Surveying - Traverse

Introduction

- Almost all surveying requires some calculations to reduce measurements into a more helpful form for determining distance, earthwork volumes, land areas, etc.
- A traverse is developed by measuring the distance and angles between points that find the boundary of a site
- We will learn several different techniques to compute the area inside a traverse

1

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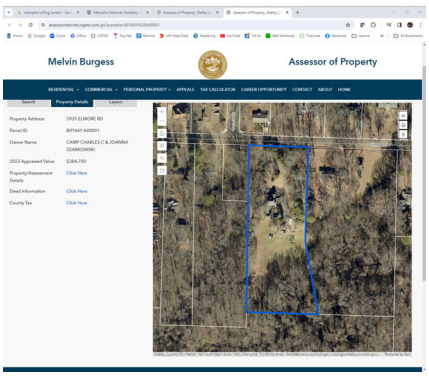
2

Surveying - Traverse

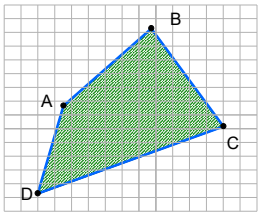


3

Distance - Traverse

Methods of Computing Area

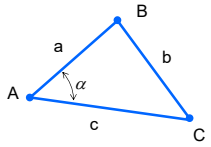
- A simple method that is useful for rough area estimates is a ***graphical method***
- In this method, the traverse is plotted to scale on graph paper, and the number of squares inside the traverse are counted



4

Distance - Traverse

Methods of Computing Area

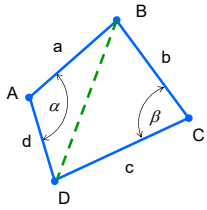


$$Area\ ABC = \frac{1}{2} ac \sin\alpha$$

5

Distance - Traverse

Methods of Computing Area



$$Area\ ABD = \frac{1}{2} ad \sin\alpha$$

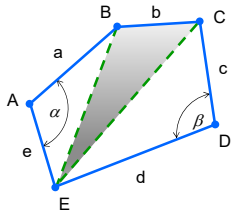
$$Area\ BCD = \frac{1}{2} bc \sin\beta$$

$$Area\ ABCD = Area\ ABD + Area\ BCD$$

6

Distance - Traverse

Methods of Computing Area



$$Area\ ABE = \frac{1}{2} ae \sin\alpha$$

$$Area\ CDE = \frac{1}{2} cd \sin\beta$$

- To compute ***Area BCD*** more data is required

7

Surveying - Traverse

Balancing Angles

- Before the areas of a piece of land can be computed, it is necessary to have a ***closed traverse***
- The ***interior angles*** of a ***closed traverse*** should total:

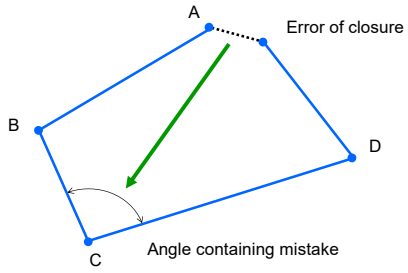
$$(n - 2)(180°)$$

where n is the number of sides of the traverse

8

Surveying - Traverse

Balancing Angles



9

Surveying - Traverse

Balancing Angles

- A surveying heuristic is that the total angle should not vary from the correct value by more than the square root of the number of angles measured times the precision of the instrument
- For example, in an eight-sided traverse using a 1' transit, the maximum error is:

$$\pm 1'\sqrt{8} = \pm 2.83' = \pm 3'$$

10

Surveying - Traverse

Balancing Angles

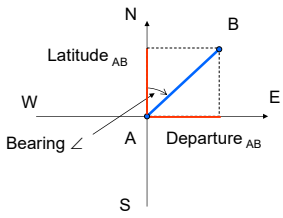
- If the angles do not close by a reasonable amount, mistakes in measuring have been made
- If an error of 1' is made, the surveyor may correct one angle by 1'
- If an error of 2' is made, the surveyor may correct two angles by 1' each
- If an error of 3' is made in a 12-sided traverse, the surveyor may correct each angle by 3'/12 or 15"

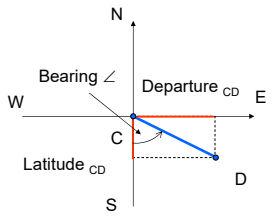
11

Surveying - Traverse

Latitudes and Departures

- The ***closure*** of a traverse is checked by computing the latitudes and departures of each of it sides



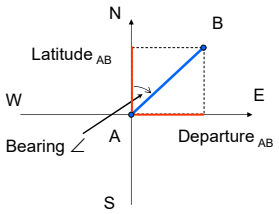


12

Surveying - Traverse

Latitudes and Departures

- The ***latitude*** of a line is its projection on the north-south meridian



- The ***departure*** of a line is its projection on the east-west line
- A northeasterly bearing has: + latitude and + departure

13

Surveying - Traverse

Error of Closure

- Consider the following statement:

"If you start at one corner of a closed traverse and walk its lines until you return to your starting point, you will have walked as far north as you walked south and as far east as you have walked west."

- Therefore Σ latitudes = 0 and Σ departures = 0

14

Surveying - Traverse

Error of Closure

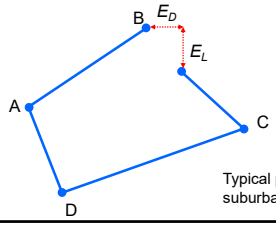
- When latitudes are added together, the resulting error is called the ***error in latitudes*** (E_L)
- The error resulting from adding departures together is called the ***error in departures*** (E_D)

15

Surveying - Traverse

Error of Closure

- If the measured bearings and distances are plotted on a sheet of paper, the figure will not close because of E_L and E_D



Error of closure

$$E_{closure} = \sqrt{(E_L)^2 + (E_D)^2}$$

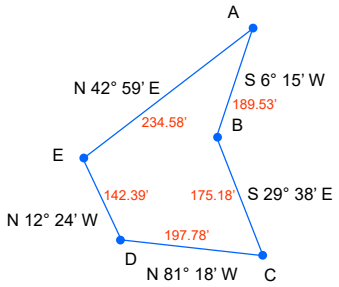
$$\text{Precision} = \frac{E_{closure}}{\text{perimeter}}$$

Typical precision: 1/5,000 for rural land, 1/7,500 for suburban land, and 1/10,000 for urban land

16

Surveying - Traverse

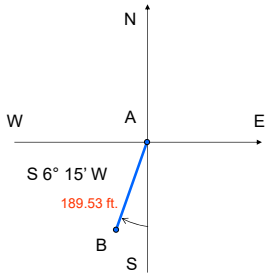
Latitudes and Departures - Example



17

Surveying - Traverse

Latitudes and Departures - Example



Departure AB

$-W = -(189.53 \text{ ft.})\sin(6°15')$

$= -(189.53 \text{ ft.})\sin(6.25°)$

$= -20.63 \text{ ft.}$

Latitude AB

$-S = -(189.53 \text{ ft.})\cos(6°15')$

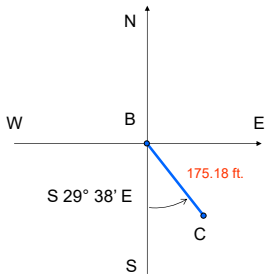
$= -(189.53 \text{ ft.})\cos(6.25°)$

$= -188.40 \text{ ft.}$

18

Surveying - Traverse

Latitudes and Departures - Example



Departure $_{BC}$

$+E = (175.18\text{ ft.})\sin(29°38')$

$= (175.18\text{ ft.})\sin(29.6333°)$

$= 86.62\text{ ft.}$

Latitude $_{BC}$

$-S = -(175.18\text{ ft.})\cos(29°38')$

$= -(175.18\text{ ft.})\cos(296333°)$

$= -152.27\text{ ft.}$

19

Surveying - Traverse

Latitudes and Departures - Example

Side	Bearing	degree	minutes		Length (ft.)	Latitude	Departure
AB	S	6	15	W	189.53	-188.403	-20.634
BC	S	29	38	E	175.18	-152.268	86.617
CD	N	81	18	W	197.78		
DE	N	12	24	W	142.39		
EA	N	42	59	E	234.58		

20

Surveying - Traverse

Latitudes and Departures - Example

Side	Bearing	degree	minutes		Length (ft.)	Latitude	Departure
AB	S	6	15	W	189.53	-188.403	-20.634
BC	S	29	38	E	175.18	-152.268	86.617
CD	N	81	18	W	197.78	29.916	-195.504
DE	N	12	24	W	142.39	139.068	-30.576
EA	N	42	59	E	234.58	171.607	159.933
					939.46	-0.079	-0.163

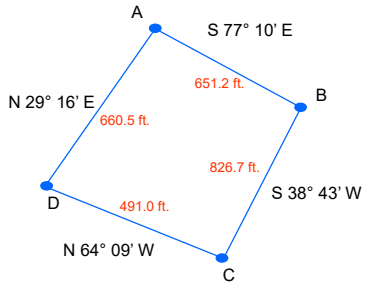
$$E_{closure} = \sqrt{(E_L)^2 + (E_D)^2} = \sqrt{(-0.079)^2 + (-0.163)^2} = 0.182\text{ ft.}$$

$$\text{Precision} = \frac{E_{closure}}{\text{perimeter}} = \frac{0.182\text{ ft.}}{939.46\text{ ft.}} = \boxed{\frac{1}{5,175}}$$

21

Surveying - Traverse

Group Example Problem 1



22

Surveying - Traverse

Group Example Problem 1

$$E_{closure} = \sqrt{(E_L)^2 + (E_D)^2} = \sqrt{(0.601)^2 + (-1.110)^2} = 1.262\text{ ft.}$$

Side	Bearing	degree	minutes		Length (ft.)	Latitude	Departure
AB	S	77	10	E	651.2		
BC	S	38	43	W	826.7		
CD	N	64	9	W	491.0		
DE	N	29	16	E	660.5		

$$\text{Precision} = \frac{E_{closure}}{\text{perimeter}} = \frac{1.262\text{ ft.}}{2,629.4\text{ ft.}} = 4.800\times10^{-4} = \frac{1}{2,083}$$

23

Surveying - Traverse

Group Example Problem 1

$$E_{closure} = \sqrt{(E_L)^2 + (E_D)^2} = \sqrt{(0.601)^2 + (-1.110)^2} = 1.262\text{ ft.}$$

Side	Bearing	degree	minutes		Length (ft.)	Latitude	Departure
AB	S	77	10	E	651.2	-144.642	634.933
BC	S	38	43	W	826.7	-645.031	-517.076
CD	N	64	9	W	491.0	214.084	-441.870
DE	N	29	16	E	660.5	576.190	322.902
					2629.4	0.601	-1.110

$$\text{Precision} = \frac{E_{closure}}{\text{perimeter}} = \frac{1.262\text{ ft.}}{2,629.4\text{ ft.}} = 4.800\times10^{-4} = \frac{1}{2,083}$$

24

Surveying - Traverse

Balancing Latitudes and Departures

- Balancing the latitudes and departures of a traverse attempts to obtain more probable values for the locations of the corners of the traverse
- A popular method for balancing errors is called the ***compass*** or the ***Bowditch rule***
- The ***"Bowditch rule,"*** devised by Nathaniel Bowditch, surveyor, navigator, and mathematician, was a proposed solution to the problem of compass traverse adjustment, which was posed in the American journal ***The Analyst*** in 1807.

25

Surveying - Traverse

Balancing Latitudes and Departures

- The ***compass*** method assumes:

  1) angles and distances have the same error
  2) errors are accidental

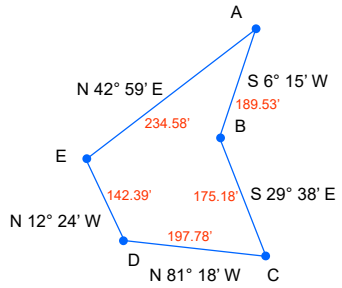
- The rule states:

"The error in latitude (departure) of a line is to the total error in latitude (departure) as the length of the line is the perimeter of the traverse."

26

Surveying - Traverse

Balancing Latitudes and Departures



27

Surveying - Traverse

Latitudes and Departures - Example

Recall the results of our example problem

Side	Bearing	degree	minutes		Length (ft)	Latitude	Departure
AB	S	6	15	W	189.53		
BC	S	29	38	E	175.18		
CD	N	81	18	W	197.78		
DE	N	12	24	W	142.39		
EA	N	42	59	E	234.58		

28

Surveying - Traverse

Latitudes and Departures - Example

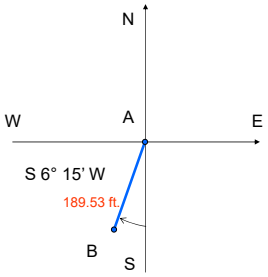
Recall the results of our example problem

Side	Bearing	degree	minutes		Length (ft)	Latitude	Departure
AB	S	6	15	W	189.53	-188.403	-20.634
BC	S	29	38	E	175.18	-152.268	86.617
CD	N	81	18	W	197.78	29.916	-195.504
DE	N	12	24	W	142.39	139.068	-30.576
EA	N	42	59	E	234.58	171.607	159.933
					939.46	-0.079	-0.163

29

Surveying - Traverse

Balancing Latitudes and Departures



Latitude_{AB}

$-S = -(189.53\text{ ft.})\cos(6°15') = -188.40\text{ ft.}$

$$\frac{\text{Correction in Lat}_{AB}}{-E_L} = \frac{L_{AB}}{\text{perimeter}}$$

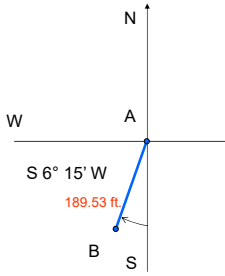
$$\text{Correction in Lat}_{AB} = \frac{-E_L(L_{AB})}{\text{perimeter}}$$

$$\text{Correction in Lat}_{AB} = \frac{+0.079\text{ ft.}(189.53\text{ ft.})}{939.46\text{ ft.}} = +0.016\text{ ft.}$$

30

Surveying - Traverse

Balancing Latitudes and Departures



Departure $_{AB}$

$-W = -(189.53 \text{ ft.})\sin(6°15') = -20.63 \text{ ft.}$

$$\frac{\text{Correction in Dep}_{AB}}{-E_D} = \frac{L_{AB}}{\text{perimeter}}$$

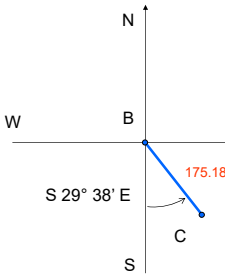
$$\text{Correction in Dep}_{AB} = \frac{-E_D(L_{AB})}{\text{perimeter}}$$

$$\text{Correction in Dep}_{AB} = \frac{+0.163 \text{ ft.}(189.53 \text{ ft.})}{939.46 \text{ ft.}} = +0.033 \text{ ft.}$$

31

Surveying - Traverse

Balancing Latitudes and Departures



Latitude $_{BC}$

$-S = -(175.18 \text{ ft.})\cos(29°38') = -152.27 \text{ ft.}$

$$\frac{\text{Correction in Lat}_{BC}}{-E_L} = \frac{L_{BC}}{\text{perimeter}}$$

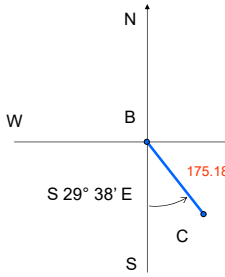
$$\text{Correction in Lat}_{BC} = \frac{-E_L(L_{BC})}{\text{perimeter}}$$

$$\text{Correction in Lat}_{BC} = \frac{+0.079 \text{ ft.}(175.18 \text{ ft.})}{939.46 \text{ ft.}} = +0.015 \text{ ft.}$$

32

Surveying - Traverse

Balancing Latitudes and Departures



Departure $_{BC}$

$+E = (175.18 \text{ ft.})\sin(29°38') = 86.62 \text{ ft.}$

$$\frac{\text{Correction in Dep}_{BC}}{-E_D} = \frac{L_{BC}}{\text{perimeter}}$$

$$\text{Correction in Dep}_{BC} = \frac{-E_D(L_{BC})}{\text{perimeter}}$$

$$\text{Correction in Dep}_{BC} = \frac{+0.163 \text{ ft.}(175.18 \text{ ft.})}{939.46 \text{ ft.}} = +0.030 \text{ ft.}$$

33

Surveying - Traverse

Balancing Latitudes and Departures

Length (ft.)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
189.53	-188.403	-20.634	0.016	0.033		
175.18	-152.268	86.617	0.015	0.030		
197.78	29.916	-195.504				
142.39	139.068	-30.576				
234.58	171.607	159.933				
939.46	-0.079	-0.163				

Corrections computed on previous slides

34

Surveying - Traverse

Balancing Latitudes and Departures

Length (ft.)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
189.53	-188.403	-20.634	0.016	0.033	-188.388	-20.601
175.18	-152.268	86.617	0.015	0.030	-152.253	86.648
197.78	29.916	-195.504				
142.39	139.068	-30.576				
234.58	171.607	159.933				
939.46	-0.079	-0.163				

Corrected latitudes and departures

35

Surveying - Traverse

Balancing Latitudes and Departures

Length (ft.)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
189.53	-188.403	-20.634	0.016	0.033	-188.388	-20.601
175.18	-152.268	86.617	0.015	0.030	-152.253	86.648
197.78	29.916	-195.504	0.017	0.034	29.933	-195.470
142.39	139.068	-30.576	0.012	0.025	139.080	-30.551
234.58	171.607	159.933	0.020	0.041	171.627	159.974
939.46	-0.079	-0.163			0.000	0.000

No error in corrected latitudes and departures

36

Surveying - Traverse

Balancing Latitudes and Departures

Combining the latitude and departure calculations with corrections gives:

Side	Bearing				Length (ft.)	Latitude	Departure	Corrections		Balanced	
	degree		minutes					Latitude	Departure	Latitude	Departure
AB	S	6	15	W	189.53	-188.403	-20.634	0.016	0.033	-188.388	-20.601
BC	S	29	38	E	175.18	-152.268	86.617	0.015	0.030	-152.253	86.648
CD	N	81	18	W	197.78	29.916	-195.504	0.017	0.034	29.933	-195.470
DE	N	12	24	W	142.39	139.068	-30.576	0.012	0.025	139.080	-30.551
EA	N	42	59	E	234.58	171.607	159.933	0.020	0.041	171.627	159.974
					939.46	-0.079	-0.163			0.000	0.000

37

Surveying - Traverse

Group Example Problem 2

Balance the latitudes and departures for the following traverse.

Length (ft)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
600.0	450.00	339.00				
450.0	-285.00	259.50				
750.0	-164.46	-599.22				
1800.0	0.54	-0.72				

38

Surveying - Traverse

Group Example Problem 2

Balance the latitudes and departures for the following traverse.

Length (ft)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
600.0	450.00	339.00				
450.0	-285.00	259.50				
750.0	-164.46	-599.22				
1800.0	0.54	-0.72				

39

Surveying - Traverse

Group Example Problem 2

Balance the latitudes and departures for the following traverse.

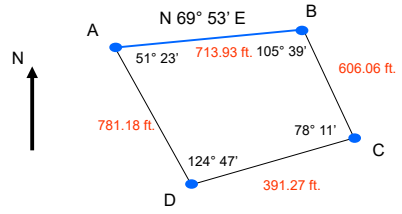
Length (ft)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
600.0	450.00	339.00	-0.180	0.240	449.82	339.24
450.0	-285.00	259.50	-0.135	0.180	-285.14	259.68
750.0	-164.46	-599.22	-0.225	0.300	-164.69	-598.92
1800.0	0.54	-0.72			0.00	0.00

40

Surveying - Traverse

Group Example Problem 3

In the survey of your assigned site in Project #3, you will have to balance the data collected in the following form:



41

Surveying - Traverse

Group Example Problem 3

In the survey of your assigned site in Project #3, you will have to balance the data collected in the following form:

Side	Bearing				Length (ft.)	Latitude	Departure	Corrections		Balanced	
	degree		minutes					Latitude	Departure	Latitude	Departure
AB	N	69	53	E	713.93						
BC					606.06						
CD					391.27						
DA					781.18						

$E_{closure}$ = ft.

Precision = 1

42

Surveying - Traverse

Group Example Problem 3

In the survey of your assigned site in Project #3, you will have to balance the data collected in the following form:

Side	Bearing				Length (ft.)	Latitude	Departure	Corrections		Balanced	
		degree	minutes					Latitude	Departure	Latitude	Departure
AB	N	69	53	E	713.93	245.544	670.376	-0.115	0.199	245.429	670.575
BC	S	35	46	E	606.06	-491.760	354.233	-0.098	0.169	-491.857	354.402
CD	S	66	3	W	391.27	-158.832	-357.582	-0.063	0.109	-158.895	-357.473
DA	N	58	44	W	781.18	405.450	-667.722	-0.126	0.218	405.323	-667.505
					2492.44	0.402	-0.694			0.000	0.000

$E_{closure}$ = 0.802 ft.

Precision = 1 / 3,107

43

Surveying - Traverse

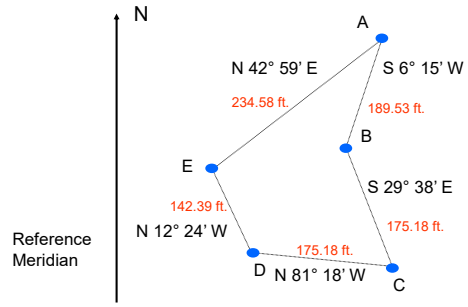
Calculating Traverse Area

- The best-known procedure for calculating land areas is the ***double meridian distance (DMD)*** method
- The ***meridian distance*** of a line is the east-west distance from the midpoint of the line to the reference meridian
- The ***meridian distance*** is positive (+) to the east and negative (-) to the west

44

Surveying - Traverse

Calculating Traverse Area



45

Surveying - Traverse

Calculating Traverse Area

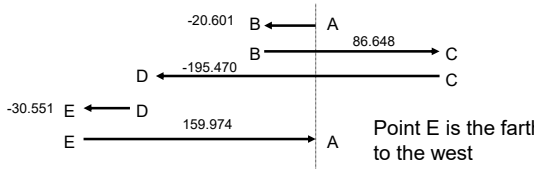
- The most westerly and easterly points of a traverse may be found using the departures of the traverse
- Begin by establishing an arbitrary reference line and using the departure values of each point in the traverse to determine the far westerly point

46

Surveying - Traverse

Calculating Traverse Area

Length (ft.)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
189.53	-188.403	-20.634	0.016	0.033	-188.388	-20.601
175.18	-152.268	86.617	0.015	0.030	-152.253	86.648
197.78	29.916	-195.504	0.017	0.034	29.933	-195.470
142.39	139.068	-30.576	0.012	0.025	139.080	-30.551
234.58	171.607	159.933	0.020	0.041	171.627	159.974
939.46	-0.079	-0.163			0.000	0.000

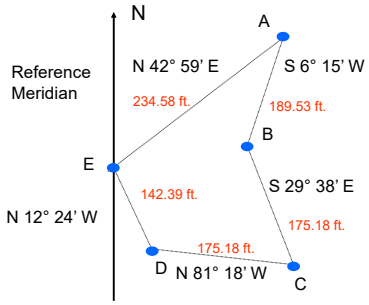


Point E is the farthest to the west

47

Surveying - Traverse

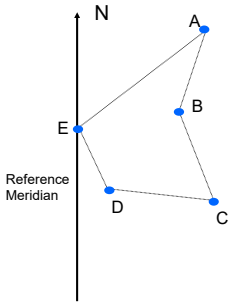
Calculating Traverse Area



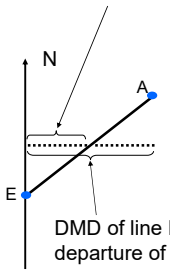
48

Surveying - Traverse

DMD Calculations



The meridian distance of line EA is:

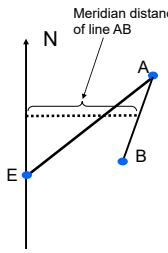


DMD of line EA is the departure of the line

49

Surveying - Traverse

DMD Calculations



- The meridian distance of line AB is equal to:

  The meridian distance of EA
  + ½ the departure of line EA
  + ½ departure of AB

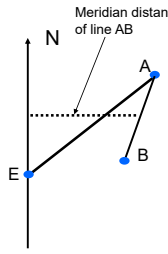
- The **DMD** of line AB is twice the meridian distance of line AB:

  Double meridian distance of EA
  + the departure of line EA
  + departure of AB

50

Surveying - Traverse

DMD Calculations



The DMD of any side is equal to:

The DMD of the last side
+ the departure of the last side
+ the departure of the present side

$DMD_{AB} = DMD_{EA} + dep_{EA} + dep_{AB}$

51

Surveying - Traverse

DMD Calculations

Side	Balanced Latitude	Balanced Departure	DMD
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	
CD	29.933	-195.470	
DE	139.080	-30.551	
EA	171.627	159.974	

The **DMD** of line AB is the departure of the line AB.

52

Surveying - Traverse

DMD Calculations

Side	Balanced Latitude	Balanced Departure		DMD
AB	-188.388	-20.601	+	-20.601
BC	-152.253	86.648	+	45.447
CD	29.933	-195.470		
DE	139.080	-30.551		
EA	171.627	159.974		

The **DMD** of line BC is the DMD of line AB + the departure of line AB + the departure of line BC.

53

Surveying - Traverse

DMD Calculations

Side	Balanced Latitude	Balanced Departure		DMD
AB	-188.388	-20.601	+	-20.601
BC	-152.253	86.648	+	45.447
CD	29.933	-195.470	+	-63.375
DE	139.080	-30.551		
EA	171.627	159.974		

The **DMD** of line CD is the DMD of line BC + the departure of line BC + the departure of line CD.

54

Surveying - Traverse

DMD Calculations

Side	Balanced Latitude	Balanced Departure		DMD
AB	-188.388	-20.601		-20.601
BC	-152.253	86.648		45.447
CD	29.933	-195.470	+	-63.375
DE	139.080	-30.551	+	-289.397
EA	171.627	159.974		

The **DMD** of line DE is the DMD of line CD + the departure of line CD + the departure of line DE.

55

Surveying - Traverse

DMD Calculations

Side	Balanced Latitude	Balanced Departure		DMD
AB	-188.388	-20.601		-20.601
BC	-152.253	86.648		45.447
CD	29.933	-195.470		-63.375
DE	139.080	-30.551	+	-289.397
EA	171.627	159.974	+	-159.974

The **DMD** of line EA is the DMD of line DE + the departure of line DE + the departure of line EA.

56

Surveying - Traverse

DMD Calculations

Side	Balanced Latitude	Balanced Departure	DMD
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	45.447
CD	29.933	-195.470	-63.375
DE	139.080	-30.551	-289.397
EA	171.627	159.974	-159.974

Notice that the DMD values can be positive or negative.

57

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	
CD	29.933	-195.470	-63.375	
DE	139.080	-30.551	-289.397	
EA	171.627	159.974	-159.974	

- The double area for line AB equals the DMD of line AB multiplied by the latitude of line AB

58

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	
DE	139.080	-30.551	-289.397	
EA	171.627	159.974	-159.974	

- The double area for line BC equals the DMD of line BC multiplied by the latitude of line BC

59

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	
EA	171.627	159.974	-159.974	

- The double area for line CD equals the DMD of line CD multiplied by the latitude of line CD

60

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	

- The double area for line DE equals the DMD of line DE multiplied by the latitude of line DE

61

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

- The double area for line EA equals DMD of line EA multiplied by the latitude of line EA

62

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

1 acre = 43,560 ft.^{2}

63

Surveying - Traverse

Traverse Area - Double Area

- The sum of the products of each point's DMD and latitude equals twice the area, or the ***double area***

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456
			2 Area =	-72,641
			Area =	36,320 ft.^{2}
				0.834 acre

1 acre = 43,560 ft.^{2}

64

Surveying - Traverse

Traverse Area - Double Area

- The word "acre" is derived from Old English æcer (originally meaning "open field," cognate with Swedish "åker," German "acker," Latin "ager," and Greek "αγρος" (*agros*).
- The acre was selected as approximately the amount of land that one man, working behind an ox, could till in a day.
- This explains one definition as the area of a rectangle with sides of length one chain (66 ft.) and one furlong (ten chains or 660 ft.).

65

Surveying - Traverse

Traverse Area - Double Area

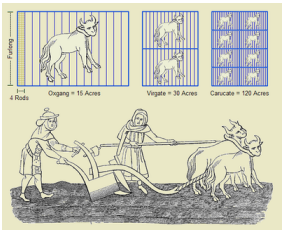
- The word "acre" is derived from Old English æcer (originally meaning "open field," cognate with Swedish "åker," German "acker," Latin "ager," and Greek "αγρος" (*agros*).
- A long, narrow strip of land is more efficient to plow than a square plot, since the plow does not have to be turned as often.
- The word "furlong" itself derives from the fact that it is *one furrow long*.

66

Surveying - Traverse

Traverse Area - Double Area

- The word "acre" is derived from Old English æcer (originally meaning "open field," cognate with Swedish "åker," German "acker," Latin "ager," and Greek "αγρος" (*agros*).



67

Surveying - Traverse

Traverse Area – Example 4

- Find the area enclosed by the following traverse

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	600.0	200.0		
BC	100.0	400.0		
CD	0.0	100.0		
DE	-400.0	-300.0		
EA	-300.0	-400.0		
			2 Area =	

1 acre = 43,560 ft.^{2}

Area =		ft.^{2}
		acre

68

Surveying - Traverse

Traverse Area – Example 4

- Find the area enclosed by the following traverse

Side	Balanced Latitude	Balanced Departure	DMD	Double Areas
AB	600.0	200.0	200.0	120,000
BC	100.0	400.0	800.0	80,000
CD	0.0	100.0	1300.0	0
DE	-400.0	-300.0	1100.0	-440,000
EA	-300.0	-400.0	400.0	-120,000
			2 Area =	-360,000

1 acre = 43,560 ft.^{2}

Area =	180,000	ft.^{2}
	4.132	acre

69

Surveying - Traverse

DPD Calculations

- The same procedure used for DMD can be used for the ***double parallel distances (DPD)*** multiplied by the balanced departures
- The ***parallel distance*** of a line is the distance from the midpoint of the line to the reference parallel or east-west line

70

Surveying - Traverse

Rectangular Coordinates

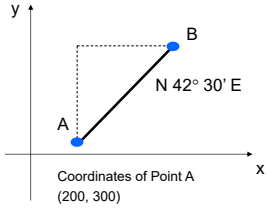
- Rectangular coordinates are a convenient method available for describing the horizontal position of survey points
- With the application of computers, rectangular coordinates are used frequently in engineering projects
- In the US, the ***x-axis*** corresponds to the east-west direction and the ***y-axis*** to the north-south direction

71

Surveying - Traverse

Rectangular Coordinates Example

In this example, the length of AB is 300 ft., and the bearing is shown in the figure below. Determine the coordinates of point B.



Latitude $_{AB}$ =300 ft. cos(42°30') = 221.183 ft.

Departure $_{AB}$ =300 ft. sin(42°30') = 202.677 ft.

x_B = 200 + 202.667 = 402.667 ft.

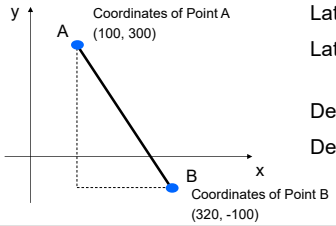
y_B = 300 + 221.183 = 521.183 ft.

72

Surveying - Traverse

Rectangular Coordinates Example

In this example, it is assumed that the coordinates of points A and B are known; we want to calculate the latitude and departure for line A.



$\text{Latitude}_{AB} = y_B - y_A$

$\text{Latitude}_{AB} = -400$ ft.

$\text{Departure}_{AB} = x_B - x_A$

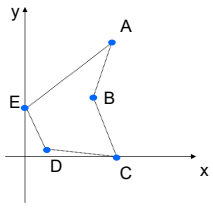
$\text{Departure}_{AB} = 220$ ft.

73

Surveying - Traverse

Rectangular Coordinates Example

Consider our previous example and determine the ***x***- and ***y***-coordinates of all the points.

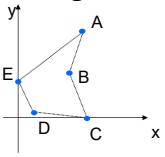


Side	Balanced	
	Latitude	Departure
AB	-188.388	-20.601
BC	-152.253	86.648
CD	29.933	-195.470
DE	139.080	-30.551
EA	171.627	159.974

74

Surveying - Traverse

Rectangular Coordinates Example



Side	Balanced	
	Latitude	Departure
AB	-188.388	-20.601
BC	-152.253	86.648
CD	29.933	-195.470
DE	139.080	-30.551
EA	171.627	159.974

- *x*-coordinates

E = 0 ft.

A = E + 159.974 = 159.974 ft.

B = A – 20.601 = 139.373 ft.

C = B + 86.648 = 226.021 ft.

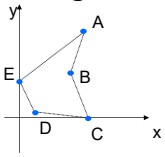
D = C – 195.470 = 30.551 ft.

E = D – 30.551 = 0 ft.

75

Surveying - Traverse

Rectangular Coordinates Example



Side	Balanced	
	Latitude	Departure
AB	-188.388	-20.601
BC	-152.253	86.648
CD	29.933	-195.470
DE	139.080	-30.551
EA	171.627	159.974

- *y*-coordinates

C = 0 ft.

D = C + 29.933 ft.

E = D + 139.080 = 169.013 ft.

A = E + 171.627 = 340.640 ft.

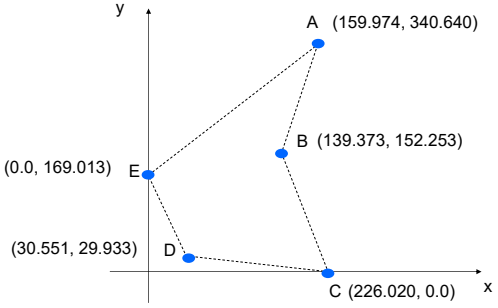
B = A –188.388 = 152.252 ft.

C = B –152.252 = 0 ft.

76

Surveying - Traverse

Rectangular Coordinates Example



77

Surveying - Traverse

Group Example Problem 5

Compute the *x*- and *y*-coordinates from the following balanced survey data

Side	Bearing				Length (ft.)	Latitude	Departure	Balanced		Points	Coordinates	
	degree		minutes					Latitude	Departure		x	y
AB	S	6	15	W	189.53	-188.403	-20.634	-188.388	-20.601	A	100.000	100.000
BC	S	29	38	E	175.18	-152.268	86.617	-152.253	86.648	B		
CD	N	81	18	W	197.78	29.916	-195.504	29.933	-195.470	C		
DE	N	12	24	W	142.39	139.068	-30.576	139.080	-30.551	D		
EA	N	42	59	E	234.58	171.607	159.933	171.627	159.974	E		
					939.46	-0.079	-0.163	0.000	0.000	A		

78

Surveying - Traverse

Group Example Problem 5

Compute the *x*- and *y*-coordinates from the following balanced survey data

Side	Bearing				Length (ft.)	Latitude	Departure	Balanced Latitude	Balanced Departure	Points	Coordinates x	Coordinates y
	degree		minutes									
AB	S	6	15	W	189.53	-188.403	-20.634	-188.388	-20.601	A	100.000	100.000
BC	S	29	38	E	175.18	-152.268	86.617	-152.253	86.648	B	79.399	-88.388
CD	N	81	18	W	197.78	29.916	-195.504	29.933	-195.470	C	166.047	-240.641
DE	N	12	24	W	142.39	139.068	-30.576	139.080	-30.551	D	-29.423	-210.708
EA	N	42	59	E	234.58	171.607	159.933	171.627	159.974	E	-59.974	-71.627
					939.46	-0.079	-0.163	0.000	0.000			

79

Surveying - Traverse

Area Computed by Coordinates

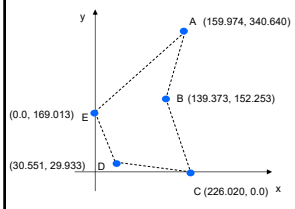
The area of a traverse can be computed by multiplying each *y*-coordinate by the difference in the two adjacent *x*-coordinates.

Use this sign convention: + for the next side and
- for the last side

80

Surveying - Traverse

Area Computed by Coordinates



Twice the area equals:

= 340.640(139.373 – 0.0)

+ 152.253(226.020 – 159.974)

+ 0.0(30.551 – 139.373)

+ 29.933(0.0 – 226.020)

+ 169.013(159.974 – 30.551)

= 72,640.433 ft.^{2}

Area = 0.853 acre

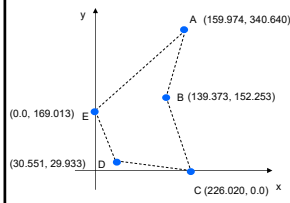
Area = 36,320.2 ft.^{2}

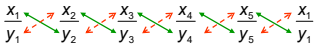
81

Surveying - Traverse

Area Computed by Coordinates

- There is a simple variation of the coordinate method for area computation





Twice the area equals:

= $x_1y_2 + x_2y_3 + x_3y_4 + x_4y_5 + x_5y_1$

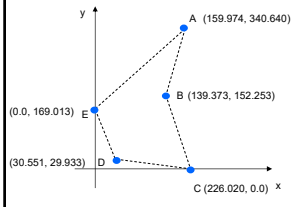
- $x_2y_1 - x_3y_2 - x_4y_3 - x_5y_4 - x_1y_5$

82

Surveying - Traverse

Area Computed by Coordinates

- There is a simple variation of the coordinate method for area computation



Twice the area equals:

159.974(152.253) + 139.373(0.0) + 226.020(29.933) + 30.551(169.013) + 0.0(340.640)

- 340.640(139.373) – 152.253(226.020) - 0.0(30.551) – 29.933(0.0) – 169.013(159.974)

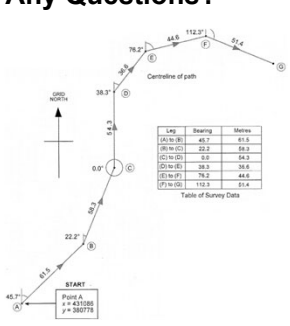
= -72,640 ft.^{2}

Area = 36,320 ft.^{2}

83

End of Surveying - Traverse

Any Questions?



84