc13 028tc09 029tc14 C26tc14 056tc09
039tc16 029tc14 C27tc14 057tc15 075tc15
042tc19 030tc10 031tc14 C28tc08 076tc15
045tc13 031tc14 C29tc13 077tc19 092tc15
048tc19 032tc14 033tc16 078tc14 106tc14
051tc15 034tc12 035tc14 079tc14 115tc14
054tc19 036tc15 037tc15 080tc14 116tc14
057tc13 038tc19 039tc19 081tc19 117tc15
060tc19 040tc14 041tc15 082tc19 118tc14
063tc19 042tc19 043tc19 083tc19 119tc14
066tc19 044tc19 045tc19 084tc19 120tc14
069tc19 046tc19 047tc19 085tc19 121tc14
072tc19 048tc19 049tc19 086tc19 122tc14
075tc19 050tc19 051tc19 087tc19 123tc19
078tc19 052tc19 053tc19 088tc19 124tc19
081tc19 054tc19 055tc19 089tc19 125tc19
084tc19 056tc19 057tc19 090tc19 126tc19
087tc19 058tc19 059tc19 091tc19 127tc19
090tc19 060tc19 061tc19 092tc19 128tc19
093tc19 062tc19 063tc19 093tc19 129tc19
096tc19 064tc19 065tc19 094tc19 130tc19
099tc19 066tc19 067tc19 095tc19 131tc19
102tc19 068tc19 069tc19 096tc19 132tc19
105tc19 070tc19 071tc19 097tc19 133tc19
108tc19 072tc19 073tc19 098tc19 134tc19
111tc19 074tc19 075tc19 099tc19 135tc19
114tc19 076tc19 077tc19 100tc19 136tc19
117tc19 078tc19 079tc19 101tc19 137tc19
120tc19 080tc19 081tc19 102tc19 138tc19
123tc19 082tc19 083tc19 103tc19 139tc19
126tc19 084tc19 085tc19 104tc19 140tc19
129tc19 086tc19 087tc19 105tc19 141tc19
132tc19 088tc19 089tc19 106tc19 142tc19
135tc19 090tc19 091tc19 107tc19 143tc19
138tc19 092tc19 093tc19 108tc19 144tc19
141tc19 094tc19 095tc19 109tc19 145tc19
144tc19 096tc19 097tc19 110tc19 146tc19
147tc19 098tc19 099tc19 111tc19 147tc19
150tc19 100tc19 101tc19 112tc19 148tc19
153tc19 102tc19 103tc19 113tc19 149tc19
156tc19 104tc19 105tc19 114tc19 150tc19
159tc19 106tc19 107tc19 115tc19 151tc19
162tc19 108tc19 109tc19 116tc19 152tc19
165tc19 110tc19 111tc19 117tc19 153tc19
168tc19 112tc19 113tc19 118tc19 154tc19
171tc19 114tc19 115tc19 119tc19 155tc19
174tc19 116tc19 117tc19 120tc19 156tc19
177tc19 118tc19 119tc19 121tc19 157tc19
180tc19 120tc19 121tc19 122tc19 158tc19
183tc19 122tc19 123tc19 123tc19 159tc19
186tc19 124tc19 125tc19 124tc19 160tc19
189tc19 126tc19 127tc19 125tc19 161tc19
192tc19 128tc19 129tc19 126tc19 162tc19
195tc19 130tc19 131tc19 127tc19 163tc19
198tc19 132tc19 133tc19 128tc19 164tc19
201tc19 134tc19 135tc19 129tc19 165tc19
204tc19 136tc19 137tc19 130tc19 166tc19
207tc19 138tc19 139tc19 131tc19 167tc19
210tc19 140tc19 141tc19 132tc19 168tc19
213tc19 142tc19 143tc19 133tc19 169tc19
216tc19 144tc19 145tc19 134tc19 170tc19
219tc19 146tc19 147tc19 135tc19 171tc19
222tc19 148tc19 149tc19 136tc19 172tc19
225tc19 150tc19 151tc19 137tc19 173tc19
228tc19 152tc19 153tc19 138tc19 174tc19
231tc19 154tc19 155tc19 139tc19 175tc19
234tc19 156tc19 157tc19 140tc19 176tc19
237tc19 158tc19 159tc19 141tc19 177tc19
240tc19 160tc19 161tc19 142tc19 178tc19
243tc19 162tc19 163tc19 143tc19 179tc19
246tc19 164tc19 165tc19 144tc19 180tc19
249tc19 166tc19 167tc19 145tc19 181tc19
252tc19 168tc19 169tc19 146tc19 182tc19
255tc19 170tc19 171tc19 147tc19 183tc19
258tc19 172tc19 173tc19 148tc19 184tc19
261tc19 174tc19 175tc19 149tc19 185tc19
264tc19 176tc19 177tc19 150tc19 186tc19
267tc19 178tc19 179tc19 151tc19 187tc19
270tc19 180tc19 181tc19 152tc19 188tc19
273tc19 182tc19 183tc19 153tc19 189tc19
276tc19 184tc19 185tc19 154tc19 190tc19
279tc19 186tc19 187tc19 155tc19 191tc19
282tc19 188tc19 189tc19 156tc19 192tc19
285tc19 190tc19 191tc19 157tc19 193tc19
288tc19 192tc19 193tc19 158tc19 194tc19
291tc19 194tc19 195tc19 159tc19 195tc19
294tc19 196tc19 197tc19 160tc19 196tc19
297tc19 198tc19 199tc19 161tc19 197tc19
300tc19 200tc19 201tc19 162tc19 198tc19
303tc19 202tc19 203tc19 163tc19 199tc19
306tc19 204tc19 205tc19 164tc19 200tc19
309tc19 206tc19 207tc19 165tc19 201tc19
312tc19 208tc19 209tc19 166tc19 202tc19
315tc19 210tc19 211tc19 167tc19 203tc19
318tc19 212tc19 213tc19 168tc19 204tc19
321tc19 214tc19 215tc19 169tc19 205tc19
324tc19 216tc19 217tc19 170tc19 206tc19
327tc19 218tc19 219tc19 171tc19 207tc19
330tc19 220tc19 221tc19 172tc19 208tc19
333tc19 222tc19 223tc19 173tc19 209tc19
336tc19 224tc19 225tc19 174tc19 210tc19
339tc19 226tc19 227tc19 175tc19 211tc19
342tc19 228tc19 229tc19 176tc19 212tc19
345tc19 230tc19 231tc19 177tc19 213tc19
348tc19 232tc19 233tc19 178tc19 214tc19
351tc19 234tc19 235tc19 179tc19 215tc19
354tc19 236tc19 237tc19 180tc19 216tc19
357tc19 238tc19 239tc19 181tc19 217tc19
360tc19 240tc19 241tc19 182tc19 218tc19
363tc19 242tc19 243tc19 183tc19 219tc19

total distance =	1515.7
average distance =	14.6
maximum distance =	39.0
dev distance =	38.5

state vehicles:

tot. allocated =	45.0
total distance =	1067.3
average distance =	23.7
privately owned:	
total distance =	448.4
average distance =	7.6

0011012
0191007
0291008
0431001
0571015
0591001
0841001
0961013
11101007
1221013

003t008
021t006
031t014
047t004
059t014
073t006
086t014
097t009
112t013

alternate solutions

010t012
024t009
036t014
050t019
063t014
077t018
090t019
104t019
117t019

0111010
0221005
0371018
0421005
0541005
0781008
0811012
0951010
1181014

0141005
0221013
0226112
0223115
0221005
0751015
0521015
1031014
1151014

0151018
0271018
0401014
0541002
0671012
0801015
0921018
1071019
1201007

03 0033
19 0019
07 0007
14 0014
14 0014
15 0015
14 0014
14 0014
15 0015

0177014
0251006
0421007
0561007
061100:
0831011
0951011
1051006
1221002

C 50.43

distance summary		one-way distance breakdown	
total distance =	1509.9		
average distance =	14.5		
maximum distance =	42.0		
dev distance =	41.5		
vehicle summary			
state vehicles:			
tot. allocated =	43.0		
total distance =	1066.3		
average distance =	24.8		
privately owned:			
total distance =	443.6		
average distance =	7.3		

distance summary		one-way distance breakdown	
total distance =	1509.9		
average distance =	14.5		
maximum distance =	42.0		
dev distance =	41.5		
vehicle summary			
state vehicles:			
tot. allocated =	43.0		
total distance =	1066.3		
average distance =	24.8		
privately owned:			
total distance =	443.6		
average distance =	7.3		

alternate solutions

001to12	002to14	003to08	004to13	006to03	007to09	010to12	011to18	014to07	015to18	016to03	017to03
019to07	020to01	020to18	021to19	022to18	023to07	024to09	025to09	026to13	027to18	028to10	029to08
030to05	031to14	032to05	033to18	035to19	036to18	037to18	038to13	040to14	041to06	042to06	043to18
044to06	045to08	046to13	047to04	048to14	049to13	050to19	052to09	053to15	054to02	054to06	054to16
055to14	055to19	056to07	057to06	057to15	058to12	059to14	059to13	060to07	061to03	062to15	062to16
054to09	066to09	067to18	068to02	069to01	069to14	072to13	072to06	074to04	075to03	076to18	077to03
078to08	079to19	080to19	081to19	083to18	084to01	084to14	085to15	086to14	087to18	088to18	089to15
091to02	091to19	092to19	093to18	094to14	095to15	096to18	097to09	098to05	101to15	102to14	103to15
104to19	105to18	106to14	106to19	107to14	108to03	109to06	110to07	111to07	112to15	113to14	114to15
116to19	117to19	118to18	119to14	119to18	120to07	121to15	122to02	122to06	122to15	123to15	124to15

C 50.42

distance summary		one-way distance breakdown	
total distance =	1510.4		
average distance =	14.5		
maximum distance =	42.0		
dev distance =	41.5		
vehicle summary			
state vehicles:			
tot. allocated =	42.0		
total distance =	1063.3		
average distance =	25.3		
privately owned:			
total distance =	447.1		
average distance =	7.2		

miles

distance summary		one-way distance breakdown	
total distance =	1510.4		
average distance =	14.5		
maximum distance =	42.0		
dev distance =	41.5		
vehicle summary			
state vehicles:			
tot. allocated =	42.0		
total distance =	1063.3		
average distance =	25.3		
privately owned:			
total distance =	447.1		
average distance =	7.2		

alternate solutions

001t012	002t014	003t001	004t013	006t003	007t009	011t018	014t007	015t018	016t007
017t003	018t007	020t001	021t019	022t018	023t007	024t005	025t005	026t010	027t010
029t008	030t005	031t014	033t018	035t019	036t018	037t018	038t018	039t006	040t010
043t018	044t006	045t008	047t004	048t014	049t013	050t015	051t015	052t002	053t002
054t016	055t014	056t007	057t015	058t012	059t014	060t017	061t017	062t013	063t013
066t009	067t018	068t002	069t014	070t013	071t006	072t014	073t014	074t006	075t006
079t019	080t019	081t019	082t001	083t018	084t014	085t015	086t015	087t018	088t018
092t019	093t018	094t014	095t019	096t018	097t009	098t015	099t015	100t015	101t015
107t014	108t003	109t006	110t007	111t007	112t013	113t013	114t013	115t013	116t013
119t018	120t007	121t019	122t002	122t015	123t019	124t019	125t019	126t019	127t019

C 50.41

one-way distance breakdown

distance summary		
total distance =	1512.2	
average distance =	14.5	
maximum distance =	42.0	
dev distance =	41.5	
vehicle summary		
state vehicles:		
tot. allocated =	41.0	
total distance =	1042.3	
average distance =	25.4	
privately owned:		
total distance =	469.9	
average distance =	7.5	

alternate solutions

distance summary		
total distance =	1512.2	
average distance =	14.5	
maximum distance =	42.0	
dev distance =	41.5	
vehicle summary		
state vehicles:		
tot. allocated =	41.0	
total distance =	1042.3	
average distance =	25.4	
privately owned:		
total distance =	469.9	
average distance =	7.5	

```

distance summary
-----

```

total distance = 1516.2

average distance = 14.6

maximum distance = 43.0

42.5

vehicle summary -----

state vehicles:

tot. allocated = 40.0

```
total distance = 1033.3
```

average distance = 25.8

privately owned:

total distance = 482.9

average distance = 7.5

miles

alternate solutions

	alternate solutions									
001t012	001t018	002t014	003t001	004t013	006t003	007t005	010t012	011t012	014t005	015t014
015t018	016t003	017t014	018t007	020t001	021t019	022t012	024t005	025t005	026t013	027t012
029t010	029t008	030t005	031t003	032t005	033t012	035t015	037t012	038t013	040t012	041t002
042t006	043t014	044t006	045t008	046t013	047t004	048t014	049t016	050t015	052t005	053t015
054t016	055t014	056t007	057t006	058t012	059t014	061t003	062t015	063t014	064t005	065t015
066t009	067t018	068t002	069t001	072t013	073t006	074t004	076t002	077t003	078t004	079t015
080t019	081t019	083t018	084t001	085t019	086t014	087t012	088t012	091t002	092t015	093t015
093t018	094t014	095t019	096t018	097t009	098t005	101t019	104t015	105t012	106t014	107t014
109t018	109t006	110t007	111t007	112t013	113t015	114t015	117t015	118t012	119t012	120t007
121t018	121t019	122t002	122t006							

C 56.35

distance summary		one-way distance breakdown	
total distance =	1520.2		
average distance =	14.6		
maximum distance =	45.0		
dev distance =	44.5		
vehicle summary			
state vehicles:			
tot. allocated =	39.0		
total distance =	1034.3		
average distance =	26.5		
privately owned:			
total distance =	485.9		
average distance =	7.5		

alternate solutions		miles	
001tol2	001tol8	002tol4	003tol0
015tol8	016tol03	017tol14	018tol07
028tol0	029tol08	030tol06	031tol03
042tol06	043tol14	044tol06	045tol08
054tol16	055tol14	056tol07	057tol06
064tol09	066tol09	067tol18	068tol02
079tol19	080tol19	081tol19	083tol18
092tol19	093tol18	094tol14	095tol19
107tol14	108tol18	109tol06	110tol07
120tol07	121tol18	121tol19	122tol02
004tol13	006tol03	007tol09	010tol18
020tol01	021tol15	022tol18	023tol07
032tol05	033tol18	035tol19	038tol12
046tol13	047tol04	048tol14	049tol16
057tol06	058tol12	058tol18	060tol07
069tol01	072tol13	073tol06	074tol04
084tol01	085tol19	086tol14	087tol18
096tol18	097tol05	098tol09	101tol15
111tol07	112tol13	113tol19	114tol15
122tol06	122tol15	116tol15	117tol15
011tol18	025tol05	026tol13	027tol18
038tol12	050tol15	052tol05	053tol15
061tol03	062tol15	063tol14	064tol14
076tol08	077tol03	078tol08	079tol18
090tol15	091tol02	092tol18	093tol18
104tol15	105tol18	106tol18	107tol18
118tol18	119tol18	120tol18	121tol18

dev distance = 44.5

vehicle summary

state vehicles:

tot. allocated = 3H.0

total distance = 1036.3

average distance = 27.3

privately owned:

total distance = 490.1

average distance = 1.4

mites

alternate solutions

alternate solutions									
001to12	001to18	002to14	003to01	003to08	004to13	006to03	007to05	010to12	014to09
015to14	016to03	017to14	018to09	020to01	021to19	022to14	023to07	024to05	027to18
028to10	029to04	030to06	031to03	032to05	033to19	035to15	036to18	037to18	041to05
042to06	043to14	044to06	045to08	046to13	047to04	048to14	049to16	050to15	054to05
054to06	055to14	056to09	057to06	058to12	058to18	059to14	060to17	061to03	064to05
065to09	067to19	068to02	069to01	072to13	073to06	074to04	074to06	075to14	077to07
079to08	079to19	080to14	081to19	083to18	084to01	085to19	086to14	087to18	091to15
092to19	093to18	094to14	095to19	096to18	097to09	098to09	099to15	100to14	104to15
107to18	108to18	109to06	110to07	110to08	111to07	112to15	113to15	114to15	116to14
119to18	120to07	121to19	122to02	122to06					118to18

C 50.37

distance summary		one-way distance breakdown	
total distance =	1533.4		
average distance =	14.7		
maximum distance =	45.0		
dev distance =	44.5		
vehicle summary			
state vehicles:			
tot. allocated =	37.0		
total distance =	1039.3		
average distance =	28.1		
privately owned:			
total distance =	494.1		
average distance =	7.4		

alternate solutions		miles	
001to12	001to18	002to14	003to01
015to03	017to14	018to09	020to01
028to10	029to08	030to06	031to03
041to05	042to06	043to01	043to14
052to09	053to19	054to02	054to06
061to18	062to19	063to14	064to09
075to03	076to08	077to03	078to08
098to18	090to19	091to13	092to19
104to19	105to18	106to14	107to18
114to19	116to19	117to19	118to18
			004to13
			021to19
			032to05
			044to06
			055to14
			066to09
			079to19
			093to18
			108to18
			119to18
			006to03
			022to01
			033to18
			046to13
			056to09
			067to18
			080to19
			094to14
			109to06
			120to07
			007to09
			022to14
			035to13
			047to06
			057to02
			068to02
			081to19
			095to19
			110to07
			121to19
			010to18
			024to09
			026to13
			027to18
			038to13
			045to19
			058to18
			060to07
			072to13
			084to01
			085to19
			097to09
			110to05
			122to02
			011to18
			025to09
			027to18
			048to14
			055to14
			073to06
			085to19
			098to19
			101to19
			112to13
			013to14
			027to18
			040to18
			050to19
			061to03
			074to18
			086to14
			103to14
			113to13

150.25

distance summary		one-way distance breakdown	
total distance =	1543.4		
average distance =	14.8		
maximum distance =	45.0		
dev distance =	44.5		
vehicle summary			
state vehicles:			
tot. allocated =	36.0		
total distance =	1036.3		
average distance =	24.8		
privately owned:			
total distance =	507.1		
average distance =	7.5		

miles

alternate solutions	
001tol2	001tol2
014tol9	015tol3
025tol9	026tol3
043tol8	041tol5
049tol9	050tol9
050tol7	061tol8
074tol6	075tol5
096tol8	088tol8
101tol9	103tol4
114tol9	116tol9
003tol4	002tol4
016tol3	016tol3
028tol0	027tol6
043tol0	042tol6
053tol9	052tol9
063tol4	062tol9
077tol3	076tol8
091tol3	090tol5
105tol8	104tol9
118tol8	117tol9
004tol3	004tol9
017tol4	017tol8
029tol0	030tol6
044tol6	045tol8
054tol2	054tol6
064tol9	064tol9
078tol8	079tol9
092tol9	093tol8
106tol4	107tol8
119tol8	120tol7
006tol3	006tol3
018tol9	018tol9
031tol1	031tol1
046tol0	046tol0
055tol4	055tol4
067tol8	067tol8
080tol5	080tol5
094tol4	094tol4
108tol6	108tol6
121tol8	121tol8
021tol9	021tol9
023tol7	023tol7
028tol8	028tol8
048tol4	048tol4
058tol8	058tol8
073tol6	073tol6
084tol5	084tol5
097tol5	097tol5
112tol5	112tol5
122tol6	122tol6

C 50.35

distance summary		one-way distance break down	
total distance =	1553.7		
average distance =	14.9		
maximum distance =	45.0		
dev distance =	44.5		
vehicle summary			
state vehicles:			
tot. allocated =	35.0		
total distance =	1035.3		
average distance =	29.6		
privately owned:			
total distance =	518.4		
average distance =	7.5		

distance summary		one-way distance break down	
total distance =	1553.7		
average distance =	14.9		
maximum distance =	45.0		
dev distance =	44.5		
vehicle summary			
state vehicles:			
tot. allocated =	35.0		
total distance =	1035.3		
average distance =	29.6		
privately owned:			
total distance =	518.4		
average distance =	7.5		

alternate solutions

0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
001tol8	002tol4	003tol01	003tol08	004tol9	006tol03	006tol18	007tol5	010tol16	011tol16	014tol05	015tol13					
015tol03	017tol18	018tol09	020tol1	022tol01	023tol08	024tol05	025tol09	026tol13	027tol18	028tol10	029tol06					
030tol06	031tol18	032tol05	033tol17	033tol18	035tol13	036tol18	037tol18	038tol14	039tol15	040tol18	041tol05					
041tol17	042tol06	043tol01	044tol06	046tol01	048tol18	049tol19	050tol19	051tol15	052tol09	053tol15	054tol06					
055tol14	056tol09	057tol06	058tol19	059tol14	060tol07	061tol18	062tol15	063tol16	064tol14	065tol15	066tol09					
067tol18	068tol02	069tol01	072tol08	073tol06	074tol06	074tol16	075tol15	076tol16	077tol18	078tol15	079tol15					
083tol18	084tol18	085tol19	086tol18	087tol18	088tol18	089tol18	090tol15	091tol15	092tol15	093tol18	094tol18					
093tol18	094tol18	095tol19	096tol18	097tol09	098tol09	099tol19	100tol19	101tol19	102tol14	103tol18	104tol18					
108tol18	109tol06	110tol08	111tol07	112tol08	113tol13	114tol15	115tol15	116tol15	117tol15	118tol15	119tol15					
121tol18	121tol19	122tol02	122tol06	122tol08	122tol13	122tol15	122tol15	122tol15	122tol15	122tol15	122tol15					

U 50.34

one-way distance breakdown

distance summary

total distance = 1567.6
 average distance = 15.1
 maximum distance = 46.0
 dev distance = 45.5

vehicle summary

state vehicles:

tot. allocated = 34.0
 total distance = 1036.2
 average distance = 30.5
 privately owned:
 total distance = 531.4
 average distance = 7.6

miles

alternate solutions

001t018	002t014	003t001	004t019	006t003	006t018	007t009	011t018	014t005	015t012	016t002
016t014	017t014	017t018	018t009	020t001	021t015	022t001	023t009	024t005	026t012	027t018
028t010	029t008	030t006	031t018	032t005	032t017	033t014	034t018	035t018	036t014	040t018
041t005	041t017	042t006	043t001	044t006	045t007	045t009	046t012	047t018	048t014	048t018
049t019	050t019	052t009	053t019	054t002	054t006	055t014	056t005	057t018	058t015	059t014
050t008	061t018	062t019	063t014	064t009	066t009	067t018	068t002	069t012	070t006	071t008
074t016	075t002	076t008	077t003	078t008	079t015	080t019	081t014	082t018	083t015	084t014
085t018	088t018	090t019	091t016	092t019	093t018	094t014	095t018	096t018	097t005	098t018
101t019	103t014	104t019	105t018	106t014	107t018	108t018	109t018	110t005	111t015	112t012
114t019	116t019	117t019	118t018	119t018	120t007	121t018	122t018	123t008	124t015	125t012

C 50.33

distance summary		one-way distance breakdown																	

total distance =	1582.1																		
average distance =	15.2																		
maximum distance =	48.0																		
dev distance =	47.5																		
vehicle summary																			

state vehicles:																			
tot. allocated =	33.0																		
total distance =	1013.7																		
average distance =	30.7																		
privately owned:																			
total distance =	568.4																		
average distance =	8.0																		

alternate solutions		miles																	
001tol8	002tol4	003tol9	004tol3	004tol9	006tol3	006tol8	007tol5	010tol8	011tol8	014tol9	015tol3	015tol3	015tol3	015tol3	015tol3	015tol3	015tol3		
016tol4	016tol8	017tol3	017tol4	018tol7	020tol1	021tol5	022tol1	023tol8	024tol5	025tol9	026tol3	026tol3	026tol3	026tol3	026tol3	026tol3	026tol3		
027tol8	028tol0	029tol8	030tol6	031tol8	032tol5	032tol7	033tol8	034tol1	035tol3	036tol8	037tol1	037tol1	037tol1	037tol1	037tol1	037tol1	037tol1		
040tol8	041tol5	041tol6	042tol6	042tol7	043tol1	044tol6	045tol7	046tol1	047tol1	048tol1	049tol1	049tol1	049tol1	049tol1	049tol1	049tol1	049tol1		
049tol8	049tol9	050tol9	052tol9	053tol9	054tol2	054tol6	055tol4	056tol9	057tol2	057tol2	057tol2	057tol2	057tol2	057tol2	057tol2	057tol2	057tol2		
059tol4	060tol7	061tol8	062tol9	063tol4	064tol3	066tol9	067tol8	068tol2	069tol1	070tol1	071tol1	071tol1	071tol1	071tol1	071tol1	071tol1	071tol1		
073tol6	074tol6	075tol3	076tol8	077tol0	078tol2	079tol8	080tol5	081tol8	082tol1	083tol1	084tol1	084tol1	084tol1	084tol1	084tol1	084tol1	084tol1		
085tol9	086tol4	086tol8	087tol8	088tol8	090tol5	091tol9	092tol5	093tol8	094tol4	095tol8	096tol1	096tol1	096tol1	096tol1	096tol1	096tol1	096tol1		
095tol8	097tol9	098tol9	101tol9	103tol4	104tol5	105tol8	106tol4	107tol8	108tol1	109tol6	110tol8	110tol8	110tol8	110tol8	110tol8	110tol8	110tol8		
111tol7	112tol9	113tol3	114tol9	116tol9	117tol5	118tol8	119tol1	120tol8	121tol8	122tol1	123tol1	123tol1	123tol1	123tol1	123tol1	123tol1	123tol1		
122tol5	122tol6																		

distance summary

total distance = 1610.1

average distance = 15.5

maximum distance = 48.0

dev distance = 47.5

vehicle summary

state vehicles:

	tot. allocated =	32.0
--	------------------	------

```
total distance = 1013.2
```

average distance = 31.7

privately owned:

total distance = 596.9

average distance = 8.3

mities

alternate solutions

alternate solutions											
001to18	002to18	003to08	004to19	006to03	006to1e	007to09	111to1e	011to18	114to01	114to05	012to12
016to02	016to18	017to03	017to18	018to17	020to01	021to15	022to0e	024to05	025to05	026to13	027to18
028to10	029to08	030to06	031to18	032to17	033to1e	035to13	036to0e	037to1e	038to14	040to1e	041to05
042to10	043to01	046to01	047to18	048to02	048to1e	049to19	050to15	052to05	053to15	054to12	055to02
054to06	055to14	056to17	057to02	057to05	058to1e	059to14	060to07	061to18	062to15	064to05	065to09
065to09	067to18	068to02	069to01	072to08	073to0e	074to06	074to1e	075to15	076to0e	077to03	078to02
079to19	080to18	081to18	083to18	084to01	085to15	086to02	086to1e	087to18	088to18	090to15	091to15
092to19	093to14	094to02	094to18	095to19	096to15	097to05	098to05	101to15	102to14	104to15	105to1e
106to14	107to18	108to18	109to06	110to08	111to09	112to19	113to12	114to15	115to15	116to15	117to1e
119to01	120to07	121to18	121to19	122to02	122to0e	122to16					

C 50.31

one-way distance breakdown

distance summary

total distance = 1643.9
 average distance = 15.8
 maximum distance = 49.0
 dev distance = 48.5

vehicle summary

state vehicles:

tot. allocated = 31.0
 total distance = 1041.0
 average distance = 33.6
 privately owned:
 total distance = 602.9
 average distance = 8.3

miles

alternate solutions

001tol8	002tol8	003tol8	004tol9	006tol03	006tol18	007tol09	011tol15	011tol18	014tol01	015tol14	016tol02
016tol18	017tol03	017tol18	018tol17	020tol01	021tol19	022tol01	022tol08	024tol05	025tol05	026tol13	027tol18
028tol10	029tol08	030tol06	031tol16	032tol17	033tol18	035tol13	036tol08	037tol18	040tol18	041tol05	042tol05
043tol01	044tol06	045tol09	046tol01	047tol05	047tol06	047tol13	047tol15	048tol02	048tol18	049tol15	050tol15
052tol09	053tol19	054tol05	054tol06	055tol18	056tol17	057tol06	058tol18	059tol14	060tol07	061tol18	062tol10
053tol02	064tol09	066tol09	067tol18	068tol02	069tol01	072tol08	072tol06	074tol06	074tol13	074tol16	075tol03
075tol08	077tol03	078tol08	079tol19	080tol19	081tol18	083tol18	084tol01	085tol15	086tol02	086tol18	087tol18
089tol18	090tol19	091tol19	092tol19	093tol18	094tol02	094tol18	095tol15	096tol18	097tol05	098tol09	099tol15
103tol14	104tol19	105tol18	106tol14	107tol18	108tol14	109tol06	110tol08	111tol19	112tol15	113tol13	114tol15
115tol19	117tol19	118tol18	119tol01	120tol07	121tol18	121tol19	122tol05	122tol18			

distance summary -----

total distance =	1712.7
average distance =	14.5
maximum distance =	49.0
dev distance =	44.5

state vehicles:

tot. allocated =	30.0
total distance =	1063.0
average distance =	35.4
privately owned:	
total distance =	649.7
average distance =	8.8

001101010	00210110
010101011	0201001
030100106	0311001
0431001	0441006
054101016	05510112
06710112	0681013
081101018	0831018
093101019	0961001
109101006	1101009
1211019	1221006

9	0141c01	0151c14	0161c02	0171c02
5	0261c16	0271c12	0281c10	0291c08
3	0381c14	0401c12	0411c05	0421c01
2	0501c15	0521c05	0531c15	0541c01
7	0621c10	0631c02	0641c05	0651c01
1	0771c03	0781c02	0791c12	0801c01
3	0911c15	0921c15	0931c12	0941c01
9	1051c02	1061c12	1071c14	1081c12
0	1181c12	1191c01	1201c07	1211c12

average distance = 7.3

files

001t012	002t014	003t001	003t008	004t013	006t003	007t009	C1f0c12	011t018	C14t007	C15t018	016t003
017t003	018t007	020t001	026t018	021t019	022t018	023t007	C24t009	025t009	C26t013	C27t018	028t010
029t008	030t005	031t014	032t005	033t018	035t019	036t018	C27t018	028t013	040t014	C41t007	042t007
043t018	044t006	045t008	046t013	047t004	048t014	049t013	C5f0c19	052t009	053t019	C54t002	054t016
055t014	056t007	057t015	058t012	059t014	060t007	061t003	C62t013	063t013	C64t019	C66t005	067t018
069t002	069t001	069t014	072t013	073t006	074t004	075t003	C76t008	077t003	C78t008	C75t015	080t019
081t019	083t018	084t001	084t014	085t019	086t014	087t018	C85t018	090t019	C91t002	C91t019	092t019
093t018	094t014	095t019	096t018	097t009	098t009	101t019	102t014	104t019	105t018	106t014	107t014
108t003	109t006	110t007	111t007	112t013	113t019	114t019	116t019	117t019	118t018	119t014	119t018
120t007	121t019	122t002	122t015								

distance summary

total distance = 1510.4
average distance = 14.5
maximum distance = 42.0
dev distance = 41.5

vehicle summary

state vehicles:

tot. allocated = 42.0
total distance = 1063.3
average distance = 25.3
privately owned:
total distance = 447.1
average distance = 1.2

cre-way distance breakdown

alternate solutions

001t012	002t014	003t001	004t013	006t003	007t009	011t018	014t007	014t005	015t014
015t003	017t003	018t007	020t014	021t019	022t018	022t007	025t005	026t013	027t018
029t010	029t008	030t005	032t005	033t018	035t019	027t018	028t012	040t018	041t008
042t006	043t018	044t006	046t013	047t004	047t006	047t015	048t014	050t019	052t005
053t019	054t002	054t006	055t014	056t007	057t006	058t012	060t007	061t002	062t015
063t013	064t009	066t009	068t002	069t001	069t014	072t013	074t006	075t002	076t008
077t003	078t008	079t019	081t019	083t018	084t001	084t014	085t015	087t018	088t018
090t019	091t002	091t019	093t018	094t014	095t019	095t018	096t014	101t015	102t014
104t019	105t018	106t014	108t003	108t014	109t006	110t007	112t005	112t015	114t015
116t019	117t019	118t018	119t018	120t007	121t019	122t002	112t012	112t015	114t015

C 80.41

one-way distance breakdown

distance summary

total distance = 1512.2
 average distance = 14.5
 maximum distance = 42.0
 dev distance = 41.5

vehicle summary

state vehicles:

tot. allocated = 41.0
 total distance = 1042.3
 average distance = 25.4
 privately owned:
 total distance = 469.9
 average distance = 7.5

miles

alternate solutions

001to12	002to14	003to01	004to13	006to03	007to09	011to18	015to14	015to18
015to03	017to14	018to07	021to19	022to18	023to07	025to05	027to18	028to10
028to18	029to08	030to05	032to05	033to18	035to19	036to18	041to06	041to07
042to06	042to07	043to18	045to08	046to13	046to18	047to04	048to14	050to19
052to09	053to19	054to02	055to14	056to07	058to12	059to14	062to18	062to19
063to14	064to09	056to09	067to18	068to02	069to01	072to13	076to08	077to02
078to08	079to19	080to19	081to19	083to18	084to01	085to15	087to18	091to02
091to19	092to19	093to18	094to14	096to18	097to09	098to14	104to19	105to18
105to14	107to14	108to14	109to06	110to07	111to07	112to13	116to19	118to18
119to18	120to07	121to19	122to02	122to15				

C 80.40

one-way distance breakdown

distance summary

total distance = 1516.2
 average distance = 14.6
 maximum distance = 43.0
 dev distance = 42.5

vehicle summary

state vehicles:

tot. allocated = 40.0
 total distance = 1033.3
 average distance = 25.8
 privately owned:
 total distance = 482.9
 average distance = 7.5

miles

alternate solutions

001t012	002t014	003t001	003t008	004t013	006t003	007t005	011t018	014t007	015t014
015t018	016t003	017t014	018t007	020t001	021t019	022t018	024t005	025t005	027t018
028t019	029t008	030t005	031t003	032t005	033t018	035t019	028t017	028t013	027t018
042t006	043t014	044t006	045t008	046t013	047t006	048t014	028t018	028t012	041t008
054t006	054t016	055t014	056t007	057t006	058t012	059t014	045t013	022t005	054t008
059t009	066t009	067t018	068t002	069t001	072t013	073t006	060t007	062t010	062t014
079t019	080t019	081t019	083t018	084t001	085t019	086t014	075t012	078t008	078t008
092t019	093t018	094t014	095t019	096t018	097t009	098t009	087t018	050t014	051t008
107t014	108t018	109t006	110t007	111t007	112t012	113t015	102t014	104t015	105t018
120t007	121t019	122t002	122t006				118t015	117t015	118t018

C 80.39

distance summary		one-way distance breakdown	
total distance =	1520.2		
average distance =	14.6		
maximum distance =	45.0		
dev distance =	44.5		
vehicle summary			
state vehicles:			
tot. allocated =	39.0		
total distance =	1034.3		
average distance =	26.5		
privately owned:			
total distance =	485.9		
average distance =	7.5		

alternate solutions		miles	
001tol2	003tol1	007tol9	018tol2
017tol4	021tol9	024tol09	028tol10
029tol8	032tol05	036tol18	041tol05
043tol4	046tol13	049tol14	052tol05
054tol2	056tol07	059tol12	062tol15
064tol9	068tol02	073tol13	077tol03
079tol9	080tol19	085tol19	091tol02
092tol19	093tol18	096tol14	105tol18
107tol4	108tol18	110tol07	117tol15
120tol7	121tol19	122tol02	122tol06

C 80.38

distance summary

total distance = 1526.4
 average distance = 14.7
 maximum distance = 45.0
 dev distance = 44.5

vehicle summary

state vehicles:

tot. allocated = 38.0
 total distance = 1036.3
 average distance = 27.3
 privately owned:
 total distance = 490.1
 average distance = 7.4

one-way distance breakdown

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
n																	
u																	
m																	
b																	
e																	
r																	
o																	
t																	
e																	
m																	
p																	
l																	
o																	
y																	
e																	
e																	
s																	

miles

alternate solutions

001tol2	002tol4	003tol1	003tol8	004tol3	006tol3	007tol9	010tol2	011tol8	014tol5	015tol4	016tol2
017tol4	018tol9	018tol9	020tol1	021tol9	022tol4	023tol7	024tol5	025tol5	026tol3	027tol8	028tol4
029tol9	029tol8	030tol6	031tol3	032tol5	033tol4	035tol9	036tol8	037tol8	038tol3	039tol8	040tol4
042tol6	043tol4	044tol6	045tol8	046tol8	047tol6	047tol3	047tol5	048tol4	049tol3	050tol5	051tol5
053tol9	054tol2	054tol6	055tol4	056tol7	056tol9	057tol6	058tol2	059tol4	060tol7	061tol3	062tol1
052tol8	063tol4	064tol9	066tol9	067tol8	068tol2	069tol1	070tol3	071tol8	072tol8	073tol3	074tol5
076tol8	077tol3	078tol8	079tol9	080tol9	081tol9	082tol8	083tol8	084tol1	085tol5	086tol3	087tol8
090tol9	091tol9	092tol9	093tol8	094tol4	095tol9	096tol8	097tol5	098tol5	099tol5	100tol4	101tol8
105tol8	106tol4	107tol8	108tol8	109tol6	110tol7	110tol8	111tol7	112tol3	113tol5	114tol4	115tol5
117tol9	118tol8	119tol8	120tol7	121tol9	122tol2	123tol6					

C 80.37

distance summary		one-way distance breakdown															
-----		-----															
total distance =	1533.4																
average distance =	14.7																
maximum distance =	45.0																
dev distance =	44.5																
vehicle summary																	
-----		-----															
state vehicles:																	
tot. allocated =	37.0																
total distance =	1039.3																
average distance =	28.1																
privately owned:																	
total distance =	494.1																
average distance =	7.4																

distance summary		one-way distance breakdown															
-----		-----															
total distance =	1533.4																
average distance =	14.7																
maximum distance =	45.0																
dev distance =	44.5																
vehicle summary																	
-----		-----															
state vehicles:																	
tot. allocated =	37.0																
total distance =	1039.3																
average distance =	28.1																
privately owned:																	
total distance =	494.1																
average distance =	7.4																

alternate solutions

001to12	002to14	003to01	003to08	004to13	004to19	006to03	007to05	010to12	011to18	014to05	015to14
015to03	017to14	018to07	018to09	020to01	021to15	022to01	023to14	023to07	024to05	025to05	026to13
027to18	028to18	028to19	029to08	030to06	031to03	032to05	033to18	035to15	036to18	037to18	038to13
040to18	041to05	042to06	043to01	043to14	044to06	045to08	047to06	047to13	047to15	048to14	049to15
050to19	052to09	053to19	054to02	054to06	055to14	056to07	058to05	057to06	058to12	059to14	060to07
061to03	061to18	062to10	062to18	063to14	064to09	066to05	067to18	068to02	069to01	072to08	072to12
073to06	074to06	074to16	075to03	076to08	077to03	078to08	079to15	080to15	081to15	083to18	084to01
085to19	086to14	087to18	088to18	090to19	091to13	091to18	092to15	093to18	094to14	095to15	096to18
097to09	098to09	101to19	103to14	104to19	105to18	106to14	107to18	108to18	109to06	110to07	110to08
111to07	112to19	113to19	114to19	116to19	117to19	118to18	119to18	120to07	121to15	122to02	123to06

C 80.36

distance summary

total distance = 1541.7
 average distance = 14.8
 maximum distance = 54.0
 av distance = 53.5

vehicle summary

state vehicles:

tot. allocated = 35.0
 total distance = 1035.3
 average distance = 28.8
 privately owned:
 total distance = 505.4
 average distance = 7.4

one-way distance breakdown

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
n																	
u																	
m																	
b																	
e																	
r																	
o																	
i																	
e																	
m																	
p																	
l																	
o																	
y																	
e																	
s																	

miles

alternate solutions

001t012 002t014 003t001 003t008 004t019 006t002 007t005 011t018 012t019 013t001 014t006 015t002 016t008 017t003 018t008 019t019 020t001 021t014 022t001 023t007 024t005 025t008 026t009 027t003 028t008 029t008 030t006 031t003 032t005 033t018 034t001 035t014 036t009 037t018 038t014 039t019 040t001 041t008 042t006 043t014 044t001 045t008 046t012 047t001 048t018 049t019 050t001 051t014 052t009 053t019 054t002 055t014 056t009 057t012 058t002 059t001 060t018 061t014 062t008 063t014 064t009 065t019 066t009 067t012 068t002 069t001 070t018 071t014 072t019 073t008 074t014 075t019 076t014 077t018 078t008 079t019 080t019 081t014 082t019 083t018 084t014 085t019 086t014 087t019 088t014 089t019 090t014 091t019 092t014 093t018 094t014 095t019 096t018 097t019 098t014 099t019 100t014 101t019 102t018 103t014 104t019 105t018 106t014 107t019 108t018 109t014 110t019 111t014 112t019 113t018 114t014 115t019 116t018 117t014 118t019 119t018 120t014 121t019 122t002

C 80.35

distance summary		one-way distance breakdown	
total distance =	1551.7		
average distance =	14.9		
maximum distance =	54.0		
dev distance =	53.5		
vehicle summary			
state vehicles:			
tot. allocated =	35.0		
total distance =	1033.3		
average distance =	29.5		
privately owned:			
total distance =	518.4		
average distance =	7.5		

alternate solutions										
001tol2	001tol6	002tol4	003tol1	004tol9	006tol0	006tol4	007tol5	010tol2	011tol6	014tc05
015tol3	016tol0	016tol4	017tol4	017tol8	018tol0	020tol1	021tc15	022tc01	023tc07	024tc09
025tol9	026tol3	026tol8	027tol8	028tol8	029tol0	030tol6	031tc18	032tc05	033tc18	035tc12
035tol8	037tol8	040tol8	041tol0	041tol7	042tol0	042tc17	043tc11	044tc06	045tc08	048tc14
049tol8	049tol9	050tol9	052tol9	053tol9	054tol2	055tol4	056tc15	058tc12	059tc14	060tc07
061tol8	062tol0	063tol4	064tol0	066tol0	067tol2	068tol8	069tc11	072tc08	073tc13	074tc16
075tol3	076tol8	077tol0	078tol8	079tol9	080tol9	083tol8	084tc11	085tc15	086tc14	087tc18
089tol8	090tol9	091tol8	092tol9	093tol8	094tol4	094tol8	095tc15	097tc09	098tc09	101tc19
103tol4	104tol9	105tol8	106tol4	107tol8	108tol8	109tol0	110tc08	111tc07	112tc19	113tol2
114tol9	116tol9	117tol9	118tol8	119tol8	120tol0	121tol9	122tc02			

one-way distance breakdown

distance summary -----

total distance = 1582.1

average distance = 15.2

maximum distance =	48.0
--------------------	------

dev o1stance = 47.5

vehicle summary

state vehicles:

tot. allocated = 33.0

```
total distance = 1013.7
```

average distance = 30.7

privately owned:

```
total distance = 568.4
```

average distance = 3.0

files

alternate solutions

Alternate solutions									
001tol2	002tol4	003tc09	004tol9	006tc03	006tc18	007tc09	010tc12	011tc18	014tc05
016tol4	016tol8	017tc02	017tc03	017tol4	018tol7	020tol0	021tc15	022tc01	023tc06
026tol3	026tol8	027tc18	028tol8	028tol9	029tc08	030tc06	031tc18	032tc05	033tc18
035tol8	037tol8	038tol4	040tol8	041tc05	041tc06	042tc06	042tc17	043tc01	044tc06
047tol3	048tc02	048tol4	049tol8	049tol9	050tol9	052tc05	053tc15	054tc02	054tc06
057tol2	057tol5	058tol2	058tol4	060tc08	061tc18	062tc10	062tc18	063tc02	064tc05
059tol8	069tc01	072tc06	073tc06	074tol9	075tc03	076tc06	077tc13	078tc08	079tc15
083tol8	084tc01	085tol9	086tc02	086tol4	086tol8	087tol8	088tc18	090tc15	091tc15
094tc02	094tol4	094tc18	095tol9	096tol8	097tc09	098tc05	101tc15	103tc14	104tc15
107tol8	109tc06	110tc09	111tc07	112tol9	113tol3	114tol9	116tc15	117tc15	118tc15
121tol9	122tc06	122tol5	122tol6						

C 80.31

one-way distance breakdown

distance summary

total distance = 1617.9
 average distance = 15.6
 maximum distance = 63.0
 dev distance = 62.5

vehicle summary

state vehicles:

tot. allocated = 31.0
 total distance = 1029.5
 average distance = 33.2
 privately owned:
 total distance = 588.4
 average distance = 8.1

miles

alternate solutions

001to12	002to14	003to09	004to19	006to03	007to09	010to12	011to18	014to05	015to14	016to02	017to02
018to17	020to01	021to19	022to01	022to14	023to08	024to09	025to05	026to12	026to18	027to18	028to18
028to19	029to08	030to06	031to03	032to17	033to18	035to13	036to18	037to18	038to14	040to18	041to05
041to06	042to17	043to01	043to14	044to06	045to09	046to18	047to13	048to02	049to15	050to15	052to05
053to19	054to06	054to16	055to18	056to09	057to02	057to05	057to15	057to16	057to19	058to12	059to14
050to07	061to18	062to10	062to19	063to02	064to09	066to05	067to18	068to12	069to01	072to13	073to06
074to19	075to03	076to08	077to03	078to08	079to19	080to15	081to18	082to18	084to01	085to15	086to02
087to18	088to18	090to19	091to19	092to19	093to18	094to02	095to15	096to18	097to05	098to05	101to15
103to14	104to19	105to18	106to14	107to18	108to18	109to06	110to05	111to07	112to15	113to13	114to15
115to19	117to19	118to18	119to01	120to08	121to19	122to16					

distance summary -----

total distance = 1657.7

average distance = 15.9

maximum distance = 75.0

dev distance = 74.5

vehicle summary

State vehicles:

tot. allocated = 50.0

total distance = 1045.5

average distance = 34.8

privately owned:

total distance = 612.2

average distance = 0.3

files

alternate solutions

[illegible]

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