



DEVELOPMENT OF GEO-SPATIAL MAPS FOR MAINTENANCE OF WATER SUPPLY SCHEMES

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ABSTRACT

Recently, multi-village water supply schemes are erected for quality affected habitations in India. Operation and maintenance of multi-village water supply schemes require a lot of data viz: source, pumping stations, pipe line alignment, sizes of pipes, pressure, elevation, soil type etc. Various drawings and plans are prepared rarely with geo-reference during project planning and design. For Engineers in charge of maintenance, Geo-spatial maps with the above details will help in effective operation and maintenance of water supply schemes like for planning for augmentation, identifying leakages, pollution control etc. An attempt has been made to prepare different utility maps for a multi-village water supply scheme, named Vellur and 24 habitations in Musiri union, Trichy district, India, using GIS tools. Methods adopted to prepare maps and uses of developed maps are presented.

Keywords: GIS, geospatial maps, operation, maintenance, multi-village water supply scheme.

1. INTRODUCTION

Regional water supply scheme (RWSS) or multi-village water supply scheme (MVWSS) covers multiple numbers of habitations from a single, perennial source. Area like fluorosis endemic is covered by such MVWSS. Generally, the water supply and sanitation systems consist of data like: source, pipe line, pump sets, sumps, elevated service reservoirs, valves, house service connection, public fountains, dust pin, toilet, sewer lines, manholes, and sewage treatment plant etc. All the details are essentially to be on hand with the Engineers/authorities in-charge of maintenance for the effective operation and maintenance besides planning for improvement and extension. Geographic Information System (GIS) is a spatial information based technology used for easy interpretation of data for creation of visual based information such as maps, etc. GIS is a tool, which helps bringing the utility details/information in the form of geo-referenced maps. Furthermore, the maps generated with GPS also form base maps for the analysis and design in other design software like EPANET, WATER CAD etc. With the facilities available in GIS, an attempt has been made to develop various utility maps, which will help in effective operation and maintenance (preventive as well crisis maintenance) of a Multi-Village Water Supply Scheme (MVWSS) in Trichy district, Tamil Nadu, India. Application of GIS in water utility management has been reported [1-3].

A MVWSS named combined water supply scheme to Vellur and 24 other habitations in Musiri block of Trichy district. It caters to the drinking water demand of the 25 rural villages spread over the Musiri block with the distance of 25 Kilo metres from the head works to the last beneficiary habitation. The scheme accommodates an infiltration well in the Cauvery river bed, four group sumps/intermediate pumping stations, 30 elevated service reservoirs (ESR), conveying pipe line and distribution system from ESRs.

2. METHODOLOGY

2.1 Base maps

Topo sheets, 58_j_5, 58_j_9 & 58_i_12, at the scale of 1:50000 were used as base maps for the entire project of combined water supply scheme to Vellur and 24 other habitations in Musiri union, Trichy district, Tamil Nadu.

2.2 GPS (Global Positioning System)

Using GPS device (JUNO JB series), the actual locations of the features such as infiltration wells, group sumps, overhead tanks (OHTs) / elevated service reservoirs (ESRs) were located in person and precise locations were recorded as latitudes and longitudes (X,Y). Interconnection of major pipelines were also located by GPS and taken as a reference.

2.3 Google earth

Google Earth, a well-known software, facilitates to fly anywhere on Earth to view satellite imagery, maps, terrain, 3D buildings, from galaxies in outer space to the canyons of the ocean. Earth is integrated with the results of GIS.

2.4 Utility software

Arc GIS version 10.1 was used to process the data, creation of maps and database creation. Canvas with GIS is an Image processing software used for integration of Topo sheets. Quantum GIS was used for visualizing data as it is an open source GIS software. Google earth was used to View the spatial data in Real-time and finally Picasa was used to geotag the photos.



2.5 Process

Pre-planned flow chart had been made to ensure that project completed without any mix-up and by the use of ArcGIS software, Geo data base was created and information for each layer was stored into the database. Then, importing the topo sheets into ArcGIS feature extraction were done based on the feature types such as points, lines and polygons. Digitization (Extraction of features) was done using topo sheets as base maps. All the features such as Infiltration wells, group sumps, elevated service reservoir (ESR) and Pipelines were created and information were stored in the geo data base. Then different maps were created with certain criteria as per the needs of the Tamil Nadu Water Supply and Drainage board (TWAD Board) such as digital elevation map (DEM), contour maps for each and every individual area.

Interpolation (Kriging method) is used for creating elevation map. Using elevation map, Slope map (steepest path), water flow map (water flow direction), Contour map (line joining same elevation) and Triangular Irregular Network (TIN) map were generated.

Pressure Contour maps were generated by using interval of 0.5 metre. Contour map and Elevation map for each group sump Coverage Area was also generated.

Google Earth was used to visualize as the maps and contents were converted to support this application for better experience and reference. Photos of the respective Infiltration well, Group sumps, elevated service reservoir (ESR) were also Geo-tagged using Picasa and imported to Google earth. List of various utility geo-referenced maps generated with its content are tabulated (Table-1).

Table-1. List of various utility maps generated.

S. No.	Title of the map	Content
1	Project Area (Satellite Layer)	Satellite Map of project area.
3	Pipe Alignment Map	Pipe line alignment, Types of Pipe Lines and infiltration well.
3	Scour Location Map	Rivers and water bodies within the project area.
4	Soil Classification Map	Types of Soil in the project area.
5	Elevation Map	Elevation.
6	Contour Map	Contour Details.
7	Leak & Burst Prone Area Map	Area prone for leak and burst.
8	Pollution Prone Stretch Map	Areas that are Prone to Pollution.(Drainage's, sewage's crossing)
9	Pressure Points Map	Includes Pressure Values of all Point features.
10	Power line alignment	Electricity line

3. RESULTS AND DISCUSSIONS

Integration of topo sheet, co-ordinates of features of the CWSS to Vellur and 24 habitations, earth map,etc in GIS platform yielded various utility geo-spatial maps. Content and usefulness of each map are narrated below.

3.1 Project area map

The entire scheme area is marked on the earth map (Figure-1). It depicts the components like elevated service reservoirs (over tanks), source (infiltration well) and group sumps (booster stations) besides the beneficiary habitations. Figure-1 is almost bird's eye view of the project area showing the drainage pattern etc.

3.2 Pipe line alignment

Map showing the pipe line alignment with the size of pipe and material of pipe is given figure 2. Cast iron pipe has been laid within the river bed and poly-vinyl-chloride (PVC) has been laid in main and branch mains size varying from 50 mm outer diameter (OD) to 140 mm OD. Pipe line alignment map will be helpful to know size and material of pipe available at a particular location which in turn facilitates during attending to any leak or burst.

3.3 River and water body

Figure-3 shows the river and water bodies with pipe line alignment which is very useful to divert the water during emptying of pipe line at the time of repairs.

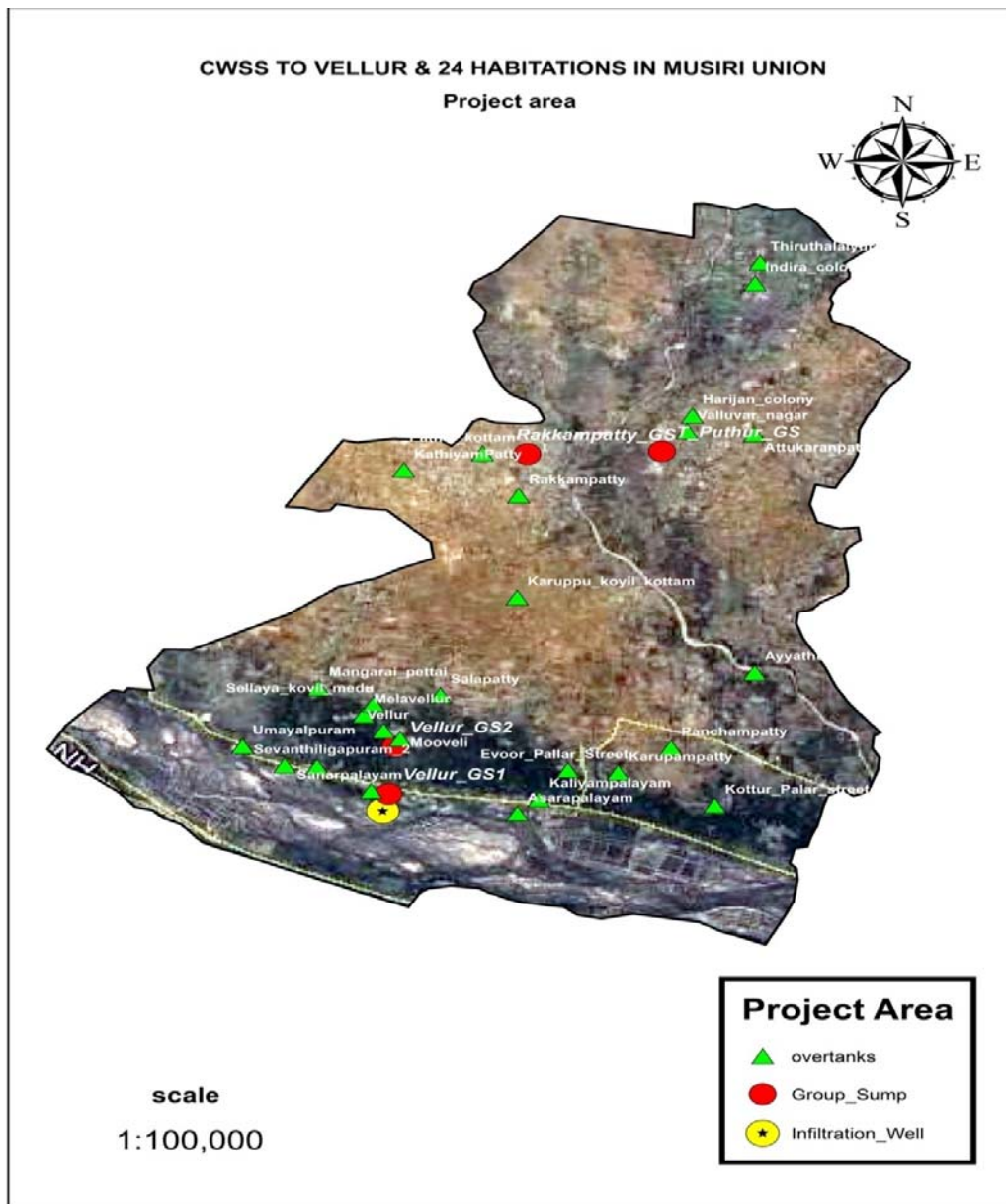


Figure-1. Project area map.

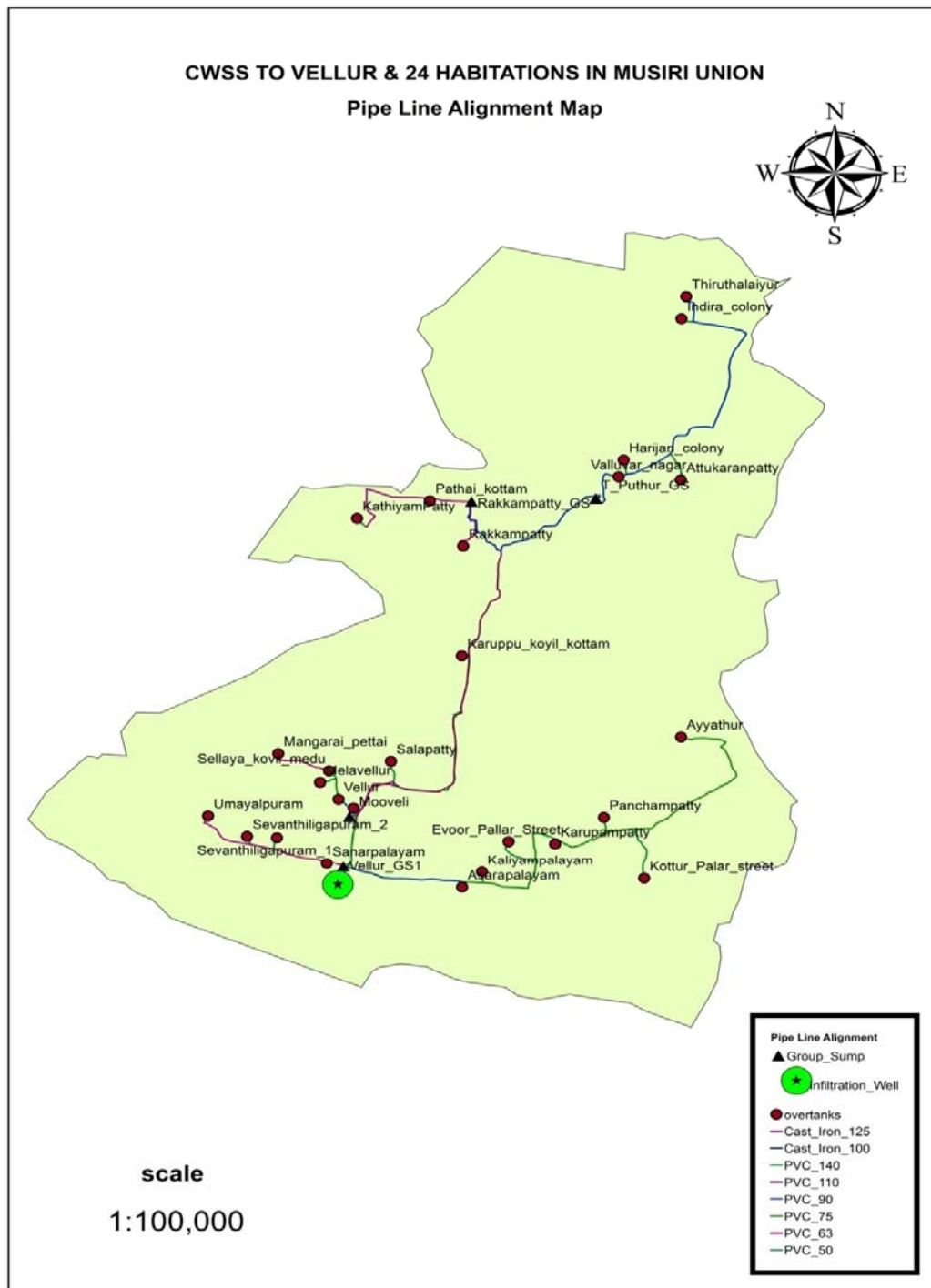


Figure-2. Pipeline alignment with size with source location.

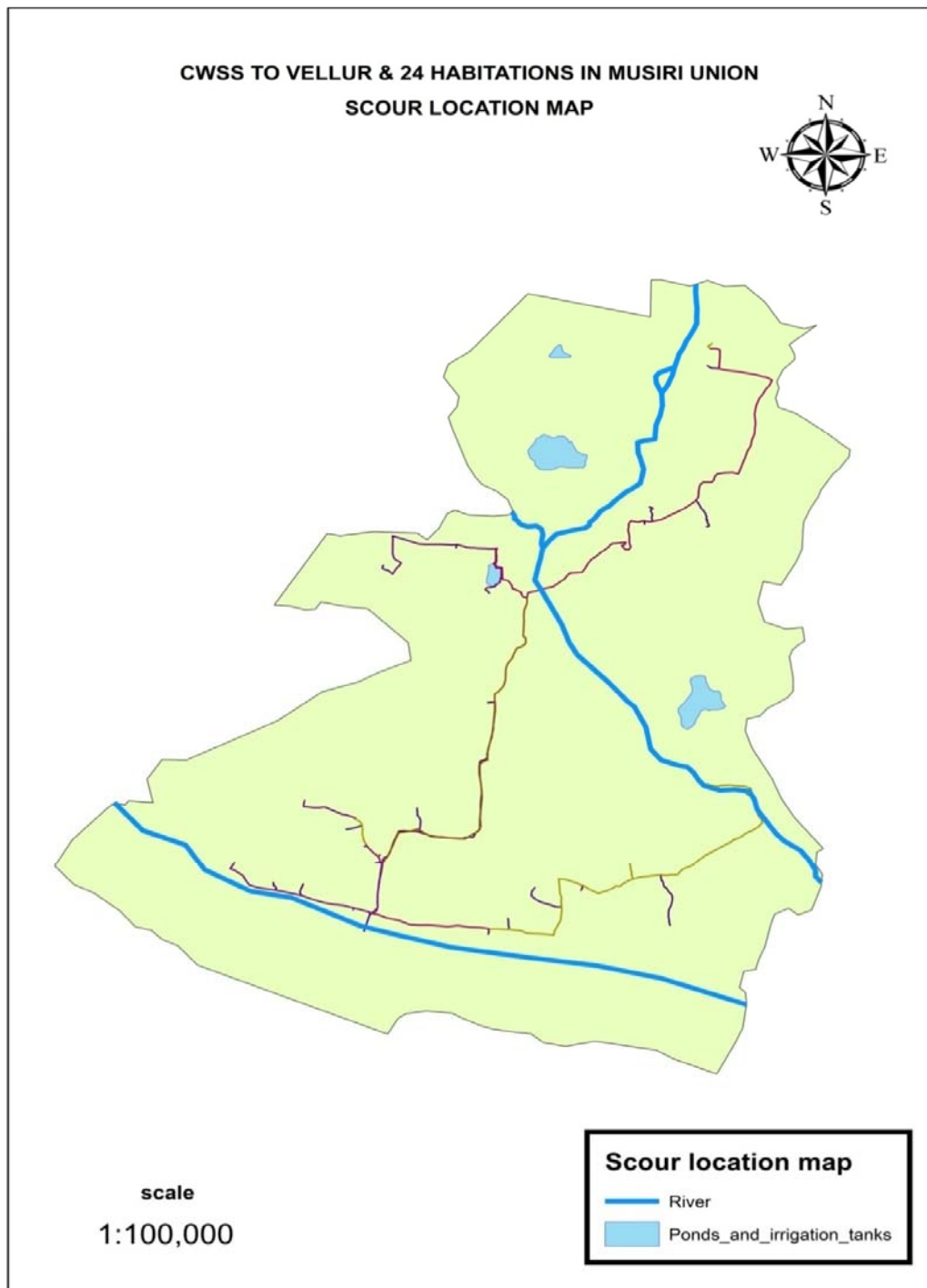


Figure-3. River and water body for scour location.

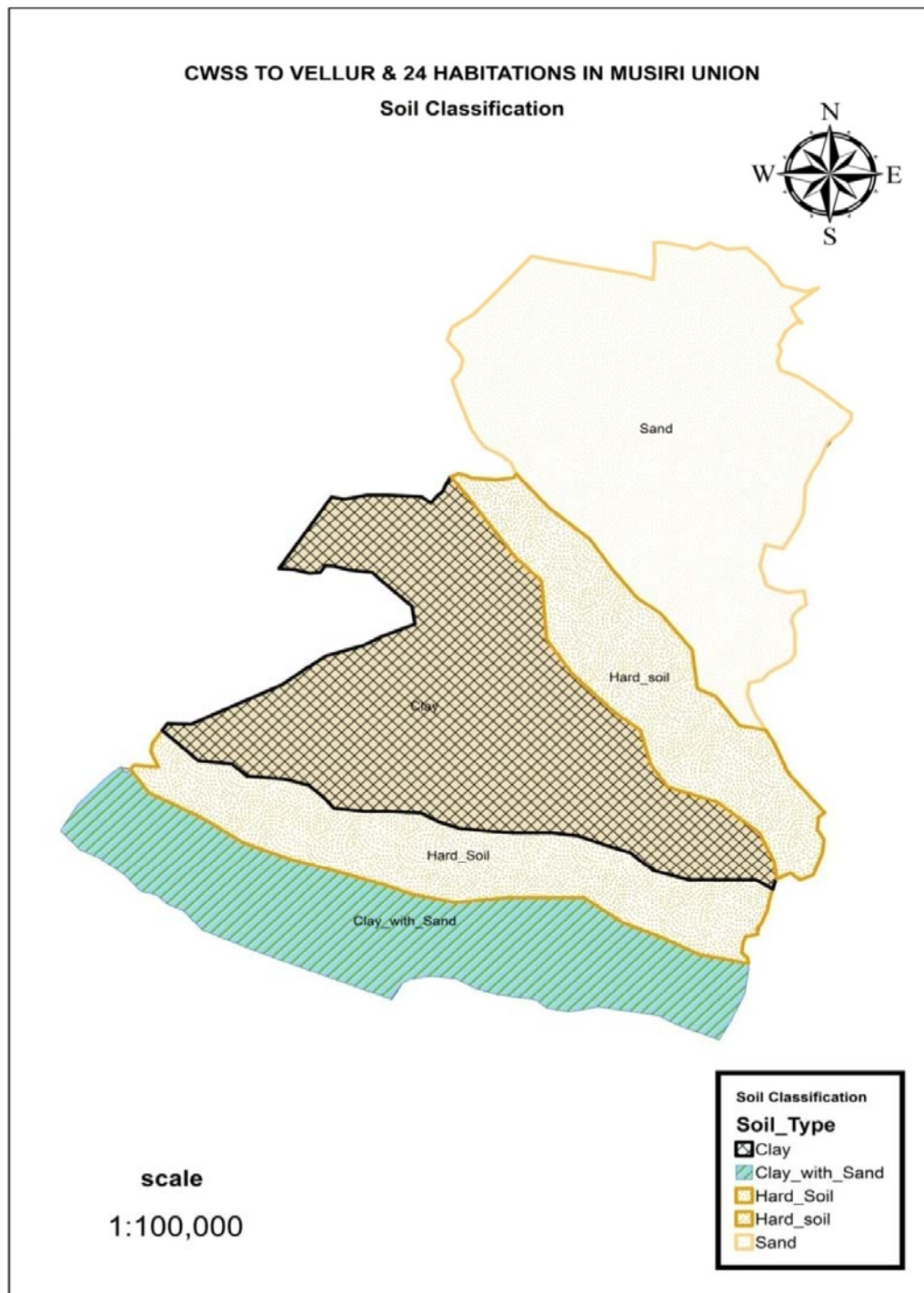


Figure-4. Soil map.

3.4 Soil map

Various types of soils present in the project are depicted in Figure-4. Knowing the soil types will help in mobilizing the machinery and men for the maintenance work.

3.5 Digital elevation map

Figure-5 gives the digital elevation map of the project area. Level variation over the area can be ascertained from the map.

3.6 Contour map

A map showing the contour lines is developed and presented in Figure-6. It provides general information



about the topography of the area. Knowledge on the topography is essential for the maintenance personnel. It provides the same.

3.7 Burst and leak prone area

Figure-7 shows the burst and leak prone area. Clay soil has the characteristics of shrinkage and expansion depending upon the soil moisture. From area marked as the burst and leak prone, size of pipe and material of the can be known from the Figure-2. It will help in material management, i.e. to have the stock of materials of frequent need.

3.8 Pollution prone area

It is common that open drain carrying sullage and the drinking water pipe line go very close to each other within the human settlements. As the chance of entering wastewater, sullage, into the pipe line has been found at many, a map showing the pollution prone stretch of pipe line has been developed integrating the pipe line and the sullage drains. It will be helpful in taking preventive maintenance.

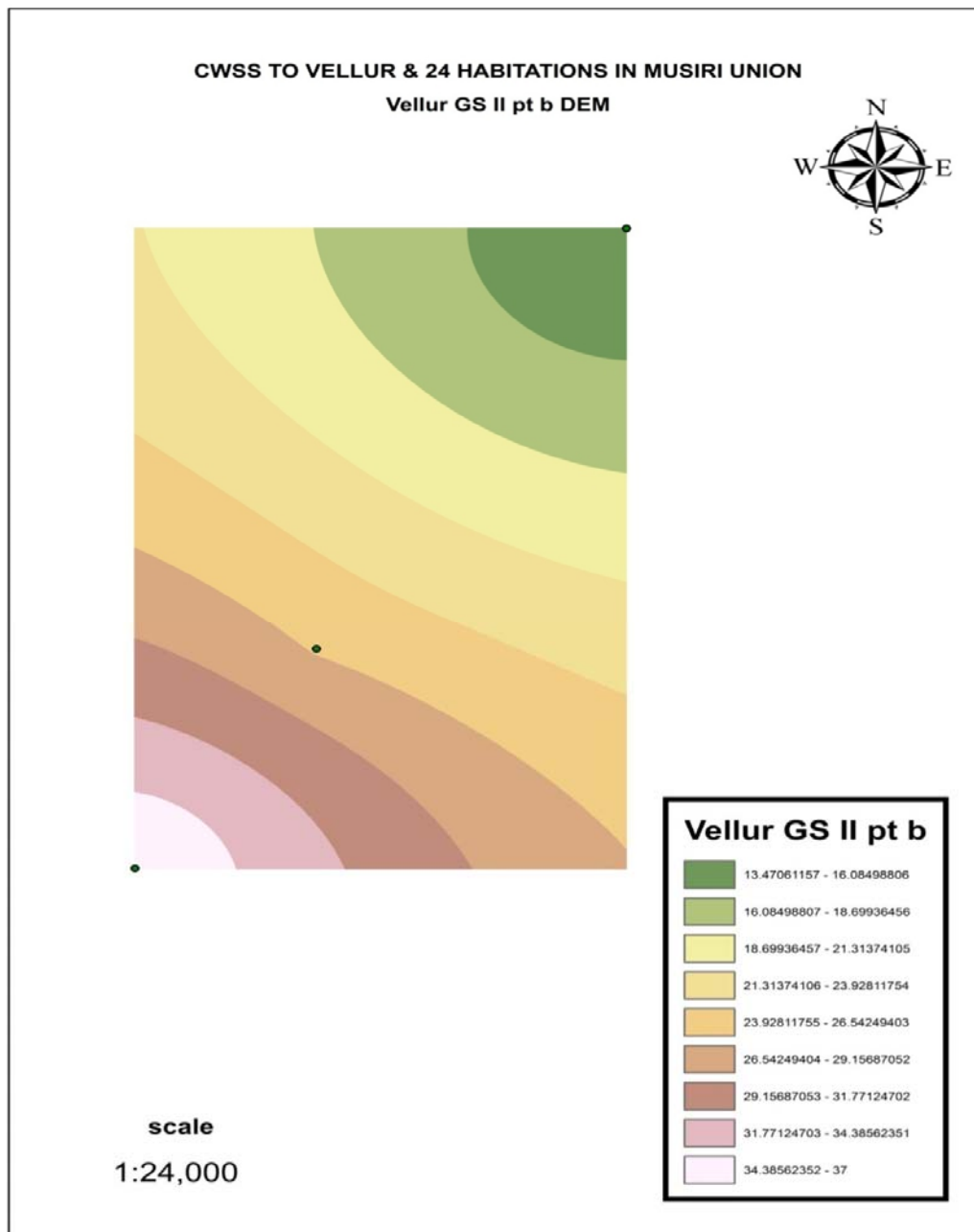


Figure-5. Digital elevation map.

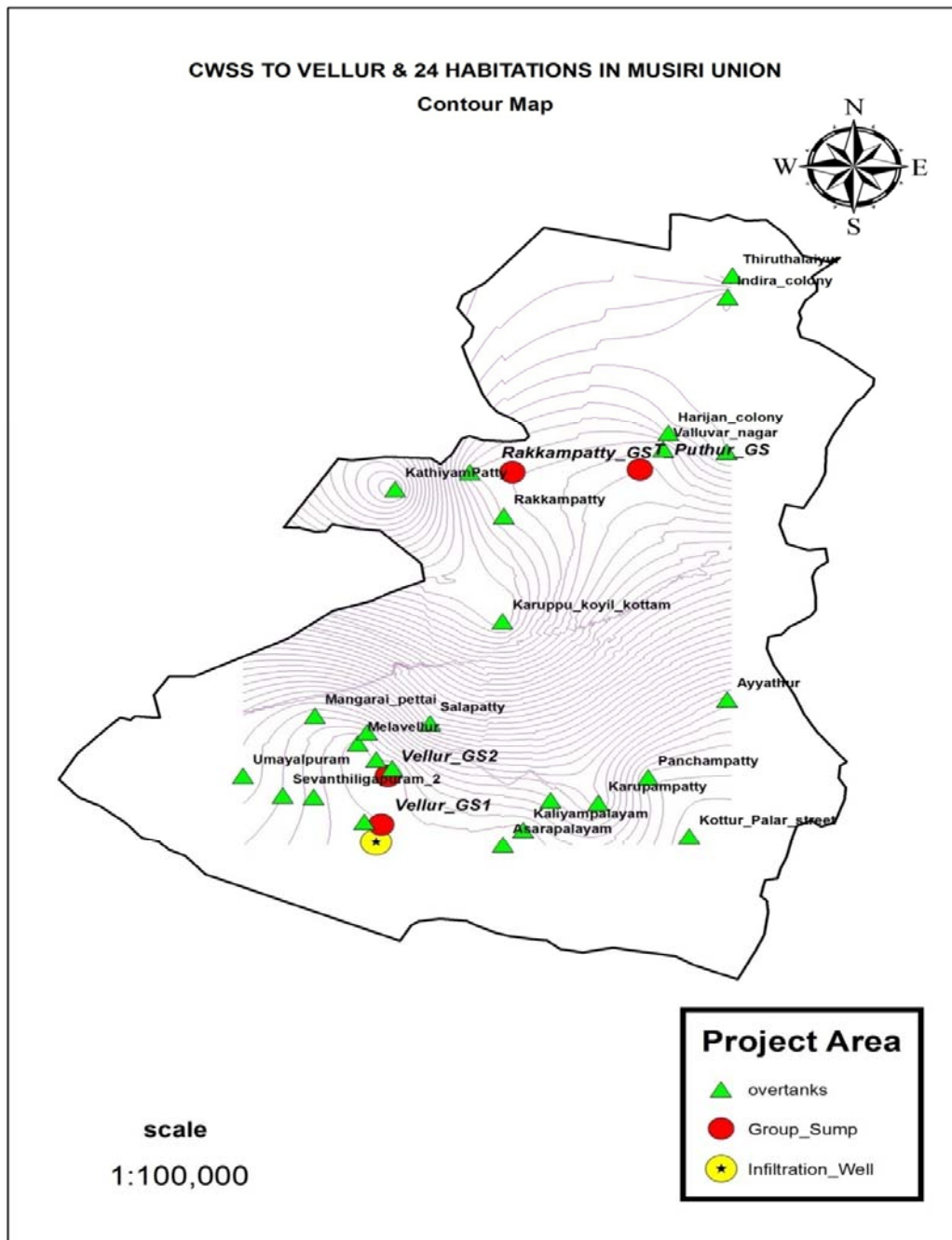


Figure-6. Contour map of project area.

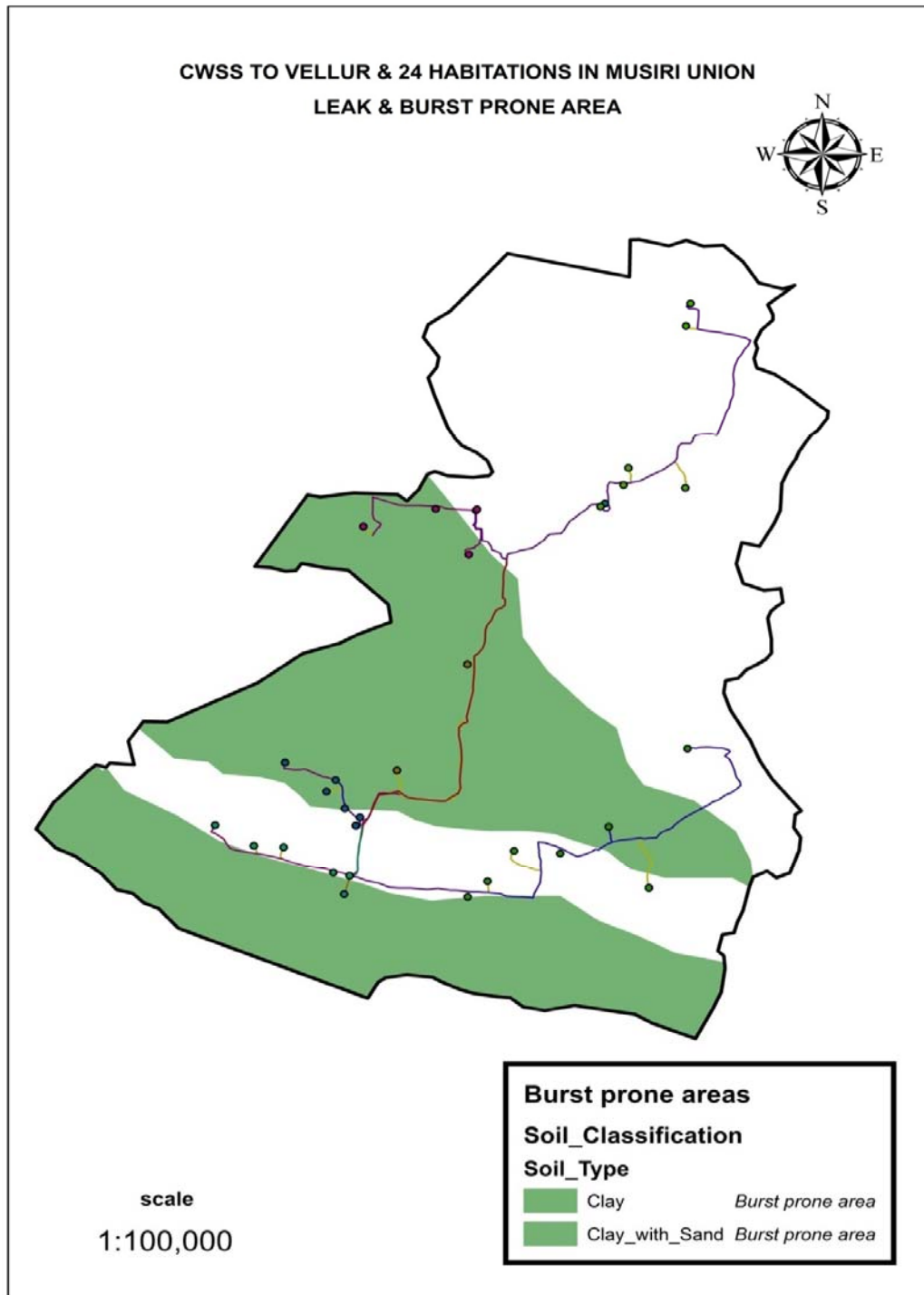


Figure-7. Burst and leak prone area.

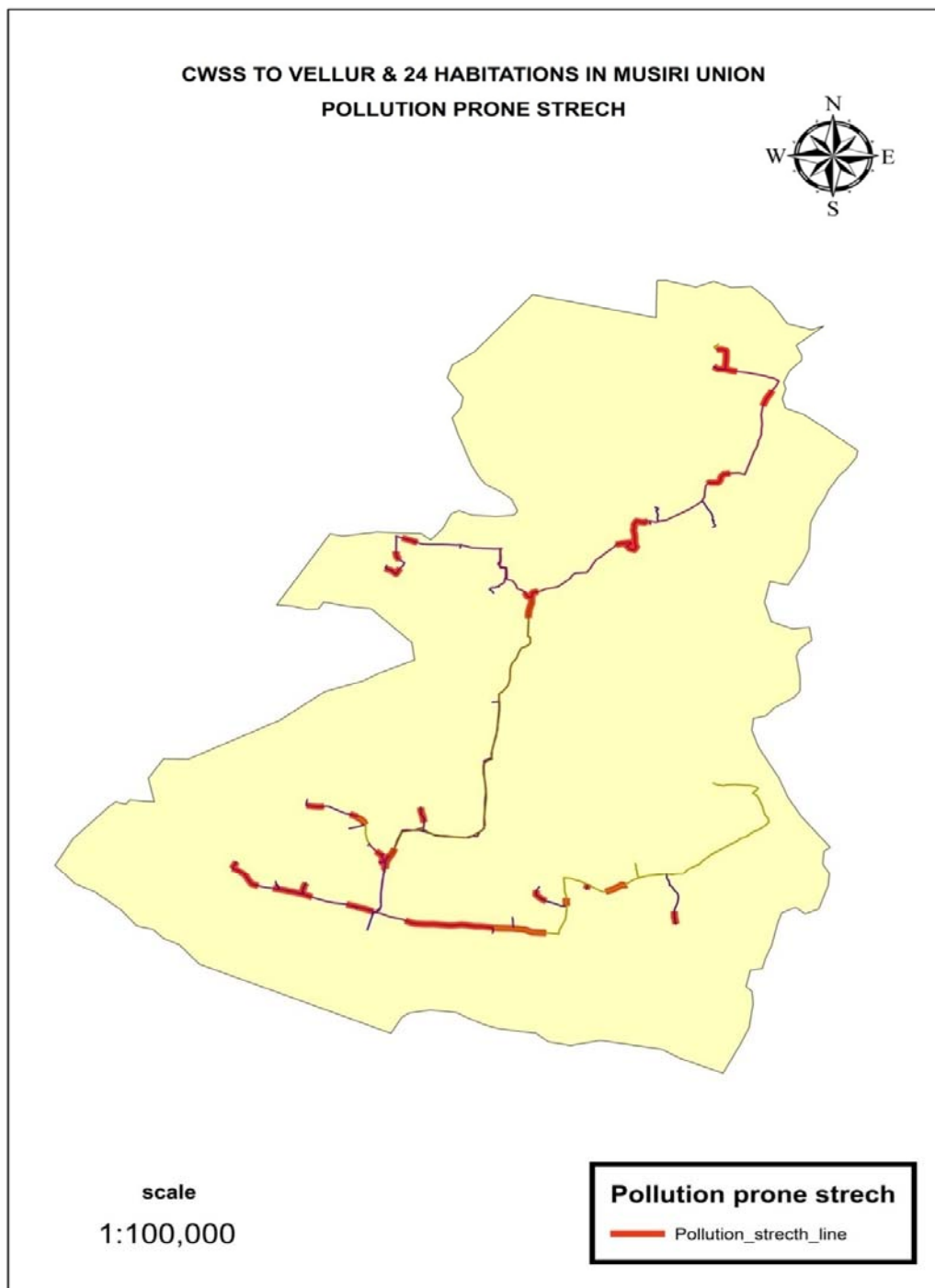


Figure-8. Pollution prone area.

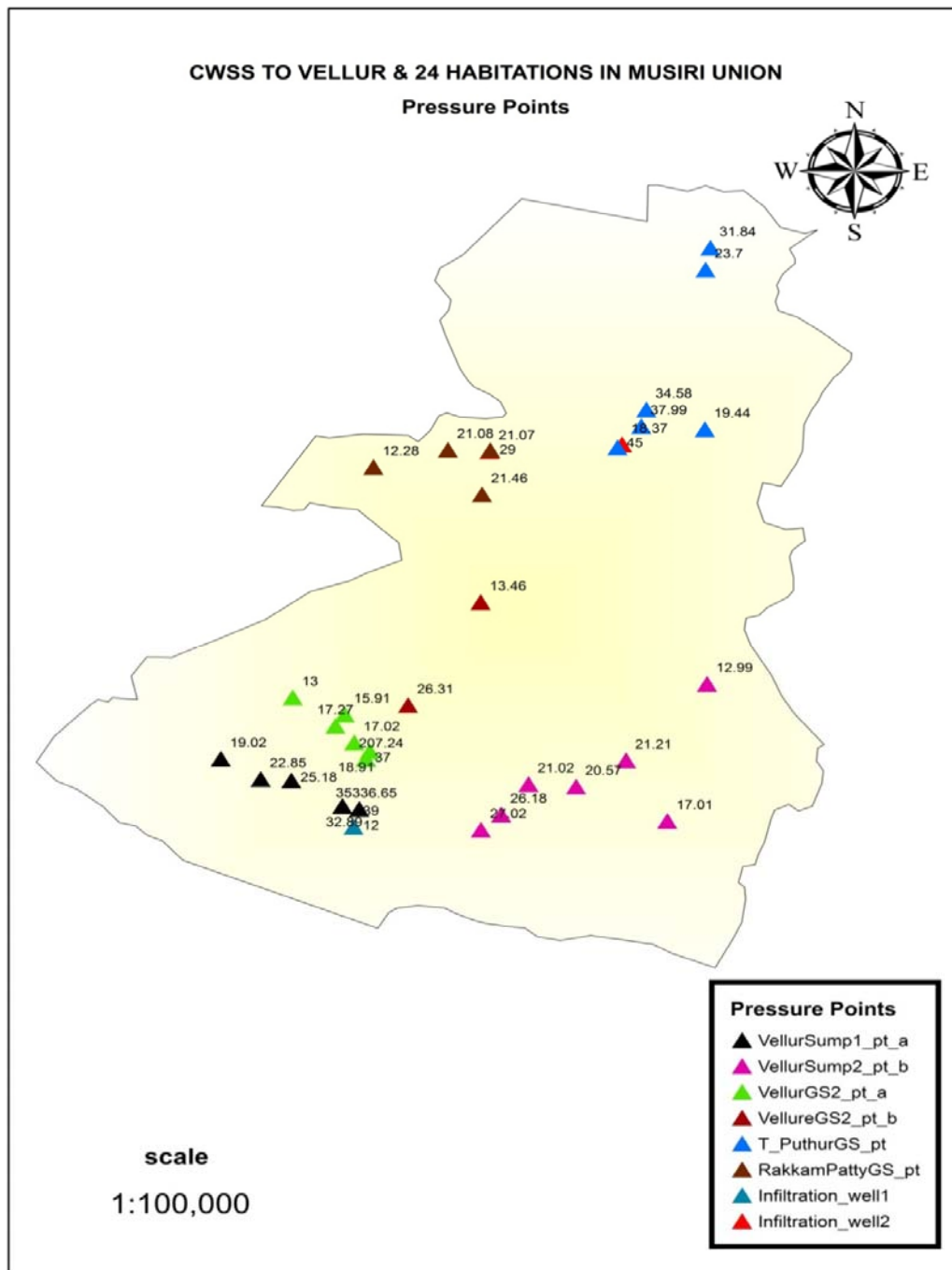


Figure-9. Hydraulic pressure at various locations.



Figure-10. Electric power line.

3.9 Hydraulic pressure map

Hydraulic pressure at each beneficiary habitation with respect to design is publicized in Figure-9. Pressure in turn indicates the flow rate. It will be help to operate the flow control valves to ensure supply at all the beneficiary habitations.

3.10 Electric power line

Electric power line in the scheme area under study is made known in figure 10. It will enable to measure the distance from the map for power supply connection and shortest point of electric supply may also be identified.



4. CONCLUSIONS

The Engineers in charge of maintenance of water supply schemes require some data base for planning preventive and crisis maintenance. The developed maps, to

the some extent, shall be useful for the same. The title of the maps with their uses for preventive and crisis maintenance of water supply schemes are tabulated below.

Figure No.	Title of the map	Uses
1	Project Area	Bird eye view of the entire project area to visualize the project .
2	Pipe Alignment Map	Pipe line alignment, Types of Pipe Lines and infiltration well can be read..
3	Scour Location Map	Location of scour can be easily made. Emptying of pipes during burst and leak may be directed accordingly without flooding the roads and residential areas.
4	Soil Classification Map	Soil classification helps to identify the bedding required and subsoil settling pattern in relation with pipe line.
5	Elevation Map	Topography
6	Contour Map	Levels of the project area. Deciding class of pipe and flow control needed
7	Leak and Burst Prone Area Map	Demarcation of area prone for leak and burst for preventive maintenance.
8	Pollution Prone Stretch Map	Identifying the areas that are Prone to Pollution.(Drainage's, sewage's crossing) for preventive maintenance
9	Pressure Points Map	Assess the residual pressure at each delivery point and to control the valves for equal distribution.
10	Power Line Alignment Map	Identification of Shortest route for brining electrical line.

The following general observations and inferences are drawn from the various maps generated using GIS:

- Project area falls on the northern side of Cauvery River. Source, infiltration well, has been located on the Cauvery bed. Majority of the beneficiary habitations are situated close to the source. Habitations are relatively close to each other in the initial reaches and scattered in the middle and end. It indicates that more quantity of water is distributed in the initial reaches. Hence, more attention is to be given for water apportion.
- Pipe line alignment shows that the pipe size decreases from 140 mm OD PVC to 50 mm OD PVC. It suggests that spare pipe and specials for the maintenance may be kept accordingly so as to minimise the transportation expense.
- Cauvery River and ArjunaRiver, a tributary to the former, are the natural drains in the project area. Emptying pipe during mending may be done into the Cauvery River in the initial reaches and into ArjunaRiver in the remaining part of the project.
- Sand, sand mixed with clay, clay and hard soil are the soil types present and clay, which behaves differently with moisture condition, solicits much attention.
- When clay expands on water absorption exerts pressure on the pipe causing damage. Otherwise, shrinkage on drying is also cause burst and leak. Hence, clay reaches require more concern. Umayalpuram and Kaliyapalayam stretch are prone for frequent burst and leak.
- Kathiyampatty habitation is the highest location. Necessary flow control arrangements are to make to make the flow to Kathiyampatty. It is quite nature that the flow direction will be towards lower level.
- Conveying mains pass through villages at many places. It is the general practice that the wastewater drains and drinking water pipe lines are accommodated on the side of the roads. So, the places where both fall close to each are vulnerable for pollution.
- Pressure head at delivery points vary from 12 metre to 37.99 metre. More flow will take place where the pressure is high. Flow control is essential at such locations.
- Electric line alignment rarely follows the pipe line alignment. Shortest point of tapping may be chosen if power supply is to be established in case additional pumping is introduced.

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