

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MYANMAR SURVEY DEPARTMENT, MINISTRY OF FORESTRY

**THE STUDY ON
THE ESTABLISHMENT OF GEOGRAPHIC DATABASE
FOR NATIONAL REHABILITATION AND DEVELOPMENT
PROGRAMME
IN THE UNION OF MYANMAR**

Final Report

Volume 2: Documents

AUGUST, 2004

**ASIA AIR SURVEY CO., LTD.
AERO ASAHI CORPORATION**

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Composition of Documents

Three kinds of document were prepared in the Study on the Establishment of Geographic Database for National Rehabilitation and Development Programme.

1. The technical specifications for preparation of topographic data and printed maps

This specifications are described the specifications with Map symbols and application rules to prepare topographic data and topographic maps.

2. The survey manual for preparation of topographic data and print maps

This survey manual is described the details how to prepare topographic data and topographic maps.

3. The GIS Guideline for construction of Geographic information system

This guideline is described how to build GIS to be used widely.

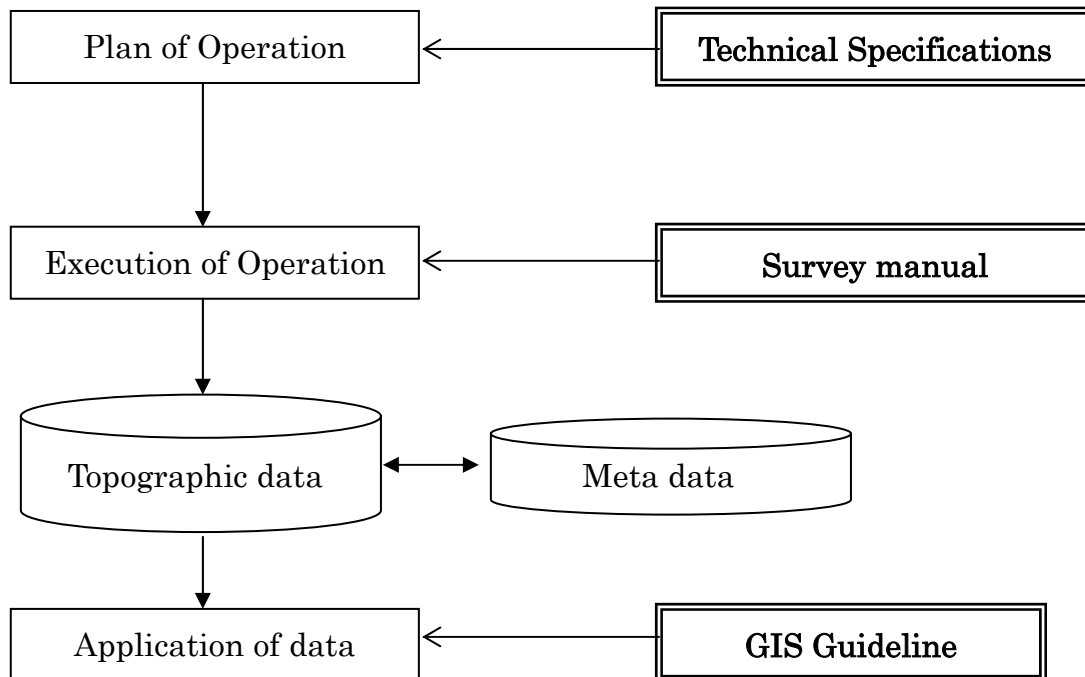


Figure 1. Composition of prepared Manuals

Japan International Cooperation Agency (JICA)

Survey Department, Ministry of Forestry

The Study on
The Establishment of Geographic Database for
National Rehabilitation and Development Programme
In The Union of Myanmar

Technical Specifications
For
Digital Topographic Mapping

August, 2004

ASIA AIR SURVEY CO. LTD.
AERO ASAHI CORPORATION

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Chapter 1. General

(Purpose)

Art.1. The purpose of the specifications are to unify standard of mapping and secure essential qualities by the definition of the method of the basic surveys which the Survey Department, Ministry of Forestry conducts to make topographic data and printing maps.

(Definition of topographic data)

Art. 2. The topographic data treated in the specifications are indispensable basic data to make printing maps.

2. The topographic maps are printed by using make-up films that is prepared from drawing file based on topographic data according to the specifications.
3. The topographic data treated in the specifications shall be used to make topographic map at scale between 1:25,000 and 1:100,000.

(Geodetic fundamental elements)

Art.4. The reference ellipsoid and geodetic fundamental elements treated in the specifications are defined as follows.

- 1) Reference ellipsoid : Everest 1830

Semi-major radius, $a=6,377,276.345\text{m}$

Flattening , $f=1/300.8017$

- 2) Parameters to convert coordinates on WGS-84 to on the reference ellipsoid.

$dX=-246.632\text{m}$

$dY=-784.833\text{m}$

$dZ=-276.923\text{m}$

- 3) Horizontal datum

First order control point : Yangon (Kyanathpo)

Latitude : $N16^{\circ} 58' 20.62762''$

Longitude: $E96^{\circ} 07' 36.99563''$

- 4) Vertical datum

First order benchmark : Kyaikkami

The mean sea level of Kyaikkami in Andaman Sea is defined as 0 meter.

(Units to be used)

Art. 5. Units of measurement treated in the specifications are as follows.

- 1) Length : meter
- 2) Square : km²
- 3) Angle : degrees, minutes and second of arc.

(Map projection)

Art. 6. Map projection treated in the specifications shall be Universal Transverse Mercator (UTM) projection.

2. The central meridian west of 96° E longitude is 93° and east of 96° E is 99°, and scale factor of central meridian is 0.9996.
3. Plane coordinates are defined as E for Easting and N for Northing, and the E-value on the central meridian is 500 km, and the N-value on Equator is 0 m respectively.

(Unit size)

Art. 7. The unit size to prepare topographic data is defined by following size of neat lines.

Table 1 Size of map sheet according to map scale

Map scale	Size on map sheet
1/25,000	7.5' x 7.5'
1/50,000	15' x 15'
1/100,000	30' x 30'

Unit is minute

2. The range of preparation of topographic data is defined as scaled coordinates of 4 corners in map sheet which are converted geographic coordinates to plane coordinates.

(Work processes and their orders)

Art. 8. The general work flow of topographic mapping and their orders are defined as follows.

- 1) Control Surveys
 - 2) Signalization
 - 3) Aerial photography
 - 4) Pricking
 - 5) Field identification
 - 6) Aerial triangulation
-

- 7) Digital plotting
- 8) Digital compilation
- 9) Field completion
- 10) Preparation of topographic data
- 11) Digital compilation for drawing
- 12) Preparation of printing film
- 13) Printing

(Quality control)

Art. 9. To secure necessary quality, the person in charge of quality control shall be selected.

2. The quality control of topographic data shall be executed based on ISO19100 series.

(Inspection)

Art. 10. The inspection shall be executed by responsible person at finished point of each work process.

(Results)

Art. 11. The results in the specifications are consist of final results, survey results, survey records and survey data.

- 1) The final results are defined as end results, which are objectives of this Study.
- 2) The survey results are defined as arranged results to proceeding work process.
- 3) The survey records are defined as intermediate results such as observation records to take out survey results.
- 4) The survey data are defined as original data or information to be collected during preparation and execution of surveying.

(Disclosure of the final results)

Art. 12. The final results should be open to the public works after finishing whole works.

Chapter 2. Topographic Data Mapping

(Definition of Topographic data mapping)

Art. 13. Data of topographic features are acquired from aerial photos or digital aerial image data, and topographic data to build geographic information system or to make maps are prepared using these data.

(Quality of Topographic maps)

Art. 14. The quality of topographic data shall be satisfied the following items.

- 1) Completeness
- 2) Logical consistency
- 3) Positional accuracy

Table 2. Accuracy of horizontal position and elevation

Item	Accuracy	Remarks
Horizontal position	Within 1.0mm	Distance on map
Spot height	Within $h/3$	h is contour interval of main contour
Counter line	Within $h/2$	h is contour interval of main contour

- 4) Temporal accuracy
- 5) Thematic accuracy

(Contour line)

Art. 15. Contour lines are defined as 3 kind of classified ones such as main contour, index contour and supplementary contour.

2. The main contour interval of contour is defined as Table 3. Index contour is defined as every 5 main contours. Interval of supplementary contour is defined as half of main contour.

Table 3. Map scale and contour interval

Map scale	Main contour interval
1/25,000	10 m (More than Elev.200m) 5 m (Less than Elev.200m)
1/50,000	20 m (More than Elev.200m) 10 m (Less than Elev.200m)
1/100,000	40 m (More than Elev.200m) 20 m (Less than Elev.200m)

(Map symbols and application rules)

Art. 16. Map symbols and application rules for printed maps should be defined according to purpose of the study and scale of produced maps.

(Plan of operation)

Art. 17. The organization of operation shall prepare the plan of operation that contains method of operation, instrument to be used, purpose and so on in each work process.

(Construction of ground controls)

Art. 18. Additional ground control points such as horizontal control points and benchmarks are established in order to aerial triangulation for topographic data mapping.

(Positional accuracy of ground controls)

Art. 19. Positional accuracy of control points are defined as Table 4.

Table 4. Accuracy in standard deviation of ground controls

Map scale	Horizontal position	Elevation
1/25,000	0.5 m	0.3 m
1/50,000	0.5 m	0.3 m
1/100,000	1.0 m	0.5 m

(Densification of necessary ground controls)

Art. 20. Additional ground control points shall be performed by control survey in case that number of control points is not sufficient to execute aerial triangulation in the study area.

(Classification of ground controls)

Art. 21. Ground controls are classified into horizontal controls and vertical controls.

(Horizontal control survey)

Art. 22. Horizontal control survey is performed by GPS survey.

(GPS survey)

Art. 23. The GPS survey is defined to receive the signal from GPS satellites and to determine horizontal and vertical coordinates of observed points.

(Location of horizontal controls)

Art. 24. Horizontal control points shall be established at suitable location to secure quality of aerial triangulation.

- 1) At four corners of the study area
- 2) On peripheral boundary of the study area
- 3) Inside of the study area

(Instruments to be used)

Art. 25. The following instrument should be used for GPS survey.

- 1) GPS survey instrument : dual frequency carrier phase receiver

(GPS observation)

Art. 26. GPS survey is performed by static positioning using carrier phase.

2. Observed hours and number of session are defined at Table 5.

Table 5 GPS observation hour and number of session

Measured distance	Observed hour	Session numbers
Less than 30km	2hour	1 time
Less than 50km	3hour	1 time
More than 50km	6hour	1 time

(Calculation of horizontal and vertical position)

Art. 27. Base lines should be calculated based on the known control points using the Base line analysis program. Furthermore, the horizontal and vertical position of new control points should be calculated based on the calculated base lines by 3-dimensional network adjustment program.

2. The position should be calculated on WGS-84, and these results should be converted to position on the reference ellipsoid using parameters shown Art.4.1.

(Arrangement of GPS survey)

Art. 28. After GPS observation, final coordinates list and description of GPS point and detail reports shall be prepared.

(Quality control/Re-observation)

Art. 29. The results of calculation shall be inspected. GPS observation should be performed again if errors exceed by tolerance.

- 1) Loop residuals that are selected periphery of polygons of adjacent session, do not exceed in 1 ppm of total distance.
- 2) Difference of duplicated sides of polygon of each session do not exceed by 1 ppm of total distance.

(Vertical control survey)

Art. 30. Vertical control survey shall be performed to determine elevation of new control points based on existing benchmarks.

2. Vertical control survey is performed by the following methods.
 - 1) Conventional leveling
 - 2) GPS survey

(Planning of leveling route)

Art. 31. Leveling routes are planned in order to establish vertical controls for orientation of aerial photos by aerial triangulation.

(Instrument to be used)

Art. 32. Instrument to be used for conventional leveling is adopted as follows.

- 1) 3-order level
Sensitivity of level : $40\sqrt{2}$ mm
- 2) Survey rods
Reading unit is 1mm

(Execution of leveling)

Art. 33. Elevation of control points shall be observed by level and survey rods based on existing benchmarks.

2. Vertical control points to be specified easily on contact print should be selected and pricked.

(Quality control)

Art. 34. Closure errors are calculated after observation. Re-observation shall be executed in case that closure errors have exceeded the tolerance.

- 1) Tolerance of loop closure error : $40\text{mm}\sqrt{S}$ S is total distance and unit is km
 - 2) Tolerance of misclosure between existing controls : $50\text{mm}\sqrt{S}$
-

(Calculation of elevation in GPS survey)

Art. 35. Calculated height of control points should be corrected based on geoid undulation.

(Arrangement of leveling)

Art. 36. Vertical control points are identified on contact print by pricking , and describe elevation.

(Quality control)

Art. 37. Results of leveling are evaluated, and results should be shown on the quality control sheet.

(Signalization)

Art. 38. Signals shall be set on ground control or eccentric location in order to identify ground controls on aerial photo.

(Setting of signals)

Art. 39. Size, shape and color are defined to identify signals easily on 2-times or 4-times enlarged prints.

2. Size of signals are decided to depend upon scale of aerial photos shown Table 6.

Table 6 Shape, size and color of signals

Photo svale	Shape	Size	Color
1/25,000	Square, 3Wings, 4Wings	5m x 1m	White
1/50,000	Square, 3Wings, 4Wings	5m x 1m	White
1/100,000	Square, 3Wings, 4Wings	10m x 2m	White

(Eccentric signalization)

Art. 40. Eccentric elements such as distance and bearing shall be observed, in case that signals have set eccentric location instead of principal control point.

2. Coordinates of signal shall be calculated, furthermore the descriptions of point should be prepared.

(Confirmation of signals)

Art. 41. Signals shall be confirmed to identify on aerial photos as soon as possible after aerial photography.

(Quality control)

Art. 42. Quality of signalization shall be evaluated, results shall be arranged on quality control sheet.

(Pricking)

Art. 43. Control points shall be identified on aerial photos by pricking in case that signals have not been able to confirm on aerial photos.

2. Pricking should be executed in case that signals are not set on control points.

(Execution of pricking work)

Art. 44. Topographic features to identify on aerial photos shall be selected, and they shall be pricked. In this case, eccentric elements shall be measured from principal control point and coordinates of pricked points should be calculated.

2. A few preliminary features as reference point should be selected and pricked. Coordinates of signal shall be calculated, and prepared detail report and description of point.

(Quality control)

Art. 45. After description and calculation sheet of pricked points shall be inspected, the results should be arranged on quality evaluation sheet.

(Aerial photography)

Art. 46. Aerial photographs to prepare topographic data shall be executed. And photo processing work shall be executed to continue next work.

(Scale of aerial photographs)

Art. 47. The scale of aerial photographs shall be determined according to the quality of prepared topographic data.

(Aircraft and aerial camera to be used)

Art. 48. The aircraft and aerial camera satisfied suitable conditions shall be used.

- 1) The aircraft should be furnished with GPS navigation system and shall be able to fly stably.
- 2) The aerial camera shall be selected precise metric camera with high resolution, small distortion and precise focal distance.

(Plan of aerial photography)

Art. 49. Aerial photography should be planned in consideration of following items.

- 1) Photo course should be planned in straight line and equi-altitude.
 - 2) Adjacent photos should be over-lapped of 60 % and adjacent courses should be side-lapped of 30 % respectively.
 - 3) Continuous airborne kinematic GPS positioning should be observed.
2. Three-dimensional coordinates of exposure position should be calculated on the reference ellipsoid.

(Execution of aerial photography)

Art. 50. Aerial photography covers whole study area shall be executed.

(Quality control)

Art. 51. After aerial photography, the negative film should be processed soon. The quality of negative film should be inspected.

The results should be arranged on quality evaluation sheet.

(Calculation of exposure position)

Art. 52. Three-dimensional coordinates of exposure position of each aerial photo should be calculated in case that Airborne kinematic GPS positioning have performed during aerial photography.

(Re-photography)

Art. 53. Aerial photography shall be executed as soon as possible, in case of re-photography because of less quality.

(Preparation of contact prints and enlarged prints)

Art. 54. Contact prints or enlarged prints should be prepared if necessary.

(Preparation of digital aerial image)

Art. 55. Digital aerial image data should be prepared from negative film or positive films using precise scanner, in case of preparation of topographic data using digital plotters.

2. The resolution of digital image data should be adopted 20 μ m .
3. Prepared digital image data should be stored on CD-ROM or equivalent general purpose media.

(Instrument to be used)

Art. 56. Precise scanner with following specifications should be used to prepare digital aerial image data.

- 1) Geometric accuracy : not less than 10 μ m
- 2) Range of observation : more than 250 mm x 250 mm

(Index map)

Art. 57. The index map of taken aerial photos shall be prepared at suitable scale.

(Quality control)

Art. 58. Quality of aerial photos should be evaluated, the results are arranged on quality control sheet.

(Field identification)

Art. 59. Field identification should be performed in order to interpret topographic features from aerial photos.

(Preparation of field identification)

Art. 60. Prior to field identification, preliminary study should be performed to grasp study items, range and volume of study, based on aerial photo, existing maps and some materials

(Execution for field identification)

Art. 61. The following items should be surveyed based on results of preliminary study.

- 1) Confirmation of preliminary study
- 2) Survey where interpretation is difficult or impossible
- 3) Survey where topographic features are changed after aerial photography
- 4) Confirmation of rules for application of map symbols
- 5) Confirmation of annotations and administrative border
- 6) Others

(Quality control)

Art. 62. Completion of field work and confirmation of study items are executed, and the results should be arranged on quality evaluation sheet.

(Aerial triangulation)

Art. 63. Aerial triangulation is performed to determine orientation parameters in order to acquire topographic data from aerial photos.

(Flight courses)

Art. 64. Flight courses for aerial photography should be planned from east to west, and vice versa.

2. Cross courses should be added in case that airborne GPS support aerial triangulation have been adopted.

(Number of control points)

Art. 65. Ground controls to control horizontal position and elevation shall be distributed at the optimum location of the study area.

2. Number of ground controls can be reduced in case of airborne GPS support aerial triangulation.

(Pass-points and Tie-points)

Art. 66. Pass-points should be selected suitable location of upper, middle and lower parts in stereo model.

2. Tie-points should be selected at least one in each model.

(Inner orientation)

Art. 67. Pass-points, Tie-points and control points shall be selected on aerial photos. These photo coordinates shall be observed, and inner orientation shall be performed.

2. Residuals after inner orientation are less than the tolerance by 20 μm .

(Relative orientation)

Art. 68. Relative orientation is carried out using Pass-points, Tie-points and control points.

2. Residuals after relative orientation shall be less than the tolerance by 20 μm .

(Execution of block adjustment)

Art. 69. The block adjustment shall be performed using the prescribed block adjustment program.

2. Standard deviation of residuals after adjustment is evaluated, and shall be confirmed less than the tolerance by 20 μ m.

(Quality control)

Art. 70. The report shall be arranged after evaluating the results of aerial triangulation.

(Digital plotting)

Art. 71. Geographic data to prepare topographic map from aerial photos or digital aerial image shall be acquired according to the specifications.

(Instrument to be used)

Art. 72. Digital plotter should be used to acquire geographic data. The digital plotter with following functions should be selected.

- 1) Correction of camera calibration
- 2) Inner orientation
- 3) Relative orientation
- 4) Aerial triangulation
- 5) Data acquisition of data structure such as point, line and polygon
- 6) Data acquisition with classified code

(Preparation of stereo model)

Art. 73. Stereo models shall be oriented using results of aerial triangulation and coordinates of control points.

(Data acquisition)

Art. 74. Topographic data shall be acquired from stereo models in following order.

- 1) Control points(GPS points, Triangulation points, Benchmarks)
 - 2) Skeletal features (rivers, coast line, roads railways)
 - 3) Urban district
 - 4) Topography
 - 5) Administrative boundary
 - 6) Border of land use
 - 7) Others
2. Classified codes to specify geographic features shall be added with geographic data.
-

(Quality control)

Art. 75. Plotted topographic features shall be inspected by draft map. The quality control sheets should be arranged.

(Digital compilation)

Art. 76. Topographic data acquired by digital plotting shall be compiled according to the specifications. These data shall be revised by materials collected in field identification and field completion.

(Instrument to be used)

Art. 77. Digital compilation system should be used to compile acquired topographic data. Digital compilation system with following functions should be selected.

- 1) To be able to acquire topographic data directly from 3-dimensional model formed by image data.
- 2) To be able to move, amend and delete topographic data.
- 3) To be able to connect to and divide into line data and polygon data.
- 4) To be able to deal with raster data.
- 5) To be able to import and export data produced by other system.
- 6) To be able to manage database
- 7) To be able to query and display digital topographic data.
- 8) To be able to represent topographic data with map symbols
- 9) To be able to output map
- 10) To be able to define a coordinates system and convert to another coordinate system.

(Jointing between adjoining map sheets)

Art. 78. Topographic data shall be divided into each map sheet, and arranged in units of map sheet.

2. Topographic data intersected at neat line shall accord with same feature of adjacent map sheet.

(Quality control)

Art. 79. Compiled data shall be evaluated by check and inspection using plotted map. The results should be arranged on quality control sheet.

(Field completion)

Art. 80. Supplementary survey to following necessary items are executed in the field based on plotted print by compiled topographic data.

- 1) Confirmation of boundaries, names of place and annotations
- 2) Field survey of doubt parts during compilation
- 3) Field survey of parts to be necessary
- 4) Confirmation of quality of plotting if necessary

2. Topographic data shall be completed to revise based on the results surveyed in the field.

(Quality control)

Art. 81. Completed topographic data shall be inspected and inspected according to specified specifications. And results shall be shown on quality control sheet.

(Preparation of metadata)

Art. 82. Metadata shall be prepared the prescribed form additionally.

Section 3 Preparation of topographic maps

(Compilation for drafting)

Art. 83. Drawing file shall be prepared to symbolize topographic data. Drawing file shall be compiled according to specified map symbols and application rules.

(Preparation of make up films)

Art. 84. Make up films shall be prepared to divide into each color edition(6 colors) using drawing file..

(Proof printing)

Art. 85. Post script editions shall be prepared from make up films. Proof prints shall be executed using proof printing machine

(Inspection/Proof)

Art. 86. Printed maps shall be inspected. Proof print should inspected that items such as omissions of feature, upside down relation of each feature, tone of color, gap of resister, dust and so on, shall be checked.

In case that some errors have been found topographic data shall be corrected first, and drawing file shall be prepared again.

(Final map print)

Art. 87. Each map sheet shall be printed by prepared post script edition films set on the offset printer machine.

(Quality control)

Art. 88. Final printed maps shall be inspected and evaluated, then the results should be shown in the quality control sheet.

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The Study on
The Establishment of Geographic Database for
National Rehabilitation and Development Programme
In The Union of Myanmar

Map Symbols and Application Rules

August, 2004

ASIA AIR SURVEY CO. LTD.
AERO ASAHI CORPORATION

Map Symbol and Legend for 1:50,000 Scale Digital Topographic Maps

Specification for Cartographic display data

Version 5 Final

Prepared for

The Study on

The Establishment of Geographic Database

for National Rehabilitation and Development Program

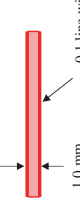







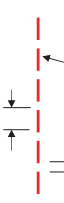



in The Union of Myanmar

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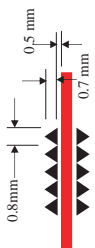

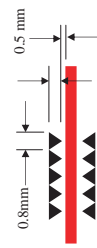

JICA Study Team

Myanmar Survey Department

Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Mapping Feature Code
				in Japanese.	in Myanmar.	
(1) Road (道路)						
01	Highway			Express way, wide width(6 lane or above), connected town to town, motorable in all seasons, paved.	Express way, wide width(6 lane or above), connected town to town, motorable in all seasons, paved.	1001
				高速道路, 6車線以上の道路で町と町を結ぶ舗装道路、(通常は都市部の外にある) 通年通行可能。	高速道路, 6車線以上の道路で町と町を結ぶ舗装道路、(通常は都市部の外にある) 通年通行可能。	
02	Main road			Road connected town to town, motorable in all seasons, paved.	Road connected town to town, motorable in all seasons, paved.	1002
				町と町を結ぶ舗装道路。自動車に通年通行可能。	町と町を結ぶ舗装道路。自動車に通年通行可能。	
03	Secondary road			Road connected town to main road, town to village, village to main road, motorable in all seasons, paved.	Road connected town to main road, town to village, village to main road, motorable in all seasons, paved.	1003
				町とMain road, 町と村、村とMain roadを結ぶ舗装された道路。自動車に通年通行可能。	町とMain road, 町と村、村とMain roadを結ぶ舗装された道路。自動車に通年通行可能。	
04	Other road			Road motorable in dry season, unpaved, connected town to town, town to village, town to main road, village to main road.	Road motorable in dry season, unpaved, connected town to town, town to village, town to main road, village to main road.	1004
				舗装されていない乾期のみ自動車が行き可能な道路。町と村。町または村とmain roadを結ぶ。	舗装されていない乾期のみ自動車が行き可能な道路。町と村。町または村とmain roadを結ぶ。	
05	Cart track			Bullock cart track, connected village to village, village to farm, farm to farm.	Bullock cart track, connected village to village, village to farm, farm to farm.	1005
				二輪馬車、ジープ、四輪駆動車が通行できる道路。	二輪馬車、ジープ、四輪駆動車が通行できる道路。	
06	Pack track			Mule pack track for transports goods by mules on hills area .	Mule pack track for transports goods by mules on hills area .	1006
				ラバやロバで荷物を運ぶ道(主として山岳地帯にある)。	ラバやロバで荷物を運ぶ道(主として山岳地帯にある)。	

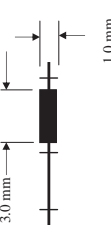

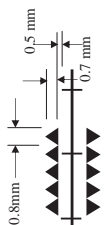
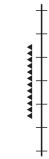
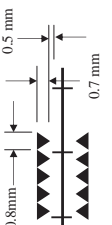
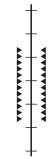
Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>		
10	Embankment for road			A raised, solid fill linear mound, constructed so as to carrying a level road over a low lying place. The difference of elevation is more than 2 m.		Size = Triangle with 1.0 mm length, 0.7mm height, Color = Black (100%).	1010
11	Cutting for road			低地において道路が周囲より高さが2m以上に盛土されている状態を表す。	A excavation for a road. The difference of elevation is more than 2 m.	Size = Triangle with 1.0 mm length, 0.7mm height, Color = Black (100%).	1011

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No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Color Separation										Mapping Feature Code
				in Japanese.	in Myanmar.		Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	
(2) Railway (鉄道)																	
01	Single railway			Single track railway 単線の鉄道	Line width = 0.2 mm, Length of crossing line = 1.5 mm, Width of crossing line = 0.1 mm, Interval of crossing line = 3.0 mm, Color = Black (100%).												
02	Multiple railway			Double or more tracks railway 複線、又はそれ以上の鉄道	Line width = 0.2 mm, Length of double crossing line = 1.5 mm, Space of double crossing line = 0.4 mm, Width of double crossing line = 0.1 mm, Interval of double crossing line = 2.6 mm, Color = Black (100%).												
031	Railway bridge (Minimum size)			A bridge for railway. Apply to case bridge length is less than 100m. 鉄道橋 橋長が100m未満	In case, length of bridge is less than 100m, represented as minimum size. Bridge length is more than 100m, represent as actual length. Line width = 0.2 mm, Length = 2.0 mm (minimum size) or according to size., Color = Black, 100%												
032	Railway bridge (Actual size)			A bridge for railway. Apply to case bridge length is equal to or more than 100m. 鉄道に架かっている橋 橋長が100m以上	In case, length of bridge is less than 100m, represented as minimum size. Bridge length is more than 100m, represent as actual length. Line width = 0.2 mm, Length = 2.0 mm (minimum size) or according to size., Color = Black (100%)												
04	Railway tunnel			A tunnel for railway 鉄道のトンネル (ミャンマーでは道路のトンネルはない)	Line width = 0.2 mm, Dot size for railway line in tunnel = 0.2 mm, Dot interval for railway line in tunnel = 1.0 mm, Color = Black (100%).												

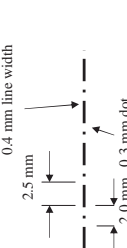

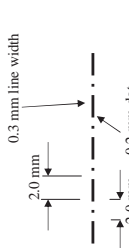

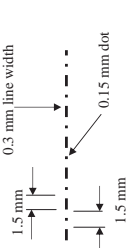
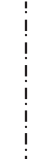
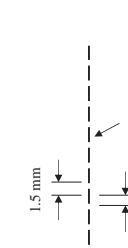
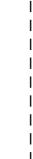
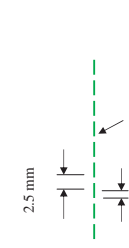

Map symbols Revised edition Ver 5.0 Final, May, 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>		
05	Railway station			A fix stopping place on a rail way line with associated building and struction.		Width = 1.0 mm, Length = 3.0 mm, Color = Black (100%). Represented using by Symbol.	1105
06	Embankment for railway			A raised, solid fill linear mound, constructed so as to carrying a level railway over a low lying place. The difference of elevation is more than 2 m. 低地において鉄道が周囲より高さが2m以上に盛り上げられている状態を表す。		Size = Triangle with 1.0 mm length, 0.7mm height, Color = Black (100%).	1106
07	Cutting for railway			A excavation for a railway. The difference of elevation is more than 2 m. 鉄道が高さ2m以上の切り通しになっている状態を表す。		Size = Triangle with 1.0 mm length,, 0.7mm height, Color = Black (100%).	1107







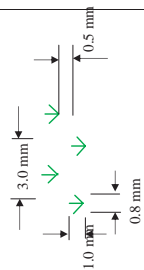
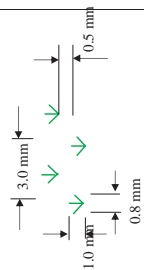


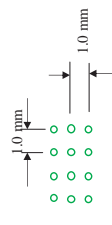
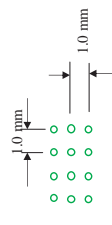
Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Color Separation										Mapping Feature Code	
				in Japanese.	Definition for Geographic Feature revated with legend. (in English) <i>#This space is for reference use only.</i>		Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15		Black100
01	Power transmission line			Electric power line with high voltage. (Applied to Main line only) 高圧送電線(主要な線のみ)に適用される。)	Line width = 0.1 mm, Dot size = 0.5 mm, Spacing of circle = 7.0 mm, Color = Black (100%).	Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15	Black100	Black20	2001
02	Power transmission station			Transformer station of transmission line 高圧送電線の変電所	Width = 0.7 mm, Length = 1.0 mm, Line width = 0.1 mm, Color = Black (100%).	Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15	Black100	Black20	2002
031	Pipe line (Oil,Gas)			Tubular conduct of sustainable length, with pumps, valves, and control devices for conveying oil or gases. 油またはガスの輸送管	Line width = 0.1 mm, Dash size = 1.0 mm, Spacing = 0.5 mm, Circle dia = 1.0 mm, Spacing of circle = 5.0 mm, Color for oil = Black (100%).	Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15	Black100	Black20	20031
032	Pipe line (Water)			Tubular conduct of sustainable length, with pumps, valves, and control devices for conveying water. 水の輸送管	Line width = 0.1 mm, Dash size = 1.0 mm, Spacing = 0.5 mm, Circle dia = 1.0 mm, Spacing of circle = 5.0 mm, Color for water = Blue (100%).	Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15	Black100	Black20	20032
04	Airport / airfield			Airport or Air field. Airport is public flying ground for commercial use by air lines. Airfield means for land particular aircraft. 空港:民間航空のための空港施設 または Airfield:飛行場	Size of Plane symbol = 2.5 mm length × 2.5 mm width. Color = Red (100%).	Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15	Black100	Black20	2004C
05	Airport area line			A boundary for air port area. 空港または飛行場の敷地の範囲を示す。	Line width = 0.2 mm, Dash size = 1.0 mm, Spacing = 1.0 mm, Color = Black (100%), Size = According to actual field.	Green100	Green15	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Yellow15	Black100	Black20	2005A

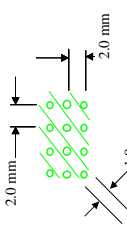

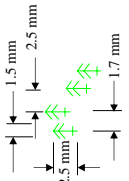

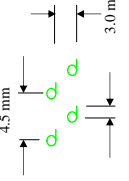

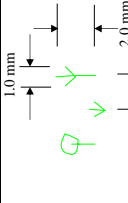

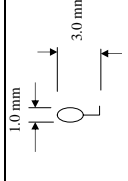

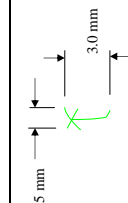

Map symbols Revised edition Ver 5.0 Final. May 2004

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				in Japanese. <small>*This space is for reference use only.</small>	in Myanmar. <small>*This space is for reference use only.</small>		
(4) Boundaries (境界線)							
01	International boundary			A line of depicting area under the jurisdiction of a sovereign government. 国境界線	Line width = 0.4 mm, Dash size = 2.5 mm, Spacing = 2.0 mm, Dot size = 0.3 mm, Color = Black (100%)	3001	
02	State / Division boundary			A separating line of administration among States and Divisions. State / DivisionとState / Divisionとの境界	Line width = 0.3 mm, Dash size = 2.0 mm, Spacing = 2.0 mm, Dot size = 0.2 mm, Color = Black (100%)	3002	
03	District boundary			A separating line of administration among Districts. DistrictとDistrictとの境界	Line width = 0.3 mm, Dash size = 1.5 mm, Spacing = 1.5 mm, Dot size = 0.15 mm, Color = Black (100%)	3003	
04	Township boundary			A separating line of administration among Townships. TownshipとTownshipとの境界	Line width = 0.2 mm, Dash size = 1.5 mm, Spacing = 1.0 mm, Color = Black (100%)	3004	
05	Forest boundary			Limit of Protected forest area specified by Forest department. 森林局が定めている森林保護区の境界	Line width = 0.2 mm, Dash size = 2.5 mm, Spacing = 1.0 mm, Color = Green (100%)	3005	



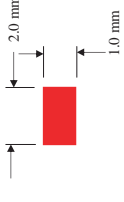



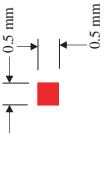

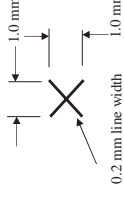

Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Color Separation												Mapping Feature Code	
				in Japanese. <i>*This space is for reference use only.</i>	Definition for Geographic Feature revated with legend. (in English) <i>*This space is for reference use only.</i>		Green 100	Green 75	Green 50	Green 25	Blue 100	Blue 75	Blue 50	Red 100	Red 75	Red 50	Yellow 100	Yellow 75		Yellow 50
(5) Vegetation (植生)																				
01	Dense forest			An area of trees very crowded in great numbers. 樹木の密生地。 植生界は地図上には示さない。		Color = Green (35%), Boundary line will not be shown on the map.														4001
03	Spasse forest			An area of trees not crowded numbers. 樹木がまばらにある場所。 植生界は地図上には示さない。		Color = Green (15%), Boundary line will not be shown on the map.														4003
05	Cultivation			An area of land use for crop cultivation. 耕作地。 植生界は地図上には示さない。		Color = Yellow (15%), Boundary line will not be shown on the map.														4005
06	Grass			An area of grass land. 草原地		Line width = 0.1 mm, Color = Green (100%), Boundary line will not be shown on the map.														4006
07	Open area / barren land			An open area or area composed of bare rock, sand, silt, gravel or other earthen material with little or no vegetation. 空き地、または植生が全くまたはほとんど見られない荒地。植生界は地図上には示さない。		Color = Blank (paper color), Boundary line will not be shown on the map.														4007
08	Orchard plantation			Orchard plantation area. 果樹を栽培している農場地		Dia = 0.5 mm, Line width = 0.2 mm, Color = Green (100%), Boundary line will not be shown on the map.														4008

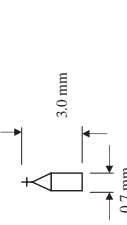
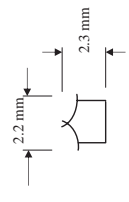
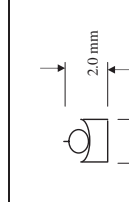
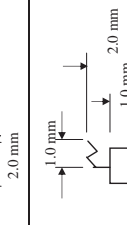
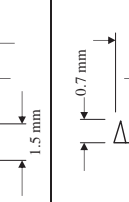
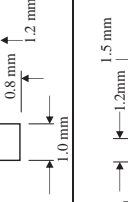
Map symbols Revised edition Ver 5.0 Final. May 2004

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				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>			
09	Plantation			Other plantation area. Dia = 0.5 mm. Line width of circle = 0.2 mm, Hatch line width = 0.1 mm, Hatch line interval = 1.0 mm, Color = Green(100%), Boundary line will not be shown on the map.			4009	
10	Pine trees			Pine trees area. Line width = 0.1 mm, Color = Green (100%), Boundary line will not be shown on the map.			4010	
11	Bush or scrub			An area of low growing plant with several or many woody stem coming up from the root. 灌木地、藪地			4011	
12	Scattered trees			An area of scattering grown trees. 遷移木(極相ではない森)、伐採等による2次遷移林。			4012	
13	Prominent tree			Big tree visible disincly 大きな独立樹			4013	
15	Coconut			An area of coconut. A large tropical and sub-tropical family of usually branchless trees with a crown fan shape leaves. 椰子地			4015	

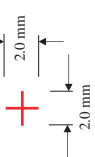
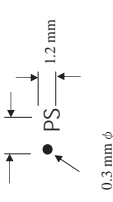
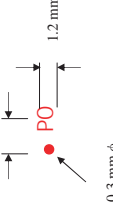
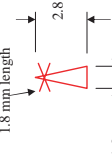
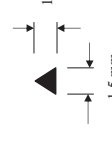

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				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>			
(6) Buildings (建物)								
01	Built-up area			Residential area, city, town, village. 居住地		Line width of boundary line = 0.1mm, Color = Red (Boundary line = 100%), Color = Red (Fill of inside = 15%).		2101
021	Public building (Minimum size)			Non private building, e.g Offices., cinema, town hall, Museum etc. Building size is less than 100 x 50m. 公衆が集まる建物、または公共の目的に供される建物。事務所、映画館、市庁舎/役場、博物館等を指す。大きさが100×50m以下のもの。		Size = 1.0 × 2.0 mm, Color = Red (100%).		2102
022	Public building (Actual size)			Non private building, e.g Offices., cinema, town hall, Museum etc. Building size is more than 100 x 50m. 公衆が集まる建物、または公共の目的に供される建物。事務所、映画館、市庁舎/役場、博物館等を指す。大きさが100×50m以上のもの		Size = Actual shape of instance, Color = Red (100%).		21022
031	House (House/Building, Minimum size)			A isolated house or group of houses out of built-up area. 家屋等の建物(Public buildingの範疇に含まれない民間の建物)でBuilt-up areaの外に存在するもの。		Size = 0.5 × 0.5 mm, Color = Red (100%).		21031
04	Deserted village			The village which was abandoned by the villagers by various reasons. Now, no one is living in this abandon village. 何らかの理由で村人により放棄された村で、現在は誰も住んでいない。		Line width = 0.2 mm, Color = Black (100%).		2104

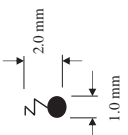
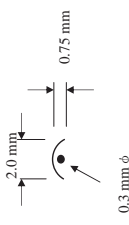
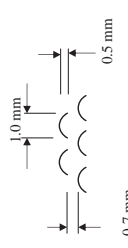

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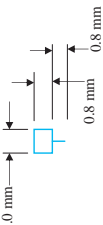

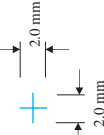

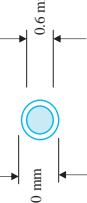





No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>		
11	Church		☩	A house set apart for public worship by a particular sect or domination of christians. キリスト教の教会	Line width = 0.1 mm , Color = Black (100%).	2111	
12	Chinese temple		☸	A place of worship of Chinese buddhism 華僑の寺院(仏教)	Line width = 0.1 mm, Color = Black (100%).	2112	
13	Mosque		☶	A moslem place of worship. イスラム教のモスク	Line width = 0.1 mm, Color = Black (100%).	2113	
14	Factory		☼	Building where goods are made by machinery. (Large size factory) 政府の工場、及び民間会社の大きな工場を示し、民間の小さな工場は対象外。	Line width = 0.1 mm, Color = Black (100%).	2114	
15	School		☎	A symbol of a school. In Yangon area, Apply to Highschool and University 学校。ただし、ヤンゴン地区では高校、大学のみに適 用する。	Line width = 0.1 mm , Color = Black (100%).	2115	
16	Rest house		■RH	Rest house/ guest house of Forestry Department 森林局のゲストハウス	Text"RH":Font = Arial narrow, Color = Red (100%) , Size= textheight = 1.5mm, Symbol: Color = Red (100%),	2116	

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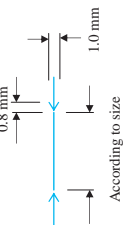





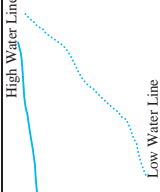

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Color Separation																Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	Definition for Geographic Feature revated with legend. (in English) <i>in Myanmar. *This space is for reference use only.</i>																		
17	Hospital		+	Hospital 病院	Line width = 0.3 mm, Color = Red (100%).	Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	Black20	2117				
18	Police station		•PS ■PS	Police station 警察署	Dia = 0.3 mm, Text "PS" = Arial narrow, Color = Black (100%).	Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	Black20	2118				
19	Post office		•PO ■PO	Post office 郵便局	Dia = 0.3 mm, Text "PO" = Arial narrow, Color = Red (100%).	Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	Black20	2119				
20	Light house		▲	A building with a light to guide or warn ships. 灯台	Line width = 0.2 mm, Color = Red (100%).	Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	Black20	2120				
21	Beacon		▲	A visual, audible or electric signal for the guidance for marine or navigation. ビーコン	Size = Width of triangle = 1.5 mm, Height of triangle = 1.3mm, Color = Black (100%).	Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	Black20	2121				
22	Oil well		⊕	A pit or hole bored into the earth for the extraction of petroleum and natural gas. 石油の掘削井戸	Line width = 0.1 mm, Dia = 1.5 mm, Cross line length = 2.0 mm, Color = Black (100%).	Green100	Green35	Green15	Green10	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	Black20	2122				

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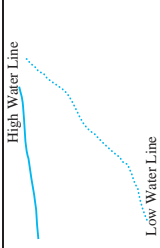

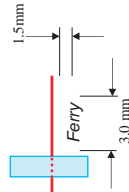







No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Mapping Feature Code
				in Japanese. *This space is for reference use only.	in Myanmar. *This space is for reference use only.		
23	Antenna mast		ㇰ	Microwave tower or other high tower or mast		Line width = 0.1 mm, Dia = 1.0 mm, Color = Black (100%).	2123
24	Cave		ㇱ	A naturally formed, sub terranean open area or chamber. Inland caves area often formed in limestone regions.		Line width = 0.1 mm, Dia = 0.3 mm, Color = Black (100%).	2124
25	Cemetery		㇭	A place of burial for one person.		line width = 0.1 mm, Color = Black (100%).	2125
27	Hotel		㇨	Hotel. Apply only prominent hotel.		Line width = 0.1 mm, Dia = 2.5 mm, Color = Black (100%).	2127

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Color Separation												Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	Definition for Geographic Feature revated with legend. (in English) in Myanmar. <i>*This space is for reference use only.</i>		Green100	Green 35	Green 15	Green 10	Green 10	Blue 25	Blue 100	Red 40	Red 15	Yellow 10	Yellow 15	Black 100	
(8) Water Area and Related Structures (水域及び関連構造物)																			
01	Lake / pond			An area of lake, pond and fish/shrimp farm. A culture pond displays a thing equal to or more than 50m *50m. Lake and pond particularly displays a big size		Line width = 0.2 mm, Color = Blue (Edge of line = 100%), Color = Blue (Fill inside = 25%)											6001		
02	Water tower			湖、池及び養殖池 (特に養殖池は50m*50m以上の物を表示する) (湖や池は特に大きな物を表示する)	Water tank tower 水タンク	Line width = 0.1 mm, Color = Blue, (100%).												6002	
03	Spring			A continuous or intermittent natural flow of water from the ground. 泉または温泉		Line width = 0.2 mm, Color = Blue (100%).												6003	
04	Water well			An under ground source of water which has been rendered accessible by the drilling or digging of a hole from ground level to water table. 井戸		Dia = 0.6 mm for inner circle and 1.0 mm for outer circle, Line width = 0.1 mm, Color = Blue (Edge of line = 100%), Color = Blue (Fill inside = 25%)												6004	
051	Canal (Single Line)			An artificial waterway with no flow or a controlled follow for a navigation, or for draining or irrigating land. The width is less than 30m. 水路 (幅30m未満のもの)		Line width = 0.2 mm, Color = Blue (100%).												60051	
052	Canal (Double Line)			An artificial waterway with no flow or a controlled follow for a navigation, or for draining or irrigating land. The width is equal to or more than 30m. 水路 (幅30m以上のもの)		Line width = 0.2 mm, Color = Blue (Edge of line = 100%), Color = Blue (Fill inside = 25%)												60052	







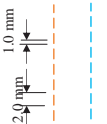

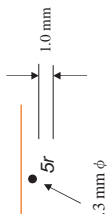

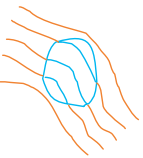

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No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>		
06	Sluice gate for canal			Apparatus, contrivance, for regulating the level of water by controlling the flow into or out of a canal.		Line width = 0.2 mm, Color = Black (100%)	6006
07	Aqueduct			A structure design to transport water from a remote source, or a bridge carrying a canal or pipe for conveying water.		Line width = 0.1 mm, Color = Blue (100%)	6007
091	Stream (Single line River)			A river with width is less than 40m width. The river will be shown by single line.		Line width = 0.2 mm, Color = Blue (100%)	60091 /6008
092	River (Double line)			A river with width is more than 40m width. The river will be shown as double lines.		Line width = 0.2 mm, Color = Blue (Edge of line = 100%), Color = Blue (Fill inside = 25%)	60092
101	Coastal line (High Water Line)			Coastal/Shore line: A natural occurring line of contact between a body of water narrow inlets and river mouth. The highest water line so reached by high water at ordinary spring tides. The highest elevation of tide.		Line width = 0.2 mm, Color = Blue (100%)	6010H

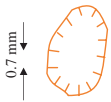





Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Mapping Feature Code
				Definition for Geographic Feature related with legend. (in English)	Definition for Geographic Feature related with legend. (in Japanese... in Myanmar... *this space is for reference use only.		
102	Coastal line (Low Water Line)			<i>in Japanese...</i> <i>in Myanmar...</i> <i>*this space is for reference use only.</i>	Coastal/Shore line: A natural occurring line of contact between a body of water narrow inlets and river mouth. The lowest line reached by the tide. The line of low water at ordinary spring tides.	Line width = 0.2 mm, Dot size = 0.2 mm, Space of dot = 0.8 mm, Color = Blue (100%).	6010L
11	Ferry			A route of carriage/boats over water for crossing a river. フェリーの発着場(航路を示す線)	A Line for Ferry Lane: Dot size of road in river = 0.1 mm, Dot interval of road in river = 0.5 mm, Color = Red (100%). Text(Symbol) for "FERRY" Color = Black (100%). Represent by using Symbol.	6011L 6011T	
12	Ford			Shallow place in a river/stream where it is possible to work or drive across. 河川の浅瀬で車輛等が横断できる場所	Dot size of road in river = 0.2 mm, Dot interval of road in river = 1.0 mm, Color = Red (100%).	6012	
13	Reservoir			A constructed basin form for recreation use, storage, treatment, collection or processing of water or other liquids. 人工の貯水池	Line width = 0.2 mm, Color = Blue (Edge of line = 100%), Color = Blue (Fill inside = 25%)	6013	
14	Dam			A barrier constructed to control the flow or raise the level of water. ダム	Size = Triangle with 1.0 mm length, 0.7mm height, Color = Black (100%).	6014	




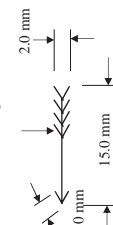

Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Cartographic Representation	Color Separation												Mapping Feature Code
				in Japanese. <i>*This space is for reference use only.</i>	Definition for Geographic Feature revised with legend. (in English) in Myanmar. <i>*This space is for reference use only.</i>		Green100	Green15	Green18	Green25	Blue100	Blue25	Red100	Red40	Red15	Brown100	Yellow15	Black100	
(9) Contour Line and Topography (等高線と地形)																			
01	Index contour			Contours with value shown by thick line. Index contour lines. Blue color will be used for snow capped mountained. 計曲線。雪がかぶっている地形では青の線で表現される。	Line width = 0.3 mm (In flat area, line width shall be 0.4 mm), Color = Blue (100%), (for snow covered area), Color = Brown (100%), (for normal topography area)												7001		
011	Index contour value			Index contour value	Font = Arial, Style = Normal, Text height = 1.5mm, Color = Blue (100%), (for snow covered area), Color = Brown (100%), (for normal topography area)												7001T		
02	Main contour line			Contours between index contours shown by thin lines. Intermediate contour lines is 10 meter interval below 200m MSL and 20 meter interval above 200 MSL. Blue color will be used for snow capped mountained. 主曲線。標高が200m以下は10m間隔、200m以上は20m間隔で表示。雪がかぶっている地形は青の線で表現される。	Line width = 0.1 mm. But, in flat land area, line width shall be 0.2 mm., Color = Blue (100%), (for snow covered area), Color = Brown (100%), (for normal topography area)												7002		
03	Intermediate contour line			If it is not enough with normal contour to be shown in flat terrain, supplementary contour is used. Blue color will be used for snow capped mountained. 補助曲線。雪がかぶっている地形では青の線で表現される。	Line width = 0.1 mm (In flat area, line width shall be 0.2 mm), Color = Blue (100%), (for snow covered area), Color = Brown (100%), (for normal opographic area)												7003		
04	Relative height			Represents the approximate height between the top and bottom of a steep slope. 斜面における標高差	Dia = 0.3 mm, Height value: Font = Arial, Style = Italic, Color = Black (100%), Text height=1.0mm												7004P 7004T		
05	Perpetual snow			An area covered by snow through whole a year 万年雪に覆われた範囲	Line width = 0.1 mm, Color = Blue (100%).												7005		

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				in Japanese. <i>*This space is for reference use only.</i>	in Myanmar. <i>*This space is for reference use only.</i>		
12	Mining site or quarry			An open excavation in rock from where building stone, lime stone and other minerals etc. are removed.	Line width = 0.1 mm, Size = Depend on ground feature, Color = Brown (100%).	7012	
13	Soil heap			Soil heap 崖崩れなどにより生じた土砂が堆積した地形	Line width = 0.1 mm, Dash size = 0.5 mm, Space = 0.5 mm, Interval = 0.5 mm, Color = Brown (100%).	7013	
14	Retaining wall			Retaining wall 擁壁	Size = Depend on ground feature, Line width = 0.1 mm, Color = Black (100%)	7014	

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No.	Legend	Symbol (Dimension)	Symbol (Full scale)	Description		Color Separation	Mapping Feature Code
				Definition for Geographic Feature revated with legend. (in English) <i>in Japanese.</i> <i>in Myanmar.</i> <i>*This space is for reference use only.</i>	Cartographic Representation		
(10) ETC.							
02	Golf course			Golf course, Annotate as "Golf Course" or name of instance. ゴルフコース 注記=Golf Course	Color = Green (10%) for filling. Color = Green (100%) for Edge line. Text height = 1.5mm, 2.0mm, 2.5mm, Depend on size of feature instance. Font = Arial, Style=Italic, Capital and small letter Color = Black:100%	Green100 Green35 Green15 Green10 Blue100 Blue25 Red100 Red40 Red15 Brown100 Yellow15 Black100 Black20	0002
03	Sport field			Spot field such as football ground, Annotate as "Sport field" or name of instance. サッカー場等のスポーツ施設 注記=Sport field	Color = Green (10%) for filling. Color = Green (100%) for Edge line. Text height = 1.5mm, 2.0mm, 2.5mm, Depend on size of feature instance. Font = Arial, Style=Italic, Capital and small letter Color = Black:100%		0003
04	Park			A place of area developed for public use or recreation. Annotate as "Park" or name of instance 公園 注記=Park	Color = Green (10%) for filling. Color = Green (100%) for Edge line. Text height = 1.5mm, 2.0mm, 2.5mm, Depend on size of feature instance. Font = Arial, Style=Italic, Capital and small letter Color = Black:100%		0004
05	Harbour			Place of shelter for ships. 港及び港湾施設	Line width = 0.1 mm, Color = Black (100%).		0005
06	River flow arrow			The arrow showing the river flow direction 流線方向	Line width = 0.1 mm, Color = Black (100%).		0006

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				in Japanese. *This space is for reference use only.	in Myanmar. *This space is for reference use only.		
07	Tidal arrow	<p>This value is maximum size. It is possible to apply smaller size.</p>		The riverflow which is affected by tide.	Line width = 0.1 mm, Color = Black (100%).	0007	
08	Jetty			Landing place for ship and boat.	Size = Depend on the size, Shape = Depend on the shape, Line width = 0.1 mm, Color = Black (100%).	0008	
09	Ruins			The remains of an ancient city or village.	Line width = 0.1 mm, Color = Red (100%).	0009	

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			Definition for Geographic Feature related with legend. (in English) <i>in Myanmar.</i> <small>*This space is for reference use only.</small>	Cartographic Representation	
(11) Annotation Text on mapface (図郭内の注記文字)					
01a	Annotation for Yangon city and Mandalay city.	YANGON CITY	Annotation for Yangon City territory (City of Yangon development territory).	Text height = 4.3 mm (in Capital height) = 6.0mm (in Bodysize) = 17pt. Font = Arial Style = Normal, All Capital letter Spelling is without blank character. Color = Black (100%).	90041a
01	Annotation for City of State or Division.	PATHEIN	Annotation for township-town which correspond to City of State / Division. "City" means capital township-town of the administration. StateまたはDivisionの州都(City)であるTownship townの地名注記 Township town とはTownshipの核となる町をいう。	Text height = 4.0 mm (in Capital height) = 5.64mm (in Bodysize) = 16pt. Font = Arial Style = Normal, All Capital letter Spelling is without blank character. Color = Black (100%).	90041
02	Annotation for City of District	MYAUNGMYA	Annotation for township-town which correspond to City of District. "City" means capital township-town of the administration. Districtの郡都(City)であるTownship townの地名注記 Township town とはTownshipの核となる町をいう。	Text height = 3.0mm (in Capital height) = 4.23mm (in Bodysize) = 12pt. Font = Arial, Style = Normal, All Capital letter Spelling is without blank character. Color = Black (100%).	90042
031	Annotation for Township town	Labutta	Annotation for Township-town name. Except the City of State/Division, City of District and township in Yangon city territory and Mandalay city territory. In Yangon and Mandalay city territory, it is no need to annotate for Township-town name, only annotate for township name (Apply to Code 90044). Township townの地名注記(State/DivisionまたはDistrictのcityではないTownship-town) Township town とはTownshipの核となる町をいう。	Text height = 3.0mm (in Capital height) = 4.23mm (in Bodysize) = 12pt. Font = Arial, Style = Normal, Capital and small letter Spelling is without blank character. Color = Black (100%).	90043
032	Annotation for Township in Yangon city and Mandalay city area.	Lanmadaw	Annotation for Township name in Yangon city territory and Mandalay city territory. ヤンゴンおよびマンダレー特別市域内のTownship名に対する注記。これらのタウンシップ名称は図郭内に注記する。	Text height = 2.5mm (in Capital height) = 3.53mm (in Bodysize) = 10pt or more small Font = Arial, Style = Normal, Capital and small letter Spelling is without blank character. Color = Black (100%).	90044
04	Annotation for other town	Taukkyan	Annotation for other town name Other townの地名注記	Text height = 2.5mm (in Capital height) = 3.53mm (in Bodysize) = 10pt. Font = Arial, Style = Normal, Capital and small letter Spelling is without blank character. Color = Black (100%).	90046

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No.	Legend	Symbol (shape and size)	Description		Mapping Feature Code
			Definition for Geographic Feature rerated with legend. (in English)	Cartographic Representation	
05	Annotation for Village name ~Header village Kyon ma nge		in Japanese. *This space is for reference use only.	Text height =2.0mm(in Capital height) =2.82mm(in Bodysize)=8pt, Font = Arial, Style=Bold, Capital and small letter Color = Black (100%).	90051
			in Myanmar. *This space is for reference use only.	Annotation for Village name ~Header village Village ~Header villageの地名注記	
06	Annotation for Village name ~Other village Ngok ta htaung		in Japanese. *This space is for reference use only.	Text height =2.0mm(in Capital height) =2.82mm(in Body size) =8pt, Font = Arial, Style=Normal, Capital and small letter Color = Black (100%).	90052
			in Myanmar. *This space is for reference use only.	Annotation for Village name ~Other village Village ~Other villageの地名注記	
07	Annotation for Famous Pagoda or Religios area. <i>Shwedagon pagoda</i> Shwedagon pagoda Shwedagon pagoda		in Japanese. *This space is for reference use only.	Text height =1.5mm,2.0mm, 2.5mm(in Capital height), Depend on size of feature instance. Font = Arial, Style=Italic and Capital and small letter Color = Black:100%	9006
			in Myanmar. *This space is for reference use only.	Annotation for Pagoda or Religios area. (Apply to famous case only.) パゴダ等宗教施設名の注記 (著名なケースのみ適用)	
08	Annotation for Hydro feature(1) Only Capital letter KAN DAW GYI LAKE AYEYAWADY RIVER AYEYAWADY RIVER AYEYAWADY RIVER AYEYAWADY RIVER		in Japanese. *This space is for reference use only.	Text height =1.5mm, 2.0mm, 2.5mm, 3.0mm, 3.5mm, 4.0mm (in Capital height), Depend on size of feature instance. Font = Arial, Style=Italic and All Capital letter Color = Blue:100%	90071
			in Myanmar. *This space is for reference use only.	Annotation for Hydrofeatures River (Biggish Double line river), Lake, Pond, and Hot spring	
09	Annotation for Hydro feature(2) Capital small letter <i>Kyaik ka san C</i>		in Japanese. *This space is for reference use only.	Text height =2.0mm(in Capital height) Font = Arial, Style=Italic and Capital and small letter Color = Blue:100%	90072
			in Myanmar. *This space is for reference use only.	Annotation for Hydrofeatures River(Biddy Double line river), and Stream(Single line river).	
10	Annotation for Sea BAY OF BENGAL BAY OF BENGAL BAY OF BENGAL BAY OF BENGAL		in Japanese. *This space is for reference use only.	Text height =2.0mm, 2.5mm, 3.0mm, 3.5mm, 4.0mm, 4.5mm, 5.0mm(in Capital height) , Depend on size of feature instance. Font = Arial, Style=Italic and All Capital letter. Color = Blue:100%	90073
			in Myanmar. *This space is for reference use only.	Annotation for Sea	
11	Annotation for Island KHAT TA KYUN KHAT TA KYUN KHAT TA KYUN		in Japanese. *This space is for reference use only.	Text height =2.0mm, 2.5mm, 3.0mm(in Capital height), Depend on size of feature instance. Font = Arial, Style=Normal and All Capital letter Color = Blue:100%	90074
			in Myanmar. *This space is for reference use only.	Annotation for island	

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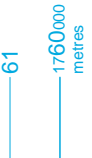


No.	Legend	Symbol (shape and size)	Description		Mapping Feature Code
			Definition for Geographic Feature rerated with legend. (in English)	Cartographic Representation	
12	Annotation for Water Infrastructure	<i>Twan te Canal</i> <i>Twan te Canal</i> <i>Twan te Canal</i> <i>Twan te Canal</i> <i>Twan te Canal</i>	Annotation for Water Infrastructure, Canal, Dam, Reservoir.	Text height = 2.0mm, 2.5mm, 3.0mm, 3.5mm, 4.0mm (in Capital height), Depend on size of feature instance. Font = Arial, Style = Italic and Capital and small letter. Color = Blue: 100%	90075
13	Annotation for Protected forest area	CHAUNGTHA RESERVED FOREST CHAUNGTHA RESERVED FOREST CHAUNGTHA RESERVED FOREST CHAUNGTHA RESERVED FOREST CHAUNGTHA RESERVED FOREST	Annotation for Protected forest area.	Text height = 1.5mm, 2.0mm, 2.5mm, 3.0mm, 3.5mm (in Capital height), Depend on size of feature instance Font = Arial, Style = Italic and All Capital letter Color = Black: 100%	9008
14	Explanatory Annotation for (Explanation for misc. .)	Yangon Central RS Yangon Central RS Yangon Central RS	Explanatory annotation for miscellaneous feature.	Text height = 1.5mm, 2.0mm, 2.5mm (in Capital height), Depend on size of feature instance. Font = Arial, Style = Normal and Capital and small letter Color = Black: 100%	9009
15	Grid Letter	GT	Designation for 100km square grid in UTM Grid system	Size = 10.0 mm Font = Times New Roman Color = Black(20%)	90015
16	Annotation for District boundary	BAGO DISTRICT NORTHERN YANGON DISTRICT	Annotation for District boundary.	Text height = 2.1mm, 1.8mm (in Capital height) = 3.0mm, 2.47mm (in Bodysize) = 8.5pt, 7pt. Font = Arial, Style = Italic and All Capital letter Spelling is without blank character. Color = Black: 100%	

Style = Normal. All Capital letter
Spelling is without blank character .

Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (shape and size)	Description		Mapping Feature Code	
			Definition for Geographic Feature rerated with legend. (in English) <i>*This space is for reference use only.</i>	Cartographic Representation		
(12) Marginal Information (整飾情報)						
01	Legend text	Highway	Text for Legend information		Text height = 1.5mm(in Capital height) =6pt. Font = Arial, Color = Black	9001
02	State / Division name	YANGON DIVISION	Annotation for State and Division name indicated as mapsheet title on marginal 整飾部State、Division名の注記(地図名で使用)		Text height = 9.34mm(in Capital height) =37pt. Font = Arial, Color = Black	9002
03	District name	MYAUNGMYA DISTRICT	Annotation for District name indicated on marginal information 整飾部District名の注記		Text height = 4.4 mm(in Capital height) =17.5pt. Font = Arial, Color = Black	9003
04	Township name	PYAPON	Annotation for Township name indicated on marginal information 整飾部Township名の注記		Text height = 3.0 mm(in Capital height) =12pt. Font = Arial, Color = Black	90045
05	Desitnation	YANGON 10.0 km	Destination and Distance. 到達注記		Text height = 1.5mm(in Capital height) =6pt. Font = Arial, Color = Black	90045

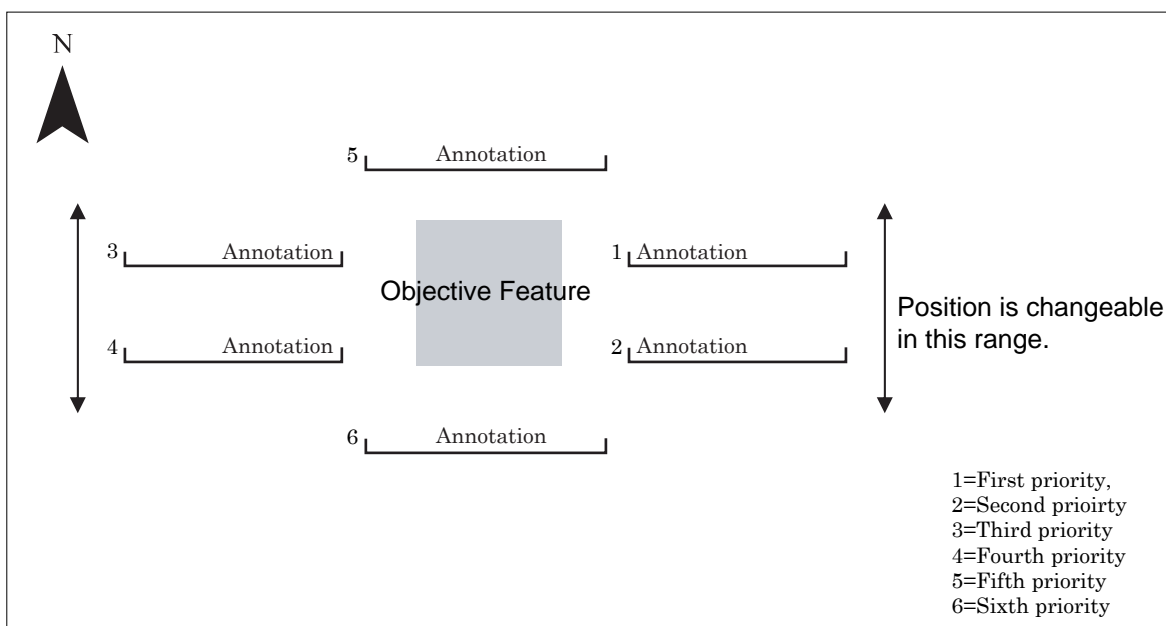
Map symbols Revised edition Ver 5.0 Final. May 2004

No.	Legend	Symbol (shape and size)	Description		Mapping Feature Code
			Definition for Geographic Feature rerated with legend. (in English)	Cartographic Representation	
05	UTM Grid for Zone 46		<p><i>in Japanese.</i></p> <p><i>in Myanmar.</i></p> <p><i>*This space is for reference use only.</i></p>	<p>Grid line(Every 10,000m) :Line width = 0.2mm Grid line(Every 1,000m) :Line width = 0.1mm Grid coordinate value: Text height = 2.15mm and 1.5mm(in Capital height) =8.5pt and 6pt, Font = Arial, Color = Black (100%)</p>	
			<p>UTM Grid for Zone 46</p>		
05	UTM Grid for Zone 47		<p><i>in Japanese.</i></p> <p><i>in Myanmar.</i></p> <p><i>*This space is for reference use only.</i></p>	<p>Grid line(Every 10,000m) :Line width = 0.2mm Grid line(Every 1,000m) :Line width = 0.1mm Grid coordinate value: Text height = 2.15mm and 1.5mm(in Capital height) =8.5pt and 6pt, Font = Arial, Color = Blue (100%)</p>	
			<p>UTM Grid for Zone 47.</p>		
06	SD Logo			<p>Color = Black (100%), Green (60%), Blue (25%), Yellow (30%)</p>	
07	JICA Logo			<p>Color = Blue (100%)</p>	

Detailed specification for Annotation

1. Arrangement of Annotation

The priority for arrangement of annotation is as follows:

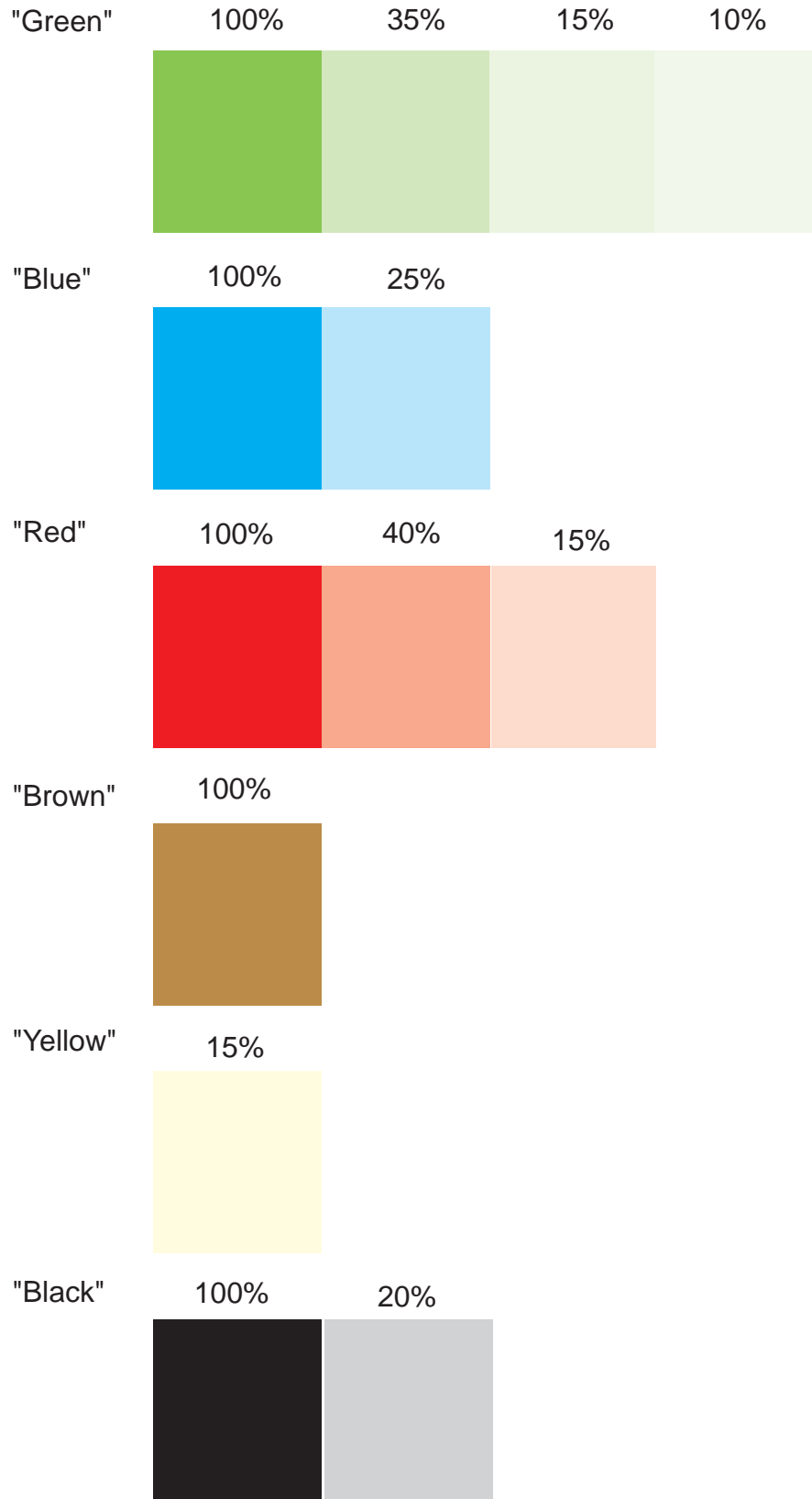


2. Size of Annotation

The conversion of text size for annotation is as follows

Text height		
in Capital Height (unit in 'mm')	in Point (unit in 'pt')	in Body size (unit in 'mm')
□ □ □ 4.3	□ □ □ 17	6
□ □ □ 4.0	□ □ □ 16	□ □ 5.64
□ □ □ 3.5	□ □ □ 14	4.94
□ □ □ 3.0	□ □ □ 12	□ 4.23
□ □ □ 2.5	□ □ □ 10	3.53
□ □ □ 2.0	8	2.82
□ □ □ 1.5	6	2.12

Sample color chart for Cartographic Display Data Files (6 Spot Colors)



This sample using below color model.

"Green"	C:50%	"Brown"	M:30%
	Y:90%		Y:70%
"Blue"	C:100%		K:30%
"Red"	M:100%	"Yellow"	Y:100%
	Y:100%	"Black"	K:100%

Japan International Cooperation Agency (JICA)

Survey Department, Ministry of Forestry

The Study on
The Establishment of Geographic Database for
National Rehabilitation and Development Programme
In The Union of Myanmar

The Survey Manual
For Topographic Mapping

August, 2004

ASIA AIR SURVEY CO. LTD.
AERO ASAHI CORPORATION

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1. Objectives of Survey Manual

This manual explains the details of the process to establish the Study on the Establishment of Geographic Database for National Rehabilitation and Development Programme in the Union of Myanmar. This manual will help to make newly and update national topographic maps in the future.

The final products to prepare in this manual have 3 items.

(1) Topographic data file

This dataset contains all topographic features to prepare the 1/50,000 scale map.

(2) 1/50,000 scale topographic maps

The drawing file will be prepared by symbolizing topographic data based on the specifications of Map Symbols and Application Rules. Topographic maps will be printed using color separated files of the drawing file.

(3) Spatial data framework

Topographic data will be structured, and this dataset will be used to construct GIS as basic database.

2. The work flow of the Study

The study is executed applying modern digital photogrammetry.

- 1) To apply digital level to leveling
- 2) To adopt GPS to control points survey
- 3) To apply GPS survey to determine orthometric elevation
- 4) To acquire topographic data directly from stereo models using digital potters
- 5) To apply digital technology to survey in the field identification
- 6) To compile topographic data using digital compilation system.

The work flow to prepare topographic map data and topographic maps by digital photogrammetry adopted in this study is shown in next page.

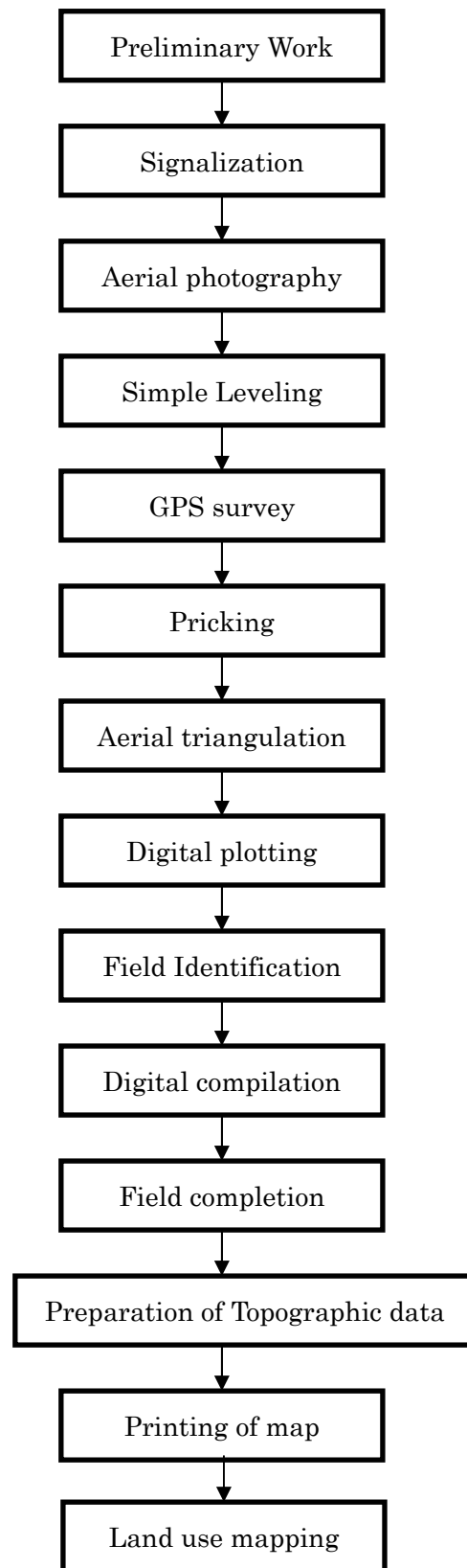


Fig. 2.1.1 The work flow adopted in the Study

3. Preliminary Work

The work plan should be prepared to adopt the following suitable technologies based on the technical specifications of the study.

- 1) Geodetic Survey technology
- 2) Digital photogrammetric technology
- 3) Geographic Information Science technology
- 4) Information Technology

3.1 Preparation for work

Following plan of work should be prepared.

- 1) Plan for aerial photography
- 2) Plan for leveling routes
- 3) Plan for distribution of ground controls
- 4) Specifications for map symbols and their application rules
- 5) Specifications for marginal information of map sheet
- 6) Map sheet plan

3.2 Preparation of machinery

Following main machineries are used.

- 1) Digital levels
- 2) GPS survey sets
- 3) Digital plotter
- 4) Digital compilation system

3.3 Collection of materials and documents

The documents necessary to prepare topographic maps should be collected.

- 1) Existing 1/50,000 topographic maps and 1inch to 1mile map
- 2) Other topographic maps (for instance 1/200,000)
- 3) Final results and description of existing control points
- 4) Magnetic declination, and annual rates of change
- 5) others

3.4 Confirmation of geodetic elements

The following geodetic elements are confirmed before starting the work.

1) Reference ellipsoid : Everest1830

Semi-major radius : 6,377,276.345 m

Flattening : 1/300.8017

2) Origin of plane control : Yangon (Kyanathpo) 1st order Geodetic Control

Table 3.4.1 Coordinate of Origin

Latitude	N 16°58'20.62762"
Longitude	E 96°07'36.99653"

3) Transformation parameters from the WGS-84 ellipsoid to the Myanmar Datum 2000.

$\Delta X = -246.632$ m

$\Delta Y = -784.833$ m

$\Delta Z = -276.923$ m

These values were calculated assuming the geoid height at Yangon 1st order Station as 0 meter.

4) Origin of vertical control :

Elevation of the existing 1st order benchmarks in Kyaikkami is adopted.

5) Map projection

UTM projection is adopted. Myanmar contains both Zone46 and Zone47 which central meridian is 93°E or 99°E respectively.

6) Map symbols and marginal information of map

They are decided after discussion between the Study Team and Survey Department based on the drafts.

7) Map sheet design

4. Signalization for Ground controls

Prior to taking aerial photographs, ground controls should be set up signalized to be identified easily on films.

(1) Final products in signalization

- Descriptions of pricked point
- Marked contact prints or enlarged photos

(2) Materials and documents used

- Distribution map of existing and planned ground controls
- Marked contact prints or enlarged photos

(3) Equipment and instruments used

- Signals
- Plane Table
- Compass
- Camera

(4) Procedure

- 1) Selection of suitable position for control point
- 2) Establishment of control point pile
- 3) Setting up Signals
- 4) Observation of position and height of eccentric reference points
- 5) Calculation of coordinates and elevation of reference points
- 6) Preparation of Description of signalized point
- 7) Confirmation of signalized points, and marking on contact prints or enlarged print

5. Simple Leveling

Vertical control survey is carried out to orient aerial photos. Vertical control points are generally executed by leveling. When leveling is difficult to be carried out due to the very long distance or mountainous area, vertical controls may be determined by GPS survey so called GPS leveling.

5.1 Reconnaissance of existing benchmarks

Benchmarks used as start point or ending point of leveling are selected, after reconnaissance of existing benchmarks.

Table 5.1.1 Classification of leveling and used instrument

Classification	Sensibility of level	Reading	Staff
1 st order	10"/2mm	0.01mm	Inver staff
2 nd order	20"/2mm	0.1mm	Inver staff
3 rd order	40"/2mm	1mm	Wooden staff
4 th order	40"/2mm	1mm	Wooden staff
Simple	40"/2mm	1mm	Wooden staff

Table 5.1.2 Specifications of leveling

Classification of leveling	Residual between go and return	Closure error of survey loop	Closure error between existing BMs
1 st order	2.5mm√S	2mm√S	3mm√S
2 nd order	5mm√S	5mm√S	6mm√S
3 rd order	10mm√S	10mm√S	12mm√S
4 th order	20mm√S	20mm√S	25mm√S
Simple	50mm√S	50mm√S	50mm√S

Note: S means distance of observation in km.

5.1.1 Products

- New leveling route map
- New benchmarks

5.1.2 Materials and documents used

- Existing leveling route map
- Final results and description of existing benchmarks
- Contact prints

5.1.3 Equipment and instruments used

- Digital levels
- Handy GPS

5.1.4 Procedure

- 1) Reconnaissance of existing benchmarks
- 2) Reconnaissance of new benchmarks at planned site
- 3) Decision of location on new benchmarks

5.2 Leveling

The simple leveling is carried out to determine elevation of benchmarks.

5.2.1 Materials and documents used

- Description of existing benchmarks
- Leveling route map

5.2.2 Equipment and instruments used

- Levels
- Tripod
- Leveling staff
- Foot plates
- Survey umbrella

5.2.3 Products

- Descriptions of benchmark
- Quality control sheet

5.2.4 Procedure

- 1) Inspection of level
- 2) Leveling to inspect the start benchmark
- 3) Observation
- 4) Calculation of elevation
- 5) Checking of observation residuals
- 6) Preparation of final result
- 7) Preparation of description of benchmarks

Elevations are filled out in the description of ground control that is prepared in previous process.

- 8) Preparation of quality control sheet

6. GPS Survey

Necessary plane coordinates of control points are surveyed in order to execute aerial triangulation.

6.1 Elements for GPS surveying

Shift parameters between two datums is necessary to transform the coordinates.

Results of GPS observation is based on WGS-84 and must be transformed to Myanmar Datum 2000. The transformation parameter was provided by Survey Department.

Fig.6.1.1 shows the image of origin shift and the geodetic elements of two datums are shown in Table 6.1.1.

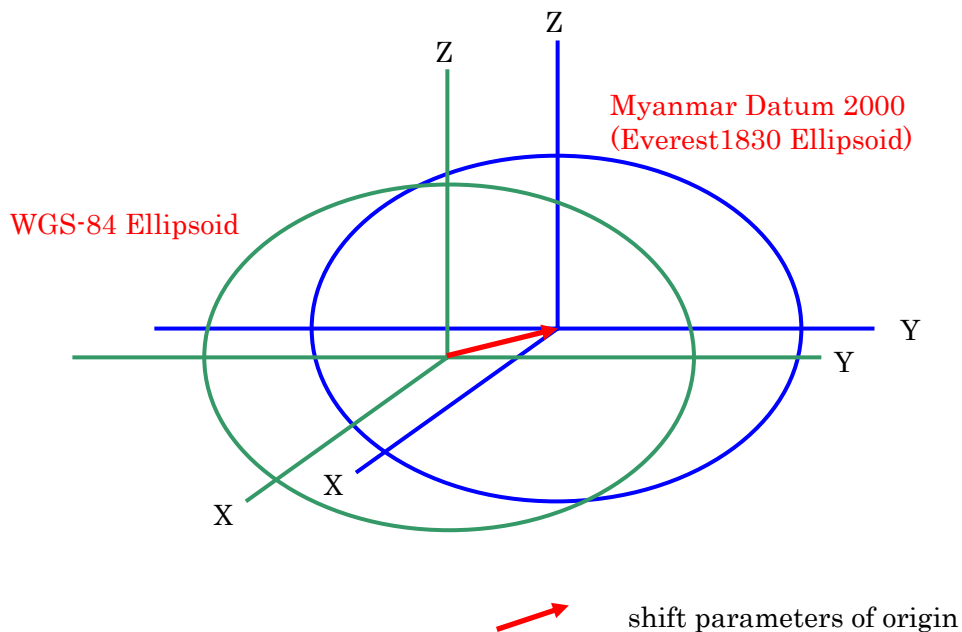


Fig. 6.1.1 Image of origin shift

Table 6.1 Geodetic elements

Geodetic System	WGS-84	Myanmar Datum 2000
Reference ellipsoid	WGS-84	Everest 1830
S. M. radius (m)	6,378,137.000	6,377,276.345
Flattening	1/298.257223563	1/300.8017
ΔX (m)	-246.632	
ΔY (m)	-784.833	
ΔZ (m)	-276.923	

6.2 Control Survey

Ground control points are established in order to perform aerial triangulation.

(1) Materials and documents used

- Control point distribution map
- Final result and description of existing control points
- 2 times enlarged aerial photos

(2) Equipment and instruments used

- GPS survey instruments
- PC with base line analysis and net adjustment software
- Plane table survey sets
- Compass

(3) Products

- Final result and description of control points
- Distribution map of control points
- Pricked aerial photos
- Quality control sheet

(4) Procedure

1) Planning of observation

Existing control point available in the study area is only Yangon 1st order station. Necessary control points are arranged on appropriate position for aerial triangulation and plotted on 1/200,000 scale map.

Based on this map, GPS observation session plan is prepared.

Table 6.2.1 Specifications of GPS Survey

Method of observation	Static observation
Observation time	1 hours
Number of session	1

2) Observation

GPS observation is executed based on observation plan

3) Pricking of control points

Position of observed control points are pricked on aerial photos.

If eccentric reference points are pricked, elements of eccentricity (eccentric distance and bearing) of reference points are measured by compass or plane table survey.

4) Calculation

Baseline vector is analyzed by base line analysis software. Coordinates and elevation of observed points is calculated by three dimensional adjustment using the baseline analysis results.

5) Checking

Quality of GPS observation is checked by the report of observation, and quality control sheets.

6) Preparation of final results

The coordinates of checked control points are transformed to the Myanmar Datum 2000 coordinates system by using 3 shift parameters.

Elevation of the results of GPS surveying is ellipsoidal height and must be converted to orthometric height.

6.3 Preparation of Geoid undulation map

The elevation we need to prepare topographic map is the orthometric height. On the other hand, the elevation measured by GPS is the ellipsoidal height and it must be converted to the orthometric height.

Geoid undulation map is necessary to convert the ellipsoidal height to the orthometric height. Geoid undulation map of the study area is prepared using the result of direct leveling and GPS observation.

6.3.1 Geoid

If static sea surface without shaking were assumed, this is one of the leveling surfaces. We call this equi-potential surface Geoid. The Geoid is a shape of the earth, and is a standard of elevation on land. The Geoid is not simple sphere, and the surface of Geoid is undulated because the mass distribution of the earth is not uniform.

The image of world Geoid undulation is shown in the fig.6.3.1

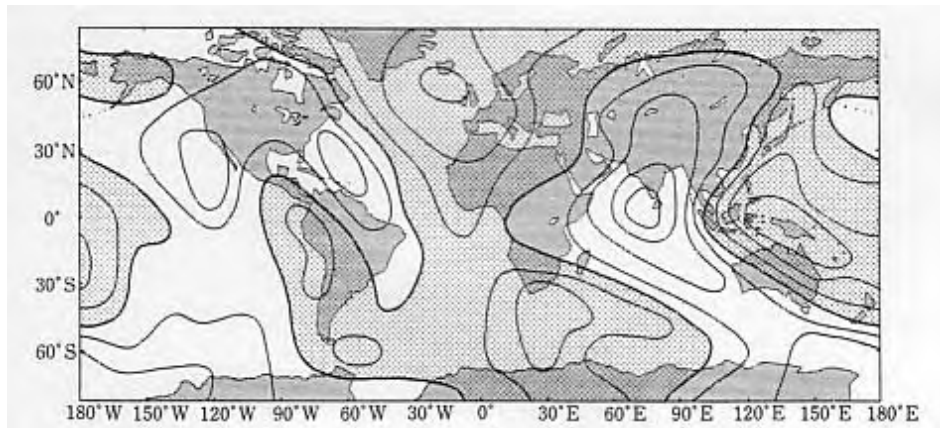


Fig. 6.3.1 World Geoid Map

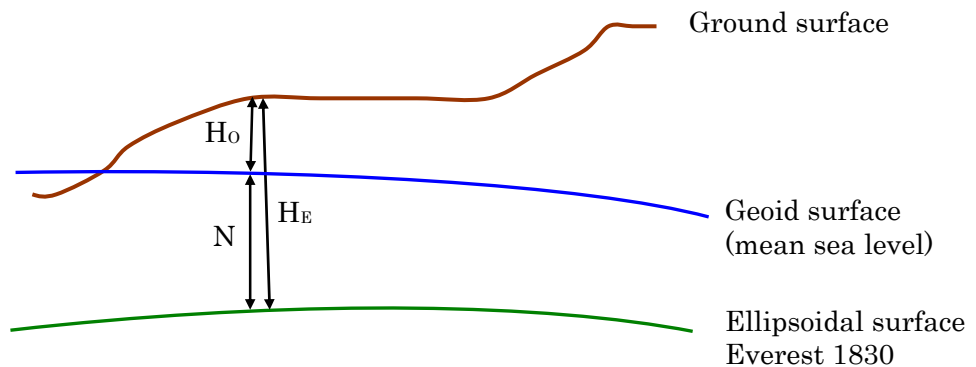
Contour interval: 20m, shadowed area means positive

Source: Introduction of geodesy by Dr. Yukio Ogiwara

6.3.2 Conversion of orthometric height from ellipsoidal height

Orthometric height is calculated as follows.

The relation between ellipsoidal height and orthometric height is shown in the fig.6.3.2.



H_o : Orthometric height

N : Geoid height

H_E : ellipsoidal height

$$H_o = H_E - N$$

Fig. 6.3.2 Relation between ellipsoidal height and orthometric height

(1) Materials and documents used

- Final result of existing benchmarks
- Final result of new benchmarks

(2) Equipment and instruments used

- GPS Survey instruments with antenna, battery, and accessories
- PC with base line analysis software and 3 dimensional network adjustment software

(3) Products

- Geoid undulation map

(4) Procedure

1) Execution of GPS survey on existing or new benchmarks

GPS survey is executed to obtain ellipsoidal height of each benchmark. In case of benchmark where GPS observation is difficult to be carried out, suitable eccentric point is observed.

2) Calculation of three dimensional coordinates

According to the same method of GPS surveying described in article 3.4. GPS calculation is carried out.

3) In case of eccentric observation, elevations of eccentric points are surveyed by direct leveling.

4) Calculation of plane coordinates

Calculated geographic coordinates are converted to UTM plane coordinates and ellipsoidal height.

5) Calculation of Geoid heights

Geoid height of each observed point is calculated. Geoid height is obtained by following formula.

$$\begin{aligned} \text{Geoid height} &= \text{Ellipsoidal height} - \text{Orthometric height} \\ &= \text{Elevation of GPS surveying} - \text{Elevation of Direct leveling} \end{aligned}$$

Geoid height calculated in this study is from the Myanmar Datum 2000 ellipsoid. The approximate range of Geoid undulation in this study area is from -13m to 6m.

6) Preparation of Geoid undulation map

Geoid heights are plotted on 1/500,000 scale map. Based on the plotted data, contour lines of 10cm interval are drawn.

7. Pricking

Aerial photo signal is desirable for new project. However, in some case pricking is necessary due to various reasons. Ground controls should be identified precisely on aerial photos, so objects to be pricked should be selected carefully.

(1) Materials and documents used

- Distribution map of control points
- Descriptions of control point
- 2 times enlarged photos

(2) Equipment and instruments used

- Plane table or Compass

(3) Products

- Distribution map of pricked control points
- Description of pricked point
- Pricked 2 times enlarged photos

(4) Procedure

- 1) Selection of reference points which are identifiable on contact prints or 2 times enlarged prints
- 2) Prick reference points on photo using pricking needle
- 3) Observation of position of reference points
- 4) Calculation of coordinates of reference points
- 5) Preparation of description of pricked points
- 6) Preparation of quality control sheet

(5) Magnetic declination and meridian convergence

- 1) If the magnetic declination and meridian convergence affect to the plane rectangular coordinate of eccentric point, they should be compensated.
- 2) Magnetic declination of the study area is almost zero and it may be omitted. In this study it is not compensated.

Meridian convergence is near 1 degree at the border of UTM zone. The influence of this value to the 1/50,000 scale mapping is ignorable. However, in this study it was compensated.

8. Aerial triangulation

Exterior parameters of each aerial photograph are computed by using block adjustment program of aerial triangulation. And these parameters are used to form stereo models in order to acquire topographic features.

(1) Products

- Final result of aerial triangulation
- Quality control sheet of aerial triangulation

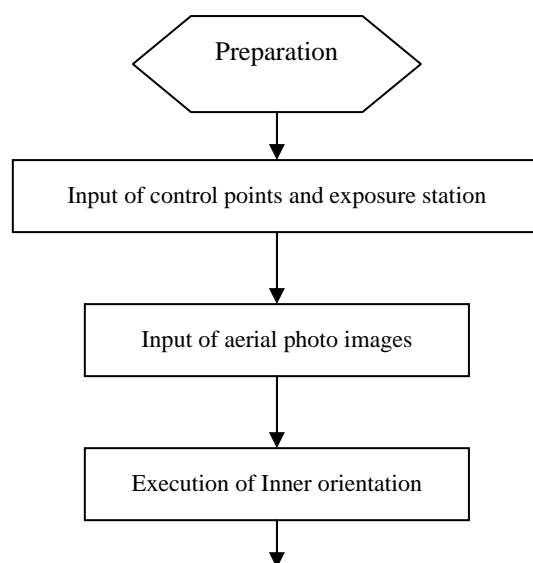
(2) Materials and documents used

- Final result and description of ground control points
- Distribution map of control points
- Index map of aerial photos
- Digital images of each aerial photo
- File of exposure station of each aerial photo
- Document of parameters of aerial camera

(3) Machines and instruments used

- Digital plotter to acquire photo coordinates
- Block Adjustment Software

(4) Procedure



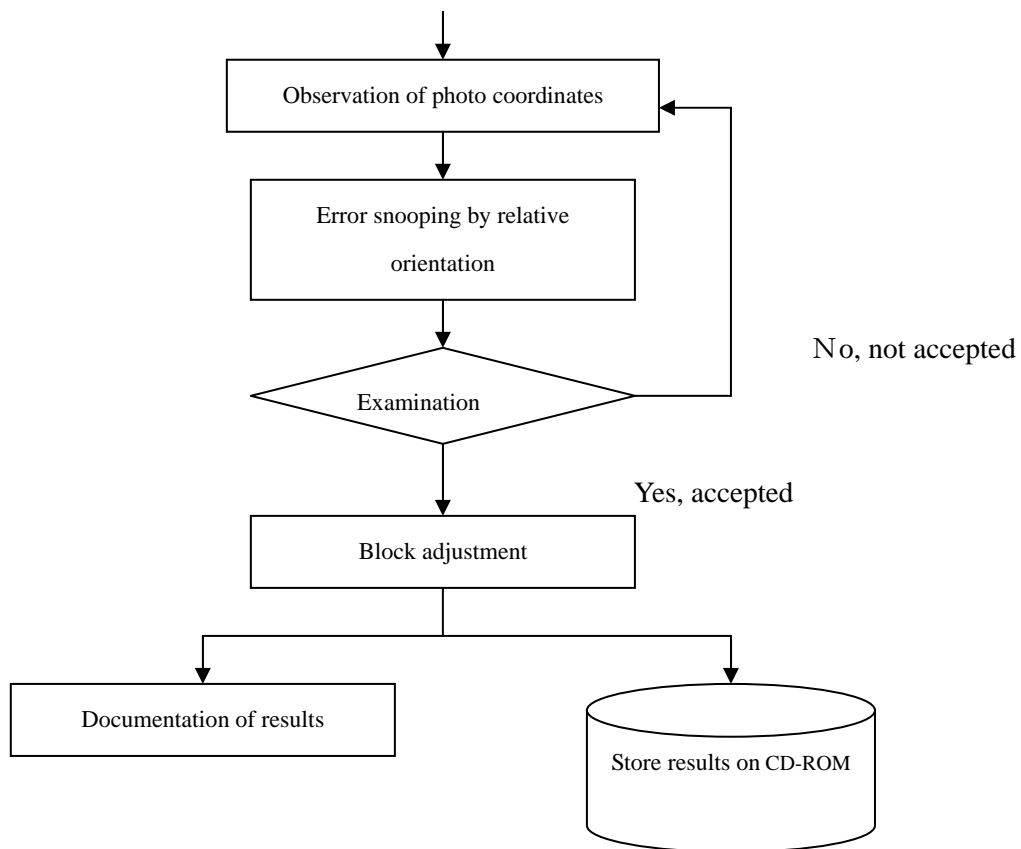


Fig.8.1.1 Flowchart of aerial triangulation

1) Preparation

Collect materials and documents to perform aerial triangulation.

Preparation of suitable instruments to perform aerial triangulation.

Design the numbering system to perform aerial triangulation

2) Input of control points and exposure station

Data files of ground control points and exposure stations are inputted to digital plotter.

Coordinates of ground control points and exposure station should be confirmed to convert to Myanmar Datum 2000 coordinates system.

3) Input of aerial photo images

Input photo images in the digital plotter according to numbering system.

4) Execution on inner orientation

Image coordinates of fiducial marks on aerial photos are observed.

Inner orientation is performed and residuals after computation are checked.

If residuals exceed the tolerance (0.030mm), re-observation should be performed.

5) Observation of photo coordinates

Pass points and tie points in suitable location of aerial photo are selected.

6) Error snooping by relative orientation

Image coordinates of pass points, tie points and control points are observed and relative orientation is performed.

If residuals of observed points exceed the tolerance (0.020mm), re-observation of rejected point should be performed and relative orientation should be performed again to eliminate wrong observation.

7) Block adjustment

Block adjustment is performed by using Block Adjustment Software.

8) Documentation of results

Result of adjustment is arranged to make a file.

9) Storage of results

Result of adjustment is recorded and stored on CD-ROM.

9. Digital Plotting

Photogrammetric mapping is a process to plot geographic features existing on the surface of mapping area by using aerial photo images. Plotting means that the features are interpreted and classified into pre-determined map features and then their figures are drawn by using points, lines and polygons with distinctive marks, symbols and colors. In case of digital mapping, points, lines and polygons are recorded as digital data often in separate layers or files. In digital mapping other cartographic features which also comprise map contents are made and recorded in digital format.

9.1 Necessary material

Collecting the following data or material before the start of the work and check the contents.

- Aerial photo image data
- Results of aerial triangulation
- Photo index maps
- Technical specifications (including map symbol and application rules)
- Data collected by field identification surveys
- Photo interpretation card (key)

9.2 Necessary instruments

9.2.1 Function of digital plotter

In digital plotting, a system called digital plotter will be used. The system has two major functions.

- (1) Display aerial photo or orthophoto mosaic in mono or stereo image as already oriented models.

- (2) From mono or stereo images displayed on the monitor, make models of geographic features in vector format and also superimpose the resultant figures onto images such as aerial photos.

Digital plotter is also called soft copy photogrammetric workstation. The major difference from conventional analogue or analytical plotters is that most of the functions are handled by software installed on PC or workstations.

Furthermore, photos to be used for plotting are not positive films but scanned image data. Plotted figures are then recorded as figures with coordinate values on CAD files.

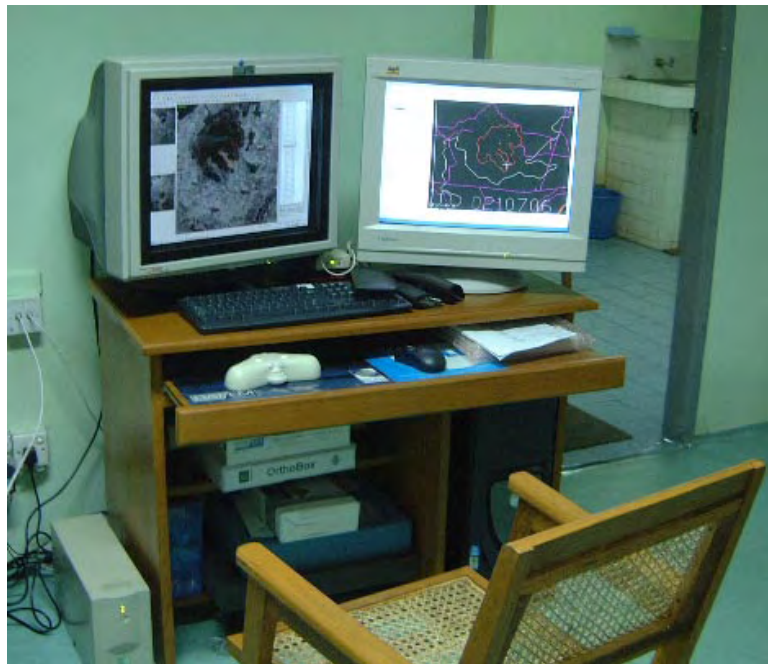


Figure 9.2.1 Digital Plotter
Summit Evolution Digital Photogrammetry Workstation

9.2.2 Component of digital plotting machine

In general digital plotting system is a part of a module which comprises digital photogrammetric workstation software. Specifications for the record of plotting data often depend on the specifications and functions of CAD software.

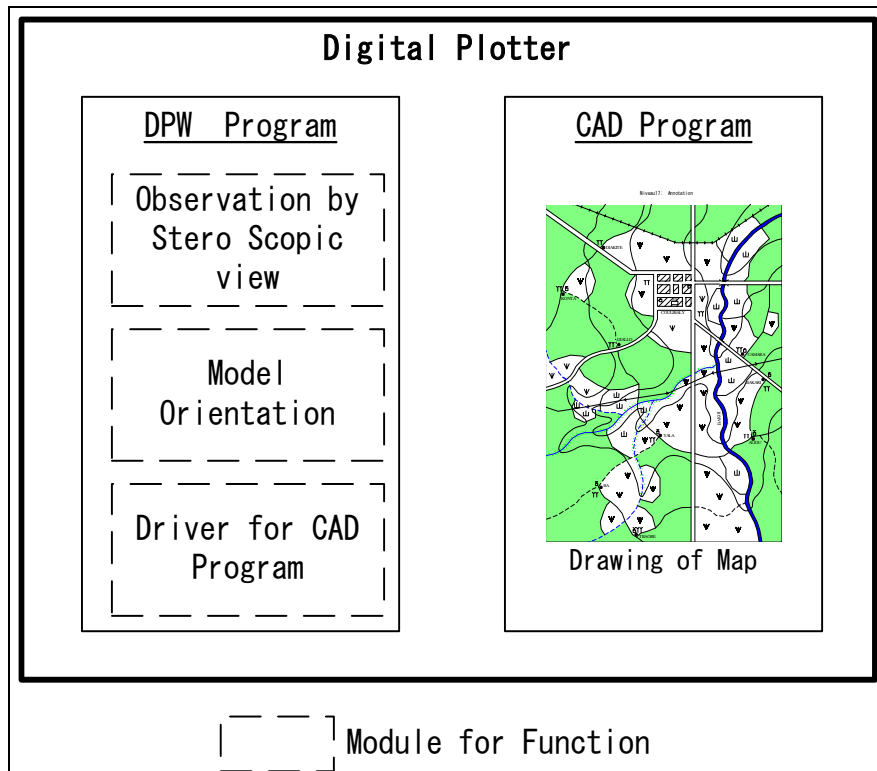


Figure 9.2.2 Composition of digital plotter

9.3 Final products

- Topographic map file (AutoCAD DWG file)
- Printed out maps of above item
- Map feature code table
- Quality control sheet

9.4 Work procedures

9.4.1 Preparation

- (1) Confirmation of mapping area and sheet allocation plan

First the extent of the mapping area is confirmed. If water areas such as sea is included in the mapping area, it is checked to see if the location and shape of shore lines are unchanged and if the planned sheet allotment needs not be changed.

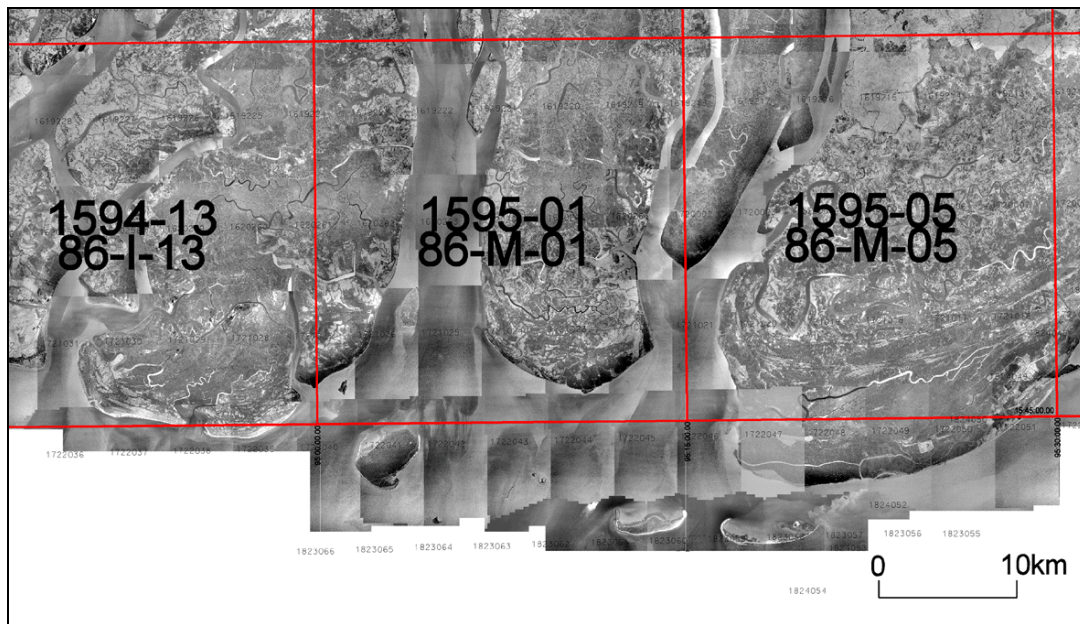


Figure 9.4.1 Orthophoto mosaic made from aerial photographs
Solid lines are original sheet assignment plan. It was found that a part of land area could be covered if original sheet assignment plan was applied. In this case addition of a new sheet or extension of the coverage is required.

(2) Preparation of map symbols

Shape and size of map symbols will be designed by referring to map symbol rules. CAD software installed on digital plotting system is used for this map symbol designing work.

(3) Preparation of map feature code table

Map feature code table is a table to define the following things for the preparation of topographic map data files. Digital mapping will be carried out according to this table.

- Geographic features to be mapped
- Rules for geographic features interpretation and classification
- Method of data recording

1) Geographic features to be acquired

Define the type of geographic features which correspond to each map symbol and annotation rules.

Map symbol consists of point, line, face or text, or a combination of one or two of these elements. In general, a map symbol corresponds to a figure of geographic feature. However, if a map symbol comprises of more than one figure, it will be defined as unique geographic feature for each element of a figure. For example, spot height point consists of

point and text objects.

2) Rule of interpretation and classification of geographic features

Considering application rules of each map symbol in annotation rules and also map scale, definition of each geographic feature will be clarified. Also, mapping method will be clarified as mapping standard.

3) Method of data recording

Information of geographic features acquired by digital plotting will be recorded onto CAD drawing files as figure data which has geometry of point, line or polygon. Method of recorded data depends on each CAD software, which is a compilation system of digital plotter. Therefore, elements of map feature code table can be divided into two groups.

Those do not depend on the compilation program of each digital plotting machine

- Geographic features classification number
- Name of geographic feature and its definition
- Type of geometry of figure by which geographic feature is represented.

Those depend upon the compilation program of each digital plotter

- Attributes of figures (such as type, image, color, line type, line width) which will be used to classify geographic features and also which is already incorporated into a compilation program. Name and function of these attributes of figure are various according to each compilation system.

If more than one type of digital plotting machine is used, elements which depend upon the function of compilation program of each machine will be made in a way they will fit to each system.

Please refer to Appendix 1 “Basic mapping feature code table for Myanmar 1:50,000 Topographic mapping” and Appendix 2 “Mapping feature code table for AutoCAD system”.

(4) Preparation photo interpretation card (key)

Purpose of making photo interpretation card (key) is the unification of rules for plotting, interpretation and feature classification. When geographic features are plotted, photo interpretation card is useful for features which may be interpreted differently by different

operators but which has some specific characters identifiable on aerial photos and help operators to make correct interpretation. Samples of such case are:

- Classification of density of forest (classification of dense and sparse forests)
- Identification of features with distinctive pattern such as orchard

9.4.3 Entry of orientation parameters and its confirmation

Import the results of aerial triangulation into digital plotter as orientation parameters. And it will be confirmed if the entered parameters are correct.

Location of existing control points will be measured on a model displayed on a monitor screen. And it will be confirmed if the measurement results are consistent with the control point coordinates and aerial triangulation results.

9.4.4 Acquisition of ground feature data

- (1) Topographic map data will be divided according to sheet assignment plan.
- (2) Digitization of geographic features will be carried out according to the definition and plotting rules defined in map feature code table. It should be noted that the photo interpretation cards are used to make the interpretation result in uniform quality.

1) Water areas (rivers, channels, sea)

- In the map symbols and application rules, rivers are classified according to their width. Special attention should be paid to the width of river.

The shape of river courses should be generalized depend upon designated map scale.

Classification of rivers from channels: Straight water routes without meandering will be classified as channels.

It should be noted that channels are often used as community roads in addition to as irrigation channels.

Shore lines will be determined by interpreting topography.

If valley lines are digitized as a break lines to generate DTM, rivers and water ways which are defined as objects required to be mapped according to map symbol rules will be clearly separated from the break lines.

2) Roads and railways

3) Buildings

- If building types are difficult to identify only by photo interpretation, existing information

will also be referred.

- Large sized schools can be identified by the shape of building and ground.

4) Vegetation

- To be interpreted and plotted based on field identification survey results.
- In map symbol rules, village areas are treated as a surface. Forests and orchards existing within a village should be interpreted carefully.
- It is not necessary to plot features which are very small and cannot be represented at the designated map scale.

5) Contour lines

- Spot height should be carefully distributed.

(3) Some line features such as embankment and cutting should be acquired along prescribed direction according to specifications.

(4) In order to understand details of geographic features on the designated map scale, same scale of orthophoto will be often referred during plotting work.

(5) Data acquisition sequence

Data acquisition will be done for each category and following the sequence listed below.

- 1) Water areas (river, channel, sea)
- 2) Roads and railways
- 3) Buildings
- 4) Vegetation
- 5) Contour lines

Line features such as water channels, roads and railways can be used as a framework .which can be used as a positional reference during plotting work. With these framework it is easy to identify other features such as buildings, vegetation and contour lines so that so that the chance of leaving some features unmapped can be reduced.

9.4.5 Acquisition of annotation data

If existing maps are used as the source of village and river names, existing maps will be scanned first. The scanned map data in raster format will be imported into a digital compilation machine and the data will be displayed on a monitor screen. Then village names and river names shown on the screen will be newly typed and the resultant text

strings will be pasted near the original location to make a file of village and river names.

The scale of existing map is 1:63,360 and map projection is Lambert's conformal conic projection system. Therefore, before starting the above mentioned process it is necessary to adjust scale and projection of existing map images by transformation.

9.4.6 Integration of geographic feature data and annotation data.

Geographic feature data and annotation data will be integrated to make topographic map data.

9.4.7 Clarification of areas which are difficult or impossible to acquire from aerial photos.

As for areas or features which cannot be identified clearly during plotting process, operators will be listed or marked. These doubt issues will be confirmed in field identification.

9.4.8 Inspection and verification of quality

The contents acquired by digital plotting will be inspected and fill out quality control sheet.

(1) Inspection method

In principle, visual inspection on monitor screen or printed maps will be applied. For the visual inspection, it will be necessary to emphasize specific code by different color or pattern so that errors can be detected easily.

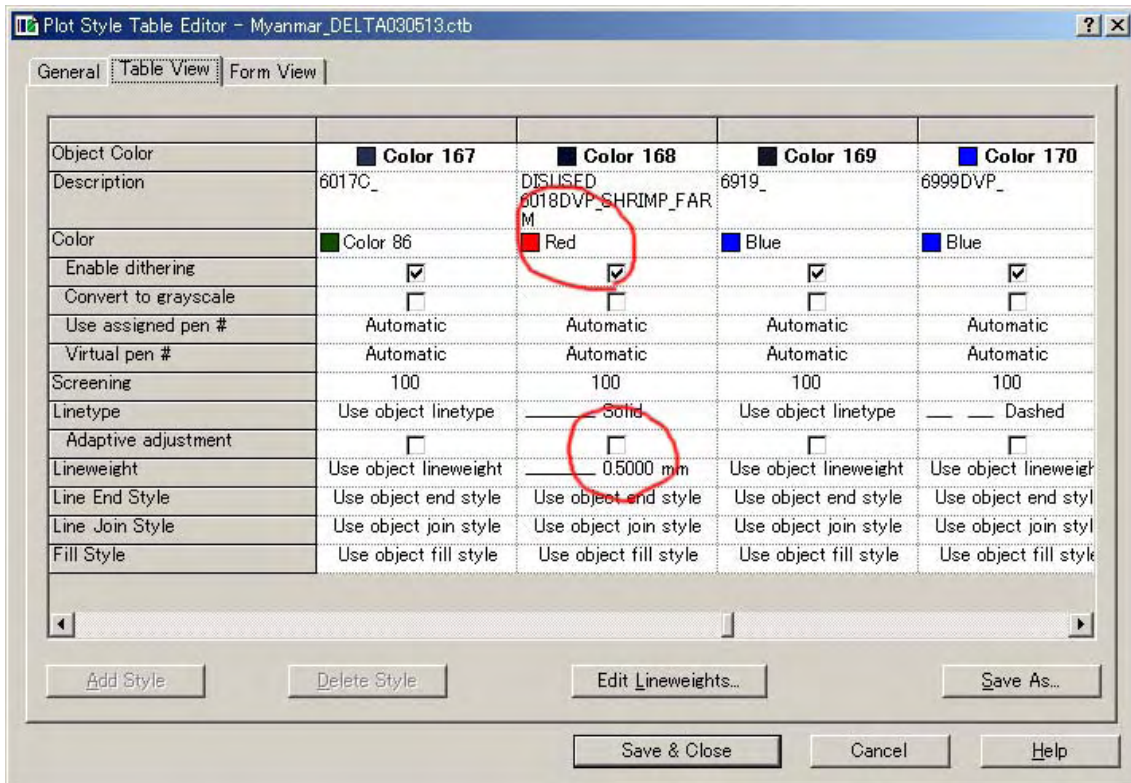


Figure 9.4.2 Control by printing style table to emphasize specific code.

In this particular case, red and 0.5mm width are selected for a line feature.

(2) Use of orthophoto image for inspection of digital plotting results

One stereo model of digital plotting is usually carried out by single operator. It is desirable that the same operator carries out digital plotting of other stereo models in the mapping area. However if the mapping area is large, digital mapping work needs to be done by many operators.

The problem is that because of the individuality of each operator, the result of image interpretation is different from one operator to the other. This difference in the photo interpretation result becomes prominent when one geographic feature covers more than one stereo model. For instance, border of one vegetation type will be interpreted differently by two operators. This will result in mismatching lines of a vegetation area of a same kind at the border between adjacent sheets.

To find this mismatching problem and make necessary corrections, the results of plotting of stereo models covering one map sheet will be overlaid on the image of the corresponding

orthophoto mosaic.

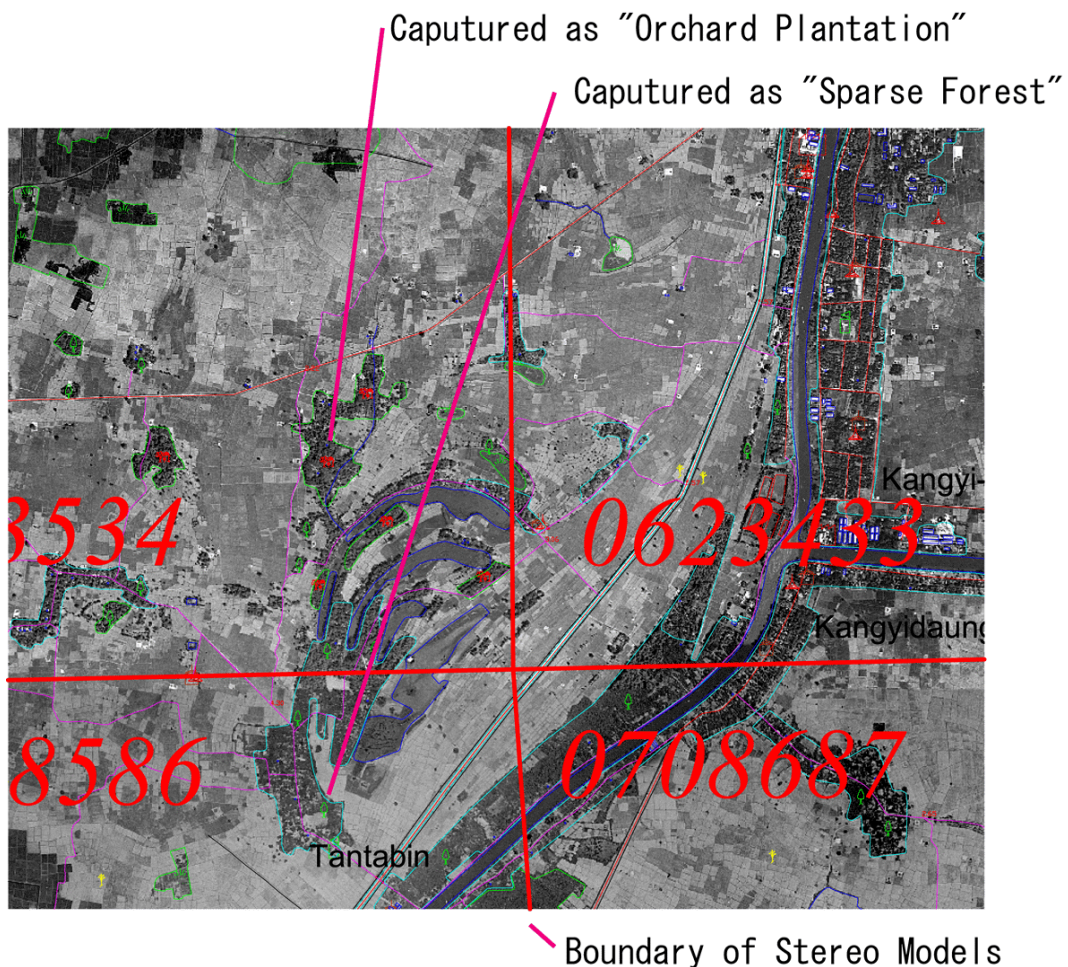


Figure 9.4.3 Overlaying orthophoto, digital plotting result and coverage of models. Sample that different operators interpret the features in different way.

(3) Elements of quality check

The prepared topographic data will be inspected for the following five elements.

1) Completeness

Redundancy, excessiveness and left over items will be checked.

Redundancy of figures can be checked by computer programs. As for the inspection of excessiveness and left over items, they will be checked by counting the number of plotted figures. Please refer to Appendix 3 "Quality control report for Topographic Data."

2) Logic consistency

- Check to see if the coordinates of figures are within the pre-determined limits.
- Check to see if data structure is as defined by topographic map data and topology is in

consistent manner.

3) Positional accuracy

Topographic map data will be overlaid with orthophoto to check the positional accuracy.

4) Temporal accuracy

Aerial photos, the results of field identification and contents of collected existing information will be compared and the most recent data will be identified and used.

5) Attribute accuracy

Classification by photo interpretation will be checked against plotting standard and photo interpretation card.

As for parts which are found to be suspicious but cannot be identified clearly, they will be registered onto a pre-determined format for confirmation by field identification. Please refer to Appendix 4 “Plot Style Table for Field Identification map”

10. Field Identification

Field identification is a work to collect information on geographic features which are difficult to identify on aerial photos or which need confirmation in the field. The results of the survey will be used in digital compilation process

Field identification will be divided into preliminary survey and field identification.

Preliminary surveys will be carried out to prepare material necessary for the smooth implementation of field identification. Geographic features which should be drawn on the map will be interpreted by using aerial photos and based on existing material

Field identification will be conducted in order to verify the results of preliminary digital plotting by using the results of the preparatory work.

10.1 Necessary material

The following material will be collected before the start of the work and their contents will be checked.

- Contact prints
- Photo index map
- Map symbols and their application rule
- Orthophoto print out
- Photo interpretation card
- List of control points and description of points
- List of place names
- Collected material (Regional maps, administration boundary maps)
- List of questions or unclear points found during the restitution processes

10.2 Necessary equipment

- Personal computer
- Printer
- Handy GPS
- Compilation software (AutoCAD)
- Coordinate system conversion software
- Camera
- Measuring tape (50m)
- Polyester base

- Drawing pens (Black, blue, green and red)

10.3 Results of field identification

- Field identification results compilation sheet (Figure 10.1.1)
- File of location data of public facilities (hospitals, hotels, stations, etc.) (Table 10.1.1)
- List of material collected in the field together with the collected material as follows:

The map of Yangon 3rd Edition, YCDC, 1996

Myanmar facts and figures 2002,

Ministry of Information Union of Myanmar

Myanmar Yellow page 2002, IMEX Co. LTD.

Gazetteer of Burma, Director of Survey India, 1944

City map of Patheingyi (scale: 1/10,000)

City map of Myaungmya



Figure 10.3.1 Sample of field identification survey result

List of POLECE					
No.	Latitude	Longitude	NAME	ADDRESS	
1	16 47.287	96 7.752	Ahlonce Police Station	Ahlonce	
2	16 53.994	96 8.383	Ayeyar Wun Police Station	Mingaladon	
3	16 50.912	96 14.803	Ayeyar Wun Police Station	South Dagon	
4	16 48.172	96 9.339	Bahan Police Station	Bahan	
5	16 51.436	96 8.092	Bayint Naung Police Station	Meyangone	
6	16 53.822	96 11.73	Dagon Myothit (North)	Dagon	
7	16 51.674	96 12.811	Dagon Myothit (South)	Dagon	
8	16				
9	16				
10	16				
List of SCHOOLS					
STATE HIGH SCHOOLS (S.H.S)					
YANGON					
AHLONCE T/S					
No.	Latitude	Longitude	NAME	ADDRESS	
1	16 47.559	96 7.708	S.H.S (1) Ahlonce		
2	16 47.416	96 7.824	S.H.S (2) Ahlonce		
3	16 47.289	96 7.946	S.H.S (3) Ahlonce		
4	16 46.865	96 8.121	S.H.S (4) Ahlonce		
5	16 47.228	96 7.784	S.H.S (5) Ahlonce		
6	16 47.339	96 7.907	S.H.S (6) Ahlonce		
7	16				
8	16				
BAHAN T/S					
No.	Latitude	Longitude	NAME	ADDRESS	
1	16 48.449	96 9.187	S.H.S (1) Bahan		
2	16 49.195	96 9.345	S.H.S (2) Bahan		
3	16 49.14	96 9.937	S.H.S (3) Bahan		

Tale 10.3.1 Sample of list of location data of public facilities

10.4 Working procedures

10.4.1 Preparation

Collect comprehensive information on the mapping area.

(1) Confirmation of the locations of major cities and towns within the mapping area

Firstly, identify major towns and cities. Then, the following matters will be checked.

- Type of available transportation

- Traveling time and distance between cities
- Availability of bridge
- Situation of accommodation
- Availability of electricity

If ferry is used to cross rivers, service time is checked.

(2) Preparation of working maps

Orthophoto maps, print out of topographic map data and existing maps will be printed at the size convenient for handling. (In this project, one sheet was divided into 9 parts.)

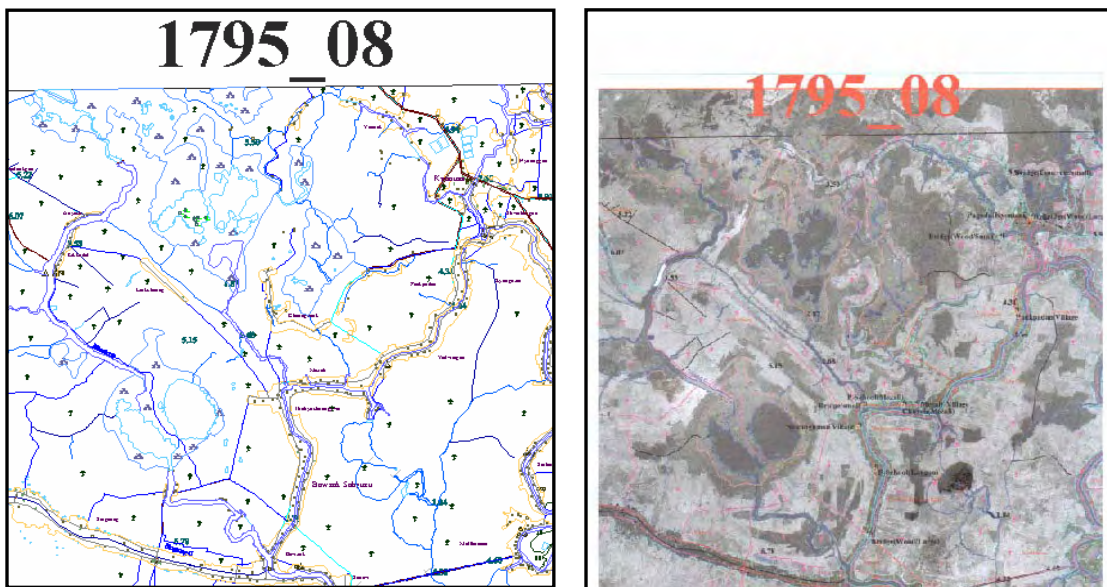


Figure 10.4.1 Sample of working maps in field identification

(3) Arrangement of collected information

- Point description of bench marks
- Large scale maps
- Results of hearing survey

(4) Preparation of plan of operation

Plan of Operation will be prepared based on the collected information. The following items will be included in the Plan of Operation

- Purpose of field identification
- List of survey team members

- Work schedule and the volume of work
- Place of accommodation
- Scope of work
- List of equipment and material required for the work

(5) Preparation for travels

Application for the permission of travels, vehicles and drivers should also be arranged.

10.4.2 Preparatory surveys

Topographic features will be tried to classify experimentally in order to make standard of photo interpretation. This work is undertaken by stereoscopic observation of topography of the mapping area on contact prints.

Annotation data compilation sheets will be prepared based on the collected information, and then material to be used in field identification will be prepared.

10.4.3 Field identification

(1) Survey items

Features which are difficult to interpret on aerial photos as well as names of villages and facilities will be checked in the field.

- Locations of bench marks will be measured by GPS and pictures of the verified bench marks will be taken for later reference.
- Bridge type (Check of the length)
- Towers, pipelines, power transmission lines
- Name of rivers and mountains. The direction of flow of river is also checked.
- Name of villages, location of boundaries between township and population.
- Taking photographs to make photo interpretation card (Major roads, secondary roads, fish ponds, ports, railways, bridges, paddy fields, villages and hearing results)
- In principle, military facilities will not be shown on the map.

(2) Arrangement

The information collected in the field will be compiled on polyester sheets to make compiled field identification sheet.

- Classification by color

Red: Important survey results such as annotation.

Green: Description of vegetation

Blue: Other description and explanation

- Classification by symbols

- OK: No change
- D: To be deleted
- M: Required to modify or correct
- CK: Required to confirm by other material
- A: Addition
- G: Re-acquisition by digital plotting

10.4.4 Preparation of annotation data file

Location of public and other facilities measured by GPS will be converted into Myanmar Datum 2000 by using coordinate conversion program, then be plotted on a sheet of paper to confirm the location.



Figure 10.4.2
Sample of Annotation data file

10.4.5 Inspection

By using inspection sheet, it is confirmed that every necessary items were checked.

11. Digital Compilation

Digital compilation is a process to prepare topographic data files by compiling topographic data prepared by digital plotting.

Digital compilation is composed of the following processes.

- Completion of topographic map data
- Completion of cartographic display data

(1) Completion of topographic map data

Topographic data file will be prepared by modifying the topographic map data by using the results of field identification.

Topographic data is CAD map data consisting of map information at the scale of 1/50,000. In a later process this CAD map data will be compiled to make cartographic display files.

(2) Preparation of cartographic display data

Topographic map data files will be transformed into cartographic display data files. At the later stage of the map production process, printing sheet (PS plate) will be made from printing film on which the image of cartographic display data is printed (See Appendix 6).

11.1 Necessary instruments

Digital compilation system

Digital compilation system consists of computer and map compilation software, inkjet plotter, and so on.

11.2 Results

- Topographic map data file in DWG (AutoCAD Drawing format)
- Cartographic display data file in EPS (Encapsulated Post Script) format
- Print out of the above listed files

11.3 Working procedures (Completion of topographic map data files)

11.3.1 Analysis and evaluation of information and collected data

The following data and information are required for compilation

- Topographic map data files (as of the end of the digital plotting process)
- Map symbol and its application rules
- Map feature code table
- Field identification compiled sheets
- Various data sheets from field identification
 - Annotation draft sheet
 - Road type map
 - Administrative boundary and forest conservation area boundary maps
 - Large scale maps of major cities
- Photo interpretation card
- Information on landscape of mapping area
- Other material as needed

The information and material collected will be analyzed and evaluated. When conducting data analysis, data sources and the history of data will be considered. If necessary, further collection and compilation of data will be done.

11.3.2 Preparation

Volume of compilation work will be estimated and work plan will be prepared based on the quality check reports of topographic map data file (as of the end of the digital plotting work) and information collected by field identification.

11.3.3 Data import

Topographic data file will be imported into digital compilation machine.

If map compilation system installed in digital plotting machine and digital compilation machine is different, it will be checked if data conversion is done properly.

11.3.4 Compilation

Compilation work consists of the following components.

(1) Map compilation

Topographic map data file will be combined with the results of field identification and collected information. If more than one geographic feature overlaps each other, shifting of map symbols will be done during cartographic display file generation.

(2) Compilation of geometric structure (geometry)

Every geometry of map information on topographic data file will be compiled to match the geometry and data structure which are defined by the specifications for topographic data file.

(3) Contour line compilation

Contour lines will be compiled.

(4) Annotation compilation

Annotation will be edited based on annotation information.

(5) Map connection compilation

Map contents at four borders of each map sheet will be compiled so that they will be connected with the contents of adjacent sheets.

11.3.5 Inspection and the preparation of quality confirmation report

Completed topographic map data files will be inspected based on the specifications for the final products and the results will be compiled as quality confirmation reports. Particular attention will be paid if there is any mistake in coding.

It will also be checked if the results of field identification are thoroughly reflected in the compilation

11.4 Digital compilation for the completion of cartographic display data

11.4.1 Preparation of map symbols on compilation system

Map symbol library will be prepared on a compilation system used for map symbol compilation based on the Map Symbols and Application Rules

11.4.2 Data import

Importing topographic map data file into digital compilation system. If a map compilation system is different from that of preceding processes, it will be confirmed if data conversion is carried out properly.

11.4.3 Compilation

During the map symbol compilation process, selection of items to be deleted, generalization and shifting will be done in addition to the ordinary conversion of geographic features into map symbols.

(1) Preparation of compilation sample map

If necessary, prior to the map symbol compilation work, compilation sample map which shows the instructions on map symbol compilation work will be prepared in order to confirm the contents of the final results.

(2) Shifting

It may happen that symbols of more than two geographic features overlap or are too close to each other. In such a case, position of one of them or both of them may be shifted.

(3) Selection

Features included in topographic map data files which are impossible to show because of the mapping scale or those which are not appropriate for 1/50,000 scale maps will be deleted. However, in reality, since the mapping scale is 1/50,000, most overlapping problem can be dealt with shifting method.

(4) Generalization

Shape of rivers, roads, houses and so on which are not appropriate for 1/50,000 scale maps will be generalized.

11.4.4 Design of marginal information

Marginal information will be designed. The following information will be included in marginal information.

- Map sheet name (State/Division name)
- Sheet number
- Index map
- Name of adjacent sheets
- Destination
- Name of administrative organizations
- Public administration boundary maps
- Location diagram
- Legend
- Lineage
- Magnetic azimuth
- Grid convergence from true north
- Military grid
- Scale and scale bar
- Name of publishing organization

11.4.5 Inspection and preparation of quality confirmation report

Completed cartographic display data will be inspected and its quality will be checked for the items specified in the specifications. The results of the inspection will be compiled as quality confirmation report.

11.4.6 Confirmation of places which need field completion survey

If it is found, as the results of compilation, that field completion should be carried out for some parts of the mapping area, then their locations will be registered as places subject to field completion.

12. Field Completion

Important or unclear parts of topographic map data prepared by digital compilation process will be checked and conformed by field completion. Items which should be confirmed during the field completion are as follows.

- 1) Unclear items or portions found during the compilation process or important things and items.
- 2) Items which are difficult to edit.
- 3) Things subject to change over time.
- 4) Boundary and annotation
- 5) Mistakes in expression or left over items.

12.1 Necessary material

- Aerial photos
- Aerial photo index sheet
- Print out of topographic map data
- Maps symbols and its application rule
- Photo interpretation card (key)

12.2 Necessary equipment

- Handy GPS (Acquisition of location data)
- Laptop Computer (Conversion of coordinate system of position data measured by GPS)
- Coordinate system conversion software (Conversion from WGS84 to UTM coordinate system)
- Printer (for printing out of GPS data)
- Camera (recording field conditions)

12.3 Final results

- Field completion compiled sheets
- Print out map
- Information collected during surveying

12.4 Working procedures

12.4.1 Preparation

- (1) Confirmation of location of field completion and survey contents

Field completion will be conducted to clarify unclear matters found using digital

compilation and to confirm the annotations such as place names. Especially unclear matters found during the digital compilation process will be arranged as shown in Table 12.4.1 to implement the field completion efficiently.

Table 12.4.1 List of questions and method of checking (Major items)

Item	by field completion	by asking to C/P	by referring to existing material	Remarks
Town and village names				Check the names of town and villages in newly developed housing areas
Light houses and buoys		○		Check location
Pipelines				Check to see if there is any interruption
Transmission lines				Check to see if there is any interruption
Railway	○			Check station and track type (single or double)
Roads				Check types
Benchmarks		○		Check location
Name of dam and lake				Check name
Information on Yangon city	○			Selection of information is important

: Use as major information ○ : Use as supplementary data

12.4.2 Planning of field completion

Before starting field completion survey, prepare an implementation plan. The following items should be included in the plan

- Purpose of the field completion
- List of survey team members and their roles
- Schedule and volume of work
- Place of accommodation
- Contents of the field completion work
- Necessary equipment and material

12.4.3 Procedures for field work

Application for permission for domestic travels. Arrangement of vehicles and drivers.

12.4.4 Field completion

(1) Survey items

Unclear matters caused during digital compilation will be checked with particular attention.

- Confirmation of town and village names (particularly those of newly developed areas)
- Light houses and light beacons (Only major ones)
- Towers, pipelines and transmission lines (Confirmation of locations)
- Roads (Confirmation of road types)
- Bench marks (Confirmation of locations)

(2) Compilation

The results of field completion will be compiled on printed maps to make field completion compiled sheets.

12.4.5 Preparation of annotation data files

Place names checked for the preparation of topographic maps, will be compiled as lists. Sample lists are presented as Figure 12.4.2 and 12.4.3.

Name	WGS84			Northing	Easting	Zone	Sheet No			
	Lat.	Long.								
Acha	N	16	13	E	95	41	1795400	788400	Zone46	169512_85P12
Alan ok	N	16	41	E	95	57	1847200	819200	Zone46	169514_85P14
Ale thaung(Thatch Area)	N	16	52	E	96	16	1868100	211600	Zone47	169605_94D05
Am ma ti	N	16	38	E	95	53	1841400	806200	Zone46	169514_85P14
Ama	N	15	48	E	95	47	1748200	745300	Zone46	159505_86M05
Auk chaung	N	16	11	E	94	45	1790100	690200	Zone46	169416_85L16
Aung daw mu	N	16	13	E	94	41	1794200	707600	Zone46	169416_85L16
Aung tha ya Village	N	16	13	E	95	41	1795300	788300	Zone46	169512_85P12
Awa bye Village	N	16	5	E	95	28	1780100	767300	Zone46	169508_85P08
Aye ywe	N	16	33	E	95	56	1833000	815000	Zone46	169514_85P14
Ba wa thit	N	15	47	E	95	17	1746400	748300	Zone46	159505_86M05
Baw di su	N	16	57	E	96	57	1876900	247200	Zone47	169609_94D09
Bo ga lay ywa thit	N	16	57	E	96	37	1875900	247300	Zone47	169609_94D09
Chan gyi gon	N	17	9	E	95	55	1898900	812600	Zone46	179516_85L16
Chan tha aye	N	16	5	E	94	57	1779300	710300	Zone46	169416_85L16
Chan tha gon	N	17	9	E	95	55	1899500	811400	Zone46	179516_85L16
Chaung wa	N	16	19	E	95	46	1807300	810300	Zone46	169515_85P15
Chaung wa	N	16	43	E	96	31	1850700	236600	Zone47	169610_94D10
Chetty gon	N	17	14	E	96	5	1908500	181500	Zone47	179604_94C04

Table 12.4.2 List of place names (sample)

No	Northing	Easting	NAME	ADDRESS
1	1864226.06	196717.47	Inya Lake Hotel	37, Kaba Aye Pagoda Road
2	1863815.23	197303.53	MICasa	17, Kaba Aye Pagoda Rd., Yankin T/S
3	1861027.19	196957.60	Mya Yeik Nyo Royal Hotel	20, Pale Road, Bahan T/S
4	1859803.95	196788.83	Yuzana Hotel	130, Shwe Gon Dine Rd, Bahan T/S
5	1859508.79	197412.33	Hotel K Paradise	12, Ko Min Ko Chin Rd., Bo Cho Ward No (1), Bahan T/S
6	1859247.84	198619.47	Hotel Nikko Royal Lake	40, Natmauk Rd., Tamwe T/S
7	1858699.82	197829.19	The Kandawgyi Palace Hotel	Kan Yeik Tha Rd., Yangon
8	1858620.04	195804.55	Summit Parkview	350, Ahlone Rd., Dagon T/S
9	1860024.56	196082.56	Savoy Hotel	129, Dhammazedl Road,
10	1860688.66	195731.24	Sakura Residence	9, Inya Road, Block 10, Kamaryut T/S
11	1858543.07	195634.44	International Hotel	330, Ahlone Road, Dagon T/S
12	1858010.65	195434.71	Pan Sea Hotel	35, Taw Win Road, Yangon
13	1857576.14	197405.95	Yuzana Garden Hotel	44, Signal Pagoda Road, Yangon
14	1857474.28	197434.68	Sofitel Plaza	33, Alan Pya Road, Dagon T/S
15	1857405.04	197497.71	Thamada Hotel	5, Signal Pagoda Road, Yangon
16	1856982.23	197500.51	Traders Hotel	223, Sule Pagoda Road, G.P.O. Box 888, Yangon
17	1856966.71	197423.89	Central Hotel	335-357, Bogyoke Aung San Street, Pabedan T/S
18	1856987.50	197906.03	Asia Plaza Hotel	277, Bogyoke Aung San Road,
19	1856195.16	198067.24	Aye Yar Hotel	170/176, Bo Aung Kyaw St., Botataung T/S
20	1855891.86	197845.97	The Strand	92, Strand Road, Yangon
21	1857078.67	197340.13	The Grand Mee Ya Hta	372, Bogyoke Aung San Rd., Pabedan T/S
22	1865831.42	193837.79	Nawarat Hotel	105/B, Parami Rd, MYGN

Table 12.4.3 List of hotel names (sample)

12.4.6 Inspection

Inspection sheets are printed out to check to see if there is any leftover items during data acquisition. Also, parts which were difficult or unclear to identify by photo interpretation during digital plotting process will be recorded.

13. Supplementary Compilation

Complete topographic map data files and cartographic display data files, by modifying or correcting them based on the results of field completion. This process is similar to digital compilation process. As for the details please refer to Chapter 11 digital compilation process.

13.1 Working procedures

13.1.1 Preparation

Confirmation of the locations and contents of field completion

13.1.2 Digital compilation

Make necessary corrections based on the results of field completion

13.1.3 Inspection

Confirm if all the results of field completion have been used in the compilation of topographic map data and cartographic display data.

14. Preparation of Topographic Map Data

Record topographic map data onto CD-ROM after adding metadata which describes the contents of the data files.

14.1 Necessary material

- Specifications for metadata
- Topographic map data

14.2 Necessary equipment

- CD-W drive

14.3 Final results

- Topographic map data file (CD-ROM)

14.4 Work procedures

14.4.1 Preparation

Confirmation of the metadata specifications

14.4.2 Preparation of metadata

Metadata should be prepared based on prescribed specifications.

14.4.3 Inspection

After inspecting the necessary data, the contents of CD-ROM are checked.

15. Land use mapping

In order to make a program for rehabilitation and development, a land use map is the most useful map among thematic maps. In this chapter the work to prepare land use maps based on topographic data is explained.

15.1 Materials for land use mapping

- Topographic dataset
- Aerial photographs and orthophoto image dataset
- Documents of field survey
- Other materials

15.2 Required software

ArcView 8.3 (necessary 3 kinds of module such as ArcMap, ArcCatalog and ArcToolBox)

15.3 Category of land use

Land use is divided into 22 categories shown as Table 1 in this chapter.

15.4 Procedure to land use mapping

Land use maps are prepared in following working steps.

1) Preparation for legend of categories

Color and pattern represented land use categories shall be decided on land use map

2) Classification of topographic data

Land use data are prepared by means that the feature types related to land use category directly, and then the feature types not related to land use category are classified as unclassified category.

To orient locations, feature of line type such as roads or railways are prepared as back ground dataset.

Lot with less than 100m x 100m in area should be deleted.

Unnecessary features to be used land use map are deleted.

3) Preparation for draft of land use map

Draft land use maps are output by unified dataset with land use dataset and back ground dataset in prior work step.

4) Compilation for land use categories

Drafts of land use maps with legend are output in units of 1/50,000 scale topographic map

sheet.

5) Compilation for land use classification

Unclassified lots should be classified by means of follows

- By collected materials

Unclassified lots are classified by collected materials such as existing maps and documents.

- By means of field survey

Unclassified lots are classified by field survey.

- Examination of classification on draft map

Whole lots shall be confirmed to classify into collect categories

6) Compilation for land use dataset

Land use dataset is prepared based on draft of land use map.

- Land use dataset

Unclassified lots are classified by collected materials such as existing maps and documents.

- Back ground dataset

Back ground feature dataset represented by line

Table 15.3.1 Classification of Land use map

	Category of land use	Definition
10	Residential area (High)	Higher buildings more than 3_stories. Including commercial space of ground floor.
20	Residential area (Low)	Lower buildings less than 3_stories
30	Business area	Head offices of second or tertiary industry Government offices, Bank etc.
40	Commercial area	Markets, Stores
50	Industrial area	Plants,
60	Education and Culture facility area	University, School
70	Health and welfare facility area	Hospital, Dispensary
80	Transportation facility area	Airport, Station yard, Port or Pier, and warehouse or shipping storage.
90	Under developing area	Under development and construction area
100	Play yard	Golf course, Stadium, Play field
110	Green space	Park, Green space or Cemetery
120	Water surface	Sea, River, Lake, Pond,
130	Cultivated land	Rice paddy, Upland farm
132	Cattle farm	Cattle farm, Pig farm, Chicken farm
140	Plantation	Large scale farmland
150	Dense forest	Dense forest
160	Sparse forest	Sparse forest
170	Scattered trees	Scattered trees
180	Grass land	Grass, Bush, or Scrub
190	Mangrove area	Mangrove trees
200	Swamp area	Swamp
210	Open space	Land not for used. (Barren land, Sand, Waste land, Mud land)