Digitization of cadastral Maps and integration with ROR Data
(A methodology implemented in West Bengal)

1. Introduction

This document discusses about the methodology of the existing paper based Cadastral *Map digitization, its integration with ROR data*.

Cadastral map:

Maps showing the individual piece of land called "parcel" or "plot" is prepared accurately following a big scale by detailed survey technique. Such a piece of land may be very small as 1 decimal area i.e 435.6 sq ft in 1:3960 scale. Such detailed maps of ownership plots are prepared for each Mouza which is equivalent to a village.

ROR:

Record of Right, also called Khatian in West Bengal, provides the information of plots held by an individual owner or joint owner. This is a legal document used in court of law to resolve disputes in determining the legal ownership land, land use etc.

Map Updation:

Plot of land may be further divided into two or many sub-plots to figure out the portion that has been transferred to other persons by way of deed of gift, sale, inheritance etc. A plot may be divided in to smaller sub plots in order to give effect the conversion of land classification (lad use) in each of the sub-plots. Such correction of plots also called "Map correction" is necessary to depict the ground reality. Obviously, need for such map correction is on continuous basis.

The development of GIS (Geographical Information System) enabled ROR consists of the following:

1) GIS ready Digitization of existing paper based Map with assured accuracy
2) Integration of text ROR database with the spatial data database as created in 1 above.
3) Division of plots based on field measurements

2. West Bengal Scenario:

For preparing the record of rights, cadastral map is prepared first following well established detailed surveying techniques using precision survey equipments like Total Station, Geographical Positioning System (GPS). For developing LR records, West Bengal has used modern survey equipments like Total Station(TS), ET(Electronic Theodolite), GPS etc. Each parcel of land called "PLOT" is drawn on such map to the scale and provided with a unique numerical number. ROR ,also called Khatian for an individual, is prepared where all the plots under one's rights is referenced by its plot number. Each plots other particulars like its area, type of land, share & share area are recorded in the khatian.

2.1 Mouza Map: West Bengal has geo-referenced Mauza (a revenue village) maps showing plots (land parcels) in the scale 16" = 1 mile which is equivalent to 1:3960. In densely populated areas such maps are prepared in bigger scales i.e. in 32"=1 mile (1:1980) or in 64"=1mile (1:990). There are 66,348 such map sheets in A0/A1 size paper covering all the 42042 Mauzas of West Bengal, prepared by well established detailed cadastral survey techniques. Each Mauza map contains 1200/1500 plots (property parcel boundaries) on the average surveyed true to scale by Theodolite traverse and chain survey. Later on the lengths of the each sides of the plot and its area is extracted from the paper map itself using acre comb. No field dimensions of the individual plots are noted on the map. The each Mouza map has the following features-

1. Sheet heading (Mauza Name & North Direction.)
2. Scale of the map
3. Plot boundaries with Plot numbers
4. Legends
5. Conventional signs (Alamats), Bata Plot nos. & Missing Plot nos.
6. Contents of the certificate block

3. Accuracy Requirement: As such, a difference of 0.25 mm of sheet measurement in 1:3960 scales between the original map and its copy, whether conventional or digitized, gives rise to a difference of about 1 metre on the ground. So an accuracy of 0.25 mm or less in meter is acceptable.

4. Scope of work for digitization: GIS-ready digitization, also termed as vectorisation, of cadastral Mauza maps are required to be done in various layers to facilitate digital capturing of all the features of existing paper map. Map, digitized this way, provides all the flexibility needed for its future corrections following the process in a very efficient & optimal way. These layers are called area layers, line layers, point layers and text layers. Each plot of land is viewed as a closed polygon and digitized in area layer to provide the area of the plot. A 5 digit number, which is written within in the paper map itself, is to be used for such unique identification of the digital polygon. Map should be scanned in true scale of the map, vectorized and converted into shape file format (.shp, .shx, .dbf) [item 2 & 3 above], .gif formats [item 1,4, 5 & 6] along with the data in .dbf format [item 5] as detailed in the scope and methodology of the work.

SLNO	JOB DESCRIPTION
1	Accurate Scanning of Original paper based Maps (Generation of Raster image of the Map)
2	Digitization of Plots (Drawing digital line on each plot boundaries of the scanned map)
3	Topology Creation & Closed Polygon Generation in Area layer
4	Creation of Plot Numbers in polygon area layer
5	Creation of Rendered Plot Numbers (RPN) and Centroid points of each polygons in point layer. Sometimes plot number can not be written inside the plot because it is small to accommodate the umber. In that case a last one or two digit is written to represent the original number. This plot umber is called rendered plot number. Centroid is the geometric centre point of the polygon. The number of the polygon is written at the centroid.
6	Creation of in-situ lines and point Alamats (line & point layer).
7	Thoka lines of Mauza and sheet control points, tri-junction pillars, permanent features or marks, old control stations, roads, railway tracks, rivers or streams, relay lines of acquisition plans, etc in .shp format of line, point and area layers
8	Creation of DBF files for Point/Area Alamats and Bata Plots (point & area layer)
9	Creation of GIF files of non map features (Sheet heading, North Direction, legends, List of Conventional Signs, Contents of Cetrificate Block)
10	Creation of text files in point layers

Besides, the following four database tables should be developed from the data as available in the paper map. This is to be done by carefully observing each & every plot in the map sheet.

Table No. 1 - The conventional signs or alamats shall have to be codified along with the reference of bata plot no. in the following dbf:

Mouza Code	Sheet No	LR/RS (L or R)	Plot No.	Alamat Code	Reference of bata plot nos.
1	2	3	4	5	6

The original plot nos. shall be written in Column 4 and any reference of parent plot no. from which the original plot has been created is to written in Column 6.

Table No. 2 - Data with respect to Alamats in point layers shall be developed that shall contain the following information. This is master data information and should be developed centrally & maintained centrally.

Alamat Code	Alamat name	Actual file as OLE object
1	2	3

Table no. 3 - This table will contain the information on the first plot and the last plot no. in a sheet of cadastral map for a particular Mauza.

Mouza Code	Sheet no.	L or R for LR / RS	First plot no.	Last plot no.
1	2	3	4	5

Table no. 4 - The table will keep track of missing plots of in a particular sheet of a mouza. Missing plots numbers are those numbers within the 1st & last plot numbers that are no longer attached with any plot.

Mouza Code	Sheet no.	L or R for LR / RS	Missing plots.
1	2	3	4

Stringent Accuracy requirement:

The digitized map should exactly match the original map dimensionally like a contact print as length & area of plots or the whole village or mouza are extracted from the map itself in this State. Tolerance may be treated as nil to 0.25 m.m. per metre.

5. Outputs of Digitization:

Vectorised Map can be stored in any open GIS format without any loss of freedom as the conversion from one format to another is built in to the software for Raster to vector conversion . One of the popular open format is SHP format which essentially a bundle of three formats to store spatial objects in .shp , text data attached to spatial objects in .dbf & the format for linkage of .dbf & .shp that is .shx. Many popular Raster to Vector digitization software available & can be used like R2V, AutoCAD map etc. These GIS files are to be provided in CD media with a print out of the digitized map.

More or less 36 numbers of files are generated for a typical GIS ready Mouza map

Those are the following.

Serial No.	File Name	Description
1.	JlNo.shp	Shape file for Mouza Map Sheet
2.	JlNo.shx	Shx file for Mouza Map Sheet
3.	JlNo.dbf	Dbf file for Mouza Map Sheet
4.	Alml. shp	Shape file for Alamat in line layer
5.	Alml. shx	Shx file for Alamat in line layer
6.	Alml.dbf	Dbf file for Alamat in line layer
7.	Almp.shp	Shape file for Alamat in Point layer
8.	Almp.shx	Shx file for Alamat in Point layer
9.	Almp.dbf	Dbf file for Alamat in Point layer
10.	Bnd.shp	Shape file for Sheet Boundary, it denotes the extent of the sheet.
11.	Bnd.shx	Shx file for Sheet Boundary
12.	Bnd.dbf	Dbf file for Sheet Boundary
13.	Centroid.shp	Shape file for the points where to place the Plot Numbers
14.	Centroid.shx	Shx file for the points where to place the Plot Numbers
15.	Centroid.dbf	Dbf file for the points where to place the Plot Numbers
16.	Img.shp	Shape file for the points where to insert the GIF files
17.	Img.shx	Shx file for the points where to insert the GIF files

18.	Img.dbf	Dbf file for the points where to insert the GIF files
19.	Mbnd.shp	Shape file for Mouza Boundary
20.	Mbnd.shx	Shx file for Mouza Boundary
21.	Mbnd.dbf	Dbf file for Mouza Boundary
22.	Scale.shp	Shape file for Scale of the Mouza Sheet
23.	Scale.shx	Shx file for Scale of the Mouza Sheet
24.	Scale.dbf	Dbf file for Scale of the Mouza Sheet
25.	Text.shp	Shape file for Texts of the Mouza Sheet
26.	Text.shx	Shx file for Texts of the Mouza Sheet
27.	Text.dbf	Dbf file for Texts of the Mouza Sheet
28.	sign.gif	Gif file for Certificate book
29.	alm_bata.dbf	Dbf file for conventional signs or alamats along with the reference of bata plot no.
30.	missp.dbf	Dbf file for Missing Plots in Mouza Sheet
31.	first_last.dbf	Dbf file for First & Last Plot Number for Mouza Sheet
32.	lege.gif	Gif file for legends
33.	name.gif	Gif file for Map Heading,i.e. it contains the District name, Mouza name, Idn etc.
34.	bata.gif	Gif file for list of bata
35.	Idn.tif	TIF image file for Mouza Map Sheet(raster image)

Sometimes legend is broken into more than one files. These files are named lege1.gif, lege2.gif, lege3.gif & lege4.gif. Accordingly total number of files varies from 35 to 38.

6 . Methodology for digitization:

The Directorate of Land Records and Survey is a nodal organization under Govt. of West Bengal. Currently the organization is involved in the digitization of Mauza maps from the already existing manually prepared maps. The process involves (i) scanning of maps to produce raster data, (ii) checking the dimensional accuracy of the raster data, (iii) garbage cleaning in the raster data, (iv) vectorising the raster data, (v) cleaning the vector data, (vi) topology building, (vii) data integration, (viii) map composition from different layers and (ix) integration on regional Script as level.

SLNO	JOB DESCRIPTION	Responsibility
1	Putting lebel of mouza code, whether RS or LR map and the sheet number sticker on the map sheet	Department Employees (DA)
2	Handing over the labeled map to the vendor for digitisation	DA
1	Scanning of Original paper based Maps.	Agency (EA)
2	Study of Original Paper Map for Dimension Extraction. This is to measure the dimensions of any two points in the horizontal & vertical direction in the original paper map	EA
3	Adjustment of Scanned Raster map with the measurement as available in Sr. 2.	EA
4	Digitization of Plots using R2V or AutoCAD software	EA
5	Cleaning up of map, Topology Creation & Closed Polygon Generation using AutoCAD map software	EA
6	Creation of Plot Numbers that is attaching text database with the spatial data	EA
7	Quality checking to account for all plots & plot numbers available in the map	EA
8	Printing for dimensional accuracy checking of all plots	EA
9	Comparison of print with original for accuracy checking	EA
10	Refinement of digitized map with respect to item9 & repeat of items 9 & 10 till desired accuracy is achieved.	EA
11	Quality Checking for correctness of Plot Numbers as attached	EA
12	Creation of Rendered Plot Numbers (RPN) and centroid points. RPN is the last one or two digits of the plot number that may be printed within the plot boundary, in case the plot is very small to accommodate its actual plot number. Centroid point is the geometric centre of the polygon where the plot number shall be printed	EA
13	Creation of in-situ Line and Point Alamats	EA
14	Quality Checking to ensure all Alamats considered and coded correctly	EA
15	Creation of DBF files for Point/Area Alamats and Bata Plots	EA
16	Creation of GIF files	EA
17	Handing over the print copy for checking correctness	EA
18	Checking of print copy with the original	DE
19	Handing over the Softcopy	EA
20	Soft copy check (Availability of files 35-38 nos as provided by agency in Sr 19)	DE
21	Generation of complete map from the files available in sr 19 and also digital ROR database using software developed by NIC	DE
22	Printing of composed map as available in Sr.21 in 120 GSM paper for preservation	DE
21	Software checking of areas extracted from digitally with that available in the ROR for each plots. This provides a error report showing plots that has area in the ROR that are incorrect.	DE
22	Error report is sent to districts for fresh review for its correction	DE
23	Integration of ROR data with Spatial Data using a software developed by NIC (explained in detail below)	DE
24	Map & Record correction through a software developed by NIC (explained in detail below)	DE

II. Scanning and Dimensional Accuracy: -

The original map is scanned to produce the raster form. For cadastral map, scanning in 400 dpi is all right. Special attention is to be given to see that the map is not deformed dimensionally. For this purpose "X" (cross) marks are placed at corners of the original map before scanning. In the next step the lengths between the "X" marks of the original map are compared with those of the scanned map to check whether any differences exist or not. Finally some raster editing is done for the elimination of some unwanted patches in order to enhance vectorisation of the raster data.

Dimensional accuracy of the raster data implies a one to one correspondence between the raster data and the original map. The following procedures are used to achieve dimensional accuracy.

1. Checking for expansion.
2. Checking for contraction.
3. Checking for translation.
4. Checking for rotation.

Raster form of the map may appear to be expanded or contracted as compared to the original map, which in turns affects the vector data. The checking for expansion and contraction is based on the property that 'area is invariant'. The Land Records Department has Jurisdiction List (JL) in which the total mauza area is defined and the Land Records information contains each plot area of an owner. These two are compared with the vector data of the map to check for the expansion or contraction of the map with respect to original map. Using a GIS tool, NIC WBSU has developed a software, which can easily integrate the Land Records data to the digitized data based on the plot numbers. Using the Software it can easily compare the total mauza area (as defined in JL) with digitized mauza data as well as digitized plot area with the individual plot area defined in the Land Records database.

Translation and rotational error may occur during the scanning process. The checking for this purpose is done using the check point. A calibrated plotter HP 1050C or higher is used to plot a map from the vector data. This map is then compared with the original map to find a one to one correspondence between the lines of the two maps. Any mismatch between the two reveals the existence of the above mentioned errors.

III. Vectorising, Topology building and Data Integration: -

The raster data may be converted to vector data using a raster to vector converting software. This software works in three distinct methods as mentioned below: -

1. Full Automatic Method
2. Semi Automatic Method
3. Completely Manual Method

The second one i.e. Semi Automatic Method is normally used. Traverse lines may have some breaks, which create some problems with the Full Automatic Method. Hence Semi Automatic Method is used such that the breaks can be manually monitored during the process of vectorisation. This is why the Semi Automatic Method is preferred over the other two alternatives.

Each plot on the map is not isolated and hence should posses some knowledge about its adjacent plots. This is why Topology building is necessary. This is done by treating each intersecting point as a node. Overshoot, undershoot, and duplicate lines are the major problems and which are to be eliminated during the process of Topology building. The overshooting dangling lines are deleted and the undershooting dangling lines are extended to their nearest node.

Non-spatial data (plot number, area, etc.) are included in the database containing the spatial data for the map, during the process of data integration.

While digitizing scale factors to be maintained accurately, so that output should be in ground scale (1:1).

Flat-bed scanner/roller type scanner as per requirement should be used as per the condition of the original map. For maps that are brittle flat bed scanner shall be most suitable.

Testing of correctness of the digitized map:

The print copy from the digitized map should be thoroughly checked so that all the plot boundaries, other line works matches with the original as contact print. Plot numbers assigned should also match with the original. In situ Alamats should be placed exactly at the point it is located in the original map. Glass Table lighted from below is used to match such accuracy.

Software checking is done through "Map Management System" software developed by NIC to find the all the files deliverable for a map sheet (these are 35-38 in all).

IV. Map composition and Query retrieval: -

Different layers (point, text, line, area) can be used for map composition. The Land Records Department has received the line and area layers for different mauzas. Line layers are required for the map composition part while area layers are mainly required for both map checking and composition. However map composition not only involves construction of the map from a

particular layer, but also the inclusion of various non-map features such as the legend for the map, the label of the map specifying its identification from the point of view of Police Station Code, Jurisdiction List Number, etc., bata information for the mauza, the authentication seal of the Government, etc. and various geographical features (the alamaths) such as the railway lines, the traverse stations, letter boxes, etc., which can be represented by symbols. NIC WBSU has developed software to compose map by integrating different layers and alamaths. It has also constructed a set of specifications as defined in the appendix.

The non-map features are mostly available in the form of images. A point layer is provided for the insertion of these images. The point layer contains the coordinates of the points where the images are to be positioned. During map composition the images are to be placed on the map (composed from the line layer already provided) at their appropriate positions. The geographical features (alamaths) can be displayed on the map by using the line, area and point layers provided. Specific symbols are used for this purpose and the layers supplied contain information regarding these symbols to be used. The final output is a completely composed map identical to the original.

7. Specifications & Alamats

I) Images

The images (in *.gif format) provided for map composition must be accompanied with a point layer in which the each point coordinate would give the **lower-left** corner of the image. The layer must have a separate attribute column, named "**image**" along with the necessary columns (specific to a point layer table). This attribute column will contain the file name of the image files corresponding to each point of the point layer. There is no restriction on the names of the image files but it must be noted that the file names mentioned in the "**image**" column of the point layer must correspond to the file names of the images provided. The base name of the files for this point layer must be "**img**". Thus the ". shp" file for the above mentioned point layer must be "**img.shp**". The names of other necessary files (. shx, etc.) for the same point layer must be given accordingly. All the images (*.gif or *.tif) of a particular sheet must be given in the same directory i.e. the **JL**-No sub-directory.

Note: - i) The scale of the map must not be an image but must be digitized and provided in
          the line layer.
       ii) **Attribute naming**: The "**image**" attribute column must be a **character field** and
          have a **maximum length of 8 characters**.

II) Alamaths

a) <u>At point layer</u>: -

Some of the alamaths that can be represented by points are to be provided in a point layer. The point layer required for this purpose must contain the attribute field "**symbol**" along with other necessary fields. The following table contains the "**symbol**" column for the above mentioned point layer. The other columns are given as descriptions to the "**symbol**" column. The column named "**Sl.No.**" is the Serial Number of the various symbols as per the conventions followed by the **Directorate of Land Records And Survey** and is given in the booklet for the list of conventional signs of the department. The basename of the files for the point layer for the alamaths must be "**almp**" i.e. the ". shp" file for the point layer must be "**almp.shp**". The names of other necessary files (. shx, etc.) for the same point layer must be given accordingly.

Note: - i) Some alamath notation comprises of a line and several points on the line. In such cases the points are to be provided in the point layer and the lines are to be provided in the Line layer that is described in the next subheading (b).

ii) In some cases, two or more alamaths are represented by the same symbol or have some symbol in common. Care should be taken in such situations.

iii) **Attribute Naming :** The "**symbol**" attribute column must be a **character field** and have a **maximum length of 4 characters**.

Item	Alamath Symbol code as specified by NIC	Descriptions	Required Features for West Bengal (NR: Not Required, R: Required) (*)
Municipal / Notified Town Boundary	1	1) Only the circles on the boundary line should be given in the point layer (the broken line being on the line layer as described in the next table).	NR

		2) The center of each circle should lie exactly on the line representing the boundary.	
Wire fencing / Railing along property boundary (showing ownership)		2	Only the 'X' marks should be given in the point layer, the line being given in the line layer (as mentioned in the next table).	NR
Village (or plot)boundary cutting across River or Road		3	Only the dots on the boundary should be given in the point layer.	R
Village boundary cutting along the length of River / Road		3	Only the dots on the boundary should be given in the point layer.	NR
Village boundary along one bank / edge of the River / Road not common to two units		3	Only the dots on the boundary should be given in the point layer.	NR
Geodetic Triangulation Station		4	1) Appropriate name of the GTS should be given as an image. 2) The dot in the middle of the Symbol should be at the 'surveyed in situ' position of G.T.S.	R
Bench Mark With Number		5	1) The dot in the Symbol should at the position of the Bench Mark as surveyed in situ. 2) The figure indicating height should be as appropriate height of the Bench Mark concerned above the Mean-Sea.	NR
Trijunction Pillar		6	Only the dot at the center of the triangle should be given in the point layer.	R
Traverse Station	(i) Present Survey	7a		R

	(ii) Last Survey	7b		R
Boundary Mark (pillar)	(i) Permanent pillar	8a		R
	(ii) Iron pillar	8b		R
Swampy Land or Marsh		10	Several points in close proximity should be given such that entire marsh is covered	NR
Overhead Tank		11	Only the center of the symbol should be provided in the point layer.	R (.dbf)
Pucca well		12	Only the center of the symbol should be provided in the point layer.	R (.dbf)
Kutcha well		13	Only the center of the symbol should be provided in the point layer.	R (.dbf)
Tube well		14	Only the center of the symbol should be provided in the point layer.	R (.dbf)
Deep Tube well / Shallow tube well		15a	Only the dot at the center of the symbol should be given in the point layer.	R (.dbf)
		15b		
Hillock with peak of known height		16	Only the center of the symbol should be provided in the point layer.	NR
Hillock without peak of known height		17	Only the center of the symbol should be provided in the point layer.	NR
Mill / Factory		18	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Coal pit		19	Only the center of the should be provided in the point layer.	R (.dbf)
Temple		20	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Mosque		21	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Church		22	Only the base of symbol be provided in the point layer.	R (.dbf)
Gurudwara		23	Only the base of the symbol	R (.dbf)

		should be provided in the point layer.	
Graveyard	24	1) Several points (each point representing one symbol) should be given such that the entire plot is covered. 2) Only the base of each symbol should be given in the point layer.	R (.dbf)
Pucca building within a plot	25	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Pucca building within a plot not surveyed in situ	26	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Kutcha house	27	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Tin / tiled shed having pucca plinth	28	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Daily market with plot boundary	29	The point must be taken inside the plot and preferably on the lower-left corner of the plot such that the symbol can be fitted completely within the plot.	R (.dbf)
Tree	30	Only the base of the symbol should be provided in the point layer.	R (.dbf)
Trees in grove (not surveyed in situ) other than orchard	30	Several points in close proximity should be given such that entire grove is covered	R (.dbf)
Forest (reserved / protected) with name	31a	1) Several points in close proximity should be given such that entire forest is covered.	R (.dbf)
	30 & 31b		R (.dbf)
		2) Only the base of each symbol is to be provided in the point layer.	
	30, 31a & 31b		R (.dbf)
Bush jungle	32	Several points in close proximity should be given such that entire bush jungle is covered	R (.dbf)
High grass	33	Several points in close proximity	R (.dbf)

		should be given such that entire High grass is covered	
Uncultivable fallow	34	Several points in close proximity should be given such that entire Uncultivable fallow is covered	R (.dbf)
Bamboo clumps	35	Several points in close proximity should be given such that entire Bamboo clumps is covered	R (.dbf)
Cluster of Palmyra	36	Several points in close proximity should be given such that entire plot containing Cluster of Palmyra is covered	R (.dbf)
Cluster of Coconut Palm	37	Several points in close proximity should be given such that entire plot containing Cluster of coconut Palm is covered	R (.dbf)
Cluster of Date Palm	38	Several points in close proximity should be given such that entire plot containing Cluster of Date Palm is covered	R (.dbf)
Cluster of Betel Palm	39	Several points in close proximity should be given such that entire plot containing Cluster of Betel Palm is covered	R (.dbf)
Orchard (perennial – like Mango, Lichi, etc.)	40	Several points in close proximity should be given such that entire plot containing the Orchard is covered	R (.dbf)
Flower garden	41	Several points in close proximity should be given such that entire plot containing Flower garden is covered	R (.dbf)
Light house	42	The Symbol should be drawn at some convenient space inside the plot concerned.	R (.dbf)
Burning Ghat	43	The point must be taken inside the plot and preferably on the lower-left corner of the plot such that the symbol can be fitted completely within the plot.	R (.dbf)
Power house	44	The Symbol is to be drawn at some convenient space inside the plot concerned.	R (.dbf)
Electric sub-station	45	The Symbol is to be drawn at some convenient space inside the plot concerned.	R (.dbf)

Transmitting / microwave station	46	The Symbol is to be drawn at some convenient space inside the plot concerned.	R (.dbf)
Trestle of Ropeway	47	The center of the baseline of the symbol should be provided in the point layer.	R (.dbf)
Pylon / electric / telegraph / telephone post with line	48	Only the dots at the center of the symbol should be given in the point layer.	R (.dbf)
Lamp post	49	Only the dot at the center of the symbol should be given in the point layer.	R (.dbf)
Letter box (immovable) of P&T Deptt.	50	Only the dot at the center of the symbol should be given in the point layer.	R (.dbf)
Kilometer post	51	Only the mid-point of the base of the symbol should be given in the point layer.	R (.dbf)
North Direction	52		NR
Text scripts mentioned on the map	53a, 53b, 53c, …		NR

(*) This may be customized as per the need of individual states

b) At line layer: -

Some of the alamaths that can be represented by lines are to be provided in a line layer. The line layer required for this purpose must contain the attribute field "**style**" along with other necessary fields. The following table contains the "**style**" column for the above mentioned line layer. The other columns are given as descriptions to the "**style**" column. The column named "**Sl.No.**" is the Serial Number of the various symbols as per the conventions followed by the department and is available in the booklet for the list of conventional signs of the department. The basename of the files for the line layer for the alamaths must be "**alml**" i.e. the ". shp" file for the line layer must be "**alml.shp**". The names of other necessary files (. shx, etc.) for the same line layer must be given accordingly.

In order to define the extents of the total map area it is essential to have a sheet boundary. This boundary is to be provided in a separate line layer, which must contain similar attribute fields as defined previously for the above mentioned line layer. This layer would contain a single line with style number 16. The base name of the files for the line layer for sheet boundary must be "**bnd**" i.e. the ". shp" file for the line layer must be "**bnd.shp**". The names of other necessary files (. shx, etc.) for the same line layer must be given accordingly. The "**style**" attribute column is as defined previously.

Note: - i) Some alamath notation comprises of a line and several points on the line. In such cases the lines are to be provided in the line layer and the points are to be provided in the Point layer that is described in the previous table.

      ii) In some cases, two or more alamaths are represented by the same symbol or have some symbol in common. Care should be taken in such situations.

      iii) **Attribute Naming:** The "**style**" attribute column must be a **character field** and have a **maximum length of 4 characters**.

Item	Style (specified by NIC)	Description	Required Features for West Bengal (NR: Not Required, R: Required) (*)
Specific lines on the village boundary	0	The portion of the village boundary drawn with broken lines must be digitized in a continuous fashion as a separate line and provided with the mentioned style no.	R
Village boundary	1	The alignment of the village boundary is along the middle of the thick line.	R
Municipal / Notified Town Boundary	2	Only the broken line of the boundary should be given in the line layer.	NR
Ward (municipal) boundary	2	This is for the broken line denoting the boundary	NR
	4	This is for the small line segments that are perpendicular to the broken line.	NR
Forest boundary	3	Only the line representing the forest boundary should be given in the line layer. The entire boundary may be divided into	NR

		different segments such that each segment is an entity in the line layer, provided all these segments contain the same style no.	
Wire fencing / Railing along property boundary (showing ownership)	4	Only the line representing the property boundary should be given in the line layer (the 'X' marks had already been given in the point layer as mentioned in the previous table). The entire boundary may be divided into different segments such that each segment is an entity in the line layer, provided all these segments contain the same style no.	NR
Village boundary cutting along the length of River / Road	2	Only the line representing the village boundary should be given in the line layer. The entire boundary may be divided into different segments such that each segment is an entity in the line layer, provided all these segments contain the same style no.	R
Village boundary cutting across a water body	2	Only the line representing the village boundary (as mentioned in the DLRS booklet) should be given in the line layer.	R
Plot boundary where there is a water body across it	2	Only the line representing the plot boundary should be given in the line layer.	R (.dbf)
Tram line	5	Only the line representing the Tram line should be given in the line layer. The entire line may be divided into different segments such that each segment is an entity in the line layer, provided all these segments contain the same style no.	NR
Railway	6	Only the line representing the Railway line should be given in the line layer. The entire line may be divided into different segments such that each segment is an entity in the line layer, provided all these segments contain the same style	R

		no.	NR
Trekking route in hilly areas (too narrow for both sides of the path to be surveyed separately).	7	Only the line representing the Trekking should be given in the line layer. The entire line may be divided into different segments such that each segment is an entity in the line layer, provided all these segments contain the same style no.	NR
Culvert	4	Only the small line segments representing the culvert should be given in the line layer.	NR
Road (flyover) over Railway	4	1) Style 4 is used for the edges of the Road (flyover) above the Railway.	NR
	6	2) Style 6 is used for the Railway line under the Road (flyover). 3) The Railway line as shown in the figure comprises of two line segments on either side of the Road (flyover).	NR
Railway (flyover) over Road	4	1) Style 4 is used for the edges of the Railway (flyover) above the Road.	NR
	6	2) Style 6 is used for the Road under the Railway (flyover). 3) The Road as shown in the figure comprises of two parts on either side of the Railway (flyover).	NR
Railway (flyover) over Railway	4	1) Style 4 is used for the edges of the flyover. 2) Style 6 is used for the	NR
	6	Railway line passing under the flyover. 3) The Railway line as shown in the figure comprises of two line segments on either side of the Road (flyover).	NR
Subway (underground) under Railway	2	1) Style 2 is used for the broken line denoting the subway	NR
	6	under the Railway line. 2) Style 6 is used for the Railway line.	NR
Subway	2	1) Style 2 is used for the	NR

(underground) under Road	4	broken line denoting the subway under the Road. 2) Style 4 is used for the Road above the subway.	NR
Road (flyover) over Road	4	The Road lying below consists of two parts on either sides of the Road lying above it	NR
Level Crossing	7	It is assumed that the Railway line is already present as an item as given in Sl.No. 19.	NR
River with, Ferry and Direction of flow of water	4	1) Style 4 is used to denote the direction of water flow along the River	NR
	7	2) The entire arrow showing the direction should be digitized. 3) Style 7 is used denote the Ferry	NR
Tidal Stream	4	The entire arrow is to be digitized.	NR
Jhora (Rivulet in hills)	4	1) Style 4 is used to indicate the edges of the Jhora as surveyed in situ.	NR
	8	2) Style 8 is used to indicate the middle of the deepest courses of the Jhora as surveyed in situ.	NR
Narrow water channel along the plot boundaries with direction of flow of water (having width too small to be surveyed).	9	The arrows on the line (boundaries) must be digitized such that it shows the proper direction of the water flow.	NR
Drain / Nala (in Basti or Town Areas) with direction of flow of water.	4	The arrow showing the direction of flow of water should be given in the line layer.	NR
Pylon / electric / telegraph / telephone post with line	2	Only the broken line is required in the line layer, the dots being provided in the point layer as mentioned in the previous table.	NR
The North-West sides of the water bodies including TANK drawn with thick lines in the map	16	Only the thick lines are to be provided with the mentioned style number. Any other lines inside the mauza having a line thickness identical to the North-West side of the water bodies should be allotted the same style.	NR

(*) This may be different for individual States.

c) **At area layer: -**

Some of the alamaths (in situ) that are to be represented by areas must be provided in an area layer. The area layer required for this purpose must contain the attribute field "**shade**" along with other necessary fields. The following table contains the "**shade**" column for the above mentioned area layer. The other columns are given as descriptions to the "**shade**" column. The column named "**Sl.No.**" is the Serial Number of the various symbols as per the conventions followed by the **Directorate of Land Records And Survey** and is given in the booklet for the list of conventional signs of the department. The basename of the files for the area layer for the alamaths must be **"alma"** i.e. the ". shp" file for the line layer must be **"alma.shp"**. The names of other necessary files (. shx, etc.) for the same line layer must be given accordingly.

Note :- i) Some alamath notation comprises of a line and several points on the line. In such cases the lines are to be provided in the line layer and the points are to be provided in the point layer that is described in the previous table.

ii) In some cases, two or more alamaths are represented by the same symbol or have some symbol in common. Care should be taken in such situations.

iii) **Attribute Naming:** The "**shade**" attribute column must be a **character field** and have a **maximum length of 4 characters**.

Item	Shade (specified by NIC)	Description	Required Features for West Bengal (NR: Not Required, R: Required)
Pucca Buildings (in situ)	1	Specific to State	NR
Pan Baroz	2	Specific to State	NR
Sand Char	3	Specific to State	R (.dbf)

IMPORTANT

1. The ". shp", ". shx" and the ". dbf" files for the mauza containing the area and the line layer should be named as "**<JLNo>.shp**", "**JL.shx**" and "**JL.dbf**" respectively. Thus if the JL No. of a mauza is 100, then the three above mentioned files should be "100.shp", "100.shx" and "100.dbf" respectively. The files are to be placed in the "**JL No.**" subdirectory under the corresponding "**PS Code**" directory in the following format :-
   <PS Code> \ <JL No.> \ <JL No>.shp
   <PS Code> \ <JL No.> \ <JL No>.shx
   <PS Code> \ <JL No.> \ <JL No>.dbf

Thus if for a particular mauza, the PS Code is 50 and the JL No. is 100, then the files corresponding to the layers of that mauza should be organized as follows :-

50 \ 100 \ 100.shp
50 \ 100 \ 100.shx
50 \ 100 \ 100.dbf

2.　If the mauza map comprises of more than 1 sheet, then the files for both the sheets are to be given the same names and as per the convention mentioned in point 1 above. However in order to avoid controversy, the files must be kept in different subdirectories denoting the sheet number under the "**JL No**" directory which itself is kept under the "**PS Code**" directory. Thus if the mauza map with JL No. 100 (see the example in point 1) comprises of 2 sheets then the file should be organized as follows :-

For sheet no. 1	**For sheet no. 2**
50 \ 100 \ 1 \ 100.shp	**50 \ 100 \ 2 \ 100.shp**
50 \ 100 \ 1 \ 100.shx	**50 \ 100 \ 2 \ 100.shx**
50 \ 100 \ 1 \ 100.dbf	**50 \ 100 \ 2 \ 100.dbf**

3.　The layers for the images and the alamaths need not be qualified with their corresponding JL nos. but they must be kept in the same directory along with the layer files mentioned in the above two points. The files will be named as **centroid.shp, almp.shp, alml.shp, scale.shp, bnd.shp, mbnd.shp, img.shp, alm_bata.dbf, first_last.dbf, missp.dbf, name.gif, lege.gif, bata.gif, sign.gif etc.**

4.　The attribute field giving the plot number of each plot of the mauza is a compulsory field. It must be a **character field of length 5 and have the name "plotno"**.

5.　The list of conventional symbols for the alamaths as followed by the department should be referred whenever required. The descriptions given in the above tables are additional to those given in the above mentioned booklet.

6.　For symbols, which are **not** "**in-situ**", the points of insertion of the symbol are to be given at the approximate center of the symbol in the point layer for alamaths.

7.　The scale for each map should be digitized and provided as a separate line layer along with the other layers for the mauza. The basename of the files for the line layer for the alamaths must be "**scale**" i.e. the ". shp" file for the line layer must be "**scale.shp**". The names of other necessary files (. shx, etc.) for the same line layer must be given accordingly.

8.　The values in the different attribute fields in the various layers should be **left justified**.

8. Integration of Map with ROR with respect to West Bengal

Each plot of land is represented on the digital map as a closed polygon. Such polygons are identified by a unique 5 digit number that is its plot number. In the ROR database

such plot numbers are referenced. This provides a basis for integration of digital map with the digital ROR data.

ROR database consists of several related tables (7 main tables & several master tables) of information that provides ownership, land classification information that is essentially text data types. All the tables are connected by two common data fields. Those are

Idn: a seven digit code to identify a Mouza (2 digit for District, 2 digit from Block & 3 digit for the Mouza)
Plot no.: a five digit Plot number

For digital map data that is contained in more or less 36 files are distributed in three table under various column having the above two common fields (IDN & Plot no.). Shape files .shp. .shx & .dbf are binary files and are stored in BLOB data format a facility available in the MS-SQL sever 2005 DBMS. Existing ROR database is added with the above three tables containing map information to form a extended database of ROR.

Data both spatial and textual are exploited by the application software "BHUCHITRA" to provide the necessary integration of data. Such integration provides all the flexibility to manipulate text data and map data without any constraint and provides a platform for various improved citizen centric services and MIS reports. Some of them are given as follows.

1) Providing Plot map (parcel map), showing dimensions of each side & area with the ROR.
2) Generating various derivative maps based on possessions, classifications, legal sections applicable, Size of the plot etc.
3) Analytical reports on area in the ROR with respect to the digital map to help in data correction, both texts as well as map.
4) ROR updation is integrated with its map updation.