

CONSERVATION OF SOIL AND WATER IN THE DAMODAR VALLEY



One

LAND RECLAMATION IN THE DAMODAR
VALLEY

Two

WATER MANAGEMENT FOR PURPOSES
OF RECLAMATION

Three

USE OF RESERVOIR AREAS FOR AGRICULTURAL
PURPOSES

**CONSERVATION OF SOIL AND WATER
IN THE DAMODAR VALLEY**

Land Reclamation in the Damodar Valley

Measuring about 4.4 million acres, the upper valley of the Damodar contains approximately a million acres of waste land if we include 200,000 acres classified as forests which have nearly disappeared. On these areas certain forces have worked so adversely that they are no longer cultivable as they stand. Some of the natural agencies which have wrought the havoc are erosion, limitation of water, invasion of arable land by deleterious bushes, and the legacy of dead stumps left behind by vanished forests. Man too has contributed his share of destruction by overgrazing, and cutting and burning of trees ; and now the deterioration has made such progress that only 350,000 acres can be reclaimed for cultivation and about 50,000 reafforested or put under pasture.

This is less than 10 per cent of the entire headwaters region, and yet its immediate reclamation is essential not merely because soil erosion and water losses are worse here than elsewhere but also because from these foci contagion, as it were, is spreading fast to land which is still under cultivation or forest. Moreover, 350,000 acres can significantly supplement the country's food production, and while 50,000 acres of forests and pastures will

be a welcome addition to a depleted national asset, they will prolong, by reducing the silt in the river waters, the life of the multi-purpose dams the Damodar Valley Corporation is building. In any case, land for land and house for house have been promised to those whom the reservoirs will displace, and since even in the upper valley of the Damodar the pressure of population is such that no good land is available for relocation, 75,000 acres of waste land must be reclaimed before the eight reservoirs envisaged under the project have been completed.

For the first phase of development, which consists of four dams and hydro-electric stations, a large thermal power plant and an extensive transmission system, an irrigation barrage and 1,500 miles of canals, about 40,000 acres of waste land will have to be reclaimed in, say, four years, and only an extensive and complex organization can hope to achieve such a big task. Obviously, the physical reclamation of 10,000 acres of badly eroded land a year cannot be undertaken without the aid of the latest earth-moving machinery of all types ; but before this, there has to be meticulous planning including soil and contour surveys and land-use as well as detailed field

planning, and mechanical treatment must be followed by post-reclamation work comprising protection, maintenance and improvement of newly reclaimed fields, sodding of bunds, fertilization, green manuring and so forth.

PLANNING

The reclamation of waste land and the establishment of conservation practices can be effective and permanent only when carefully planned, and planning for these purposes resolves itself to the following :

- (a) *Soil survey* : This includes reconnaissance and detailed soil mapping.
- (b) *Land-use survey* : This is based on soil survey and indicates the particular use that should be made of the soil in a particular area : whether, for example, it is suitable for paddy, upland crops, pasture, or forest.
- (c) *Contour survey* : This is necessary especially for the areas where reclamation is done for paddy and upland fields.
- (d) *Detailed planning of fields* : This involves marking on the contour maps the kinds of terraces and their vertical intervals, as also various other means of achieving soil conservation.

(a) *Soil Survey* : A soil survey is undertaken before any new area is considered for reclamation. In other words, the soils of a particular locality are examined, classified and mapped in the field, and their characteristics are recorded, particularly with regard to reclamation.

The systematic examination of soils and underlying formations can be best done by digging test pits, making borings and studying gullies and other exposures. Each of these operations lays bare a series of distinct soil layers, or horizons, termed collectively the soil profile. Every such horizon, as well as the underlying parent material, is scrutinized in detail and the colour, structure, porosity, consistence, texture and content of the organic matter, roots, gravels and stones are noted. The chemical reaction of soil (*pH*), and its content of lime (HCl test in the field) and salts (including nutrient elements), are determined by simple laboratory tests. Other features taken into account are the drainage, both internal and external, the relief, or the lay of the land, and the inter-relations of the soil and vegetation. The resultant detailed soil map, on the scale of 16 inches to a mile, shows the various soil characteristics necessary for efficient reclamation. A great many particulars are necessary, as the nature of the country and the underlying geological formation, soils and slopes vary sharply over short

distances. The soil characteristics that are observed in mapping soils for reclamation are noted below :

I. MAJOR SOIL CHARACTERISTICS :

- (i) Effective depth of soil
- (ii) Soil series
- (iii) Texture of the top horizon, 0-6 in.
- (iv) Texture of the next horizon, usually 15-18 in.
- (v) Permeability from field characteristics

II. ADDITIONAL SOIL CHARACTERISTICS :

- (i) Reaction
- (ii) Organic matter content
- (iii) Inherent fertility
- (iv) Type of parent material, etc.

III. ASSOCIATED LAND FEATURES :

- (i) Slope
- (ii) Erosion
- (iii) Phase
- (iv) Any special feature

All these characteristics need to be known to determine the best use for each plot of land ; but every one of them is not put on the soil map. Soil depth, however, is very

important, and is shown by a distinct colour, whereas the other soil characteristics and land features are shown by certain symbols. The soil depth indicates how much of soil will be left even after some amount of earth movement has taken place for the purpose of terracing. The soil series is a group of soils having similar horizons in so far as their important characteristics, arrangements in the profile, and parent material are concerned. Thus the series comprises soils having essentially the same colour, structure, natural drainage and other essential internal features, as well as the same range in relief.

The surface texture (0-6 inches) and the texture at 15-18 inches are described by epithets like heavy, moderately heavy, medium, light and very light. Heavy soil includes the texture class—clay, silty clay, and sandy clay, whereas light soil includes fine sand and loamy sand*.

Soil reaction is mapped as pH of various ranges. Slope is indicated by certain slope percentage classes, such as

* The variations adopted for the survey are :

1. Soils containing less than 20 per cent clay are classified as, "sands" group—like fine sand, loamy sand.
2. Soils containing 20-30 per cent clay—but silt + clay = approx. 50 per cent—are classified as "loam" group—like sandy loam, loam, silt loam, silty clay loam and clay loam.
3. Soils containing more than 30 per cent clay are classified as "clay" group—like sandy clay, silty clay and clay.

	dia. in mm.
Fine sand	0.20 — 0.02
Silt	0.02 — 0.002
Clay	Below 0.002

0.2 per cent, 2.3 per cent, 3.5 per cent, 5.8 per cent and over 8 per cent. These slope classes are arbitrary, but help in determining the types of terraces needed for conservation.

Erosion is mapped separately by certain symbols like sheet erosion, and phases are mapped by other definite symbols, as, for example, gravelly, kankar, CaCO_3 , stony phase, etc.

(b) *Land-Use Survey* : A land-use map is then drawn up. It specifies the particular use that should be made of each part of the waste land when reclaimed. The fertility of soil can be maintained over a long period only when plots of land are used according to their inherent capacities. Although social conditions and economic necessities must continue to influence the use of land, it is important that its classification should be on the basis of its different potentialities. This approach is essential if the classification is to ensure the most sustained use consistent with the preservation of land as a permanent productive resource. The use-capability of various classes of land can be determined only by considering the physical factors influencing land use. These factors include soil characteristics and such soil conditions as slope, the degree of erosion, texture, etc., and certain environmental features such as climate, drainage, vegetation, etc.

There are five capability classes applicable to the Damodar Valley area, and the actual use recommended for any piece of land is a compromise, as it must be, between theoretical land-capability and the farmer's need determined by past use and the prevailing social and economic conditions.

In general, four land-use classes are planned, namely, paddy, upland (tanr), pasture and forest.

(c) *Contour Survey* : The area meant for reclamation for cultivated fields (paddy and tanr) is contour-mapped. The scale used is 32 inches to a mile with $2\frac{1}{2}$ -foot contour intervals. Such a contour map gives exact location of gullies and flats, indicating at the same time the slope of flats, depth of gullies, etc.

(d) *Detailed Field Planning* : The soil map and the contour map govern, in general, the detailed planning of fields. This planning prescribes the type of terraces, vertical intervals, etc., and suggests what the most suitable means of conservation is.

In addition to the soil map and the contour map, certain figures of rainfall intensities, run-off, etc., are required before the types of terraces, or other conservation measures, can be decided upon. These data are being collected by our run-off plots in the experimental station.

RECLAMATION

The detailed field plans form the basis on which earth-moving machines start working. These are of various descriptions, and used to convert highly gullied and eroded areas into different types of terraces, like bench terraces for paddy fields, level and graded channel terraces for upland fields, and contour ditches for upland cultivation and also for afforestation, pasture, etc.

Building land into a series of level or nearly level strips running across the slope is probably as close a definition of bench terraces as is possible. These strips of land are separated by vertical bunds, or rises, called terraces. The work involves earth-moving.

The growth of paddy demands water standing in the field. Bench terraces are, therefore, desirable for most fields in the area where paddy is the main crop. The design and construction of bench terraces must, however, be done carefully with earth-moving machinery. As far as possible, fields are marked on the contour map, and the primary object is not only to move the least amount of earth but also to fulfil particular specifications. The machinery used for these operations includes carry-all scrapers, bulldozers and power scrapers.

The bench terraces made on certain slopes and in some deeply gullied areas are provided with 18-inch, or even

higher, bunds. In the initial operation the top soil is scraped, and put on one side. Bunds are then made of the lower horizon and the top soil is spread back. Where such double operation is necessary, the cost is naturally increased.

For the upland terracing work the motor grader or bulldozer is used for making level or graded channel terraces. A level terrace, or a ridge, constructed well above the original ground surface, with as little channel as possible, is the best structure for impounding run-off for increased absorption over a wide area above the ridge.

Erosion control by the level terrace can be accomplished indirectly by water conservation. The level terrace is most effective on surface slopes which are fairly flat, on soil which is fairly light in texture, so as to allow increased absorption. The ridge for this purpose should be of a sufficient height to pond water over a relatively large surface.

The level terrace can be with closed ends for highly absorbent soil, or with partially open ends to avoid indefinite ponding which hampers the growth of crops. The idea is to keep the ends open, or partially open, so that the excess rainfall can escape before the terrace overtops. A slightly graded channel, particularly near the outlet, may be kept for the safety of the level terrace designed.

Graded channel terraces are also made by motor graders or bulldozers. These channel terraces act primarily as drainage channels to take away the excess rainfall from the fields at non-erosive velocities. Unlike level terraces, here the channel, and not the ridge, is of primary importance. The capacity of the water channel is calculated for a peak discharge of 3-inch intensity per hour. The ridge is considered supplementary to the channel and blends gradually with the surface slope to afford the minimum of interference with ploughing operations. A high ridge is seldom required. Channel terraces are usually constructed in uplands, sloping land with impervious soils and soils comparatively deficient in water-holding capacity.

These level and channel terraces can be used for upland crops, like millets, oil seeds, legumes and small grains. The level terraces have an added advantage in that they permit the growth of rabi cereals, gram and so forth.

Contour ditching is resorted to for same types of steep slopes and shallow soils. Land with these characteristics can be put under cultivation only partially ; a good portion should be under pasture or forest. For reclamation of this nature a ditcher is used. It is pulled by heavy crawler tractors of 80-100 H.P., and a ditch, about 12 inches to 14 inches deep, is made along the contour. Generally speaking, certain bushes and quartz veins tend to lower the

quality of such ditches, and to counteract their mischief double ditching may have to be done.

Terraces for reclaiming waste land is, as a rule, dug according to the following specifications, which can, however, be deviated from in individual cases.

Bench Terraces :

Type of soil	...	Clay loam and heavier varieties
Depth of soil	...	Over 4 ft.
Slope of land	...	Usually not exceeding 5 per cent
Average width of fields	...	30—60 ft.
Average width of bunds	...	5—6 ft.
Height of bunds	...	1½—2 ft. compacted

Level Terraces :

Type of soil	...	Sandy loam and light varieties
Depth of soil	...	Over 3 ft.
Maximum slope of land	...	3 per cent
Width of fields	...	50—100 ft
Width of bunds	...	8—10 ft.
Height of bunds	...	1½ ft.

Graded Channel Terraces :

Type of soil	...	Loam and heavier varieties
Depth of soil	...	Over 3 ft.
Maximum slope of land	...	6 per cent
Width of fields	...	More than 50 ft.
Width of bunds	...	Depending on the channel to be made
Grade of the channel		0—300 ft. 1 in. fall per 100 ft. 300—600 ft. 1 in. fall per 100 ft. 600—900 ft. 2 in. fall per 100 ft. 900—1200 ft. 3 in. fall per 100 ft.

Contour Ditches :

Type of soil	...	Not important
Depth of soil	...	1—2 ft. (for upland cultivation over 2 ft.)
Depth of ditches	...	12—14 in.
Width of ditches	...	About 2½ ft. depending on the ditcher
Width of fields between two ditches	...	25—100 ft.

For afforestation ditching can be done on slopes, where there may be a ditch every 12 ft.

Strip Cropping :

Contour ditching (or grass strips, etc.) at 1 ft. vertical interval and graded channel terrace (or level terrace) after every 4—6 ft. vertical interval or the slope length, whichever is shorter.

Reclamation in such areas is incomplete without ensuring adequate moisture conditions for the newly reclaimed fields, including irrigation facilities. This last is provided from surface storage, and several small dams have already been built in the area which is being reclaimed. The detailed discussion on this subject is given in a separate chapter entitled "Water Management for Purposes of Reclamation".

POST-RECLAMATION WORK

Completing the earthwork for terraces and providing water for the newly reclaimed fields do not by any means end the process of reclamation. The newly moved earth is always a problem, especially during the first rains when the terraces are loose and insufficiently compacted.

To ensure that newly reclaimed fields are improved, terraces are vegetated, and good crops begin to grow, a large programme of post-reclamation work must be

undertaken immediately after the earthwork has been finished. This programme consists essentially of the following :

(i) Contour ploughing of the newly reclaimed fields should be undertaken as soon as their moisture status permits. This and other conservation practices force the farmer to do various operations on the contour. The present practice of ploughing up and down the slope is ruining the uplands. All soil conservation measures are connected with the contour, and the terracing on the uplands necessitates ploughing on the contour, which in its turn reinforces the value of level, or channel, terraces.

(ii) Seeding and sodding of bunds, channels and spillways are taken up after reclamation, but before the first rains. If this is not done, the danger of erosion will increase, as what little normal cover there is will have been removed in the process of earth-moving.

(iii) The safe disposal of surplus water is through spillways for bench terraces and through special outlets for other types of terraces. The spillways are designed and constructed to accommodate a maximum rainfall of 3-inch storm intensity per hour. There is sodding and seeding to be done of spillways, and outlets have often to be stone-pitched and provided with a safe drop for the water to go to the next field.

(iv) The maintenance of certain bunds and fields is extremely important. For newly reclaimed fields the first year's rains are crucial. Where there is filled earth, differences in compaction result from the rains, and consequential differences of level set in. Manual earthwork to protect the weak spots from the storm must, therefore, be undertaken ; but such maintenance should be reduced to the barest minimum.

(v) Usually, the top soil in the areas under reclamation has already been partially, or wholly, washed off by erosion before reclamation starts. During reclamation almost all bushes, stumps and any green covering matter are bodily removed to clear the field, level the land, prepare the bunds and embankments and fill in gullies. Thus reclaimed fields are initially poor in organic matter and nutrient elements, like nitrogen and phosphate, and if the displaced persons who will be allotted these fields are to get good crops in the shortest possible time, the reclaimed land must be previously improved and fertilized. Fortunately, the local soils are, in general, highly responsive to nitrogenous and phosphatic fertilizers, particularly when applied together, and more than a 100 per cent increase in the yield of a few trial crops was obtained by combining the principal fertilizing elements in the proportion of 40 : 50 : 0 (i.e., 40 lbs. of N, 50 lbs. of P_2O_5 and no potash per acre).



1. Even badly wasted land can, however, be reclaimed with the aid of modern earth-moving machinery like bulldozers which level down gullies. Then power graders get to work forming terraces of various kinds to slow down the rush of ← rain water along slopes.

2. Improper use of land, overgrazing, and cutting or burning of forests destroy the vegetable cover and start heavy gullies which erode away the soil, nature's greatest gift. What is left behind is a wilderness of waste land. →



3. In some areas several machines have to work together. A good combination is a bulldozer, a scraper and a rooter. Such a team is seen transforming bleeding slopes into ← productive paddy fields.



Before reclamation

Mechanized reclamation can completely change the characteristics of entire regions. This can be best appreciated from the air as the two aerial photographs

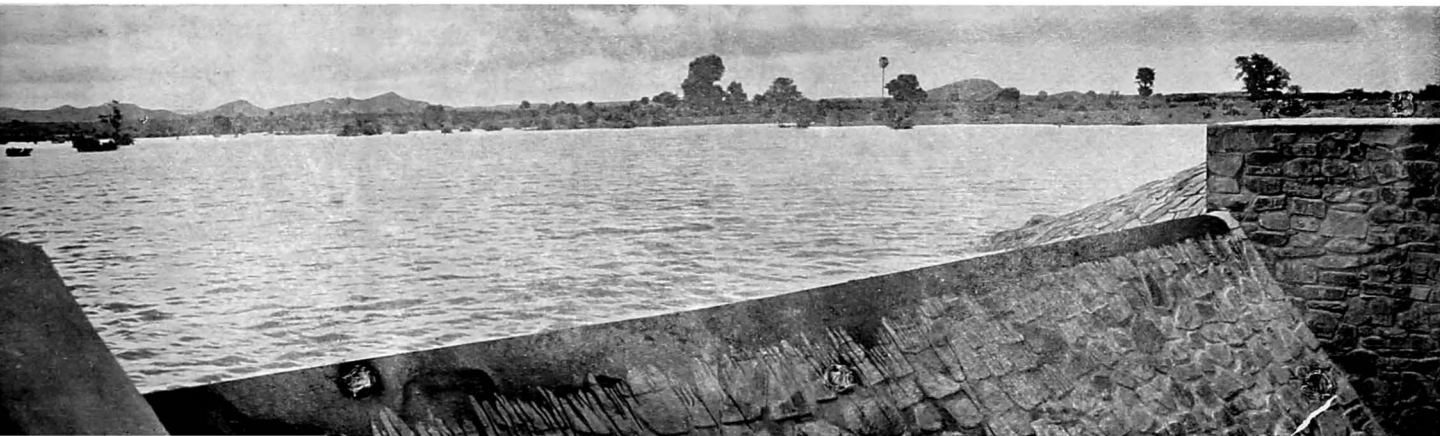
of the Tilaiya Rehabilitation Area show. The stony and barren ridges around Gauriakarma are now fertile terraces watered by a reservoir formed by damming a large depression.

After reclamation



Reclaimed fields have to be tended if they are not to revert to waste land after one or two monsoons. Ploughing on the contour, as opposed to up and down the slope, is one of the surest way of maintaining them.

Small dams converting nullahs into reservoirs are a part of our reclamation work. These not only provide irrigation for the surrounding fields but also prevent the monsoon downpour from carrying away the soil of the neighbourhood to silt up the main rivers. The Deochanda dam completed in January 1950 irrigates 100 acres of newly reclaimed land, and is used for piscicultural experiments.



In order to incorporate organic matter, and thus improve the physical condition and quality of the soil in the new areas, it is necessary that the land should be green-manured and fertilized with chemical fertilizers before it is made to raise a crop. Dhaincha and sun hemp are being sown as green-manuring crops, and for them too a small dose of fertilizers is added to the soil.

The average cost of reclamation for paddy terraces and for upland terraces is Rs. 400 and Rs. 130 per acre respectively. The cost, however, varies a bit depending on various soil, slope and other factors, and as waste lands are mainly reclaimed, another Rs. 40 to Rs. 50 should be added as the cost of acquisition. A further sum of approximately Rs. 60 per acre has to be spent on post-reclamation improvement including fertilizers, green-manuring, ploughing, etc. Even so, the total cost compares favourably with the prevailing cost of cultivable lands in the locality. This is between Rs. 900 and

Rs. 1,000 for Dhan Class I, Rs. 650 for Paddy Class II, and Rs. 225 for Upland Class II.

Proper planning is essential for reclamation. And every plan must be so designed as to involve the minimum amount of earthwork. Improvement of newly reclaimed fields is unavoidable, and test cropping must be undertaken to demonstrate the efficacy of conservation methods. The ultimate object is to make reclaimed fields grow good crops in the minimum period of time. Reclamation does not mean only jungle clearance and ploughing, or ridging. Incomplete measures are uneconomic in the long run. Reclamation must be carried on until bleeding slopes and heavy gullies have been transformed into green fields producing paddy and upland crops. Thereby there will be more food and better soil and water conservation in the Damodar Valley, and ultimately improvement of the river regime. This is the task laid on the DVC, and it must be completed successfully.

Water Management for Purposes of Reclamation

The success of reclamation is largely dependent on the handling of the excess rainfall which forms the surface run-off from the reclaimed land. This part of the job can be broadly divided into three distinct operations : (1) conservation, (2) utilization, and (3) disposal of excess water.

CONSERVATION

Conservation of water starts really at the upland fields where it is combined with conservation of soil. Any excess water that flows down, in spite of various conservation practices, has to be allowed to run to waste. But this excess water can be again used for irrigating reclaimed paddy fields if properly conserved. Further, the reclamation of paddy fields is incomplete without providing proper facilities for their irrigation.

For using the excess run-off from upland fields for the irrigation of lower paddy fields a number of ponds are designed and constructed. In the selection of the site for a pond and its bund the following points are kept in view to ensure economical construction and safety :

(a) The site for the bund is so located as to have

the largest capacity for the pond with the minimum amount of earthwork for the bund. This is easily achieved by a careful study of the topography of the area with the help of the 2½-foot interval contour map.

(b) A safe spillway site is also selected on one or both flanks.

(c) The pond is generally located over very slowly permeable soil. This can be discovered by studying the soil survey map in conjunction with the contour map and verifying on the site.

(d) The bund axis is so placed that it has a fairly impervious foundation within a reasonable depth from surface, say, about three feet. This again is done by examining the soil by an auger, or from soil profiles, if available near by.

(e) For a pond with an average depth of five to six feet, a catchment area about six to eight times the submerged area of the pond is desirable. This ensures the pond filling at the proper time.

(f) The pond is also so located that its effective capacity (by which is meant the volume of water

available for irrigation) in acre feet is about a third to half of the commanded area in acres.

(g) Wherever possible, ponds are located in gullies which have some spring flow also.

(b) In high silt-producing areas, water is allowed to be discharged into the ponds only through stilling, or desilting basins. These basins should either be cleared periodically or made into fields after they have been silted up to the required level.

UTILIZATION

The next operation after conserving the excess water in the ponds is its proper utilization. The primary task of all these ponds is to provide irrigation to the lower paddy fields. For proper irrigation outlets should be provided from the ponds. This is achieved by installing a pipe outlet at the proper level. In fixing the levels of these pipes considerable care is exercised, so that they are not too low for the commanded area, nor too high to reduce the available volume of water for irrigation. Very often, in some of the larger ponds, outlets at two different levels are fixed, so that the maximum volume of the stored water is available for irrigation.

The next problem that immediately arises is the conveyance of the water to the fields from the outlet. The provision of channels for this purpose is, on the one hand,

expensive for such small projects if they may be so called, and the loss due to percolation and evaporation are too high, on the other. Hence, the system of field to field flow is adopted. This saves the expenditure on channels and also the losses through percolation. It also conforms to the local practice.

Sometimes, when other conditions are satisfactory but a suitable impervious foundation for the bund is not available, the pond is designed as a seepage pond, which is also a very popular local practice. The main difference between such ponds and those of the conventional type is that the former have no permanent irrigation outlets. As the name itself suggests, the water goes on percolating under the bund, and keeps the fields below moist. Though no permanent irrigation outlets are provided, water can still be made available by narrow slits cut through the bund, and these can be readily closed when required. This practice is a popular local one.

DISPOSAL OF EXCESS WATER

All ponds and ahars are provided with emergency spillways unless the catchment is small and the capacity of the ponds large. In either case no spillways are necessary. But such conditions are exceptional, and spillways are generally located at one or both flanks, leading the excess water into some existing and stabilized waterway.

Considerable care is exercised in the design of the spillways to keep the velocity of flow within non-erosive limits. Sometimes, and especially when the catchment is large, and consequently the run-off is high, or when no proper site is available for a natural spillway, permanent structures, like a drop inlet pipe spillway, or a straight drop spillway, are designed as a safe outlet for the excess flow.

It is sometimes possible to locate more than one pond in a sub-catchment, especially when it is large and a single pond is not enough for catering to the needs of all fields. In such cases the ponds are so located that the excess from the upper flows into the lower, in addition to the run-off from the latter's own catchment below the upper one.

When the excess water leaves the last pond, it has again to travel through the gully before it reaches the main

natural and stable waterway, and the water disposal problem is not completely solved until the excess water reaches the main waterway without doing any damage en route. It is evident that a gully is the most vulnerable point, and accelerates erosion if the velocity of the water flowing through it goes beyond non-erosive limits. This, of course, happens wherever the gully is very steep. Then suitable check drops of a permanent or semi-permanent nature have to be designed along the gully to control the velocity of the water and at the same time to reduce the slope of the gully, so that the velocity does not exceed non-erosive limits.

Channel improvement also finds a place in our design of the excess water disposal. This is achieved by straightening the regime of gullies and providing proper side slopes wherever they are very steep and liable to slip.

Use of Reservoir Areas for Agricultural Purposes

When the Damodar Valley Scheme with its eight major reservoirs and a certain number of headwaters dams will be completed, an area totalling about 120,000 acres will be submerged periodically. To obtain good storage capacities, reservoir sites have to be selected in flat and wide sections of the valleys, where the best cultivable lands are normally situated. Consequently about 60,000 acres of cultivable land will be submerged by the reservoirs, the loss of which will curtail agricultural production. To avoid this loss and also for social reasons it has been decided to replace all the cultivable land in the submergence areas by reclaimed waste land. Nevertheless it is highly desirable to retain under cultivation as much land in the reservoir areas as is economically justifiable.

The reservoirs of the Damodar Valley will fill at the end of the monsoons. Water will be drawn every year steadily from October, reservoir levels reaching their lowest point in the first half of June. Thus large parts of the reservoir areas above dead storage will be exposed for a sufficiently long period to raise a crop, and on the fields situated higher double cropping will be possible. The productive value of the fields will be greatly increased

by the high moisture content resulting from long flooding. The easy access to the reservoir water for irrigation and the silt deposited in the reservoirs will also contribute to higher yields.

Such use of seasonally submerged land is made in many countries. It is for instance practised extensively on the Nile reservoirs. There the land as it emerges out of the receding water is put under cultivation. As the soil is soaked with water, the moisture lasts if not through the entire period of cultivation at least for the first phase. Additional irrigation is provided by the help of ditches dug from the edge of the receding water into the fields and by lifting the water by simple means.

The reservoir areas for our purpose can be divided into three groups: (a) areas which will not be submerged every year; (b) areas which, though submerged every year, will be free of water for at least three months, a period sufficient to produce most crops; and (c) areas permanently submerged (dead storage) or free of water for too short a period to produce a crop. The land in the first category may be as much as 15 per cent to 20 per cent of the total area acquired for reservoirs. The second

category will include about 50 per cent of the total reservoir area, leaving for the third category 30 per cent to 35 per cent. Elevations of fields in relation to reservoir levels, land slopes and time of exposure being different, the methods of use of water will also differ for the various sections.

Where the edges of the reservoir are flat and existing paddy fields fertile, land should be protected against exceptional floods by the construction of relatively low dykes. Provision must be made for the effective drainage of these fields by intercepting rainwater reaching them from higher land and by building effective outlets. In these fringe areas where fields are situated above normal maximum reservoir level, the cultivation of paddy will be possible. The easy availability of water will be protection against crop failure.

For the areas of category (b), submerged every year but free of water continuously for at least three months, a time table will have to be worked out for the cultivation of the fields. The reservoirs will fill at the end of August or the first half of September, and the water level will start to drop in October at a rate of 7—10 inches per week. The planting of crop can follow the receding water.

As already mentioned, small ditches dug from the receding reservoir to the fields will bring water to the fields. As the reservoir recedes, these canals will have to

be lengthened and deepened. When the depth of the canals increases beyond a certain measure, new canals have to be started, using double lift. As the crops on the higher fields mature, the canals serving them will be put out of use and new canals dug for the irrigation of the lower fields.

Simple lifting devices will provide the best means for watering. Ridges may be used for the conveyance of lifted water. Existing bench terraces will help irrigation. In some cases floating pumps may be introduced with advantage. At favourable sites stationary pumping plants could be installed. Where permanent transmission lines are near, electricity may be used with advantage.

It has also been suggested that dams be built on tributaries of the rivers, or around depressions within the submerged areas, thus forming compartments within the reservoir. These pocket reservoirs should be kept full up to a time when sufficient cultivable land has already emerged from the major reservoirs. These pocket reservoirs should then be used for irrigation of the fields. Existing tanks situated in the reservoir areas could be made use of in the same way.

The methods described above will be tried out for irrigation of the cultivable areas which will be exposed for sufficiently long periods to produce crops. Intensive production of vegetables, of winter paddy (boro), of

wheat and other rabi crops, like mustard and grams, will be possible in such areas.

Management of these areas is to be under a special agency instituted for the purpose. The land will, however, be leased out if it is advantageous to do so, and the management will make arrangements for water lifting, fertilizers and better seeds. Demonstration farms for the submergence areas will be set up. Sound agricultural marketing will be arranged for the villagers.

The lands will be leased to the villagers, preferably to whom they belonged originally. A certain amount of co-operative farming will also be introduced to encourage the use of such areas for seasonal cropping.

Out of the approximate 120,000 acres one-third of the total reservoir area, or about 40,000 to 50,000 acres, can be seasonally cultivated. This will contribute significantly to greater food production, especially if intensive cultivation is practised.

CHARTS

1. Soil Map of Village Gajo
2. Contour Plan of Village Gajo
3. Soil Map of Village Dumardih
4. Submergence Area and Rehabilitation Sites of Tilaiya Reservoir

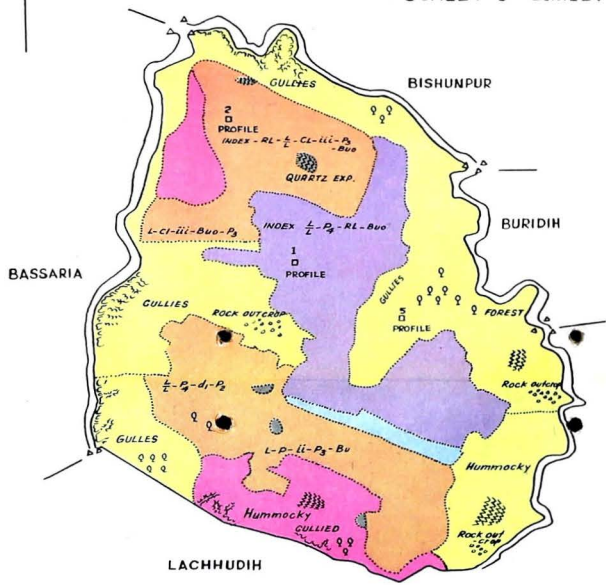
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SOIL MAP OF VILLAGE GAJO

SCALE :- 8" = 1 MILE.



INDEX

SOIL DEPTH

- OVER 5'
- 3' - 5'
- 2' - 3'
- 1' - 2'
- 0' - 1'

GULLIED, HUMMOCKY
FORESTED AREAS OF
MISC. DESCRIPTION

ROCK OUTCROP

SOIL TEXTURE

- CLAY, SILTY CLAY
- SANDY CLAY ----- H
- SILTY CLAY LOAM,
- SANDY CLAY LOAM. D



- SILTY LOAM... M
- SANDY LOAM. L
- COARSE SAND... C

PHASE

- STONEY... S¹, S², S³
- OPEN ... O
- GRAVELLY... Q
- BUSHY... Bu.
- KANKAR... K.

SLOPE CLASSES

- (To be seen by Abney Level)
- NEARLY LEVEL. 0-1% ... (i)
- GENTLY UNDULATING. 1-3% ... (ii)
- MODERATELY SLOPING. 3-5% ... (iii)
- STRONGLY SLOPING. 5-10% ... (iv)

L Texture 0-6"
L " 15-18"

VERY STRONGLY SLOPING
OVER 10% ... (V)

SOIL REACTION

- pH LESS 5.0 ... P₁
- " 5-6.5 ... P₂
- " 6.6-7.3 ... P₃
- " 7.4-8.5 ... P₄
- " OVER 8.5 ... P₅

PROFILE ... □

GULLIES ...

QUARTZ EXPOSURE ...

ROCK OUTCROP ...

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S.P.P. 15-8

OFFICE OF THE LAND USE PLANNING
& RECLAMATION DIV. S.C.D. DVC
HAZARI BAG

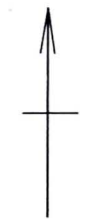
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CONTOUR PLAN OF VILLAGE - GAJO

SCALE :- 8" = 1 MILE.



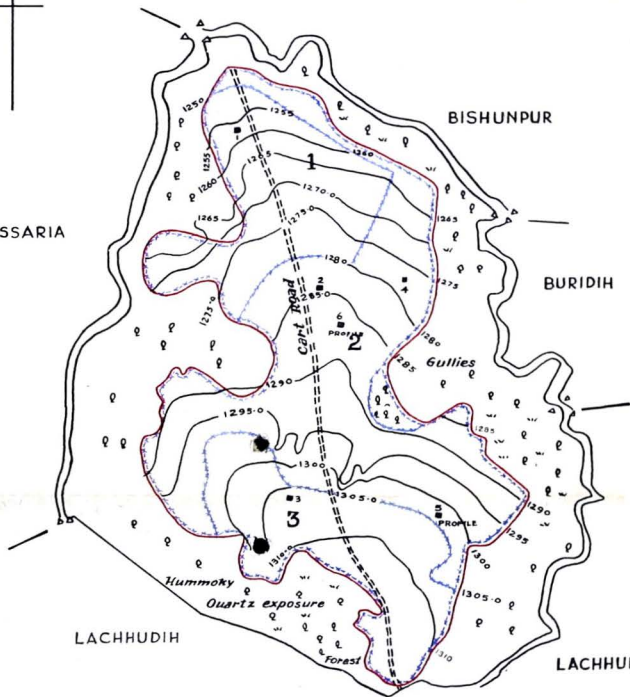
BASSARIA

BISHUNPUR

BURIDIH

LACHHUDIH

LACHHUDIH



Area acquired for Reclamation shown in Red line

INDEX

BLOCKS	SYMBOL	DESCRIPTION	ACRAGE
'SUB-BLOCK 1		ONE FOOT VERTICAL INTERVAL CONTOUR DITCH. GRADED CHANNEL TERRACES.	19.92.
"	2	$\frac{3}{4}$ - $1\frac{1}{2}$ ' VERTICAL INTERVAL BENCH TERRACES.	44.92.
"	3	ONE FOOT VERTICAL INTERVAL CONTOUR DITCH. GRADED CHANNEL TERRACES.	20.06.

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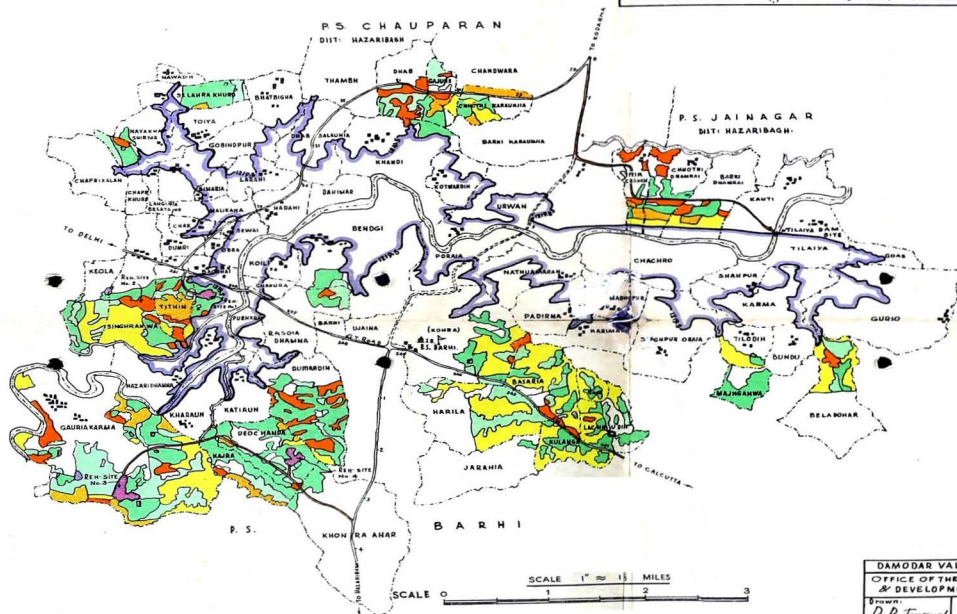
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SUBMERGENCE AREA & REHABILITATION SITES

OF TILAIYA RESERVOIR

LEGEND

1. EXISTING BASTI	101 PASTY FIELD
2. SUBMERGENCE LINE	102 TAMR FIELD
3. PUCCA ROAD	103 PASTURE
4. KUTCHA ROAD	104 FOREST
5. D.V.C. ROAD	105 FOREST CUM PASTURE
6. VILLAGE BOUNDARY LINE	106 PROPOSED VILLAGE SITE
7. THANA	107 AHARS, TANKS
8. RIVERS & NALLAH	



DAMODAR VALLEY CORPORATION
 OFFICE OF THE DIRECTOR OF REHABILITATION
 & DEVELOPMENT, LAW COTTAGE, H. HAZRAT
 Drawn by: *R.P. Jeyaraj*
 Director of Rehab. & Development
 The 22nd Dec '80
 Drg. No. DVC/HZB/DRD-163