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Public Works DEPARTMENT.

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Proceedings of the Madras Government, Public Works Department, 24th November 1875.

Read the following :—

No. 575. *Memorandum relative to the changes required in the organization of the Public Works Department, Madras Presidency, in view to its more efficient technical administration.*

In August 1874 the undersigned submitted to the Chief Engineer a Memorandum, in which certain existing defects in the organization for the technical administration of the public works in this Presidency were alluded to. The want of a complete code, of standard specifications for all descriptions of work, of forms for estimates, returns and correspondence, and of complete schedules of rates and data was pointed out.

In a draft Circular Memorandum addressed to District Engineers, (submitted for the approval of the Chief Engineer in February 1875, and issued in July 1875,) these officers were directed to furnish with their schedules next due, specifications of the work for which rates were quoted.

In their Order of the 17th March 1875, No. 748, the Government point out the necessity for the preparation in districts of standard specifications, and for enforcing the observance of the forms by subordinates. The Controller of Public Works Accounts in his letters printed in the Proceedings of Government of the 24th June and 31st July 1875, refers to the necessity for compiling standard specifications and for the preparation of a code, and in their orders thereon the Government approve of the propositions made, and depute certain officers to assist the Controller in the duty.

But in the memorandum of the undersigned of August 1874, before mentioned, the necessity for affording to the chief officers concerned with the administration of the department at head-quarters, technical assistance in the details of their duties in order to enable them to devote themselves more often to questions of general importance was also suggested, and believing that unless such assistance is given, and unless arrangements are made for enforcing attention to codes and forms the measures which have now been initiated will not produce the good effect anticipated, but will in fact prove abortive, he offers the following observations for consideration. In making them the defects of the present arrangements are recapitulated in order to the production of a connected argument, known examples of failure in projects are traced as far as may be to those defects, and the operation of the reforms advocated in preventing such failures in the future is attempted to be described.

2. It has been the duty of the writer to deal generally with the estimates sent up from the districts for all services except irrigation, and as regards these he has seen the reviews of the Chief Engineer for Irrigation. Moreover, the histories of various projects have unfolded themselves during the past few years, and it is impossible to avoid the recognition of the fact that grave defects of system exist, that projects have been and continue to be sent up for the approval of Government which contain within them the germs of failure partial or complete, and that the present organization of the department has been and is still ineffective in preventing this evil. The Note of the Chief Engineer for Irrigation on the Controller's letter already referred to contains one remark which is pregnant with meaning. He states that the specifications now written for works are in general not worth the paper they are written on, and yet it is by the specifications that the construction of works is supposed to be regulated, and it

is admitted that the manner in which a specification is written is a test of the knowledge of the work possessed by the writer.

3. It may be said that under the heads of Imperial, Provincial, and Local Fund expenditure a sum of at least one million sterling is annually at the disposal of the Department of Public Works of this Presidency. Year after year the same expenditure is gone through and work of the same nature is performed, but the formulation of the processes by which the results are produced has been very imperfectly carried out. The proper classification and division of labor connected both with executive and administrative work has therefore not been possible, and further the arrangements for the collection and application of general experience to the improvement of processes and formulæ can hardly be said to exist. To put it in other words, there is no complete code for the guidance of officers in the administration of the public works of their districts and their relations with other departments. There exists scattered throughout a mass of Government Proceedings Orders on all sorts of subjects relating to Account, Establishment, and Construction, sometimes annulling each other; but there is no arrangement for periodically abstracting, classifying them or adding them to a code and placing them in a handy form in the possession of officers and subordinates. There is no book of standard specifications defining the nature of materials to be used, the nature and mode of execution of all varieties of work. The schedules of rates in districts are in the highest degree incomplete, the data on which they are based uncertain or non-existent. Such data are not actively investigated, corrected from fresh information, or enlarged by observation of new work. Estimates are not framed on recognised examples. Tables of scantlings for timber adapted to the current work of the districts, and for facilitating the calculation of earthwork have not been prepared, and the system partially adopted of issuing standard plans and drawings with estimates needs extensive development, more especially in the Irrigation branch.

The use of printed forms for estimates, returns, and correspondence has not been sufficiently recognised and enforced, although the economy in clerical labor thereby obtained would often be enormous. In short, the importance of that part of administration and management which formulates processes and regulates as well as simplifies labor by classification and division, is not sufficiently valued, and yet it is by such management alone that the profitable employment of inferior, and therefore cheaper, agency in both administrative and executive work is rendered possible.

[illegible]qually defective is the present organization in all pertaining to that important [illegible]unction of a technical department: the utilization of information derived from the results of its operations. Failures are usually traced to their true causes in the correspondence or orders recorded in the Government Proceedings. New rules or principles of construction are there often stated, but the steady and constant reflection of the experience gained, on the work of all members of the department, is not attained as it should be, by the insertion of the acquired rules, either by way of amendment or enlargement in the codes of construction, in the standard plans, specifications and estimates, in short in the formularies generally, which should be constantly in the hands of all and be constantly referred to. Finally, there is no central establishment for the systematic enforcement of well-settled principles, of economical arrangements, or of rules generally by an examination of projects, estimates and plans, based on the Standards and Codes. Yet it has been amply shown by experience that the constant pressure thereby implied

is absolutely necessary to prevent such codes or rules in general from becoming i[illegible] great measure dead and inoperative.

5. Officers of the department ought to be called to account not so much for want of ability in comprehending their work and describing it clearly, as for not describing it in accordance with the standard specifications to which they should simply be referred; not for imperfect estimates or plans, but for estimates and plans not in accordance with those placed in their hands as examples or standards; for data or rates not in accordance with the standard schedules; for scantlings not in accordance with their tables; for reports omitting particulars required in their code; and an establishment is required which, having before it code, circular orders or addenda to code, forms of estimates, reports and schedules of rates, standard data and plans, tables of scantlings and hydraulic discharges, &c., would only have to ascertain that the documents sent up were in accordance with the above, or note deviations for the information and orders of the Chief Engineer, Deputy Chief Engineer, or other responsible head of the office. The division of the labor of examination being so carried out as to render it as mechanical as possible, and tending to create specialists for the several branches of construction.

The application of the principles of organization indicated above by no means implies interference with the legitimate functions of a Chief Engineer, or with those of the higher officers of the department. It simply relieves them of a mass of work which must be attended to, but which can be done with infinitely greater economy and certainly by a properly organized staff than by themselves, so long as that staff is under their supervision and control. It enables the Chief Engineer, for instance, to devote himself to his legitimate occupation—the study of works and projects in their general scope, and the establishment of general principles of design and construction to which his standard plans give expression. It gives him leisure to view the working of the department as a whole, and to study and initiate improvements having general effect. As Secretary to Government he would also by the arrangements proposed have more leisure for the administrative work which, while it is not independent of technical considerations, is closely connected with questions of general policy. The vesting in the same individual of the functions appertaining to the dual office of Chief Engineer and Secretary to Government is the only key to that complete grasp and effective control of a technical department, so important as that of the Public Works, which the Government should possess; but for the effective performance of these higher functions it is obviously necessary that ample assistance should be given in the carrying out of minor duties.

The aid given should however not stop here; the operation throughout the Presidency of the formularies referred to requires to be watched, they need to be amended or enlarged, and extended as experience suggests. Work is undertaken under hitherto unknown conditions: specifications require to be amended or provided; new materials are used or construction of a new class is carried out; rates and data require to be investigated and established. Failures occur, they indicate defects in design or execution which have not hitherto been provided against. Codes of construction, standard specifications, schedules of rates and standard plans must be brought into conformity with the acquired information. This labor, these duties, require a staff with somewhat higher qualifications, greater technical knowledge than that simply employed to enforce attention to forms already adopted; but this element should be represented in a Chief Engineer's Office and be employed for the purposes mentioned, and its employment under proper management would be attended with benefits which would repay its cost a thousandfold.

There is not, so far as the writer is aware, in the office of the Chief Engineer of the department, or the Chief Engineer for Irrigation, a single representative of either section of the establishment referred to, to give aid in the details of the technical administration of the works throughout the Presidency. The personal check of these officers on estimates and projects is now necessarily required to extend from considerations involving lakhs of expenditure to those relating to the height of a wing-wall, the depth of a joist, or the iron work of a door, and an equal amount of time may be required to investigate the fitness of the one class of items as the other. It is self-evident that the mass of work thus thrown on individuals must be so great as to be utterly unmanageable.

On the other hand, the principles of organization which are advocated are only those which obtain in every successful manufactory in a civilized country. The formulation of processes and division of labor, together with the employment of agency suited to the labor, is the key to success in all such enterprises, and the Department of Public Works is no exception to the rule.

6. The creation of a central establishment, with thorough organization, for technical administration will not do away with the functions of District Engineers in examining and checking plans and estimates which they receive from Range Officers. They have already a staff in their offices for this purpose, as well as to assist them in the preparation of projects and designs; but the formulation of the process of examination proposed for the central office can be carried out with most beneficial results in the district office. The possession of standard plans and specifications, together with the other formularies and clear codes of instruction, will lighten the labors of both officers and subordinates to an incalculable degree, while the knowledge that scrutiny in the central office will be based on the same data, will compel that constant reference to the information placed in their hands which is necessary as a means of instruction.

To the work of Range Officers, and even that of Overseers and subordinates in general, the same principles can be applied and the same aid and instruction will be given by codes and standards for constructive work. The education of subordinates will proceed in the right direction; they will be initiated into correct methods, and they will acquire their first lessons in the constructive art, not as is now generally the case from the vicious practices of maistries or native workmen, but from well-written specifications, the directions in which they will have no excuse for not carrying out.

7. The adoption of the principle of working in accordance with well-considered standards and methods does not imply in any way whatever that there is to be a bigoted adherence to formularies, regardless of their application to particular cases, or that the inventiveness and ability of executive agents is to be cramped thereby. It has already been explained that the operation of all standards and codes is to be subjected to continued scrutiny, and that they are to be constantly amended or enlarged when necessary. Officers may improve on the methods adopted; they may point out defects in standard plans; and they may dispute data and rates; but it will be necessary for them to justify their proposed deviations from rule, and the accuracy of their conclusions must be tested. Once thus established the change will be adopted as an amendment or as an optional method or increase to the recognized resources of construction. It will be incorporated in all the standard formularies, and it will thus be placed at the disposal of every officer of the department, and its adoption by them will, if needful, be enforced.

8. The working of the department in the absence of the organization described is carried on with an amount of friction and difficulty as well as waste of time and money, which is palpable to all who have anything to do with it. No doubt a large amount of good work is executed; but this is entirely due to the individual character and ability of a certain number of the officers, and in spite of the system, or rather want of system, which prevails. It must be repeated that, at present, except as regards the Irrigation branch, there is absolutely no specific arrangement whatever for the proper examination of projects, designs, and estimates sent up to Government by District Engineers, or for comprehensive technical administration; and, as regards the Irrigation Department, the Chief Engineer will probably concur with the writer in the assertion that the provision is most inadequate. There is no technical staff whatever attached to that officer, and it is impossible that the duty of examination can be efficiently and economically carried out without aid, and ample aid, of this kind.

9. The evil effects of this absence of organization will be most forcibly illustrated by reference to particular and well known instances of failure in projects and buildings, and by showing how these may be traced for the most part, if not wholly, to such defects. The Madras Water-supply Project was originally estimated to cost some six and a half lakhs of Rupees. It will actually cost not less than thirteen. The returns from irrigation and the sale of water to the Madras Municipality were calculated at Rupees 92,000; they have hitherto not exceeded Rs. 29,772, and the prospect of substantial increase in revenue is small. There were evidently therefore large errors in the calculations on which the estimate of the cost of the works and the returns were based. Yet these passed unchallenged, and the errors were only revealed after operations had commenced, and the Government were committed to the execution of the project.

Every irrigation project ought to be based on an accurate survey of the ground included, accurate levels and sections, accurate statistics and observations regarding rainfall, drainage area, flood levels, cultivated and cultivable areas; accurate plans of existing works and accurate information regarding available resources in building materials and labor, and current rates for work. Failures to a greater or less extent arise from incorrect or imperfect information on such subjects, or from incorrect surveys or observations, and also from attempts to construct works in violation of natural laws or well-established principles, or, again, the executive arrangements and supervision may be faulty. The failure of the Red Hill Project is attributable to various causes belonging to all the heads indicated. In regard to those classifiable as incorrect information it may be recalled to mind that the *regime* of the Cortelliar river, the source of supply was very imperfectly investigated: the maximum flood level was assumed at 10 feet, while it was actually 15 feet, above the bed at the site of the head works. Overflow was not provided against, the works were damaged, and additional ones were required to a large extent not foreseen originally. The areas draining across the channel leading from the river were under-estimated, and the provision for disposing of the drainage was consequently insufficient. Extra works were found necessary and further cost was incurred. The area of the land available for additional cultivation under the tanks was over-estimated and thence arose exaggerated forecasts of returns. The rates allowed for the execution of all the more expensive portions of the work were insufficient.

Of causes connected with incorrect surveys or operations of that nature, it is to be observed that a large source of unforeseen expenditure was additional earthwork in the embankments not originally provided for, owing to incorrect levels and sections of the original ground on which they were thrown up. The original designs of the masonry works were ill-calculated to withstand the strains to which all hydraulic works are exposed, and more massive and expensive constructions were necessarily substituted. The original estimate was here again falsified, and the failure of the project in a financial point of view further secured. Finally, the executive agency employed during the inception of the work did not belong to the trained staff of the department, and errors of execution were committed which were subsequently a cause of increased expenditure.

The question now to be considered is how far in this case an organized technical administration of the nature described would have prevented unprofitable expenditure. It must be premised that the Red Hill Project, as presented for sanction by the special Executive Engineer employed in its preparation, was subjected to no real professional scrutiny of an independent character before it was stamped with the approval of the Local Government, and forwarded to the Government of India. Specially deputed for this duty on account of presumed exceptional qualifications as a Civil Engineer at Home, the officer in question was placed in a quasi-independent position in reference to the superior officers of the Public Works Department more immediately in contact with him. The routine of the department placed over him as his immediate director the Superintending Engineer of the Circle or Division in which the work was situated, and in the office of that division the project should naturally have been examined. Obviously the details were not tested at all, and probably this was owing to the exceptional position occupied by the Engineer referred to, which had the pernicious effect of depriving Government of the benefit of the experience of the department, such as it was, then available. Its then existing organization placed between the framer of the project and the Government no responsible officer other than the Superintending Engineer. The Secretary to Government did not assume to exercise the functions of Chief Engineer; the appointment of Chief Engineer for Irrigation did not exist, and, extraordinary as it may appear, there was practically no check of a technical character which would expose errors on the part of the Engineer employed. But let us suppose that there had existed a central office of technical administration. This project would then have been subjected to a scrutiny based on the whole experience of the department as epitomised in the codes, standard specifications, standard rates and data, and other formularies. It would at once have been noted that its designs for masonry works, its rates for labor and material, its channel slopes, were condemned by that experience, and the further investigation of the general arrangements by the Chief Engineer would have led to the timely exposure of other errors which have caused increased expense and aided its financial failure. It may be contended that the object in view has been attained by the appointment of a Chief Engineer for Irrigation, and no doubt to a certain extent it has. A project and estimate of the character of the one originally brought forward for the water-supply of Madras could not now reach Government without condemnation being recorded against it; but, it is nevertheless asserted, that the present organization is defective, that the formularies and codes do not exist, and that in the absence of the subordinate technical assistance which must necessarily work by such aid, the Chief Engineer is overwhelmed with details of a petty nature which ought to be disposed of for him, and all of which he cannot possibly attend to, and which could, moreover, be got through, more certainly, more methodically, and much more economically by means of the arrangements advocated.

10. The observations which have been made in reference to the Red Hill Project apply with almost equal force to that for enlarging the Chembrumbaukum Tank. This was worked out by the same Engineer, passed in like manner without adequate scrutiny, and it was only after its execution had been commenced that a serious error in the levels was discovered and caused its modification. It was originally estimated to cost Rupees 3,55,000, and subsequently in its modified and reduced form Rupees 4,14,000. The outlay on it has been up to the present Rupees 4,51,204, and the present estimate for completion amounts to Rupees 5,24,805. The returns were estimated at Rupees 78,330. They cannot, it is now estimated, exceed Rupees 14,657, and it is tolerably certain that there can never be an adequate return for the expenditure.

As in the case of Red Hills Project the rates allowed were too low, the masonry works were inappropriate or insufficient, and the investigation was incomplete. The experience of the department was not brought to bear on it by means of an examination conducted in a methodical manner, and the result was loss of public money and discredit to irrigation projects in general.

11. If we turn to that branch of the department where expenditure other than that for irrigation is supervised or administered, it is not difficult to recall instances of abortive and wasteful expenditure which may be traced in a great measure, if not entirely, to the same chain of causes. The history of what is called the Bellary Water-supply Project is recorded in a Government Order of the 2nd November 1874, No. 3,118. The original estimate amounted to Rupees 69,300. The works have cost Rupees 1,41,628, of which it is calculated that Rupees 40,000 have been uselessly expended. There were grave errors in the executive arrangements connected with the works, it is true, but the project as originally presented was so defectively prepared, the specifications were so faulty and imperfect, the rates so fictitious, and there were such violations of constructive and hydraulic principles, that wasteful expenditure was the necessary consequence of its adoption. The system threw on the Superintending Engineer of the Division the duty of final examination of the designs, but in the first place there was no guarantee that the previous experience of the officer who held that appointment, or that of the Range Officer, had included the design and construction of such works, and, moreover, the absence of all formularies to which the latter would be bound to adhere in preparing his project, and on which examination in the Superintending Engineer's Office would be based, removed all safeguard against the ill-effects of such inexperience, while finally the non-existence of a central office of technical administration where the necessary knowledge would be found, rendered still more possible the approval by Government and the initiation of works the failure of which should, under a proper system, have been foreseen.

12. The Ulsoor Water Works at Bangalore during the course of their construction have not omitted to supply illustrations of the defects of the present system. The reservoirs for the storage of water or for its retention during the process of filtration, have, it is believed, almost without exception given way at some time or other, and their repair has been costly. There is even now awaiting sanction an estimate for the restoration of a ruptured filtering tank. All these failures were owing to simple errors in constructive detail, which proper specifications or descriptions of the design and the manner in which the work was to be executed would have prevented. The only test applied to the design and specifications as prepared was the personal experience of the Executive Engineer for the time being, not the collective experience of the department, and certainly not its hydraulic experience. The foundations of the reservoirs were some of them, if not all, built with stone-in-mud. The floors were founded on made-earth, both circumstances almost certainly fatal to stability. The previous experience of the department might easily have been epitomised in two or three standard designs and specifications for such reservoirs for water-supply. The system might have enforced reference to standards, scrutiny of the project might again have been based on those standards, and in this as in hundreds of other instances of various degrees of importance abortive expenditure might have been saved.

13. The Koilguntla and Cumbum Cutcherries in the Kurnool District are instances of the failure of buildings of another class. In both the foundations gave way from being built on made-soil or after a slovenly and inferior manner. But apparently the specifications were defective and trial pits were not sunk or sections of the soil supplied when forwarding the estimate. Here again there was an absence from defective system of the necessary check on the form and extent of the information given by the Range Officer and subsequently by the District Engineer.

14. In detailing in paragraph 9 the classification which might be given to the general causes leading to the failure of engineering projects, allusion was made to those included under the head of incorrect or imperfect information of the physical conditions which had to be dealt with, whether arising from incorrect surveys, levels or observations. As belonging to the first-class it has been stated that, in connection with the Red Hill Project, the flood levels of the Cortelliar river were not correctly ascertained, and that the levels of the ground line at the base of the reservoir embankments were in error. Again, in the Chembrambaukum Project, a serious error of levelling was not discovered in time to prevent useless expenditure*. It is further to be observed that survey and levelling operations in general, as conducted at present by subordinates under the presumed direction of Range Officers, have often proved to be useless from their incorrectness and from the absence of proper check and record. The Cauvery surveys may be instanced, and also that under the Red Hill and Cholaveram tanks where, for want of proper supervision, the time and work of a Surveyor for months has been wasted.

The successful conduct of such operations as surveying and levelling, flood and tidal observations, and the establishment and record of bench-marks, or permanent reference marks for levels, requires more than in any other case proper system and check. At present if a project is to be investigated, or if observations are to be made, the District Engineer is directed to engage a temporary survey establishment. There is no guarantee that those who present themselves for employment are really efficient; and as they have the prospect before them of being discharged so soon as they complete the work on which they are engaged, they have no great inducement to establish a good reputation. It is desirable that the Central Office should exercise more control over such operations, that a certain number of Surveyors should be permanently employed under the direct supervision of the Chief Engineer in carrying lines of initial levelling and establishing bench-marks in directions where they are required for the study of projects of irrigation, &c. The work of Surveyors employed by the District Engineers would be checked by these levels, which would only be known in the Central Office, so that all falsification of field work would be at once detected. For the gauging of rivers and streams it is desirable that primary forms of registration should be issued by the Chief Engineer as well as those for abstracting the results.

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* £11,000 were wasted.

15. In carrying on the executive duties connected with the construction of works, no formulation of details and no general instructions will altogether replace that practical knowledge which experience alone can give; but, on the other hand, it is most evident that the only way by which the officers of the department can benefit by the experience of others and avoid making mistakes, which, however corrected and afterwards avoided, are expensive to the State, is by the study of such formularies in which the experience referred to is epitomised. A thoroughly well-considered specification of the work to be executed in which the best methods of procedure are detailed, an estimate in which everything necessary is fully provided and in which the rates are based on well-established data; data available for reference and giving exact information as to the quantity of materials and the number of men necessary to execute a given quantity of work; plans containing full information and details of all the work to be done and drawn up by aid of the concurrent experience of the whole department as concentrated in standards and codes; these are aids to the officer concerned in executing the work which it would be the aim of the Central Office to secure to him, and it would thus in no small measure prevent failures apparently due to defective control and supervision.

16. It has been stated in a previous part of this paper that one function of a *Central Office of Administration* should be the collection of the results of general experience, and their application to the extention and improvement of processes and modes of construction, and the dissemination thereby of this experience throughout the Presidency generally, in a manner which would ensure the attention of officers of the department. It was added that practically with the present organization this function was not exercised. In proof of this it might be considered sufficient to allude to the fact already adduced of the non-existence of any but an obsolete code, of the absence of standard specifications, and of the absolute want of certain knowledge of the proper cost of most descriptions of work. But having taken as examples of defective conception certain works, and having shown how from defective administration their execution was undertaken under circumstances which ensured their failure, it will be a test of the efficiency of the present system to inquire how far by the natural operation of its machinery the experience gained by failure has been rendered effective in preventing the repetition in any other locality of similar mistakes, or to what extent the knowledge acquired during the execution of these works of specialities in construction, has been rendered available for the use of the department generally.

Now, as regards the Red Hill Project, it has been shown that there were certain glaring discrepancies between calculation and fact in respect of the flood-level of the Cortelliar river before and after the head works were constructed. The head sluice has been topped, the river has three times transgressed the limits assigned to it, and the anicut has been turned. But the calculations have never been verified. It is not known whether, and if so, to what extent the disasters were caused by want of knowledge of the proper co-efficients to apply to the hydraulic formulæ in order to adapt them to the case of the rivers of this part of the Presidency with their large inclinations of surface, sandy-beds, and silt-laden waters. The proper co-efficients can only be ascertained by experiments, but the higher officers of the department are far too much harassed with the petty details of work which, under a proper organization, would be dealt with for them, to be able to find time for such inquiries, although it is for such purposes that they receive their higher technical education.

Again, from the manner in which the earthwork of the embankments of the reservoirs were executed, certain failures occurred. These have been remedied in various ways and after considerable trouble. It is not necessary to enter here into technical details. It is, however, certain that experience was gained which should be useful elsewhere, but there exists no effective means of diffusing it. If searched for it might no doubt be found in a number of Government Orders and in certain reports printed in Government Proceedings, but it is not brought home to those engaged in works; it is not to be found in text books for daily use. If the results here alluded to found their place in due course in standard specifications which were in the hands of all, and if it were the routine work of an office to enforce attention to them, the effect would be felt everywhere. The same observations apply to much more of the work of this project. A class of masonry was used which was of exceptional quality and suited to the important works which had to be constructed. Its cost was perhaps for the first time in this part of the Presidency ascertained, but this knowledge is of no avail elsewhere. There are no standard specifications for masonry of this description. The rates at which it was executed find no place in the schedule of rates such as they are, and the data are buried in station books and records which in a few years authority will be given to destroy.

17. The Bellary Water Works Project has already been referred to as an instance of the necessity for organized technical examination of plans and estimates. The causes of the failures of the work during construction are well known. The revetment of the main reservoir was pitched at too great a slope, and it was not supported at the toe by a foundation. Its slipping was inevitable, and the same result would follow a similar plan of construction wherever tried. The principal supply-channel, chiefly in embankment, had a surface inclination and section given to it which would induce a mean velocity of discharge of more than 7 feet per second—sufficient to render the embankment a vanishing quantity. It would be a proper exercise of the functions of an administration for the technical direction of the department to take note of such defects and accidents when they did occur, and to so disseminate the experience gained by embodying it in the codes and standards as to guard against any repetition of the faulty design. The code of construction would prohibit thenceforth such slopes for tank revetments; the specification for that species of work would direct the insertion of proper foundations; tables of maximum velocities to be allowed or other information of the kind would be placed before subordinates, and the active enforcement of attention to standards and codes (without which they are useless) by the routine action of the Central Office of examination, would complete the safeguard. At present there is no safeguard except the personal recognition of defects by the Chief Engineer, in the course of a scrutiny necessarily cursory in character, of such projects and designs as may pass through his hands. But a trained Examiner with no more technical knowledge than an Overseer, and with nothing but the education of a matriculated student at the Madras University, aided by the codes and standards, and with the aptitude engendered by practice, would have been a machine quite efficient enough to have prevented the waste of Rupees 40,000 on the Bellary Water Works.

18. The reservoirs of the Bangalore Water Works have been mentioned as being all originally faulty. There is, however, no code of construction in which the laying down of the floors of masonry tanks on made-earth is prohibited. There is no standard specification for water tanks compiled with special reference to the avoidance of this defect for the future, nor is there any standard design in which properly constructed foundations for such works is shown. There is nothing apparently to prevent the repetition in other districts, or in the same district by another officer, of similar mistakes. Nothing to prevent the adoption again of the same faulty design by Government except the personal equation, so to speak, of the Chief Engineer for the time being.

19. Very large expenditure has been incurred during the past ten or fifteen years at Bangalore in the construction of barracks and their accessories, and the experience gained should certainly have been most extensive and complete. Yet the history of the construction of the barracks recently completed at the Mount has shown that estimates and specifications of a very imperfect character were originally furnished for that work in 1868. But this is not surprising when it is considered that there is no provision for rendering available in one locality the experience gained in another on the same class of work. Had there existed during the years the barracks at Bangalore were under construction, a central office of administration, of a technical character, complete in its organization—one of whose functions it was to watch the results of operations—to ascertain how far estimates had failed to provide what was necessary, in what respects rates had proved insufficient, where specifications had been incomplete in description, how far it had been necessary to alter or add to standard plans, and, finally, in what degree the constructions had after all answered the purpose in view, and if, moreover, standard plans and estimates had been revised, and specifications altered and enlarged in accordance with the teachings of such experience, the data for the designs and estimates at the Mount would have been tolerably complete, and the officers who were charged with their preparation would have received such assistance as they had a right to expect. But in addition to this since under the arrangements supposed the plans and estimates and specifications, whatever they were, would have been subjected to the trained scrutiny of that very section of the central office which dealt with the designs for the barracks at Bangalore, there would have been an additional guarantee that what had been learnt at the one locality would have been applied for the benefit of the work at the other. The mode of working has been very different. The Range Officer at the Mount was probably called on to prepare designs and estimates, with the assistance of some of the standard skeleton plans of barracks furnished by the Government of India.

He might probably never have been charged with work of the kind before, and there was no central office where experience existed and whence he could derive assistance or information. It is not to be wondered at, therefore, that estimates were exceeded between 20 and 30 per cent., and that revised estimates were succeeded by other revised estimates; that specifications and, consequently, executive arrangements were defective. Again, the experience gained at the Mount is of no avail for use elsewhere, and if barracks were now called for at Bellary much of the work would probably be to the officer concerned tentative in its nature.

20. The Guindy Water Supply Project is practically a failure; yet the department had carried out at Bangalore arrangements for the application of steam-power to pumping purposes. The special knowledge of the one locality was not, however, available for the other.

21. The failures of certain bridges and anicuts during the floods of 1874-75 brought into prominence the necessity for providing in such works more than had previously been the practice, against the effect of upstream scour whether caused by lateral (cross) currents or impinging flow of water. So long as the officers present during the floods are concerned with the construction of the same works in the flooded districts, the necessity will probably be recognized and provided for; but when they leave or in districts not affected, there is nothing to prevent the experience gained from being lost. It has no expression in any general standard code or specification for bridge or anicut work, for there are none such.

22. Numerous, indeed almost numberless, instances might be adduced in support of the assertion, that that function of technical administration which diffuses the experience gained and guards against the repetition of error is practically in abeyance from want of the organized subordinate assistance which is necessary in order to carry it out.

23. In the memorandum already referred to of September 1874, addressed by the writer to the Chief Engineer, it was stated to the effect that although efforts had been sometimes made to convey instruction they were necessarily spasmodic and abortive. As an instance showing the defective organization provided for this purpose, Dr. Nicholson's labors in the analysis of natural and artificial cements and limes may be mentioned. This officer was employed for, it is believed, some months, and produced a valuable report which, together with a box of specimens, was sent to each District Engineer. There has been no evidence whatever that the knowledge acquired has been utilized, and it seems in the highest degree probable that no improvement in construction will follow. The machinery by means of which such researches would be turned to general profit does not exist, and yet it could be simply arranged. Let a list of limes and cements for each district be constructed, let the denominations be fixed and the compositions where artificial be laid down, let the use of certain limes and cements be described in the standard specifications for the works to which they are applicable, let them be entered in the standard rates with ascertained prices from given data, and finally (without which all would be in vain) let it be the routine work of the central office to enforce attention to these standards; the benefit to be derived from the experiments would be brought by this steady, unremitting pressure irresistibly into operation.

24. It would be easy to enlarge to almost any extent the foregoing description of what the writer conceives to be some of the functions of an organized central administration for the direction of the technical work of the department. The argument for its employment rests on the grounds of economy and efficiency. It would be economical, because it is possible under such circumstances to sub-divide duties and so to simplify them. One section may deal with everything relating to civil buildings; another may devote itself to roads; another to military buildings; and another to town water supply and irrigation. The requirements of each class of construction may be thoroughly mastered, so far as they are laid down by orders of Government, standards and formulæ, and that by subordinate agency. Examination and check of projects and even design may become to a great extent a matter of routine and almost instinct. It would be efficient, because it is made mechanical; formal certainly, but unvarying in the certainty of its operation, and the effect of the pressure it would unremittingly exert would filter throughout every grade of the executive branch.

25. A duty of the central office would be the production of standard designs. The issuing of these has already been recognized as beneficial and to a considerable extent carried out, but the extension of the system is necessary. Talent for design is not by any means common, and its full employment where recognized should, if possible, be ensured, and in a manner in which its influence would be most generally felt. The education of subordinates is promoted by placing before them for execution designs framed on sound principles, and not only should they be prepared for established types of buildings, but for works of irrigation, for details, such as carpentry, joinery, and even fittings as the iron work of doors and windows, sluice shutters, and gearing. It must be recollected that the knowledge of artisans in the districts is on such points exceedingly defective, and there is no doubt that a series of illustrations on European pattern of such apparently insignificant details as are included in the iron work of a dwelling house would have good effect if placed in the hands of Overseers as models for imitation. A description of the fitting of the doors and windows of certain subsidiary jails, recently given by the Collector of the District, showed how primitive were still the ideas on such subjects of native subordinates and workmen. Every standard design, whether of buildings or details, with its specification, numbered and occupying its place in the series, would form a stand point of reference for the central office and for those in the districts, and it would thus be forced into knowledge and use.

26. The functions of a central office, such as has been alluded to, are also intimately connected with the management and utilization of the Central Workshop at the Presidency. There are many general questions involved which affect the works throughout the districts. The extension of railway and steam communication should vastly enlarge the field for the economical supply of manufactures from the Presidency town. It is not easy to understand why unsawn and unwrought timber should be sent from Madras to the districts. Why, in fact, it cannot be sawn and often even wrought and fitted ready for framing or fixing in the Madras Workshop and forwarded with the necessary iron work at a cheaper rate than under present arrangements, where wood is often obtained from long distances in log and worked up by village carpenters. It should be possible to supply now by rail a much larger proportion of the joinery required in the districts than is now done. The use of iron girders for road bridges has extended but little in the country; yet the advantages they confer of large

effective waterway and diminution of the number of costly pier foundations and the absence of centering during construction are very important. All such matters are now left practically to the discretion of the District Engineers or even Range Officers, but it seems clear that they would be better dealt with in the office of the Chief Engineer.

It is a matter for observation that the administration of the Railway Constructive Department has been too much separated from that of Public Works generally. At any rate it would certainly seem desirable that experience gained in one branch should be available in the other, and yet it is not so. While, on the one hand, officers of the Public Works Department might learn something from the details of station buildings and the use of iron on railway bridges; the Railway Officers, on the other hand, might no doubt, had they studied the experience of Madras Engineers, have avoided mistakes in the construction of bridge foundations which have caused very large outlay in repairs. The elaboration of standards in design and specification on either side, and the interchange of these and schedules of rates, would prevent this considerable waste of experience.

27. The training of the subordinates in the Civil Engineering College ought to be a subject of continued scrutiny by the central administration. The object in view being to ensure that the text books used were precisely in accordance with the codes adopted in the department. In fact, the codes, standard plans, specifications and forms generally which were in use in the districts should form the text books of the students; and some practical training in the workshops, in carpentry and iron work, might well form a part of the educational course.

28. The above is a very imperfect sketch of some of the duties which might be undertaken by the central office for the administration, in a technical sense, of the Public Works of the Presidency, and let it be remembered that by the present system their performance is not really provided for at all, or at any rate only recognized to some extent and most imperfectly provided for in the Irrigation branch. No doubt this tendency to decentralization, and this habit of making each district a species of *imperium in imperio* originated at a time when communication was difficult, and when officers were isolated and thrown on their own resources. This is, however, no longer the case; railways traverse those parts of the Presidency which were formerly the most inaccessible. Steam communication along both coasts renders nearly all parts of the districts which are without railways of easy access from Madras, and every District Engineer can, by telegraph, place himself in instantaneous communication with head-quarters. Almost complete centralization is, therefore, perfectly practicable, and its advantages in the present case would be enormous. The failure of projects alluded to above is no measure of the amount of money which may be unprofitably spent. It is impossible to say how much of the expenditure for repairs is due to faulty construction originally. It is impossible to deal with the work as it is now sent up without becoming convinced of the great necessity for reform in an organization which produces it and the importance of the results which would follow. It must be admitted, however, that a difficulty exists in carrying out the change. Most of the arguments in favor of the provision of a central technical establishment will probably be endorsed by the Chief Engineer, who the writer is aware has long been in favor of the introduction of a technical subordinate element into the central office. The rigid restrictions imposed by the Government of India in respect to establishment charges, and the extreme difficulty which already exists in meeting with the present establishment, the urgent demands from the districts for officers to supervise current work, has rendered it, and still apparently renders it, impossible to provide the necessary staff at head-quarters. Expenditure on establishments has always been viewed simply in relation to the outlay on works, and the rates of establishment charges to the outlay has been considered to afford the means of judging whether such establishment was or was not excessive. But a very important element in the question is the area over which the expenditure is distributed. In this Presidency, on the average, every District Engineer supervises works scattered over 5,890 square miles of country. Every Range Officer's charge is 1,750 square miles, and that of every Overseer 655 square miles. Under such circumstances, establishment charges must necessarily represent a very large percentage on the general expenditure, and a mere consideration of that percentage without reference to areas leads to fallacious ideas and restrictive orders which operate perniciously. It is worthwhile, however, to consider whether even under present circumstances the more efficient administration which it is believed would follow the centralization advocated would not far more than compensate for the reduction of district supervision and establishment which the concentration of the necessary staff at head-quarters would at present entail. And if the conclusion arrived at is that that staff cannot be provided without an increase to the general strength, while at the same time the necessity for its employment is admitted, it seems desirable that the fact should be authoritatively stated, and that the responsibilities involved by continued restriction should be clearly announced.

29. To sum up, the changes suggested as being desirable are—

(1.) The formation of a complete staff for the office of the Chief Engineer *containing a large and picked element having technical and special knowledge.*

(2.) The placing of this staff under the direction of one or more officers, to be specially charged with the technical administration of Public Works under the Chief Engineer.

(3.) The allotment of a certain proportion of this staff or of additional staff to furnish technical assistance to the Chief Engineer for Irrigation.

(4.) The placing of the public workshops under the direct control of the senior officer in charge of the technical staff or office of the Chief Engineer.

(5.) The formation of a Standing Committee consisting of the Controller of Public Works Accounts, the officer in charge of the technical staff, and the Principal of the Civil Engineering College, to arrange the general course of education and training at the College, and to maintain its accordance with the practical work in the districts.

The duties of the officer or officers and the staff attached to the Chief Engineer would be :—

(*a.*) The thorough and searching examination of all projects, plans and estimates for new works, whether Imperial, Provincial, or Local Fund. The examination of details carried on by the subordinate staff to be based on the standards and codes and general instructions, formularies, &c., maintained and issued by the officers in charge, and the projects to be reported on to the Chief Engineer by these officers as to their general scope, feasibility, &c. Instructions for the revision of estimates and projects will be issued, and fresh designs will occasionally be prepared to give aid to the district officers. A percentage of repair estimates to be also examined.

(*b.*) The maintenance in complete efficiency of codes, standard specifications, schedules of rates and data, standard plans, tables, &c., by their continual correction and enlargement in accordance with orders issued by Government, or with the results of current work and experience or research, and the regular issue to all officers of the department of amendments or additions so worked out, of standard plans, and of instructions of general utility and application, under the authority of the Chief Engineer.

(*c.*) The preparation, in a systematic manner, of forms for correspondence, returns, estimates, and reports, and their issue in print to officers of the department as well as the enforcement of their use.

(*d.*) The inspection of works in progress on behalf of the Chief Engineer, the preparation of reports thereon, and the issuing of instructions to officers concerned with their execution, under the authority of the Chief Engineer.

(*e.*) The study of general questions affecting construction throughout the Presidency. The utilization of experience gained by the record of facts for future guidance. The reception and preliminary study of proposals for works coming from other departments of the administration. The acquisition of a knowledge of the progress of engineering in other countries so far as it can be gained from published works and reports.

Ootacamund, (Signed) A. deC. SCOTT, Major, R.E.,
29th September 1875. *Under Secy. to Govt., P.W.D.*

No. 576. *Chief Engineer's Memorandum.*

I agree in the conclusions summed up in paragraph 29 of Major Scott's elaborate and practical memorandum, and I would provide the assistance required by the Chief Engineer by the creation of a Deputy Chief Engineer with rank of Superintending Engineer, 1st Grade, in lieu of the two Inspecting Engineers who now form a nominal part of the establishment, but whose functions have had to be held in abeyance of late on account of the scarcity of District and Executive Engineers. For the assistance of the Chief Engineer for Irrigation, the services of the Under Secretary to Government might be made exclusively available, with the designation of Assistant to the Chief Engineer for Irrigation, and his present rank of Executive Engineer, 1st Grade. To give Assistants of lower standing would not sufficiently strengthen the hands of the Chief Engineers; and to permit of freedom in dealing with all papers in the offices of the Chief Engineers and Secretaries to Government, both Assistants should be Under Secretaries. The duties of the Chief Engineer's Deputy may be simply stated as those of the two Inspecting Engineers combined; those of the Assistant to the Chief Engineer for Irrigation would be the performance of such portions of the latter officer's work as he might desire to confide to him. Adequate office establishments might be made up from the members of the former

This accords with Government of India proposals in their No. 635 of 8th May 1872 (G.O., No. 2,190, of 14th September.)

In accordance with the practice in Bombay.

Inspecting Engineers' establishments now distributed amongst five Superintending Engineers, and by a selection from the offices of the Secretary to Government, Chief Engineer for Irrigation, and Lithographic Establishment.

Ootacamund, (Signed) G. W. WALKER, Major-General, R.E.,
18th October 1875. *Chief Engineer, Public Works Department.*

No. 1,257.

I have read with great interest Major Scott's very valuable memorandum, dated September 1875, on the technical administration of the Public Works Department. His observations point to defects in the present system which are of essential importance, and there is no room for doubting the possibility of removing, by the reforms he advocates, the causes of inefficiency, and consequent waste of money, at any rate to a very large extent. It may be noticed here that I have found that, in too many cases, the instructions which have been given during tours of inspection, and in the notes of inspection, are not attended to as fully as they should be, even as regards the particular works in connection with which the instructions were given, while their extended application to other works similarly circumstanced is but rarely made.

2. There is undoubtedly vast room for improvement, and it is clear that, as far as possible, the task of ascertaining that orders and instructions are receiving attention, must be transferred to comparatively subordinate establishments, seeing that it is altogether impracticable for the Chief Engineers to attend properly to such details. We cannot possibly read, for instance, all the specifications that come in, neither can we, as a rule, see whether the dimensions of masonry works, designs for which are submitted for sanction, are all correct. Such details are often examined into and put right, but there is not time to do this regularly and invariably. Very few district officers show on their plans the essential information needed, but at present, so far as irrigation work is concerned, I have myself to look over the plans, see what is wanting, and return them that omissions may be rectified, and of course there is great waste of time in taking up projects and then being unable to dispose of them because certain well known requirements have not been attended to. In some districts, notably in the Godavery Delta, the way in which work has been carried out, as well as the data on which the works have been arranged, has been greatly improved in recent years, but this higher standard is at present almost incapable of communication to other districts, because there is no machinery available for making available the experience of, and the results worked out by, officers in the delta of exceptional intelligence and zeal, or of ensuring attention to the general instructions which are issued from time to time for the guidance of all in consequence of circumstances coming under observation in particular localities. To take a very simple instance. Every officer of even very small experience must know that fat limes are unadapted for use on hydraulic works; the evidence that this is the case is patent, well their attention has been called to the subject; they have been told how these limes, if hydraulic limes be not available, can be made serviceable, and recently they have had Dr. Nicholson's reports to help them. It is still, however, quite an exception to find hydraulic mortar in use, and I often find shell lime—the fattest of the fat—entered in specifications for tank sluices and other works similarly situated, although it is certain that such lime, so used, can never set.

3. In some particulars my opinions differ to some extent from the views enunciated by Major Scott, and I have made a few notes in the margin of his memorandum.

4. As regards the reorganization of district establishments, I am of opinion that, if any change be made, the alterations should be such as to ensure every separate executive charge being held by a member of the department, who may be presumed to have the necessary qualifications. There are many Range Officers now who cannot be expected to carry on their work satisfactorily; they are qualified only to carry out definite instructions and to be subordinate executive agents.

FORT ST. GEORGE,
[illegible] *October* 1875.

(Signed) JOHN MULLINS, Lt.-Col., R.E.,
Chief Engineer for Irrigation.

THE following remarks are submitted with reference to the details of the establishments required for the offices of technical administration of the non-irrigation and irrigation branches of the Department of Public Works.

2. The work to be done *at the first* includes not only that involved by a performance of what will be the normal duties of such offices, but also the construction of the machinery which is to economize labor.

Codes, standing orders, standard plans and specifications, forms and tables have to be elaborated and brought into general use; an immense mass of unused information which has accumulated for years, especially in the Irrigation Office, has to be digested and made available, and order and method have to be introduced.

The strength of the staff in either branch ought to be sufficient to cope with the work which presents itself under both aspects.

3. The immediate head of the non-irrigation branch, by whom is meant the Deputy Chief Engineer or Inspecting Engineer, whichever designation may be adopted, ought it is thought to have in his office at least one young officer of Engineers of about four or five years standing as an Assistant, and two subordinates besides, who should possess technical knowledge, both practical and theoretical, of elementary engineering and general construction.

Draftsmen, Estimators, Computers, Clerks, Plan and Recordkeepers are, of course, understood accessories, but the work performed by the three former is almost purely mechanical, and cannot replace the element which affords intelligent technical supervision of details.

The employment of the younger officers of the corps is not too costly, while their high technical and general education which includes the higher mathematics and physical science would enable them to render valuable assistance in any branch of construction.

4. The amount of work which ought to be taken up as properly belonging to the irrigation branch is most extensive, and the arrears to be disposed are immense.

For years the central office has been swamped with projects, reports, statistics and plans which it has been impossible to deal with. The end and object of so much work in collecting information was a comprehensive study of the economics of irrigation and the application of such study to current work, but it has remained in a great measure barren of results, because no one had leisure to abstract and establish principles.

A young officer of Engineers of three or four years standing might be usefully employed in working up these arrears, and preparing standard plans and specifications without dealing at all with current work, which to deal with effectually requires in addition an Assistant to the Chief Engineer.

Some additional clerical assistance and some draftsmen will also be required for the compilation of statistics and the drawing of plans, &c., designed as standards.

5. Considering that the approved organization provided for two Inspecting (first-class Superintending) Engineers, the employment of one such officer with two junior officers involves no startling change.

(Signed) A. DEC. SCOTT, Major, R.E.,
Under Secretary to Government.

13th November 1875.

No. 576-A. MINUTE BY THE HONORABLE THE GOVERNOR.

MAJOR DEC. SCOTT's paper is admirable, and deserves the full commendation of Government.

2. It is most seriously to be regretted that, after so many years, deficiencies so serious should rule in the department. I attribute this condition in large measure to the initial error of making the head of the department a Secretary to Government, and to dealing with all sorts of departmental subjects, organizations, &c., as if they are matters to be disposed of by Government and suited for the decisions of Government. Confusion in the administration of Government and shortcomings in the department have been the inevitable consequences, and will continue in their degree; while attempted rectifications will be costly.

3. I have no objections to the proposals made by General Walker, except in so far as I entirely object to have further Secretaries and Assistant Secretaries to Government created. The duty required from the additional aid sought by the heads of the respective Engineering Department, are purely departmental—wanted for the satisfaction of the Chief Engineers who have to submit projects to Government as Secretaries, and additional aid afforded—must be strictly separated from the Government Secretariat.

4. I approve of the creation of a Departmental Chief Engineer and think that the Chief Engineer for Irrigation should have an Assistant in his departmental capacity.

5. I would ask the Chief Engineer to report more in detail the reorganization. I cannot join in asking increased establishment which he proposes with a view to remove the obvious shortcomings brought to notice.

8th November 1875. W. ROBINSON.

No. 577. MINUTE BY THE HON. R. S. ELLIS, C.B.

I HAVE read with the greatest interest the excellent memorandum prepared by the Under Secretary Major deCourcy Scott.

2. He has, in the clearest language, described the necessity of an organized central administration for the direction of the technical work of the Department of Public Works, and he has brought very apt illustration of facts in support of his argument.

3. No one can have had charge of the Department of Public Works without the strongest feeling of impatient regret at the failures of works of kindred nature, in various parts of the country, and this during perhaps a series of years. Major Scott explains why this is, and he shows that not only the State fails to benefit, in the future, by the example of really good work which may be done, but it has not even the consolation that the too numerous failures will serve as warnings and prevent future disaster. The good and the evil work remain as regards details and causes of success or failure unknown, though these particulars have been recorded. All this knowledge would, under Major Scott's proposal, be arranged, published, cast into forms, and every future work would benefit alike by the faults or the merits of its predecessors. The memorandum shows how an inferior agency properly directed, may be made to deal with technical details with almost mechanical precision, while the Chief Engineers will be relieved of work they cannot perform and deal with large questions and general principles for which their services are required. I commend every portion of this memorandum to my colleagues. In all essentials it is supported by General Walker and Colonel Mullins. It should, I think, receive the acknowledgments of the Government and its recommendations be approved. If, as stated by General Walker, this central establishment can be formed by a redistribution of the existing department, without additional charge the proposal should at once be carried into effect. But I consider the subject so important that I should not hesitate, if necessary, to apply to the Government of India for a special grant for this object.

4th November 1875. R. S. ELLIS.

No. 578. Note by the Hon. W. HUDLESTON, dated 6th November 1875.

No. 579. Note by His Excellency the Commander-in-Chief, dated 22nd Nov. 1875.

No. 580. ORDER THEREON, 24th November 1875, No. 3,373.

ESTABLISHMENT, No. 38.

HIS EXCELLENCY the Governor in Council has read with much interest the excellent memorandum of the Under Secretary in the Public Works Department. He has, in the clearest language, described the necessity of an organized central administration for the direction of the technical work of the department, and he has brought very apt illustrations of facts in support of his argument. The acknowledgments of Government are due to him for his excellent paper.

2. It is concurred in essentially by the Chief Engineer of Department Public Works and by the Chief Engineer for Irrigation, and the practical suggestions made by the former for carrying out his views commend themselves to the approval of Government.

3. The Senior Inspecting Engineer, Colonel E. A. Foord, R.E., whose work as such is at present in abeyance, is accordingly appointed Deputy Chief Engineer, an office the creation of which has already been approved by the Government of India in their letter recorded with G.O., No. 2,190, of 14th September 1872; his departmental rank remaining that of Superintending Engineer, 1st Grade. He will also be styled, and perform the duties of, Under Secretary in the Public Works Department. During his absence on leave the Junior Inspecting Engineer, Lieutenant-Colonel Farewell, who is shortly expected from home, will officiate for him. From the date of his assumption of his new duties, Major A. deC. Scott will become the Deputy of the Chief Engineer for Irrigation and Under Secretary in the Irrigation Branch of the Public Works Department, with his present departmental rank of Executive Engineer, 1st Grade. If possible, a junior officer of the department will be attached to each of them, at a later date, when the strength of the department shall have been completed, and those now joining it shall have acquired some experience.

4. The members of the office establishments placed at the disposal of Superintending Engineers in G.O., No. 1,328, of 18th May 1874, will proceed to Madras, and report themselves to the Under Secretary in the Public Works Department, who will arrange for their proper employment.

(True Extract.)

(Signed) G. W. WALKER, Major-General, R.E.,
Secretary to Government.

To District Engineers.
To the Special Executive Engineer, Wynaad.
,, Controller of Public Works Accounts.
,, Chief Engineer for Irrigation.
,, Under Secretary to Government, Public Works Department.
,, Col. W. Farewell, Offg. Dy. Chief Engr.

Exd. E. C. Shunker.
Spare Copies.

I have read with the greatest interest the excellent Memorandum prepared by the Under Secy Major de Courcy Scott.

He has, in the clearest language described the necessity of an organized central administration for the direction of the technical work of the D.P.W., and he has brought very apt illustration of facts, in support of his argument.

No one can have had charge of the department of Public works, without the stringest feeling of impatient regret at the failures of works of kindred nature, in various parts of the country and this during perhaps a series of years. Major Scott explains why this is - and he shows that not only the State fails to benefit in the future by the example of really good work which may be done - but it has not even the consolation that the too numerous failures will serve as ~~beacons~~ warnings & prevent future ~~shipwreck~~ disaster - The good & the evil work both remain, as regards details & causes of success or failure

unknown - though recorded. All this knowledge would, under Major Scott's proposal be arranged, published cast into forms & every future work would benefit alike by the faults or the merits of its predecessors. The Memo: ~~exhibits~~ shows how an inferior agency properly directed, may be made to deal with technical details, with almost mechanical precision - while the Chief Engineers will be relieved of work they cannot perform and deal

C/

If these portions have been

the proposal should at once be carried to effect.

with large questions & general
principles for which their
services are required.
I commend every portion
of this Memo: to my colleagues
In all essentials it is sup-
-ported by Genl Walker and
Col Mullins — It should I
think receive the ~~commendation~~ acknowledgments
of the Govt and its recommendations
be approved. If as stated by
Genl Walker this central establishment can be
formed by a redistribution of the existing
department, without additional charge, we should
at once do this. But I consider the subject so
important that I should not hesitate, if
necessary, to urge its adoption on the
Govt of India. R S Ellis.
4th Nov. 75.

Print

No. 577. MINUTE BY THE HON. R. S. ELLIS, C. B.

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2. He has, in the clearest language, described the necessity of an organized central administration for the direction of the technical work of the Department of Public Works, and he has brought very apt illustration of facts in support of his argument.

3. No one can have had charge of the Department of Public Works without the strongest feeling of impatient regret at the failures of works of kindred nature, in various parts of the country, and this during perhaps a series of years. Major Scott explains why this is, and he shows that not only the State fails to benefit, in the future, by the example of really good work which may be done, but it has not even the consolation that the too numerous failures will serve as warnings and prevent future disaster. The good and the evil work ~~both~~ remain, as regards details, and causes of success or failure unknown, though recorded. All this knowledge would, under Major Scott's proposal, be arranged, published, ~~cast into forms, and every future~~ work would benefit alike by the faults or the merits of its predecessors. The memorandum shows how an inferior agency properly directed, may be made to deal with technical details, with almost mechanical precision, while the Chief Engineers will be relieved of work they cannot perform, and deal with large questions and general principles for which their services are required. I commend every portion of this memorandum to my colleagues. In all essentials it is supported by General Walker and Colonel Mullins. It should, I think, receive the acknowledgments of the Government, and its recommendations be approved. If, as stated by General Walker, this central establishment can be formed by a redistribution of the existing department, without additional charge, ~~we should at once do this.~~ the proposal should at once be carried into effect. But I consider the subject so important that I should not hesitate, if necessary, ~~to urge its adoption on the Government of India.~~ to apply ~~for funds, for~~ to the Govt of India for a special grant for this object

these portions have been

4th November 1875. **R. S. ELLIS.**

GO-24/11/75 No 3373
Public Works
No 57

I have only to record my admiration of Major [illegible] Memorandum and my concurrence in the remarks passed by the Honble R S Ellis in bringing it to the notice of Government.

22.11.75

Erratum:

In para 3 line 9 of Letter No 3273, dated 24th November 1875

For "Assistant"

Read "Deputy"

WH

To District Engr.
" Exec. S.W. Accts.
" Chief Engr. for Irrigation
" Under Secy. to Govt.
O.H.C.
Irrign Branch

Accd 10/3/76

GD 24/11/75 No 2293

Minute —

Major DE Scott's paper is admirable - and deserves the full Commendation of Government

It is most seriously to be regretted that, after so many years, deficiencies so serious should rule in the Department

I attribute this condition in large measure to the initial error of making the Head of the Department a Secretary to Government - and to dealing with all sorts of Departmental subjects, organizations &c

as if they are matters to be disposed of by Government and sealed for the decisions of Government. Confusion in the administration of Government and shortcomings in the Departments have been the inevitable consequences and will continue in their degree while attempted rectifications will be costly.

I have no objections to the proposals made by General Walker – Except in so far as I entirely object to have further Secretaries and Assistant Secretaries to Government created – The duty required from the additional aid sought by the Heads of the respective Engineering Department are purely departmental – wanted for the satisfaction of the Chief Engineers, who have to submit projects to Government as Secretaries and additional aid afforded ~~and~~ must be strictly separated from the Government Secretariat.

I approve of the creation of a Departmental Chief Engineer and think that the Chief Engineer for Irrigation should have an Assistant in his Departmental Capacity.

I would ask the Chief Engineer to report more in detail the reorganization – I cannot join in asking increased Establishments – which he proposes with a view to remove the obvious shortcomings brought to notice

8/11

GO 24 Novr/75
No 3373

GO 24/11/75 No 3373

No 578

I entirely concur with
the Dr McEllis in his
high appreciation of
Major Young's letter
so instructive & convincing
Memorandum &c is
a practical denunciation
of our neglect of
method as if very
long so many families,
& proved in our
room for 'adoption'
I cannot speak

GD 24/4/75 No 337

Movement & don't doubt that
add. expenditure in
this direction if necessary
shd. be the truest
Economy. but if as
Gen. Butler appears
to consider the
necessary Office
Establishment may
be provided by contribution
so much more desirable
& some could probably
be effected -
I shd. at once

carry out whatever
purposes I desire in
this direction -
If experience proves
it to be inexpedient
for the purpose - we
can ultimately
apply to the Govt.
for necessary
sanction
Major Elliott is
deserving of the
thanks of Govt. for
drawing attention
so convincingly

& this radical defect in our system.

6.11.75

G.O. 24 November/75
No. 3373

G.O. 24/11/75 No. 3373

With reference to N. 2. the Governor's remarks the undersigned would respectfully observe that he has recommended that the Officer appointed to be his Deputy in the Office of Chief Engineer should likewise assist him in the Secretariat Office, simply because in that way alone can he be fully available to carry out the reforms ad-

:vocated by Major
Scott and approved
by Govt. – The two
Offices of Secretary
and Chief Engineer
in the P.W. Dept. are
indissolubly connect:
:ed by order of the
Govt. of India; to
whose practice in the
Pub. Wks. Dept. it is
the intention of this
Govt. to assimilate
their practice more
and more – Vide
late orders on the
subject of Irrigation
and other Accounts,
& the Pub. Wks. Code.

It would be anomalous
therefore, the under:
:signed respectfully
submits, that his
Deputy should work
with him in one ca:
:pacity, and not in
the other; especially
if the Joint Secretary
and Chief Engineer
for Irrigation is al:
:lowed a Deputy as
Asst. in both capacities.
For it is not supposed
to be H. E. the Governor's
intention to eject Ma:
:jor Scott from the
post which he fills

so well, and in which the value of his services has just been recognized —

One reason why assistance is specially req.d by the Secy to the Govt. of Madras in the P.W. Dept. is that he is deprived of that aid which in other Presidencies is given to the Secretary, by the Railway Consg Engr. and Controller, being Dy Secretaries, each in his own branch —

G. McCallum, Major
Secy to Govt. P.W.

13.11.75.

Establishment allowed to Inspecting Engrs.

1.	Manager @ Rs —	150
1.	Clerk ——— "	40
1	Do ——— "	20
1	Do "	30
1.	Draftsman & Estimator	75
1	Do Do	50
1	Do Do	40
1	Moochee ———	8
1	Peon ———	6
3	Lascars @ 7 Rs each —	21
	For each	440

Extra Establishment granted to Supg Engrs on abolishing Inspecting Engrs Offices

1st Division – Kistnah

P. Muthoosawmy Moody Draftsman & Estimator —	60
Narasimha Row – Clerk	40
	100

2d Division Bellary

M. Appasawmy Row Do —	60
Mr J E Bent – Clerk	40
	100

3d Division Chingleput

M. Mooneswamy Naidoo Draftsman & Estimator	40
K. Venkatachella Chetty	30
	70

4th Division Coimbatore

P. Parthasarathy Hindoo Draftsman & Estimator	40
Mr. J C Bernard - Clerk	30
	70

5th Division Tanjore

C Manikam Moodr - Draftsman & Estimator	60
G Meer Rahamathoollah - Clerk	40
	100

Available

3 Draftsmen & Estimators	at Rs 60	180
2 ————	40	80
3 Clerks ————	40	120
2 ————	30	60
		440

P.W.D.

Notification

Colonel R. A. Foord R.E. Superintending Engineer, 1st grade, to be Deputy Chief Engineer and Under Secretary to Government, Public Works Department.

Colonel W. S. F. Farewell, Madras Staff Corps, Superintending Engineer, 1st grade, to officiate as Deputy Chief Engineer and Under Secretary to Government, Public Works Department during

during the absence of Colonel Foord or until further orders.

Major A. De C. Scott R.E. Under Secretary to Government, Public Works Department, to be Assistant to the Chief Engineer for Irrigation and Under Secretary to Government in the Public Works Department.

GMW

Connected with G.O. No 3338
24-11-7-

G.O. 24 November 75
No 337

Recorded
7th Dec 1875

Memorandum relative to the changes re-quired in the Organization of the Public Works Department, Madras Presidency, in view to its more efficient technical Administration.

In August 1874 the undersigned submitte to the Chief Engineer a Memorandum, in whic certain existing defects i the organization for the technical Administrati of the Public Works in th Presidency were alluded t The want of a complete Co of Standard Specification for all descriptions of work of forms for estimates, returns and correspondenc and of complete schedule of rates and data was pointed out.

in a draft Circular Memo. addressed to District Engineers (submitted for the approval of the Chief Engr. in February 1875 and issued in July 1875) these Officers were directed to furnish with their Schedules next due, Specifications of the work for which rates were quoted.

In their Order of the 17 March/75 No. 748, the Government point out the necessity for the preparation in Districts of Standard Specifications and for enforcing the observance of the forms by subordinates. The Controller of P.W. Accounts in his letters printed in the Proceedings of Government of the 24th June and 31st July

1875, refers to the necessity for compiling Standard Specifications and for the preparation of a Code an in their orders thereon the Government approve of the propositions made an depute certain Officers to assist the Controller in tha duty.

But in the Memorandum of the undersigned of August 1874 before mentioned the necessity for affording to the Chief Officers concerned with the administration of the Department at head quarters, technical assistance in the details of their duties in order to enable them to devote themselves more often t questions of general importance was also suggested and believing that unless such assistance is given and unless arrangements are made for enforcing attention to Codes and forms the measures which have now been initiated will not produce the good effect anticipated but will in fact prove abortive, he offers the following observations for Consideration.

In making them, the defects of the present arrangements are recapitulated in order to the production of a Connected argument, known examples of failure in projects are traced as far as may be to those defects and the operation of the reforms advocated in preventing such failures in the future is attempted to be described -

2. It has been the Duty of the writer to deal generally with the estimates sent up from the Districts for all services except irrigation and as regards these he has seen the reviews of the Chief Engineer for Irrigation - Moreover the histories of various projects have unfolded themselves during the past few years and it is impossible to avoid the recognition of the fact that grave defects of system exist, that projects have been and continue to be sent up for the approval of Government which contain within them the germs of failure partial or complete and that the present organization of the Department has been and is still ineffective in preventing this evil - The Note of the Chief Engineer for Irrigation on the Controller's

letter already referred to contains one remark which is pregnant with meaning. He states that the Specifications now written for works are in general not worth the paper they are written on and yet it is by the Specifications that the construction of works is supposed to be regulated and it is admitted that the manner in which a Specification is written is a test of the knowledge of the work possessed by the writer.

3. ~~In a Memo addressed to the Chief Engineer in September 1874, the undersigned adverted to certain defects in the system for the checking & examination of projects at the~~

~~Central Office. The absence of a complete code of standard Specifications for all descriptions of work, of schedules of rates based on accurate data and of forms for estimates was noticed and the necessity for the first is also now attended to by the Controller.~~

3 It may be said that under the heads of Imperial, Provincial and Local Fund Expenditure a sum of at least One Million sterling is annually at the disposal of the Department of Public Works of this Presidency. Year after year the same expenditure is gone through and work of the same nature is performed but the formulation of the processes by which the results are produced has been very

imperfectly carried out. The proper classification and division of labor connected both with Executive and Administrative work has therefore not been possible and further the arrangements for the collection and application of general experience to the improvement of processes and formulae can hardly be said to exist. To put it in other words - There is no complete Code for the guidance of Officers in the Administration of the Public Works of their Districts and their relations with other Departments - There exists scattered throughout a mass of Government Proceedings Orders on all sorts of subjects relating to Account, Establishment and Construction sometimes annulling each other, but there is no arrangement for periodically abstracting classifying them or adding them to a Code and placing them in a handy form in the possession of Officers and subordinates. There is no book of standard Specifications defining the nature of materials to be used, the nature and mode of execution of all varieties of work. The Schedules of rates in districts are in the highest degree incomplete, the data on which they are based uncertain or non existent. Such data are

are not actively investigated, corrected from fresh information or enlarged by observation of new work. Estimates are not framed on recognised examples. Tables of Scantlings for timber adapted to the current work of the Districts and for facilitating the Calculation of earth work have not been prepared and the system partially adopted of issuing Standard plans and drawings with estimates needs extensive development more especially in the Irrigation branch.

The use of printed forms for estimates, returns nd Correspondence has not been sufficiently recognized and enforced lthough the economy

Standard plans in the ordinary lines are not sufficient to the Irrigation Works, the circumstances of works not being alike; but designs by way of examples are much required

Wy.

in clerical labor thereby obtained would often be enormous. In short the importance of that part of Administration and Management which formulates processes and regulates as well as simplifies labor by classification and division, is not sufficiently valued and yet it is by such management alone that the profitable employment of inferior and therefore Cheaper Agency in both Administrative and Executive work is rendered possible.

in Administrative

4. Equally defective is the present organization in all pertaining to that important function of a technical department;-

the publication of information derived from the results of its operations. Failures are usually traced to their true Causes in the Correspondence or Orders recorded in the Government Proceedings. New rules or principles of Construction are there often stated but the steady and Constant reflection of the experience gained, on the work of all members of the Department is not attained as it should be, by the insertion of the acquired rules, either by way of amendment or enlargement in the codes of Construction, in the Standard plans, Specifications and estimates, in short in the formularies generally which should be Constantly in the hands of all and be constantly referred to. Finally there is no Central establishment for the systematic enforcement of well settled principles, of economical arrangements or of rules generally by an examination of projects, estimates and plans, based on the standards and Codes. Yet it has been amply shown by experience that the constant pressure thereby implied is absolutely necessary to prevent such Codes, or rules in general from becoming in a great measure dead and inoperative.

5. Officers of the Department ought to be called to account not so much for want of ability in comprehending their work and describing it clearly as for not describing it in accordance with the standard specifications to which they should simply be referred, not for imperfect estimates or plans but for estimates and plans not in accordance with those placed in their hands as examples or standards;- for data or rates not in accordance with the standard Schedules, for scantlings not in accordance with their tables,- for reports omitting particulars required in their Code; and an

Establishment is required which, having before it Code, Circular orders or addenda to Code, forms of estimates, reports and Schedules of rates, Standar data and Plans, tables of scantlings and hydraul discharges &c, would only have to ascertain that the documents sent up were in accordance with the above or note deviati for the information and orders of the Chief Enginee Deputy Chief Engineer or other responsible head of the Office. The division of the labor of examinat being so carried out as t render it as mechanica as possible and tending to create specialists for the several branches of Construction.

The application of the principles of organization indicated above by no means implies interference with the legitimate functions of a Chief Engineer or with those of the higher Officers of the Department. It simply relieves them of a mass of work which must be attended to but which can be done with infinitely greater economy and certainty by a properly organized Staff than by themselves, so long as that staff is under their supervision and Control. It enables the Chief Engineer for instance to devote himself to his legitimate occupation; the study of works and projects in their general scope and the establishment of general principles of design and Construction to which his Standard plans give expression: It gives him leisure to view the working of the Department as a whole and to study and initiate improvements having general effect.* The aid given should however not stop here, the operation throughout the Presidency of the formularies referred to requires to be watched, they need to be amended or enlarged, and extended as experience suggests. Work is undertaken under hitherto unknown conditions. Specifications require to be amended or provided. New materials are used or construction of a new class is carried out - rates and data require to be investigated and established. Failures occur - they indicate defects in design or execution which have not hitherto been provided against - Codes of Construction, Standard Specifications, Schedules of rates and Standard Plans must be brought into conformity with the acquired information. This labour, these duties, require a staff with somewhat higher qualifications, greater technical knowledge than that simply employed to enforce attention to forms already adopted, but this element should be represented in a Chief Engineer's Office and be employed for

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*As Secretary to Government he would also by the arrangements proposed, have more leisure for the Administrative work which, while it is not independent of technical considerations, is closely connected with questions of General Policy. The vesting in the same Individual of the functions appertaining to the dual Office of Chief Engineer & Secretary to Government is the only key to that complete grasp and effective control of a technical dept. so important as that of the Public

Works, which the Government should possess; but for the effective performance of these higher functions it is obviously necessary ~~that~~ ample assistance should be given in the carrying out of minor duties.

the purposes mentioned and its employment under proper management would be attended with benefits which would repay its cost a thousandfold.

There is not so far as the writer is aware, in the Office of the Chief Engineer of the Department or the Chief Engineer for Irrigation a single representative of either section of the Establishment referred to, to give aid in the details of the technical administration of the works throughout the Presidency. The personal check of these Officers on estimates and projects is now necessarily required to extend from considerations involving lakhs of expenditure to those relating to the height of a wing wall the depth of a joist or the iron work of a door and an equal amount of time may be required to investigate the fitness of the one class of items as the other. It is self evident that the mass of work thus thrown on individuals must be so great as to be utterly unmanageable. On the other hand the principles of organization which are advocated are only those which obtain in every successful manufactory in a civilized country. The formulation of processes and division of labor together with the employment of agency suited

to the labor is the key to success in all such enterprises and the Department of Public Works is no exception to the rule.

6. The creation of a Central establishment, with thorough organization, for technical administration will not do away with the functions of District Engineers in examining and checking Plans and estimates which they receive from Range Officers. They have already a staff in their Offices for this purpose as well as to assist them in the preparation of Projects and designs; but the formulation of the process of examination proposed for the Central

Office can be carried out with most beneficial results in the District Office. The possession of Standard Plans and Specifications together with the other formularies and clear Codes of instruction will lighten the labors of both Officers and subordinates to an incalculable degree, while the knowledge that scrutiny in the Central Office will be based on the same data, will compel that constant reference to the information placed in their hands which is necessary as a means f instruction.

To the work of Range Offi-rs and even that of verseers and subordinates i general the same principles can be applied and the same aid and instruction will be given by Codes and Standards for Constructive work. The education of subordinates will proceed in the right direction, they will be initiated into correct methods and they will acquire their first lessons in the Constructive art not as is now generally the case from the vicious practices of maistries or native workmen but from well written specifications, the directions in which they will have no excuse for not carrying out.

f. The adoption of the principle of working in accordance with well considered standards and methods does not imply in any way whatever that there is to be a bigoted adherence to formularies regardless of their application to particular cases or that the inventiveness and ability of Executive Agents is to be cramped thereby. It has already been explained that the operation of all standards and Codes is to be subjected to continued scrutiny and that they are to be constantly amended or enlarged when necessary. Officers may improve on the methods adopted, - they may point out defects in standard Plans, and they may dispute data and rates: but it will be necessary for them to justify their proposed deviations from rule and the accuracy of their conclusions must be tested. Once thus established the change will be adopted as an amendment or as an optional method or increase to the recognized resources of construction. It will be incorporated in all the standard & formularies, and it will thus be placed at the disposal of every Officer of the Department and its adoption by them will if needful be enforced.

8. The working of the department in the absence of the Organization described is carried on with an amount of friction and difficulty

as well as waste of time
and money which is
palpable to all who
have anything to do
with it. No doubt a
large amount of good
work is executed, but
this is entirely due to
the individual character
and ability of a certain
number of the Officers,
and in spite of the system
rather want of system which
prevails. It must be re-
ked that at present &
st as regards the irriga-
branch there is ab-
lutely no specific ar-
gement whatever for
proper examination of
jects, designs & estimates
up to fort. by District
ineers or for comprehensive
nical administration,
as regards the irrigation
t., the Chief Engineer
l probably concur

with the writer in the assertion that the provision is most inadequate. There is no technical staff whatever attached to that Officer, and it is impossible that the duty of examination can be efficiently and economically carried out without aid and ample aid of this kind.

9. The evil effects of this absence of organization will be most forcibly illustrated by reference to particular and well known instances of failure in projects and buildings and by showing how these may be traced for the most part if not wholly to such defects. The Madras Water Supply

Project was originally estimated to cost some six & a half lakhs of Rupees. It will actually cost not less than thirteen- the returns from irrigation and the sale of water to the Madras Municipality were calculated at Rupees 92000,

they have hitherto not exceeded Rs 29776 and the prospect of substantial increase in Revenue is small. There were evidently therefore large errors in the calculations on which the estimate of the cost of the works and the returns were based. Yet these passed unchallenged and the errors were only revealed

after operations had commenced and the funds were committed to the execution of the project.

Every Irrigation Project ought to be based on an accurate survey of the ground included, accurate levels and sections, accurate statistics and observations regarding rainfall, drainage area, flood levels, cultivated and cultivable areas, accurate plans of existing works and accurate information regarding available resources in building materials and labour, and current rates for work-

Failures to a greater or less extent arise from incorrect or imperfect information on such

subjects or from incorrect
surveys or observations
and also from attempts
to construct works in
violation of natural laws
or well established prin-
ciples, or again the execu-
tive arrangements and
supervision may be faulty.
The failure of the Red Hill
Project is attributable
to various causes belong-
ing to all the heads
indicated. In regard
to those classifiable
as incorrect information
t may be recalled to
mind that the regime
the Cortelliar river,
he source of supply
as very imperfectly
ivestigated, the maxi-
um flood level was
ssumed at 10 feet while

it was actually fifteen feet above the bed at the site of the head works. Overflow was not provided against, the works were damaged and additional ones were required to a large extent not foreseen originally. The areas draining across the channel leading from the river were under estimated and the provision for disposing of the drainage was consequently insufficient. Extra works were found necessary and further cost was incurred. The area of the land available for additional cultivation under the banks was over estimated and thence arose exaggerated forecast of returns. The rates allowed for the execution of all the more expensive portions of the work were insufficient.

Of causes connected with incorrect surveys or operations of that nature, it is to be observed that a large source of unforeseen expenditure was additional earthwork in the embankments not riginally provided for wing to incorrect levels nd sections of the origi-al ground on which hey were thrown up. he original designs of the masonry works were ill calculated to withstand the strains to which all hydraulic works are exposed and more massive and expensive constructions were necessarily substituted. The original estimate was here again falsified and the failure of the project in a financial point of view, further secured. Finally the executive agency employed during the inception of the work did not belong to the trained staff of the Department and errors of execution were committed which were

Subsequently a cause of
increased expenditure.
The question now to be consi-
dered is how far in this
case an organized technical
administration of the nature
described, would have pre-
vented unprofitable ex-
penditure. It must be
premised that the Red
Hill Project as presented for
sanction by the Special
Executive Engineer employed
n its preparation, was
ubjected to no real pro-
essional scrutiny of an
ndependent character, be-
ore it was stamped with
e approval of the local
vernment and for-
rded to the Government
India - Specially deputed
this duty on account
presumed exceptional
alifications as a Civil
ineer at home, the
icer in question was

placed in a quasi independent position in reference to the Superior Officers of the P. W. Dept. more immediately in contact with him. The routine of the Department placed over him as his immediate Director the Superintending Engineer of the Circle or Division in which the work was situated and in the Office of that Division the project should naturally have been examined. Obviously the details were not tested at all and probably this was owing to the exceptional position occupied by the Engineer referred to which had the pernicious effect of depriving Government of the benefit of the experience of the Dept. such as it was, then available. Its then existing organization placed between the framer of the project and the Government no responsible Officer other than the Supg. Engineer. The Secretary to Government did not — assume to exercise the functions of Chief Engineer. The appointment of Chief Engineer for Irrigation did not exist and extraordinary as it may appear there was practically no check of a technical character which would expose errors on the part of the Engineer employed. But let us suppose that there had existed a Central Office of technical administration. This project would then have been subjected to a scrutiny based on the whole experience of the Department, as epitomised in the codes, standard specifications, standard rates and data and other formularies. It would at once have been noted that its designs for masonry works, its rates for labor and materials, its channel slopes, were condemned by that experience and the further investigation of the general arrangements by the Chief Engineer would have led to the timely exposure

of other errors which
have caused increased
expense and aided its
financial failure.
It may be contended that
the object in view has
een attained by the
ppointment of a Chief
ngineer for Irrigation
nd no doubt to a cer-
ain extent it has. A
roject and estimate of
he character of the one
riginally brought for-
ard for the Water Sup-
ly of Madras could not
ow reach Government
ithout condemnation
ing recorded against
but it is nevertheless
serted that the pre-
nt organization is de-
tive, that the formularies

and Codes do not exist and that in the absence of the subordinate technical assistance which must necessarily with try such aid, the Chief Engineer is overwhelmed with details of a petty nature which might be disposed of for him and all of which he cannot possibly attend to, and which could moreover be got through, more certainly, more methodically and much more economically by means of the arrangements advocated.

10. The observations which have been made in reference to the Red Hills Project apply with almost

equal force to that for enlarging the Chembrumbakum tank. This was worked out by the same Engineer - passed in like manner without adequate scrutiny and it was only after its execution had been commenced that a serious error in the levels was discovered and caused its modification. It was originally estimated to cost Rs: 355000 and subsequently in its modified and reduced form Rupees 414000. The outlay on it has been up to the present Rupees 451204 and the present estimate for

Some of the difference is due to changes [illegible] but [illegible] in first estimate

Completion amounts to Rs: 524805 The returns were estimated at Rupees ~~Rs 78320~~ They ~~can~~ it is now estimated not exceed Rs: 14657 and it is tolerably certain that there can never be an adequate return for the expenditure.

As in the case of the Red Hills Project the rates allowed were too low - the masonry works were inappropriate or insufficient and the investigation was incomplete - The experience of the Dept. was not brought to bear on it by means of an examination conducted in a methodical manner and the result was loss of Public money and discredit to irrigation projects in general.

11. If we turn to that branch of the Department where expenditure other than that for irrigation is supervised or administered it is not difficult to recall instances of abortive and wasteful expenditure which may be traced in a great measure if not entirely to the same chain of causes. The history of what is called the Bellary Water Supply Project is recorded in a Government Order of the 2 Novr 1874. No 3118. The original estimate amounted to Rs: 69,300. The works have cost Rs 1,41,628 of which it is calculated that Rs: 40,000 have been ~~carelessly~~ uselessly expended.

There were grave errors in the executive arrangements connected with the works, it is true, but the project as originally presented was so defectively prepared, the specifications were so faulty and imperfect, the rates so fictitious and there were such violations of constructive and Hydraulic principles, that wasteful expenditure was the necessary consequence of its adoption. The system threw on the Supdg Engineer of the Division the duty of final examination of the designs but in the first place there was no guarantee that the previous experience of the, Officer who held that appointment or that of the Range Officer had included the design and construction of such works, and moreover the absence of all formularies to which the latter would be bound to adhere in preparing his project and on which examination in the Supe Engineers Office would e based, removed all afe guard against the l effects of such inexperience, while finally non existence of a tral Office of technical ministration where the essary knowledge would found rendered still

[illegible]

This is a very perfect illustration

Rs 20,000

more possible the approval by Government and the initiation of works the failure of which should under a proper system have been foreseen.

12. The Ulsoor Water Works at Bangalore during the course of their construction have not omitted to supply illustrations of the defects of the present system. The Reservoirs for the storeage of water or for its retention during the process of filtration, have it is believed, almost without exception given way at some time or other and their repair has been costly. There is even now awaiting sanction an estimate for the restoration of a

ruptured filtering tank. All these failures were owing to simple errors in constructive detail, which proper specifications or descriptions of the design and the manner in which the work was to be executed would have prevented. The only test applied to the design and specification as prepared - was the personal experience of the Executive Engineer for the time being - Not the Collective xperience of the Dept nd certainly not its ydraulic experience. he e foundations of the reser- irs were some of them not all built with ne in mud - The floors e founded on made earth

both circumstances almost certainly fatal to stability. The previous experience of the Dept. might easily have been epitomised in two or three standard designs and specifications for such reservoirs for water supply. The system might have enforced reference to standards - scrutiny of the project might again have been based on these standards and in this as in hundreds of other instances of various degrees of importance abortive expenditure might have been saved.

13. The Koilguntla and Cumbum Cutcherries in

the Kurnool District are instances of the failure of buildings of another class. In both the foundations gave way from being built on made soil or after a slovenly and inferior manner. But apparently the specifications were defective and trial pits were not sunk or sections of the soil supplied when forwarding the estimate. Here gain there was an absence from defective system of the necessary heck on the form and tent of the information ven by the Range Offi- and subsequently by District Engineer.

14. In detailing in para: 9 the classification which might be given to the general causes leading to the failure of Engineering projects, allusion was made to those included under the head of incorrect or imperfect information of the physical conditions which had to be dealt with, whether arising from incorrect surveys, levels or observations. As belonging to the first class it has been stated that in connection with the Red Hill Project, the flood levels of the Cortelliar river were not correctly ascertained and that the levels of the ground

rupti line at the base of the
All the Reservoir embankments
owing were in error. Again
in c in the Chembrumbakkum
which Project a serious error
tions of levelling was not
desig discovered in time
in or to prevent useless
to be expenditure. It is fur
have ther to be observed that
test survey and levelling opera
and p tions in general as con
pare ducted at present by
exper subordinates under the
time presumed direction of
being Range Officers have often
exper proved to be useless from
and their incorrectness and from
hyd the absence of proper check
the and record. The Cauvery
voir surveys may be instanced
and also that under the
done Red Hill and Cholaveram

~ £1100 were wasted

which could be absolutely refused

tanks where for want of proper supervision the time and work of a surveyor for months has been wasted.

The successful conduct of such operations ~~such~~ as surveying and levelling, flood and tidal observations and the establishment and record of bench marks, or permanent reference marks for levels, requires more than in any other case, proper system and check. At present if a project is to be investigated or if observations are to be made the District Engineer is directed to engage a temporary survey establishment. There is no guarantee that those who present themselves for employment are really efficient and as they have the prospect before them of being discharged as soon as they complete the work on which they are engaged they have no great inducement to establish a good reputation. It is desirable that the Central Office should exercise more control over such operations - that a certain number of Surveyors should be permanently employed under the direct supervision of the Chief Engineer in carrying

lines of initial levelling and establishing bench marks in directions where they are required for the study of projects of irrigation, &c. The work of Surveyors employed by the District Engineers would be checked by these levels which would only be known in the Central Office, so that all falsification of field work would be at once detected. For the gauging of rivers and streams it is desirable that primary forms of registration should be issued by the Chief Engineer as well as those for abstracting the results.

15. In carrying on the

This would not be a proper way. The fact that levels have been checked would be recorded in the place as required by the Circular, but the responsibility for all necessary precautions must rest primarily with the District Officers.

Executive duties connected with the construction of works, no formulation of details and no general instructions will altogether replace that practical knowledge which experience alone can give, but on the other hand it is most evident that the only way by which the Officers of the Department can benefit by the experience of others and avoid making mistakes, which however corrected and afterwards avoided expensive to the

State - is by the study of such formularies in which the experience referred to is epitomised - A thoroughly well considered specification of the work to be executed in which the best methods of procedure are detailed, an estimate in which everything necessary is fully provided and in which the rates are based on well established data: data available for

reference and
giving exact information as to
the quantity of
materials and the
number of men necessary to execute
given quantity of
ork. Plans contain-
g full information
d details of all the
rk to be done and
awn up by aid of the
current experience
the whole depart-
t, as concen-
ed in standards

and Codes:- These are aids to the Officer concerned in executing the work which it would be the aim of the Central Office to secure to him and it would thus in no small measure prevent failures apparently due to defective control and supervision.

16. It has been stated in a previous part of this paper that one function of a Central Office of Administration should be the collection of the results of general experience and their application to the extension and improvement of processes and modes of construction and the dissemination thereby of this experience throughout the Presidency generally in a manner which would

ensure the attention of Officers of the Department. It was added that practically with the present organization this function was not exercised. In proof of this it might be considered sufficient to allude to the fact already adduced of the non existence of any but an obsolete Code, of the absence of Standard Specifications and of the absolute want of certain knowledge of the proper st of most descriptions work. But having aken as examples f defective conception rtain works and having own how from defective administration their execution was undertaken under circumstances which ensured their failure, it will be a test of the efficiency of the present system to inquire how far by the natural operation of its machinery, the experience gained by failure has been rendered effective in preventing the repetition in any other locality of similar mistakes or to what extent the knowledge acquired during the execution of these works of specialities in construction has been rendered available for the use of the Department generally.

Now as regards the Red Hill Project, it has been shown that there were certain glaring discrepancies between calculation and fact in respect of the flood level of the Cortellias River before and after the head works were constructed. The head sluice has been topped, the River has three times ransgressed the limits ssigned to it and the nicut has been turned. ut the calculations e never been verified. is not known whether if so to what extent disasters were caused want of knowledge the proper coefficients pply to the hydraulic mula in order to adapt to the case of the rivers his part of the

Presidency with their large inclinations of surface sandy beds and silt laden waters. The proper coefficients can only be ascertained by experiments but the higher officers of the Department are far too much hamped with the petty details of work which under a proper organization would be dealt with for them, to be able to find time for such inquiries although it is for such purposes that they receive their higher technical education.

Again from the manner in which the earthwork of the embankments of the reservoirs were

executed certain failures
occurred. These have
been remedied in various
ways and after considera-
ble trouble. It is not
neceſsary to enter here
into technical details.
It is however certain
that experience was gained
which should be useful
elsewhere but there exists
no effective means of
diffusing it. If searched
for it might no doubt
e found in a number
Government orders and
certain reports printed
Government Proceed-
gs but it is not
ought home to those
gaged in works.

It is not to be found in text books for daily use. If the results here alluded to found their place in due course in Standard Specifications which were in the hands of all and if it were the routine work of an Office to enforce attention to them, the effect would be felt everywhere. The same observations apply to much more of the work of this project. A claſs of masonry was used which was of exceptional quality, and suited to the important works which had to be constructed. Its cost was perhaps for the first time in this part of the Presidency ascertained, but this knowledge is of no avail elsewhere. There are no standard specifications for masonry of this description. The rates at which it was executed find no place in the schedule of rates such as they are, and the data are buried in station books and records which in a few years authority will be given to destroy.

7. The Bellary water works project has already been referred to as an instance of the necessity for organized technical examination of plans and estimates. The causes of the failures of the work during construction are well known. The revetment of the main reservoir was pitched at too great a slope and it was not supported at the toe by a foundation. Its slipping was inevitable and the same result would follow a similar plan of construction wherever tried. The principal supply channel, chiefly in embankment, had a surface inclination and section given to it which would induce a mean velocity of discharge of more than seven feet per second, sufficient to render the embankment

a vanishing quantity. It would be a proper exercise of the functions of an administration for the technical directi of the Department to take note of such defects and Accidents when they did occur and to to disseminate the experience gained by embodying it in the Codes and Standards, as to guard gainst any repetition f the faulty design. he code of construction ould prohibit thenceth such slopes for nk revetments. The ecification for that cies of work would ect the insertion of per foundations --

Cf. of [illegible] [illegible] the same circumstances — the [illegible] of tank [illegible] [illegible] may [illegible] between [illegible] Accidents to [illegible] Soil of tank [illegible]. Wy.

Maximum velocity allowable have to be determined by the [illegible] & [illegible] settled by Constituted Officers familiar with the facts. Wy.

Tables of maximum velocities to be allowed or other information of the kind would be placed before Subordinates and the active enforcement of attention to Standards and Codes (without which they are useless) by the routine action of the Central Office of Examination, would complete the safeguard. At present there is no safe guard except the personal recognition of defects by the Chief Engineer, in the course of a scrutiny necessarily cursory in character, of such projects and designs as may pass through his hands. But a trained Examiner with no more technical knowledge than of an Overseer and with nothing but the education of a matriculated Student at the Madras University - aided by the Codes and standards and with the aptitude engendered by practice, would have been a machine quite efficient enough to have prevented the waste of Rs: 40,000 on the Bellary Water Works:

18. The reservoirs of the Bangalore water works have been mentioned as being all originally faulty. There is however no code of construction in which the laying down of

[illegible] 1914.

the floors of masonry tanks on made earth is prohibited. There is no standard specification for water tanks compiled with special reference to the avoidance of this defect for the future, nor is there any standard design in which properly constructed foundations for such works is shown. There is nothing apparently to prevent the repetition in other Districts or in the same District by another Officer of similar mistakes. Nothing to prevent the adoption again of the same faulty design be by Government except on the personal equation so to speak, of the Chief Engineer for the time being.

19. Very large expenditure has been incurred during the past 10 or 15 years, at Bangalore in the Construction of Barracks and their accessories and the experience gained should certainly have been most extensive and complete. Yet the history of the Construction of the Barracks recently completed at the Mount has shown that estimates and specifications of a very imperfect character were originally furnished for that work in 1868. But this is not surprising when it is considered that there is no provision for rendering available in one locality the experience gained in another on the same class of work. Had there existed during the years the barracks at Bangalore were under construction, a Central Office of administration, of a technical character, complete in its organization — one of whose functions it was to watch the results of operations —

to ascertain how far estimates had failed to provide what was necessary, in what respects rates had proved insufficient, where specifications had been incomplete in description, how far it had been necessary to alter or add to standard plans and finally in what degree the constructions had after all answered the purpose in view and if Moreover standard plans and estimates had been revised and specifications altered and enlarged in accordance with the teachings of such experience. The data for the designs and estimates at the Mount

would have been tolerably Complete and the Officers who were charged with their preparation would have received such assistance as they had a right to expect. But in addition to this since under the arrangements supposed, the plans and estimates and specifications whatever they were, would have been subjected to the trained scrutiny of that very section of the Central Office which dealt with the designs for the barracks at Bangalore there would have been an additional guarantee that what had been learnt at the one locality would have been applied for the benefit of the work at the other.

The mode of working has

been very different. The Range Officer at the Mount was probably Called on to prepare designs and estimates - with the assistance of some of the Standard Skeleton plans of Barracks furnished by the Government of India. He might probably never have been charged with work of the kind before and there was no Central Office where experience existed and whence he Could derive assistance or information. It is not to be wondered at therefore that estimates were exceeded between 20 and 30 per Cent and that revised estimates were succeeded by other revised estimates - that specifications and Consequently Executive arrangements were defective. Again the experience gained at the Mount is of no avail for use elsewhere and if Barracks were now Called for at Bellary much of the work would probably be to the Officer Concerned tentative in its nature.

20. The Guindy water Supply project is practically a failure - yet the Dept. had carried out at Bangalore arrangements for the application of Steam power to pumping purposes - the Special Knowledge

of the one locality was not however available for the other.

21. The failures of certain bridges and anicuts during the floods of 1874/75 brought into prominence the necessity for providing in such works more than had previously been the practice, against the effect of upstream scour whether caused by lateral (cross) currents or impinging flow of water. So long as the Officers present during the floods are concerned with the construction of the same works in the flooded districts – the necessity will probably be recognized and provided for – but when they leave or in districts not affected, there is nothing to prevent the experience gained from being lost. It has no expression in any general Standard Code or Specification for bridge or Anicut work for there are none such.

22. Numerous, indeed almost numberless instances might be adduced in support of the assertion that that function of technical administration which diffuses the experience gained and guards against the repetition of error is practically in abeyance from want of the organized subordinate assistance –

This para. is very much to the point. – It is surprising how very little had been done until quite recently in guarding against damage from floods. Some progress is now being made there has certainly, but not as extensively or as quickly as is necessary in order to ensure attention being given to obvious requirements

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which is necessary in order to carry it out.

23. In the memorandum already referred to of September 1874 addressed by the writer to the Chief Engineer - it was stated to the effect that although efforts had been sometimes made to convey instruction they were necessarily spasmodic and abortive. As an instance showing the defective organization provided for this purpose Dr. Nicholson's labours in the analysis of natural and artificial cements and limes may be mentioned. This Officer was employed

I am afraid even the best possible central administration possible will not do much with those officers who will not take sufficient interest in their work to make use of the information made available - The information given in Dr Nicholson's reports can be turned to account by any officer who has the [illegible] of [illegible]

for it is believed some months and produced a valuable report which together with a box of specimens was sent to each District Engineer. There has been no evidence whatever that the knowledge acquired has been utilized and it seems in the highest degree probable that no improvement in construction will follow. The machinery by means of which such researches would be turned to general profit does not exist and yet it could be simply arranged - Let a list of limes and cements for each District be constructed, let the denominations be fixed and the compositions where artificial be laid down, let the use of certain limes and Cements be described in the standard specifications for the works to which they are applicable, let them be entered in the standard rates with ascertained prices from given data and finally (without which all would be in vain), let it be the routine work of the Central Office to enforce attention to these standards. The benefit to be derived from the experiments would be brought by this steady unremitting

I am sorry that the
pressure is so urging
but the point is [illegible]

pressure irresistably into operation.

24. It would be easy to enlarge to almost any extent the foregoing description of what the writer conceives to be some of the functions of an organized Central administration for the direction of the technical work of the Department. The argument for its employment rests on the grounds of economy and efficiency. It would be economical because it is possible under such circumstances to subdivide duties and so to simplify them. One section may

deal with everything relating to civil buildings. Another may devote itself to roads, another to Military buildings and another to town water supply and irrigation. The requirements of each class of construction may be thoroughly mastered so far as they are laid down by Orders of Government, Standards and formulae and that by subordinate Agency Examination and Check f projects and even design may become to a reat extent a matter routine and almost nstinct. It would be fficient because it made mechanical-

formal certainly but unvarying in the certainty of its operation and the effect of the pressure it would unremittingly exert would filter throughout every grade of the Executive branch.

25. A duty of the Central Office would be the production of Standard designs. The issuing of these has already been recognized as beneficial and to a considerable extent carried out, but the extension of the system is necessary. Talent for design is not by any means common and its full employment where recognized should if possible be ensured

and in a manner in which its influence would be most generally felt. The education of Subordinates is promoted by placing before them for execution designs framed on sound principles and not only should they be prepared for established types of buildings, but for works of irrigation, for details such as carpentry joinery and even fittings as the iron work of doors and windows, sluice shutters and gearing. It must be recollected that the Knowledge of Artisans in the Districts is on such points exceedingly defective and there is

? imitation

no doubt that a series of illustrations on European pattern of such apparently insignificant details as are included in the ironwork of a dwelling house would have good effect if placed in the hands of Overseers as models for initiation. A description of the fitting of the doors and windows of certain subsidiary jails recently given by the Collector of the District showed how primitive were still the ideas on such subjects of Native subordinates and workmen.

“Every standard design whether of buildings or details, with its specification—numbered or occupying its place in the series would form a stand point of reference for the Central Office and for those in the Districts and it would thus be forced into knowledge and use.”

26. The functions of a Central Office such as has been alluded to are also intimately connected with the management

And

and utilization of the Central Workshop at the Presidency. There are many general questions involved which affect the works throughout the districts. The extension of Railway and Steam Communication should vastly enlarge the field for the economical supply of manufactures from the Presidency town. It is not easy to understand why unsawn and unwrought timber should be sent from Madras to the Districts. Why in fact it cannot be sawn and often even wrought and fitted ready for framing or fixing in the Madras Workshop forwarded with the necessary iron work at a cheaper rate than under present arrangements, where wood is often obtained from long distances in log and worked up by village Carpenters. It should be possible to supply now by rail a much larger proportion of the joinery required in the Districts, than is now done. The use of iron girders for road bridges has extended but little in the country. Yet the advantages they confer of large effective water-way and diminution

of the number of costly pier foundations and the absence of Centring during Construction are very important. All such matters are now left practically to the discretion of the District Engineers or even Range Officers but it seems clear that they would be better dealt with in the Office of the Chief Engineer.

It is a matter for observation that the administration of the Railway Constructive Department has been too much separated from that of Public Works generally. At any rate it would certainly seem desirable that experience gained in one branch should be available in the other and yet it is not so. While on the one hand Officers of the Public Works Dept. might learn something from the details of Station buildings and the use of iron on Railway bridges; ~~the~~ Railway Officers on the other hand might no doubt, had they studied the experience of Madras Engineers, have avoided mistakes in the construction of bridge foundations which have

caused very large outlay in repairs. The elaboration of standards in design and specification on either side and the interchange of these and schedules of rates would prevent ~~prevent~~ this considerable waste of experience.

27. The training of the subordinates in the Civil Engineering College ought to be a subject of continued scrutiny by the Central Administration. The object in view being to ensure

that the text books used were precisely in accordance with the Codes adopted in the Department. In fact the Codes, Standard plans, Specifications and forms generally which were in use in the Districts should form the text books of he students and ome practical raining in the Workops, in Carpentry and iron work might well form a part of the Educational course.

28. The above is a very imperfect sketch of some of the duties which might be undertaken by the Central Office for the administration, in a technical sense, of the Public Works of the Presidency and let it be remembered that by the present system their performance is not really provided for at all or at any rate only recognized to some extent and most imperfectly provided for in the Irrigation branch. No doubt this tendency to decentralisation and this habit of making

each District a species
the of Imperium in Imperio
ns originated at a time when
Communication was dif-
n ficult and when Officers
he were isolated and thrown
the on their own resources. This
is however no longer the
Case - Railways traverse
those parts of the Presidency
which were formerly the
most inaccessible. Steam
Communication along
both Coasts renders nearly
all parts of the Districts
which are without Railways
easy access from Madras
nd every District Engi-
neer can by telegraph
lace himself in in-
tantaneous Communi-
tion with head Quar-
rs. Almost complete
tralisation is therefore
fectly practicable

and its advantages in the present case would be enormous. The failure of projects alluded to above is no measure of the amount of money which may be unprofitably spent. It is impossible to say how much of the expenditure for repairs is due to faulty construction Originally. It is impossible to deal with the work as it is now sent up without becoming convinced of the great necessity for reform in an organization which produces it and the importance of the results which would follow. It must be admitted however that a difficulty exists in Carrying out the change. Most of the arguments in favor of the provision of a Central Technical Establishment will probably be endorsed by the Chief Engineer who the writer is aware has long been in favor of the introduction of a technical subordinate element into the

the Central Office. The rigid restrictions imposed by the Govt. of India in respect to Establishment charges and the extreme difficulty which already exists in meeting with the present Establishment, the urgent demands from the Districts for Officers to supervise current work, has rendered it and still apparently renders it impossible, to provide the necessary staff at head quarters. Expenditure on Establishments has always been viewed simply in relation to the outlay on works and the rates of Establishment charges to the outlay has been considered to afford the means of judging whether such Establishment was or was not excessive. But a very important element in the question is the area over which the expenditure is

distributed

distributed. In this Presidency on the average, every District Engineer supervises works scattered over 5800 square miles of Country. Every Range Officer's charge is 1750 square miles and that of every Overseer 655 square miles. Under such circumstances Establishment charges must necessarily represent a very large per centage on the general expenditure and a mere consideration of that percentage without reference to areas leads to fallacious ideas and restrictive orders which operate perniciously.

It is worth while however to consider whether even under present Circumstances the more efficient administration which it is believed would follow the Centralization advocated would not far more than Compensate for the reduction of District Supervision and Establishment which the Concentration of the necessary staff at head Quarters would at present entail. And if the Conclusion arrived at is, that that staff annot be provided ithout an increase o the general strength

while at the same time the necessity for its employment is admitte it seems desirable ~~th~~ that the fact should be authoritatively stated and that the responsibilities involved by Continued restriction should be clearly announced.

29. To sum up the Changes suggested as being desirable are:-

1 The formation of a Complete staff for the Office of the Chief Engineer Containing a large and picked element having technical and special Knowledge.

2. The placing of this Staff under the direction of one or more Officers to be specially charged with the technical administration of Public Works under the Chief Engineer.

3. The allotment of a certain proportion of this staff or of additional staff to furnish technical assistance to the Chief Engineer for Irrigation.

4. The placing of the Public Workshops under the direct control of the Senior Officer in charge of the technical staff or Office of the Chief Engineer.

5. The formation of a Standing Committee consisting of the Controller of P. W. Accounts, the Officer in charge of the technical staff and the Principal of the Civil Engineering College to arrange the general course of education and training at the College and to maintain its accordance with the practical work in the Districts.

The duties of the Officer or Officers and this Staff attached to the Chief Engineer would be:-

a The thorough and searching examination of all projects, plans and estimates for new

Works whether Imperial Provincial or Local Fund.

The examination of details carried on by the subordinate staff to be based on the standards and Codes and general instructions, formularies, &c, maintained and issued by the Officers in charge and to be reported on to the Chief Engineer by these Officers as to their general scope-feasibility, &c. Instructions for the revision of estimates and Projects will be issued and fresh designs will occasionally be prepared to give aid to the District Officers. A percentage of repair

estimates to be also examined.

b The maintenance in complete efficiency of Codes standard specifications, schedules of rates and data, standard plans, tables, &c. by their continual correction and enlargement in accordance with orders issued by Govt. or with the results of current work and experience or research and the regular issue to all Officers of the Department of amendments or additions to worked out, of standard plans, & of instructions of general utility and application under the authority of the Chief Engineer.

c. The preparation in a systematic manner of forms for correspondence returns, estimates and reports and their iſsue in print to Officers of the Department as well as the enforcement of their use.

d. The inspection of works in progress on behalf of the Chief Engineer, the preparation of reports thereon and the iſsuing of instructions to Officers concerned with their execution - under the authority of the Chief Engineer.

e. The study of general questions affecting construction throughout the Presidency. The utilization of experience gained by the record of facts for future guidance. The reception and preliminary study of proposals for works coming from other Departments of the administration. The acquisition of a knowledge of the progress of Engineering in other Countries so far as it can be gained from published works and reports.

[illegible] Scott
Major R.E.
Under Secy to Govt. P.W.D.

Ootacamund
Sept. /75

To
The Chief Engr & Secy to Govt.
P.W.D.

G. O. 17th March 1875 Nos 437 & 438
" 31st July 1875 No 839 & 840
" 26th July 1875 Nos 672 to 674
Chief Engrs Circular Memo of 2nd July 1875 No 157.
G. O. 24th June/75 No 494 to 496
" 2nd Novr 1874 No 28 to 30
" 12th Septr/71 No 186 to 189 & 190
" 14th Septr/72 No 217 to 219

GO 24 November/75
No 3373

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91

Chief Engineer's Memo:

I agree in the conclusions summed up in para 29 of Major Scott's elaborate and practical memorandum and I would provide the assistance required by the Chief Engineer by the creation of a Deputy Chief Engineer with rank of ~~Chief~~ Supdt Engineer 3rd Grade in lieu of the 2 Inspecting Engineers who now form a nominal part of the Establishment, but whose functions have had to be held in abeyance of late on account of the scarcity of District and Executive Engineers. For the assistance of the Chief Engineer for Irrigation the services of the Under Secretary to Government might be made exclusively available, with the designation of Assistant to the Chief Engineer for Irrigation and his [illegible]

This accords with Govt. of India proposals in their No. 635 of 8th May 1872. (S.O. No. 2190 of 14th Sept.)

In accordance with the practice in Bombay.

rank of Executive Engineer 1st grade. To give assistants of lower standing would not sufficiently strengthen the hands of the Chief Engineer. And to permit of freedom in dealing with all papers in the office of the Chief Engineers and Secretaries to Government both Assistants should be Under Secretaries. The duties of the Chief Engineer's Deputy may be simply stated as those of the 2 Inspecting Engineers combined; those of the Assistant to the Chief Engineer for Irrigation would be the performance of such portions of the latter Officer's work as he might desire to confide to him. Adequate Office Establishments might be made up from the members of the former Inspecting Engineers' Establishments now distributed amongst 5 Superintending Engineers, and by a selection from the offices of the Secretary to Government, Chief Engineer for Irrigation and Lithographic Establishment.

C M Walker Major Genl. R.E.
Chief Engineer D.P.W.

Ootacamund
18th October 1875

Circulated for
Orders. together with
memo. by Chief Engr.
for Irrigation —
C M Walker Major Genl. R.E.
Secretary to Government
P.W.D.

No 576

3-11.75

No 1257

I have read with great interest Major Scott's very valuable memorandum dated September 1875, on the technical administration of the Public Works Department. His observations point to defects in the present system which are of essential importance – and there is no room for doubting the possibility of removing, by the reforms he advocates, the causes of inefficiency, and consequent waste of money, at any rate to a very large extent. It may be noticed here that I have found that, in too many cases, the instructions which have been given during tours of inspection, and in the Notes of inspection, are not attended to as fully as they should be, even as regards the particular works in connection with which the instructions were given, while their extended application to other works similarly circumstanced is but rarely made.

There

There is undoubtedly vast room for improvement, and it is clear that, as far as possible, the task of ascertaining that orders and instructions are receiving attention, must be transferred to comparatively subordinate establishments, seeing that it is altogether impracticable for the Chief Engineer to attend properly to such details. We cannot possibly read for instance all the specifications that come in, neither can we, as a rule, see whether the dimensions of masonry works, the designs for which are submitted for sanction, are all correct. Such details are often examined into and put right, but there is not time to do this regularly and invariably. Very few District officers show on their plans the essential information needed but, at present, so far as irrigation work is concerned, I have myself to look over the plans, see what is wanting and return them that omissions may be rectified, and of course there is great waste of time in taking up projects and then being unable to dispose of them because certain well known requirements have not been attended to.

In

In some Districts - notably in the Godavery Delta, the way in which work has been carried out as well as the data on which the works have been arranged, has been greatly improved in recent years, but this higher standard is at present almost incapable of communication to other Districts, because there is no machinery available for making available the experience of, and the results worked out by, officers in the Delta of exceptional intelligence and zeal, or of ensuring attention to the general instructions which are issued from time to time for the guidance of all in consequence of circumstances coming under observation in particular localities. To take a very simple instance. Every officer of even very small experience must know that fat limes are unadapted for use on hydraulic works; the evidence that this is the case is patent - well their attention has been called to the subject; they have been told how these limes, if hydraulic limes be not available, can be made serviceable, and recently they have had Dr. Nicholson's reports to help them. It is

still

still however quite an exception to find hydraulic mortar in use, and I often find shell lime - the fattest of the fat - entered in specifications for tank sluices and other works similarly situated, although it is certain that such lime, so used, can never set.

In some particulars my opinions differ to some extent from the views enunciated by Major Scott, and I have made a few notes in the margin of his memorandum.

As regards the reorganization of District establishments, I am of opinion that if any change be made, the alterations should be such as to ensure every separate executive charge being held by a member of the Department, who may be presumed to have the necessary qualifications. There are many Range officers now who cannot be expected to carry on their work satisfactorily:

they

they are qualified only to carry out definite instructions and to be subordinate executive agents.

Fort Saint George
23rd October 1875

Lt. Col. R.E.
Chief Engineer for Irrigation

To
The Secretary to Government
Public Works Department

R+D RG

13: Novr 1875

The following remarks are submitted with reference to the details of the Establishments required for the Offices of technical administration of the Non Irrigation & Irrigation branches of the D.P.W.

2 The work to be done at the first includes not only that involved by a performance of what will be the normal duties of such Offices, but also the construction of the Machinery which is to economise labour.

Codes, Standing Orders, Standard plans & Specifications, forms & tables have to be elaborated & brought into general use. An immense map of

No 5-75

3-11.75

unused information which has accumulated for years especially in the Irrigation Office has to be digested & made available, and Order & Method has to be introduced.

The strength of the Staff in Either branch ought to be sufficient to cope with the Work which presents itself under both aspects.

2

The immediate head of the Non Irrigation branch, by whom is meant the Deputy Chief Engineer or Inspecting Engineer, whichever designation may be adopted, ought it is thought to have in his Office at least One young Officer of Engineers of about four or five years Standing as an Assistant & two Subordinates besides who should possess technical knowledge both practical & theoretical of Elementary Engineering & General Con-struction.

3

Draftsmen, estimators, Computers, Clerks, Map & Record Keepers are of course understood accessories, but the Work performed by the three former is almost purely mechanical and cannot supply the element which affords intelligent technical Supervision of details.

The employment of ~~the~~ younger Officers of the Corps is not too costly, while their high technical & general Education which includes the higher Mathematics

c. 3-11.75

& Physical Science which enable them to render valuable assistance in any branch of construction

4

The amount of work which ought to be ~~taken~~ up as properly belonging to the Irrigation branch is most extensive and ~~the~~ arrears to be disposed are immense. In years the central Office has been swamped with projects, reports, statistics & plans which it has been impossible to deal with. The ~~end~~ & object of so much work in collecting information was a comprehensive study of ~~the~~ economics of Irrigation & the application of such study to current work. but it has remained in a great measure barren of results because no one had leisure to abstract & establish principles.

An young Officer of Engineers of ~~three~~ or four years standing might be usefully employed in working up these arrears & ~~collecting~~ & preparing standard plans & specifications without dealing at all with current work, which to deal with effectually requires an addition an assistant to the Chief Engineer.

Some additional clerical assistance & some Draftsmen will also be required for the compilation of statistics & the drawing of plans &c. designed as standards.

C.3-11.75

5

Considering that the approved organization provides for two Inspecting (1 Supg Superintending) Engineers the employment of one such Officer with two junior Officers involves no startling change.

G.O. 24 Novembr/75
No 337

1. Memo by U. S. d/29th Sept 1875
2. Do by Chief Engr d/18 Octr 1875
3. Do by Chief Engr for Irrign d 23/10/75 Rd 25/
4. Do by ~~Secy~~ U.S. d/13 Novr 1875
5. Minute by Hon the Govr d/8/11/75
6. Note by Hon R S Ellis d/4 Novr 1875
7. Do by Hon W Hudleston d/6 Novr 1875
8. Do by H.E. the C. in Chief d/22 Novr 1875

PUBLIC WORKS DEPARTMENT.

Appointment of Deputy Chief Engineer, Public Works Department.

(G.O., No. 3,373, dated 24th November 1875.

MINUTE BY THE HONORABLE THE GOVERNOR.

MAJOR DEC. SCOTT'S paper is admirable, and deserves the full commendation of Government.

2. It is most seriously to be regretted that, after so many years, deficiencies so serious should rule in the department. I attribute this condition in large measure to the initial error of making the head of the department a Secretary to Government, and to dealing with all sorts of departmental subjects, organizations, &c., as if they are matters to be disposed of by Government and suited for the decisions of Government. Confusion in the administration of Government and shortcomings in the department have been the inevitable consequences, and will continue in their degree; while attempted rectifications will be costly.

3. I have no objections to the proposals made by General Walker, except in so far as I entirely object to have further Secretaries and Assistant Secretaries to Government created. The duty required from the additional aid sought by the heads of the respective Engineering Department, are purely departmental—wanted for the satisfaction of the Chief Engineers who have to submit projects to Government as Secretaries, and additional aid afforded—must be strictly separated from the Government Secretariat.

4. I approve of the creation of a Departmental Chief Engineer and think that the Chief Engineer for Irrigation should have an Assistant in his departmental capacity.

5. I would ask the Chief Engineer to report more in detail the reorganization. I cannot join in asking increased establishment which he proposes with a view to remove the obvious shortcomings brought to notice.

8th November 1875. W. ROBINSON.

No 3373

24 Novr 1875

H. E. the G. in C. has read with much interest the excellent Memorandum of the Under Secretary in the P.W. Dept. He has, in the clearest language, described the necessity of an organized central administration for the direction of the technical work of the Dept, and he has brought very apt illustrations of facts, in support of his argument. The acknowledgements of Govt.

B.S.C.

one due to him for his excellent paper.

It is concurred in essentially by the Ch. Engr. D.P.W. and by the Ch. Engr. for Irrig., and the practical suggestions made by the former for carrying out his views commend themselves to the approval of Govt. The Senior Inspecting Engineer Col. E.A. Frood R.E. whose work as such is at present in abeyance, ~~will~~ is accordingly ~~be~~ appointed Dy. Ch. Engr.

an office ~~which~~ the creation of which has already been approved by the Govt. of India in their letter recorded with G.O. No. 2190 of 14th Sept. 1872; his Departmental rank remaining that of Superg. Engr. 1st Grade. He will also be styled, and perform the duties of, ~~Deputy~~ Under Secretary in the P.W. Dept. During his absence on leave the Junior Inspecting Engr. Lt. Col. Farewell, who is shortly expected from home, will offi

=ciate forthwith — from the date of his assumption of ~~th~~is new duties Major A. DeL. Scott will become the Asst. of the Ch. Engr. for Irrig: ~~[illegible]~~ ~~and~~ Under Secy in the Irrigation Branch of the P.W. Dept. with his present Dept. rank of Ex. Engr. 1st Grade — If possible, a junior officer of the Dept. will be attached to each of them, at a later date, when the strength of the Dept. shall have been completed, & those now joining it shall have acquired some experience —

The members of the Office Establishments placed at the disposal of Supg Engineers in G.O. No. 1328 of 18th May 1874 will proceed to Madras, and report themselves to the Under Secretary in the P.W. Dept, who will arrange for their proper employment — Their distribution will be as follows viz:

		Ch. Engr.	Irrign Branch
Draftsmen on Rs	60 -	2	1
Do	40 -	1	1
Clerks on Rs	40 -	2	1
Do	30 -	1	1
		6	4

G.H.W.
13-11-75

Dispd.
9-12-75

Engrs
Ex Eng N Madd } 130
Controller - 6
Ch Eng for Irrn 6
Under Secy to Govt PWD
Col. N. J. Farewell
Offg Secy Ch Engr & Under Secy to Govt PWD

9-8-07 B II

P. W. Dept

3373 W

24-11-1875

24 Nov 75 3373 W

No. 575-

Depty Chief Engineer

Subt — Certain arran

-ments made in connecti

with the appointment of

Col. Ford as ——

the direction of the techni

-cal work of the dep

No. 575/80