Using Real Time Kinematic (RTK) Survey Technology and Blue Marble Software to Streamline Coordinate Conversion

Presented By
Julian Calabrese
and
Catherine A. Dreesbach, P.E.

Objective

- By the end of this talk you should be able to describe the transformation method adapted by Montana's Coal Program to convert localized coordinates into common coordinates

Overview

- Montana and transformation need
- Development of process
- RTK survey and coordinate transformation
- Questions

Montana's Program

- Montana Mines and the Coal Program
  - 16 Permits
  - 12 Active permits; 6 Mine Areas
  - 2 Permits finalizing reclamation
  - 2 Permits completing final bond release
  - 2 Mines expanding and 1 new mine
- This number of permits may seem small compared to some states
- Mine areas range from 2,500 to 10,500 ac.

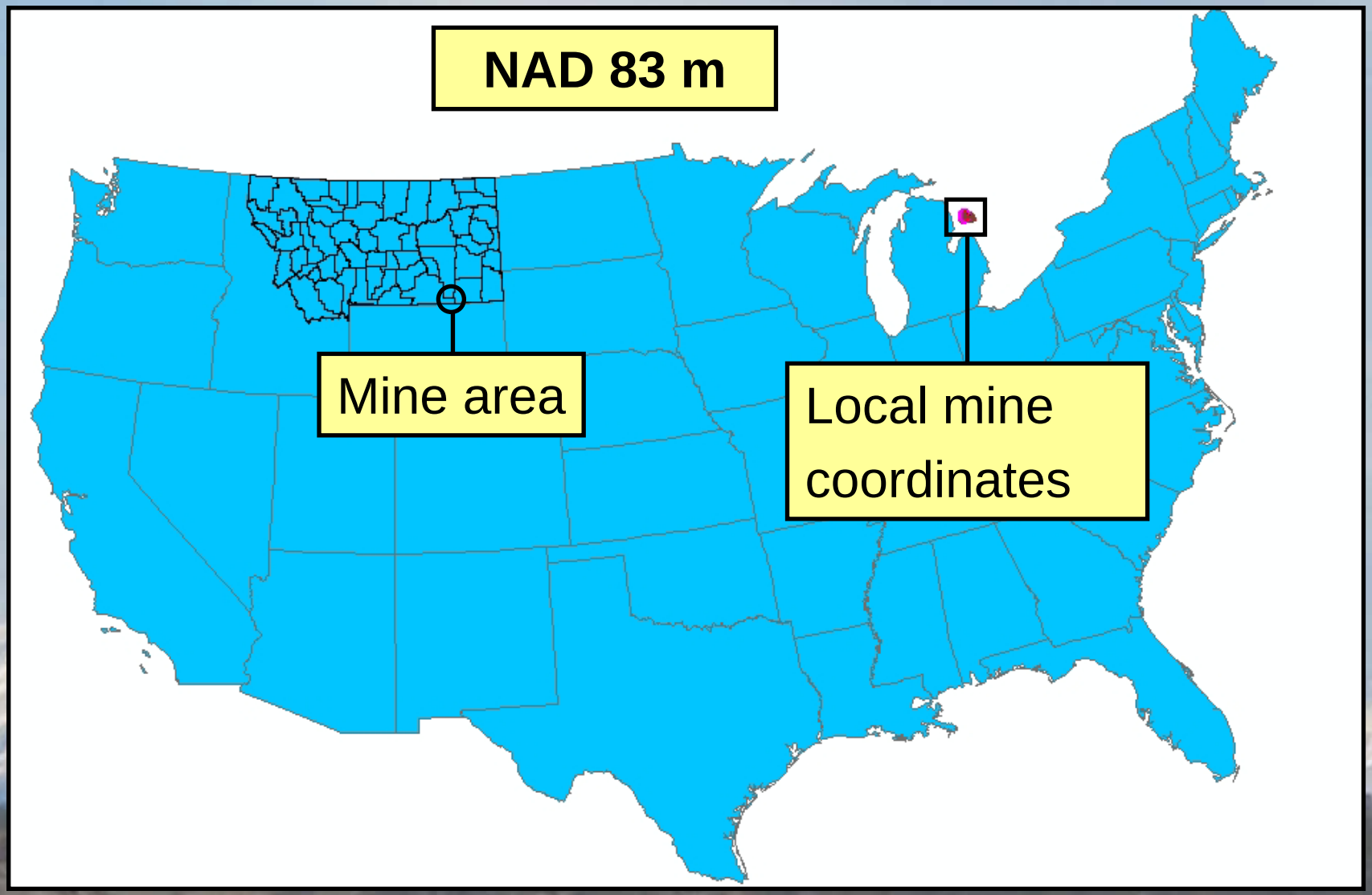
Employee Work Efficiency

- Permits
  - Familiarity of structure, knowledge of rules, and institutional memory
- Computers
  - Digitally formatted data storage, manipulation, and access
  - Reduced search time
  - Added accuracy to spatial data
- Efficiency is only improved if
  - In an intuitive database employees use
  - Compatible with standard coordinate formats

Spatial Data

- Digital data since the mid 90's
  - Mine plan, vegetation or wildlife communities, and disturbance limits are all part of the digital mine map
- Comparison of layers requires they all use a common coordinate system
- Mapping software use common coordinate systems based on the globe
- Clearinghouse data sources
  - Natural Resource Information System (NRIS), OSM, USGS …
  - North American datum 1983 (NAD 1983) meters

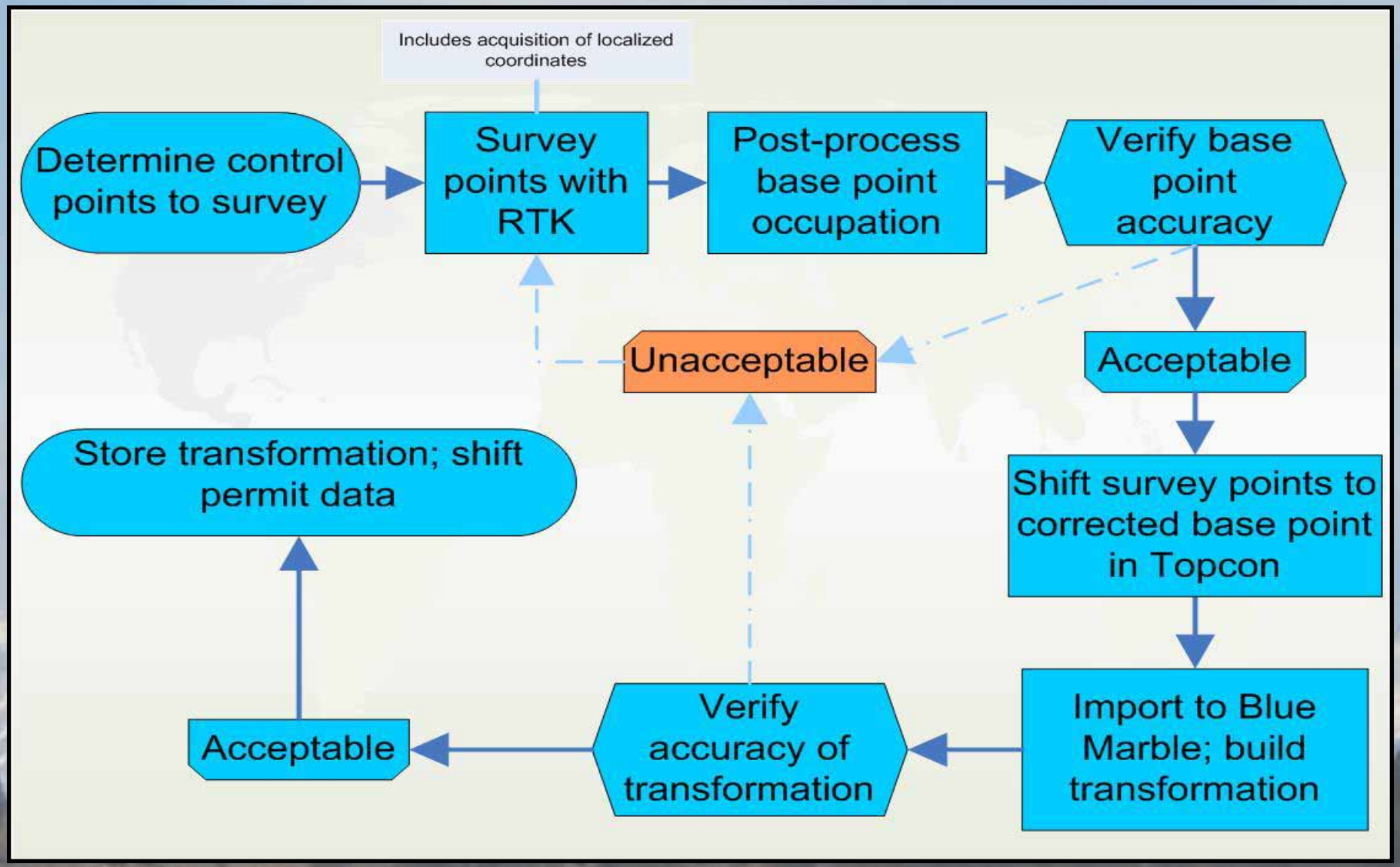
Un-transformed Layers



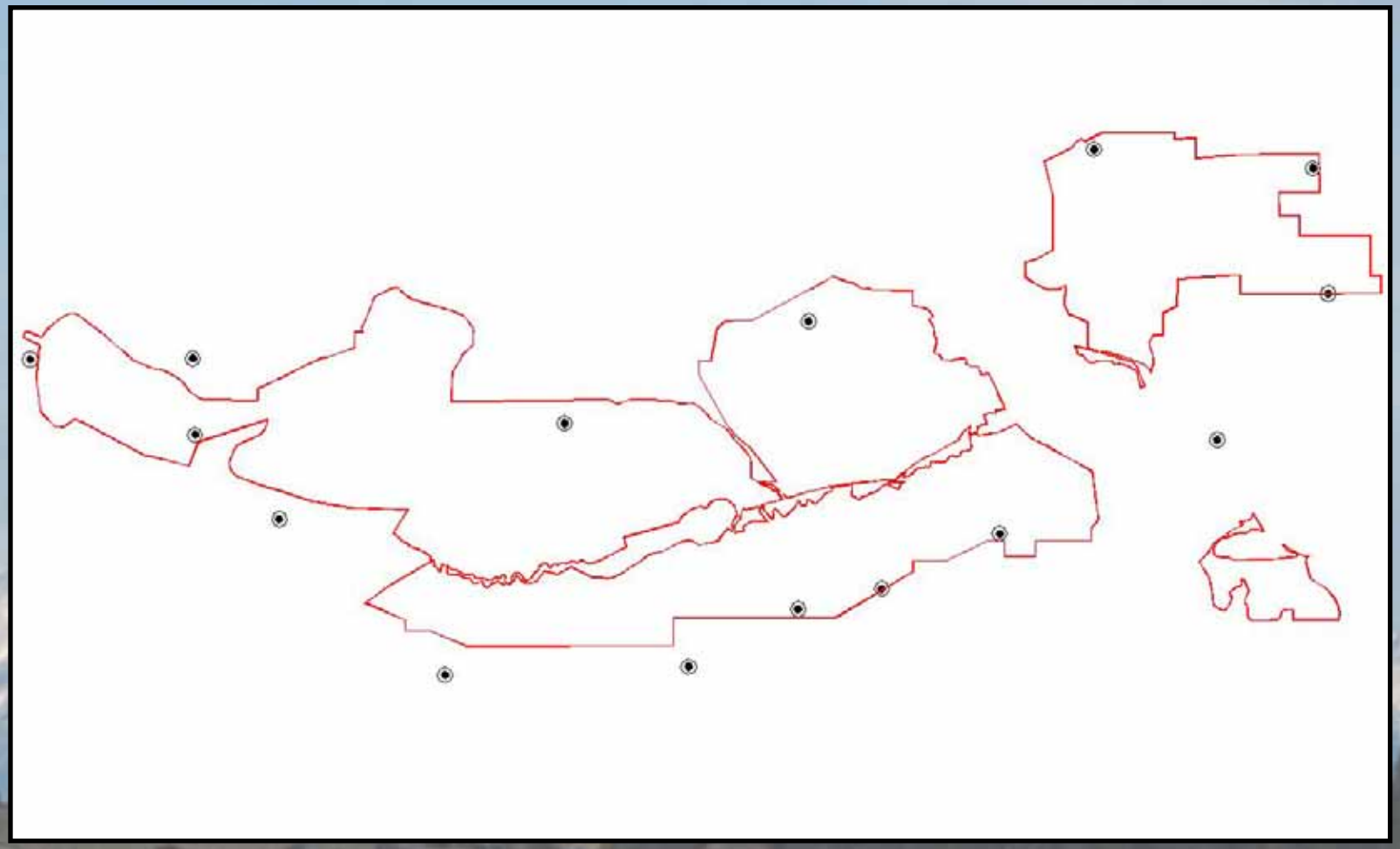
Spatial Adjustment

- How did we tackle this?
  - Require mines to change to a standard
- Set a Standard with a common coordinate system and units
  - Mines use Imperial units e.g. coal density pounds per cubic foot, reclamation in acres, distance in feet.
  - Clearinghouses mostly use NAD 83 meters
- North American Datum 1983 (NAD 83) U.S. Survey Feet.
  - Historical use, standardization in the U.S., ease of explanation

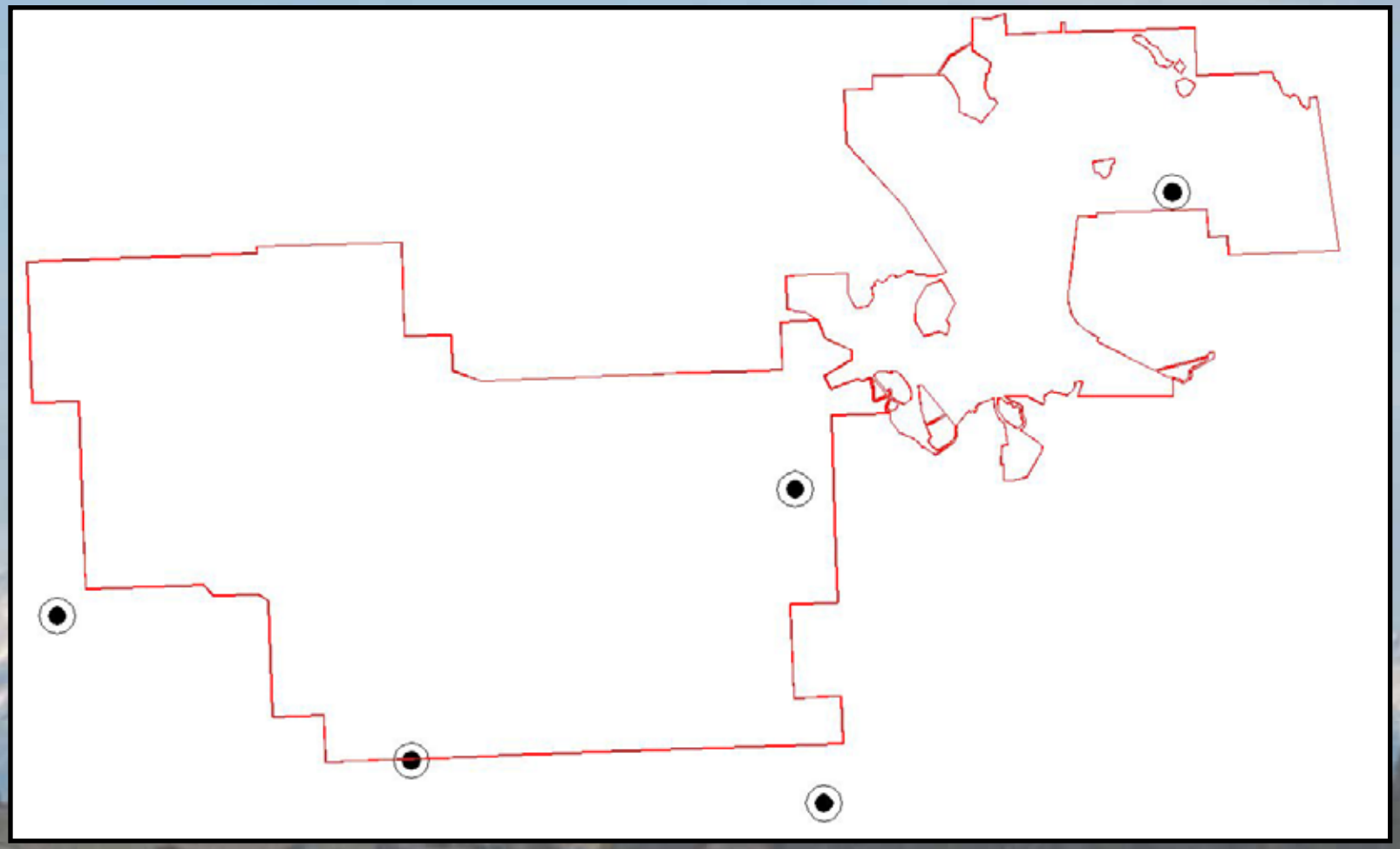
Basic Methodology



Good Distribution



Lopsided Distribution



BASE

Rover Unit

Montana Department of
Environmental Quality

Post Processing

- Online Positioning User Service (OPUS)
  - Managed by NGS and NOAA
- Continuously Operating Reference Stations (CORS)
  - Compared to three CORS sites
  - CORS monitor GPS satellites
  - CORS generates base point error by knowing actual satellite positions and the position the base receiver reported (removes atmospheric noise)
- The Base point is adjusted to the CORS corrected coordinates

FILE: scc_base-static.tps 000174781

NGS OPUS SOLUTION REPORT

==========

USER: jcalabrese@mt.gov DATE: July 13, 2007

RINEX FILE: scc_313r.06o TIME: 18:07:04 UTC

SOFTWARE: page5 0612.06 master3.pl START: 2006/11/09 17:51:00

EPHEMERIS: igs14004.eph [precise] STOP: 2006/11/09 20:00:30

NAV FILE: brdc3130.06n OBS USED: 4191 / 4231 : 99%

ANT NAME: TPSHIPER_PLUS NONE # FIXED AMB: 22 / 22 : 100%

ARP HEIGHT: 1.161 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2006.8569)

X:	-1310215.300(m)	0.022(m)	-1310216.029(m)	0.022(m)
Y:	-4316295.932(m)	0.012(m)	-4316294.679(m)	0.012(m)
Z:	4495725.916(m)	0.024(m)	4495725.895(m)	0.024(m)
LAT:	45 5 47.99775	0.006(m)	45 5 48.01992	0.006(m)
E LON:	253 6 51.43841	0.021(m)	253 6 51.38987	0.021(m)
W LON:	106 53 8.56159	0.021(m)	106 53 8.61013	0.021(m)
EL HGT:	1112.017(m)	0.029(m)	1111.305(m)	0.029(m)
ORTHO HGT:	1126.411(m)	0.038(m) [Geoid03 NAVD88]		

Peak to Peak Error

	UTM COORDINATES UTM (Zone 13)	STATE PLANE COORDINATES SPC (2500 MT)
Northing (Y) [meters]	4995418.568	97540.509
Easting (X) [meters]	351627.254	805731.615
Convergence [degrees]	-1.33588993	1.91236299
Point Scale	0.99987069	0.99994336
Combined Factor	0.99969640	0.99976905

US NATIONAL GRID DESIGNATOR: 13TCK5162795419(NAD 83)

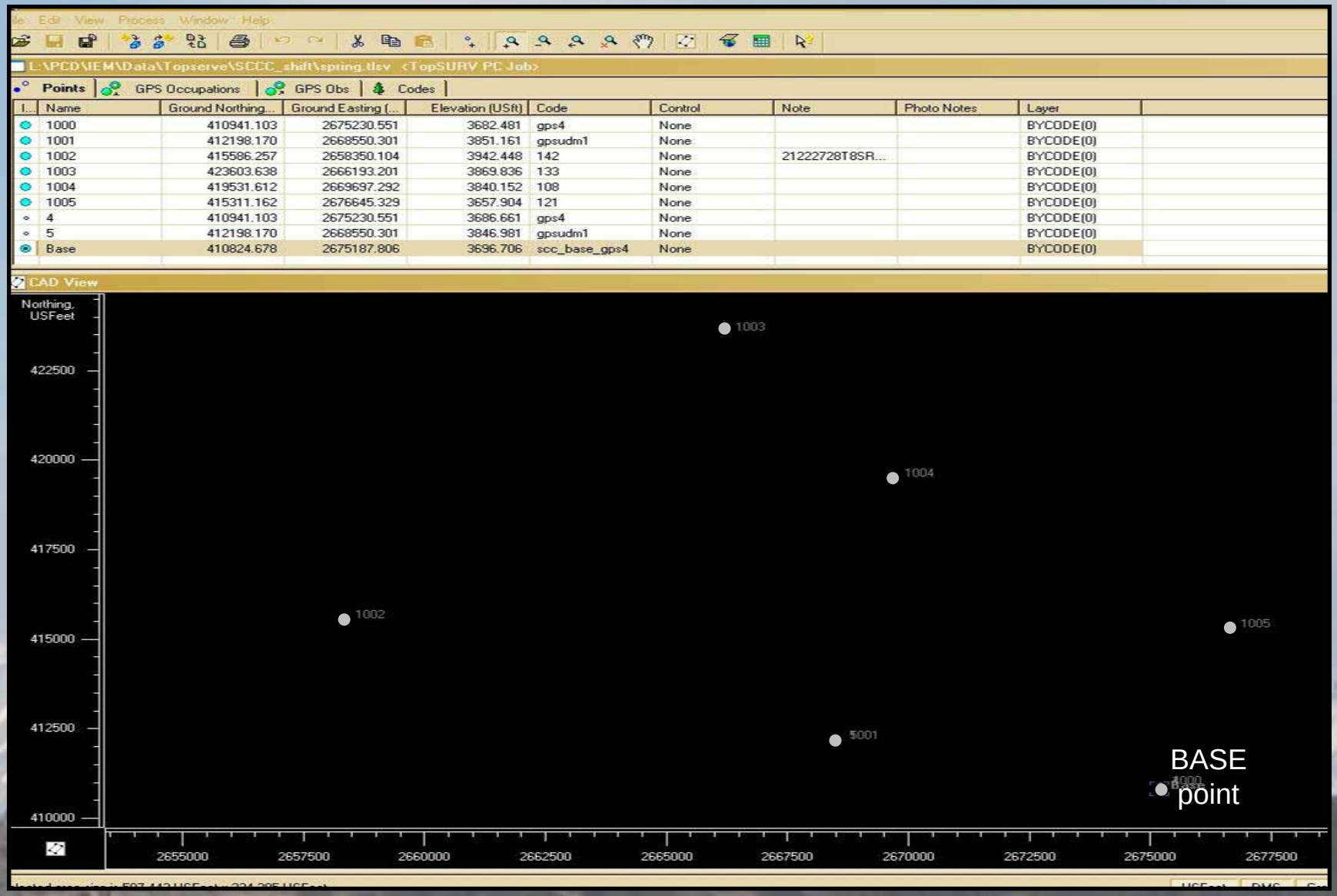
BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DG9745	MTEI ENGINC CORS ARP	N454447.035	W1083600.737	152400.0
DI3062	BIL5 BILLINGS 5 CORS ARP	N455816.237	W1075947.299	130302.3
DI2260	P054 TEREKALAKAMT2006 CORS ARP	N455046.833	W1042629.062	208524.1

NEAREST NGS PUBLISHED CONTROL POINT

QV0068	U 221	N450614.	W1065044.	3256.2

Topcon Adjustment



I...	Name	Ground Northing...	Ground Easting (...	Elevation (USft)	Code	Control	Note	Photo Notes	Layer
	1000	410941.103	2675230.551	3682.481	gps4	None			BYCODE(0)
	1001	412198.170	2668550.301	3851.161	gpsudm1	None			BYCODE(0)
	1002	415586.257	2658350.104	3942.448	142	None	21222728T8SR...		BYCODE(0)
	1003	423603.638	2666193.201	3869.836	133	None			BYCODE(0)
	1004	419531.612	2669697.292	3840.152	108	None			BYCODE(0)
	1005	415311.162	2676645.329	3657.904	121	None			BYCODE(0)
	4	410941.103	2675230.551	3686.661	gps4	None			BYCODE(0)
	5	412198.170	2668550.301	3846.981	gpsudm1	None			BYCODE(0)
	Base	410824.678	2675187.806	3696.706	scc_base_gps4	None			BYCODE(0)

Blue Marble Geographic Calculator

The Geographic Calculator

File Options Window Help

Interactive Conversions | Point Database Conversions | Batch Point Database Conversions | Map File Conversions

Point Database Conversion - DCC_BM_Data.xls

	Point Name	Decker Northing	Decker Easting	Decker Elevation	Nad83 ft Northing	Nad83 ft Easting	Nad83 ft Elevation	Comments
R1	HZ-20	390133.45	2693782.26	3463.36	299286.638	2662101.527	3464.993	
R2	RES-2001	412199.94	2693780.33	3500.04	321348.111	2662081.954	3500.884	
R3	HARRY	411975.28	2690175.28	3608.98	321120.763	2658477.905	3610.199	
R4	DCC-1	411446.77	2685886.66	3682.99	320588.532	2654190.071	3685.331	
R5	B-SIGN	390514.77	2689485.3	3509.3	299664.139	2657804.672	3510.128	
R6	HZ-101	390516.33	2678105.43	3893.15	299657.15	2646427.014	3894.72	
R7	N. 1/4 sec 12	401037.83	2703706.71	NA	310196.132	2672015.069	3458.092	
R8	DUMP	400984.53	2704015.26	3483.01	310143.104	2672323.647	3484.599	
R9	P-5	399507.66	2708826.29	3537.78	308669.679	2677134.802	3539.819	
R10	BIG_JOHNSON	398929.35	2700335.55	3454.65	308085.424	2668646.13	3455.727	
R11	ROW	388847.2	2697860.53	3464.4	299287.084	2662101.428	3465.005	This point may
R12	Opus_Base_DCC	397593.82	2689694.16	3619.61	306741.814	2658008.175	3620.472	

Load Data | Save Data | Clear Data | Conversion Settings | Load Settings | Save Settings | Header

Source Coordinate System
Geodetic Latitude / Longitude, WGS 1984, Degrees
Define Coordinate System... | Units | Format

Destination Coordinate System
Geodetic Latitude / Longitude, WGS 1984, Degrees
Define Coordinate System... | Units | Format

Source Vertical Reference: None via Units

<< >>

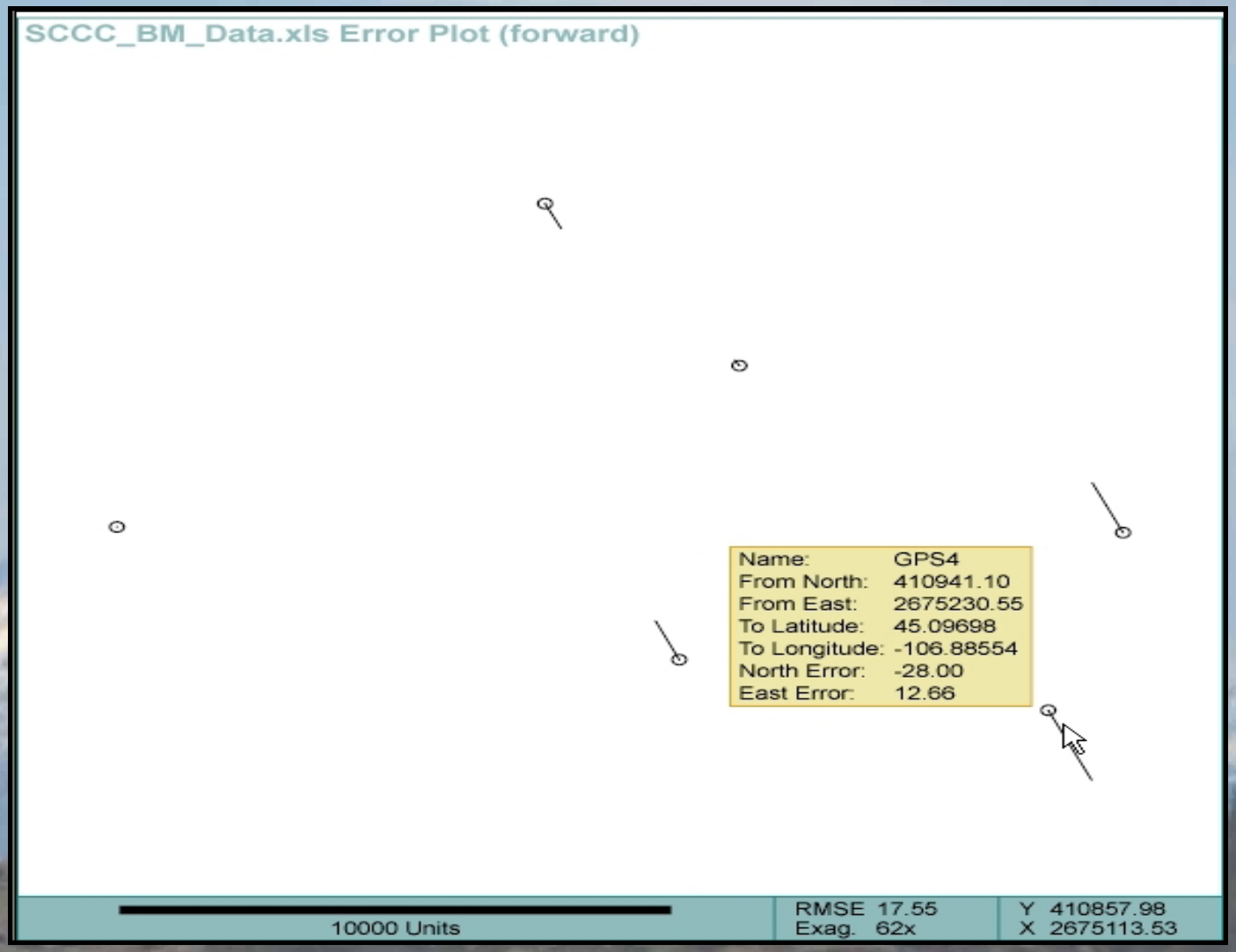
Destination Vertical Reference: None via Units

Ignore Errors

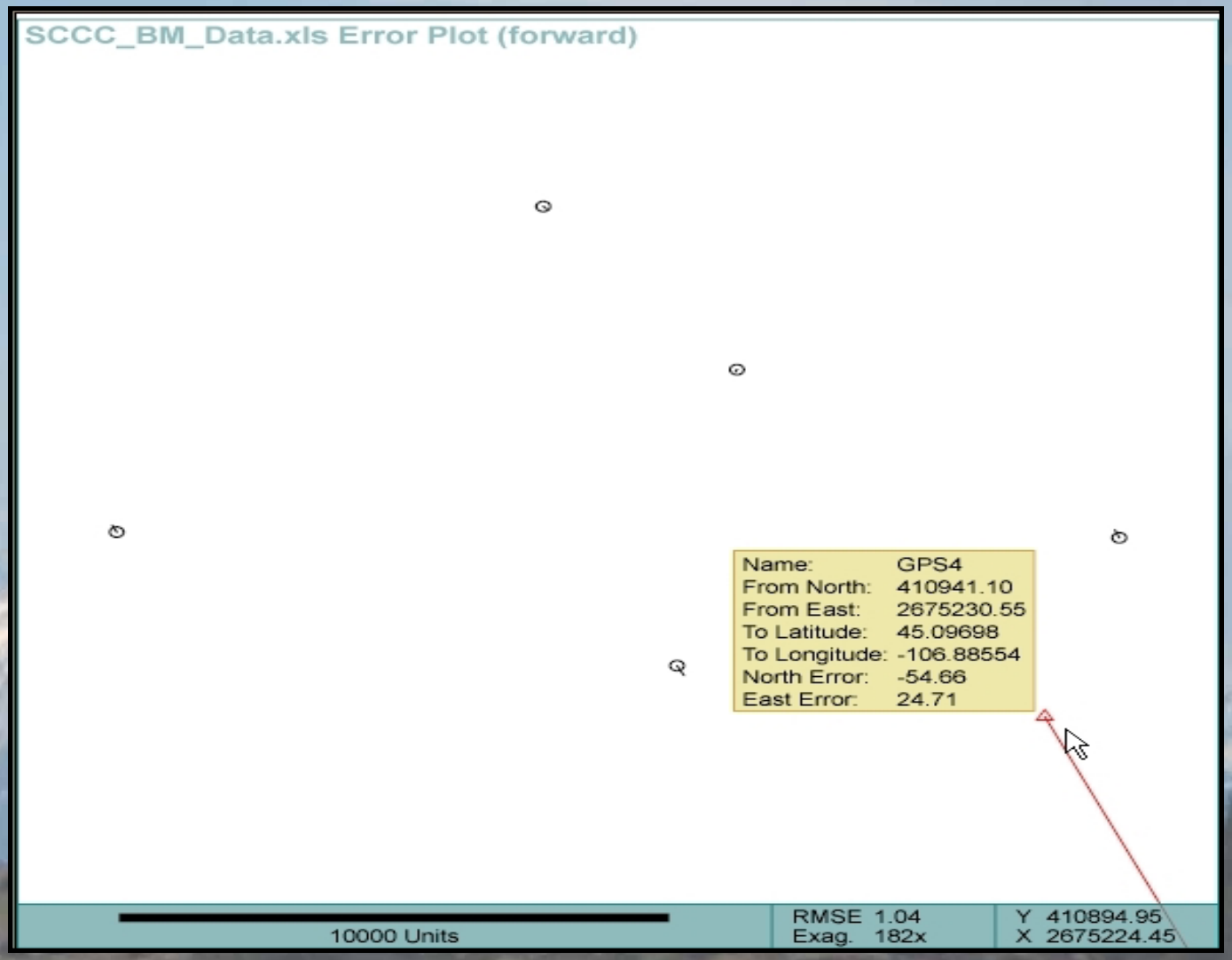
Convert >> | Forward >> | Inverse >> | Best-Fit >>

Montana Department of Environmental Quality

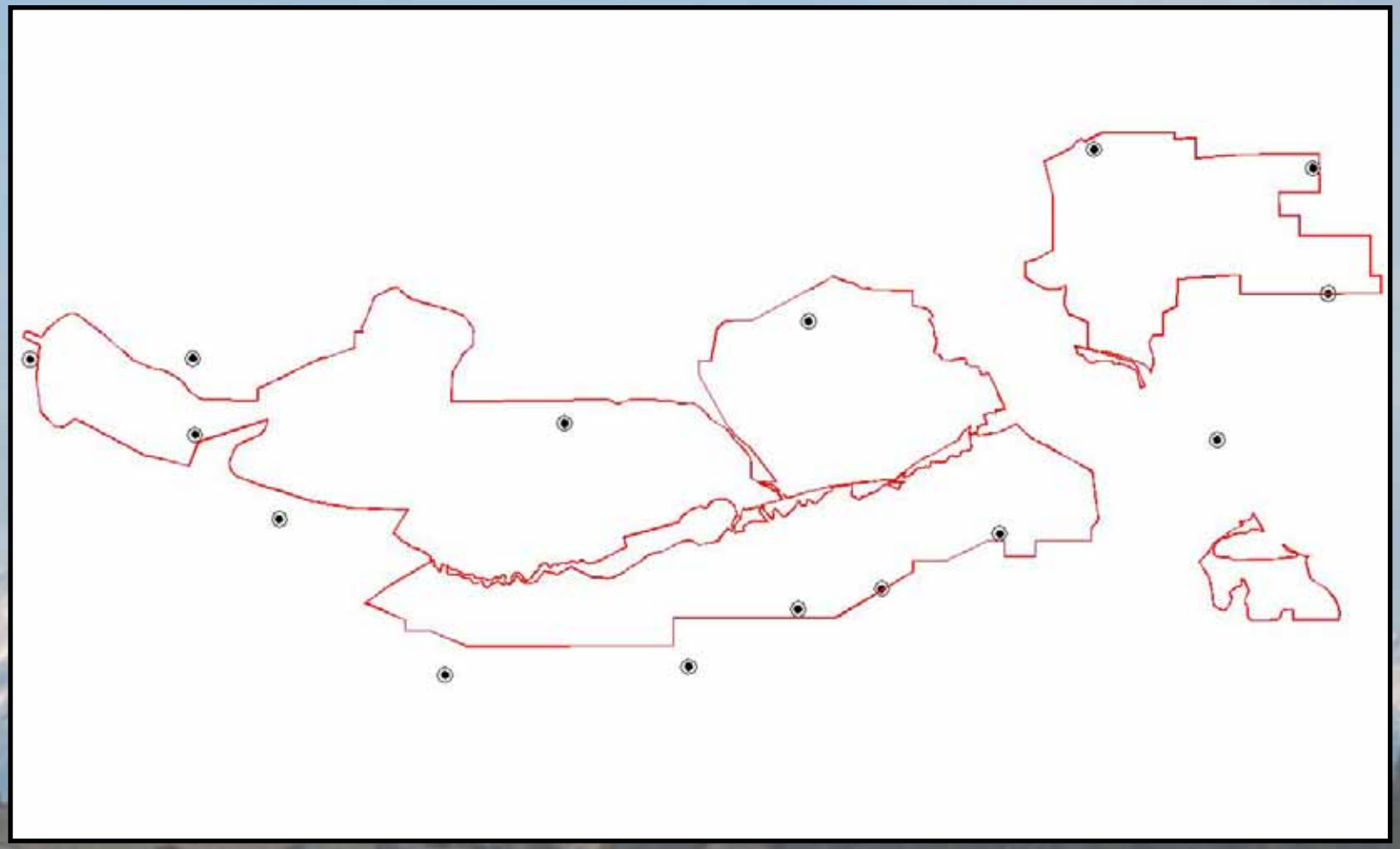
Points with Outlier



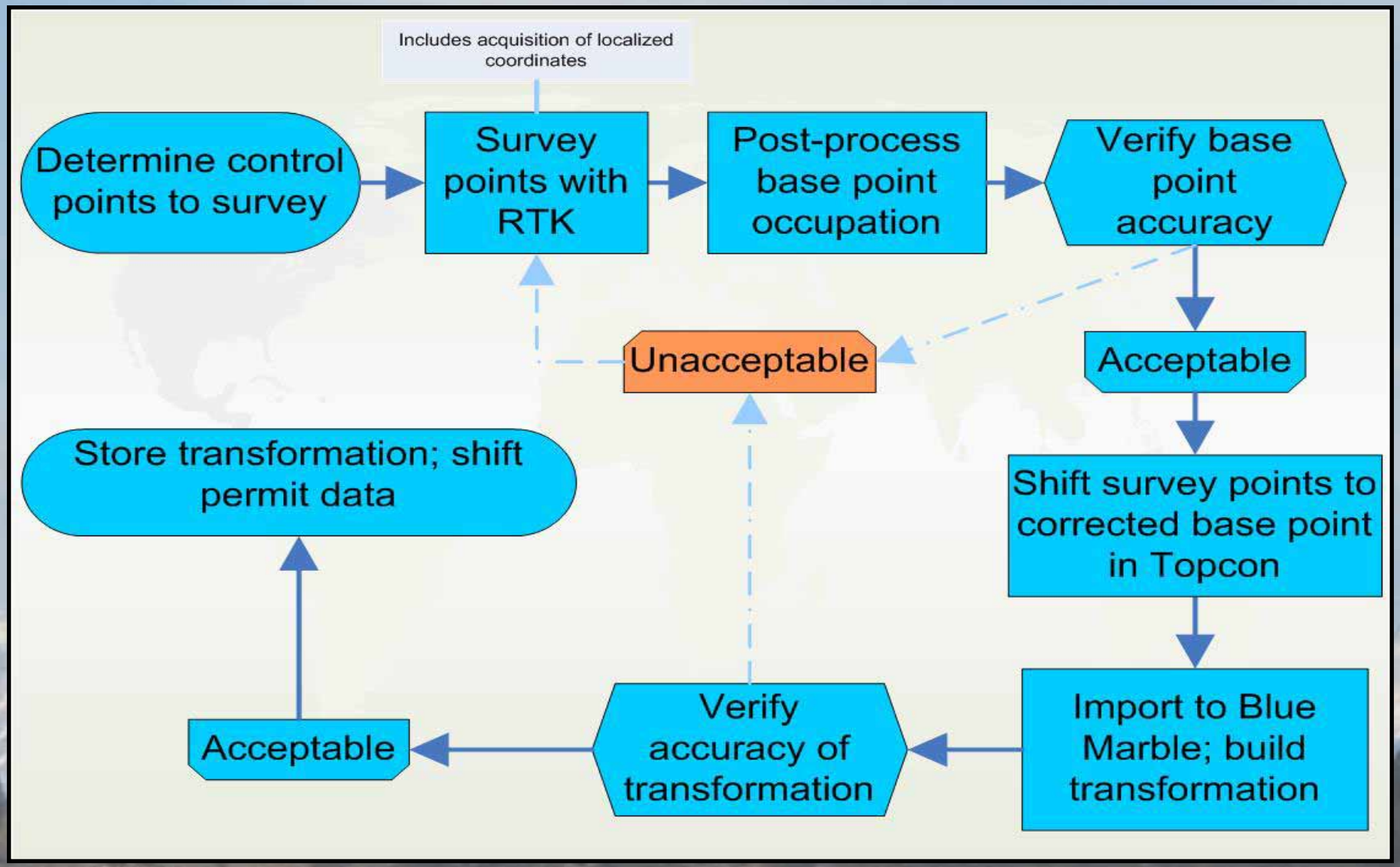
Outlier Flagged



Rosebud Mine



Basic Methodology



Results/Conclusion

Mine	Total Points Surveyed	Total Points Used	RMS Error In Meters
Absaloka	10	5	**0.68**
Big Sky	5	3	**N/A**
Bull Mountains	7	5	**0.76**
Decker	14	8	**0.92**
Rosebud	15	14	**N/A**
Spring Creek	7	4	**0.29**

Questions?
Decker Montana