Mr Target Transfer

acknowledge the receipt
of your letter No 2026 G
dated 12th Octr 1887, and
in reply to forward for
the information of the
Govt of India the
accompanying note by
the Chief Engineer from
which it will be seen
that, after perusal of
the report on the
irrigation of the Kyaukse
District, Colonel Haste
is of opinion that Mr
Target is a fit officer to
undertake the work.

No 2844-5 W dt 22.10.87

M
22.10

Recd with Govt note

22.10.87

19/11/87

No. 2844 W.

PUBLIC WORKS DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

UNDER date the Octr 22. 1887

READ the following

Letter from the Govt of India. (No. No. 2026 G of Octr 12. 1887)

Note by the Chief Engineer, P. W. Dept of Octr 19. 1887)

Ordered that the following letter be addressed to the Govt of India.

(No. No. 2845 W of 22. 10. 87)

To,

The Secretary to the
Govt of India. P. W. D.

Sir,

I am directed to

15th June 1883, No. 1671 W., Public Works.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

General.
Establishment.

Read—the following docket from the Government of India, Public Works Department (General), dated Simla, 15th May 1883, No. 710 G.:—

The following is forwarded to the Government of Madras, Public Works Department, for information and guidance.

(By Order.)

(Signed) G. H. W. WALKER,
Offg. Under Secy. to the Govt. of India.

From the Secretary to the Government of India, Public Works Department, to the Accountant-General, Public Works Department, dated 15th May 1883, No. 709 G.

In reply to your No. 266 E., of 7th May 1883, submitting for orders a letter from the Examiner of Public Works Accounts, Madras, inquiring whether the ruling contained in Public Works Department letter to the Government of Madras, No. 380 M. and C.E., of 17th September 1880, to the effect that the provisions of the Acting Allowance Code may be acted upon in determining the grant of acting allowances to Upper Subordinates who may, through the exigencies of the service, be placed in executive charge, even when there are no vacancies in Engineer class, applies to the appointment of Upper Subordinates to executive charge for long periods, I am directed to state that acting allowance can only be given under the rules when there is a vacancy in the sanctioned scale of establishment, and that this interpretation must be taken as in supersession of all previous rulings.

2. The allowance, however, under paragraph 36, Exception (2), of the Acting Allowance Code, for having charge of the current duties of an Executive Engineer's Office, in addition to his own duties, may be drawn by an Upper Subordinate even if there is no vacancy in the Engineer Establishment.

Order—dated 15th June 1883, No. 1671 W., Public Works.

Recorded for guidance.

2. Under the foregoing order Captain Jackson will, on his return from privilege leave, resume charge of the Kurnool Division as Assistant Engineer, First Grade, honorary rank, until an opportunity offers to promote him to Officiating Executive Engineer, Fourth Grade. His reversion will be notified in the *Fort St. George Gazette.*

3. The notification appointing Sub-Conductor Cormac to officiate as Executive Engineer, Fourth Grade, will be cancelled.

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Examiner, Public Works Accounts.
" Superintending Engineers.
" Consulting Architect to Government.

Exd. C. Howarth.
Spare Copies

GENERAL.
ESTABLISHMENT.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated June, 15th.

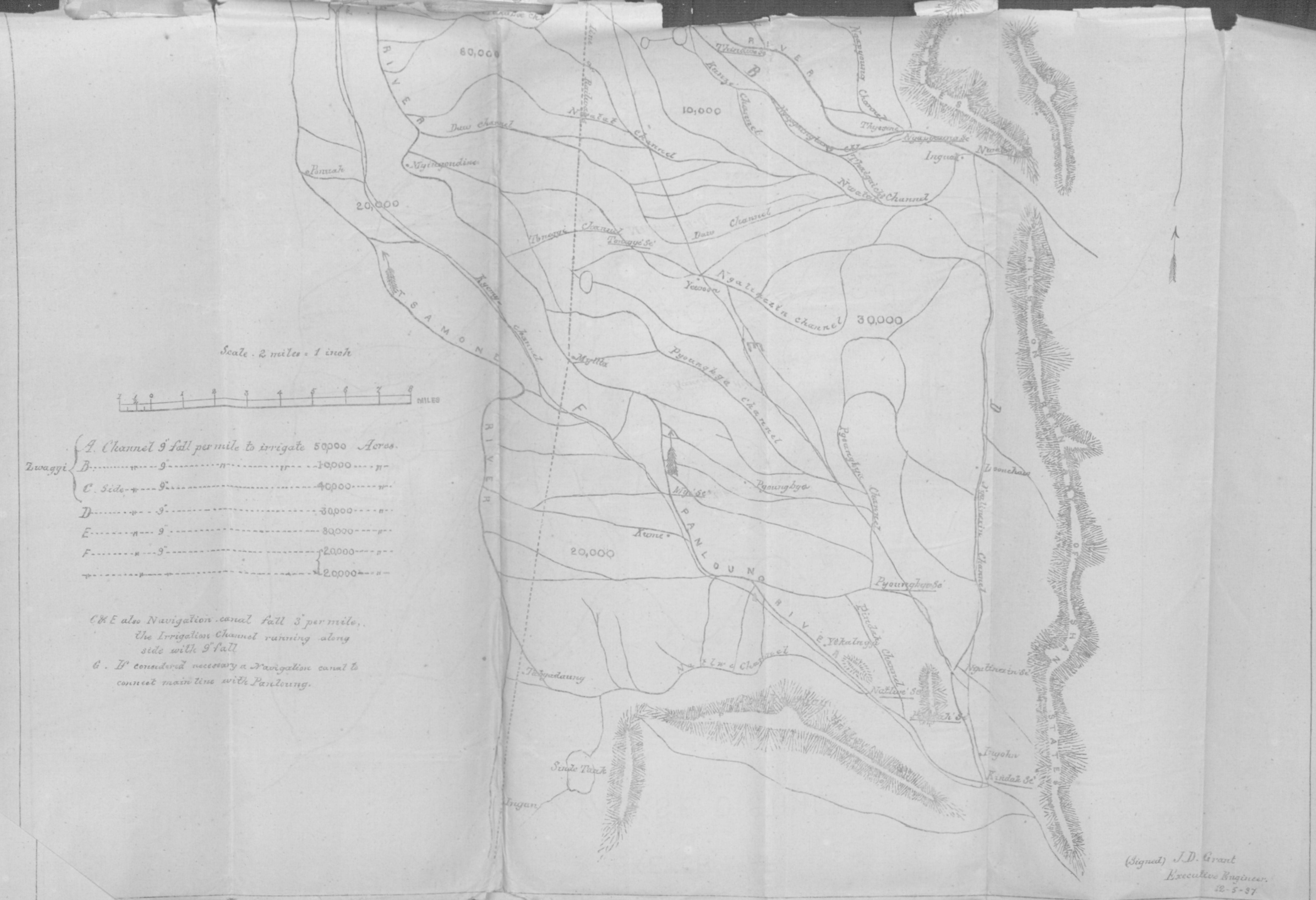
Recd. *Encl.*

G.O., 15th June 1883, No. 1671 W.

JUNE.

Acting Allowances

Letter from the Government of India declaring that — to Upper Subordinates placed in executive charge are inadmissible under the general provisions of the Acting Allowance Code unless there are vacancies in the sanctioned scale of Engineer Establishment, recorded with remarks.


Scale. 2 miles = 1 inch
MILES
A. Channel 9" fall per mile to irrigate 50,000 Acres.
Zwaggi B ... 9" ... 10,000
C. Side ... 9" ... 40,000
D ... 9" ... 30,000
E ... 9" ... 30,000
F ... 9" ... 20,000
... 20,000
C & E also Navigation canal fall 3" per mile, the Irrigation Channel running along side with 9" fall
G. If considered necessary a Navigation canal to connect main line with Panloung.
(Signed) J.D. Grant
Executive Engineer.
22-5-97
SAMON RIVER
PANLOUNG RIVER
SHAN STATES
Line of Railway
Ngalingazin channel
30,000
20,000
10,000
60,000
Pyoungbya Channel
Nwalat Channel
Daw Channel
Kyaung Channel
Pyinzaw Channel
Sinde Tank
Ingun
Kindah Sc
Natlaw Sc
Yewon
Mytha

SKETCH MAP
OF
KYAUKSE DISTRICT

N
W E
S

TSANGYI RIVER
PANLOUNG RIVER
MYITNE RIVER
NWAGYI RIVER
Palatho
Wootka Tank
Kokogeung
Paleik Canal
Kyaungbaw Canal
Nwadaw Canal
Kunu Canal
Paleik
Taborati
Seiktha
Nwadaw Be
Kinye Be
Bogannee
Uwatho
Mintakan Tank
Kaseng Hill
Sanye Tank
Thindaung Tank
Minmwa Hill
Kadawdaw Springs
Thindaung
Pibo
Thamaw myet Hill
Kyinpan
40,000
50,000

F. S. L —

Cross Section



Frame 4½"×4½"

Planking 2" thick

Bed level of Irrigation Ch

rom

For a ver... ...ter
should ...
below. *...s*

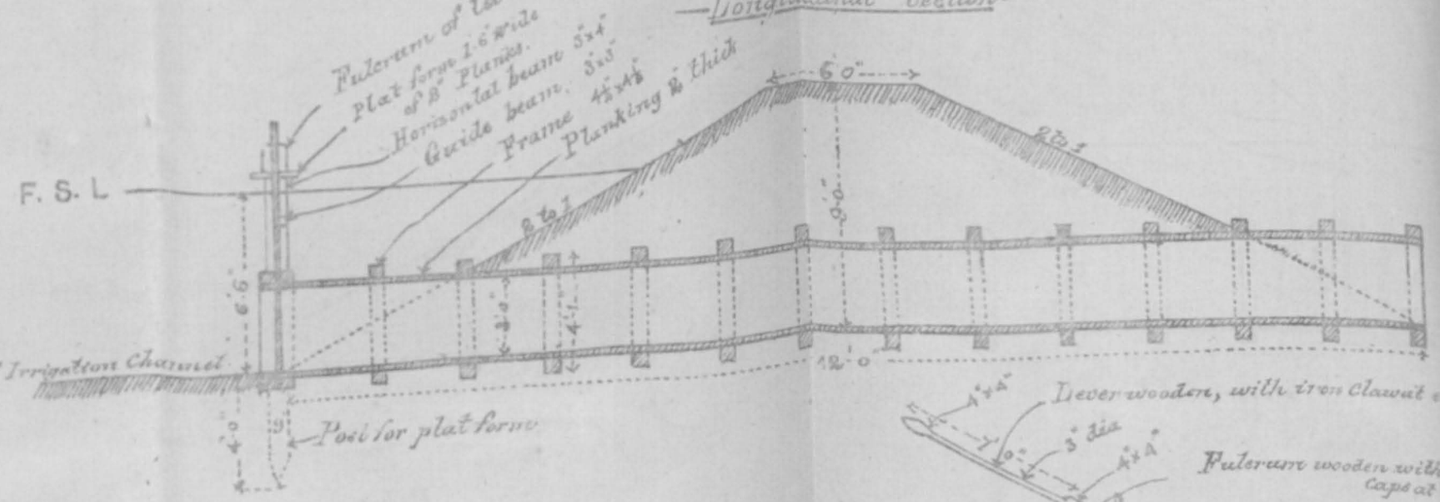
...ation Channel

(Signed) J.D. Grant
Executive Engineer

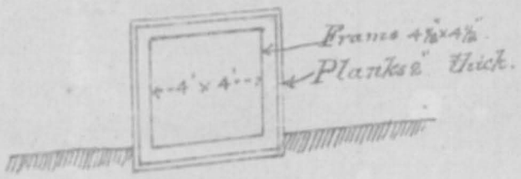
Plan of a Box Sluice with vent 3'-0" × 3'-0"

Scale 6 ft to an Inch

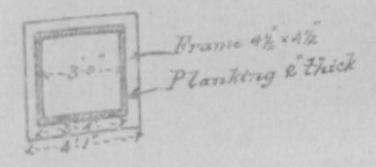
Longitudinal Section



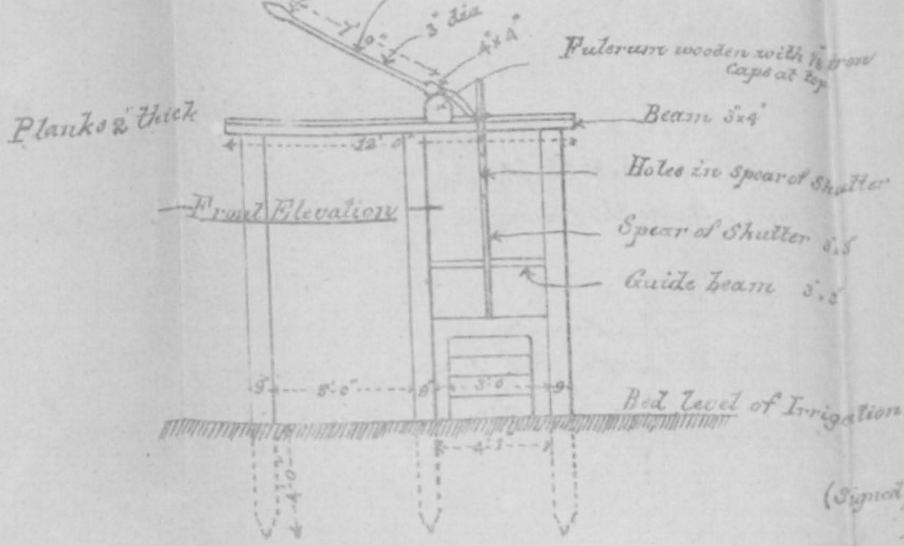
For a vent larger than 3'x3' the planks should be placed outside the frames as below.



Cross Section



Front Elevation



(Signed) J. D. Grant
Executive Engineer

Report by J. D. GRANT, Esq., Special Irrigation Engineer, on the irrigation of the Kyauksè district,—dated Kyauksè, the 12th May 1887.

THE Kyauksè district, covering approximately an area of 900 square miles, is bounded on the north by the Myitgnè river, on the east and south by hills, and on the west by the Samôn river.

The hills forming the eastern and southern boundary are of no great height, nowhere exceeding perhaps 3,000 feet: they rise very abruptly from the plains, and as their western slopes thus present but a small catchment area to the rainfall, there are no streams of any importance draining off them, but through gaps in the hills three streams find their way to the plains. These, taking them in their order from north to south, are—

(1) The Zawgyi river. | (2) The Panlaung river.

(3) The Samôn river.

Of these the Samôn may be left out of consideration in dealing with the channel irrigation of the district, as it cannot be depended on to afford a constant supply of water. It brings down large quantities of water at uncertain intervals, and rapidly dries up again.

Mr. Gordon, in his note of the 29th July 1886, mentions that even so late in the year as but a few days previous to the date of writing there was no water in the Samôn river: this coupled with the fact that no attempt has been hitherto made to turn the Samôn river to account as a source of water-supply for irrigation purposes, while so much has been done in other directions, would seem to show that it cannot be depended on.

There is another stream rising in the hills called the Chowlay. It is at best an insignificant stream, no water is drawn from it along its course, but it supplies a swamp, which is used to raise an early crop of rice, the water being raised by hand.

The irrigation of the district then depends entirely on the Zawgyi and the Panlaung rivers. The Zawgyi leaves the hills at a point about 18 miles south-east of Kyauksè and runs slightly west and north for a direct distance of 25 miles, where it falls into the Myitgnè river, a little above Paleik; its length is considerably greater than the 25 miles given above, as it winds considerably, particularly along the lower part of its course.

The Panlaung enters the plains near Ingôn, about 19 miles south of the head of the Zawgyi river, and after a direct course of about 55 miles, it falls into the Samôn river, and finally reaches the Myitgnè at a direct distance of about 48 miles from Ingôn, its actual length being necessarily much greater.

The general bed fall of these two rivers is much the same, being something more than two feet per mile; near the hills the fall is of course greater.

The whole country has a general inclination from south to north, approximating to that of the rivers, and amounting to a little more than 1½ feet per mile. Transversely (from east to west) the country falls gently towards the Panlaung, whose bed is lower than that of the Zawgyi; the difference being due to the difference of level of the Myitgnè river bed at the points where the Zawgyi and Panlaung fall into it.

The bed of the Panlaung where it reaches the plains is, however, at a higher level than that of the Zawgyi, the difference being perhaps 40 feet. The effect of these varying levels is apparent on the accompanying sketch-map, which shows that while the channel, taken off the right bank of the Panlaung at Ingôn, runs almost due east towards the Zawgyi, nearer the Myitgnè, the Zawgyi channels all tend towards the Panlaung.

Along the course of the Zwagyi river there are five dams, namely,—

The Wadet dam	...	...	Throwing off a channel on the left bank.
The Ngapyaung dam	...	...	Throwing off channels on both banks.
The Thindwè dam	...	...	Throwing off a channel to the right.
The Kyauksè dam	...	...	Throwing off channels on both banks.
The Zidaw dam	...	...	Throwing off a channel on the left to Paleik.

On the Panlaung there are four dams, namely,—

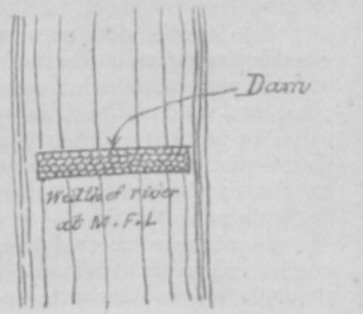
The Kinda dam, throwing off a channel on the right.
The Pinda dam, disused and out of order.
The Natwè dam, throwing off a channel on the left.
The Kyimyi dam, throwing off a channel on the left.

These dams are all similar in construction, they are formed of rows of stakes driven across the river bed, and tied together by cross pieces of palmyra, bamboo, or jungle wood; the spaces between the rows of stakes are filled in with stones picked up in the river bed or neighbourhood, covered with a layer of larger stone brought specially from some distance.

They are, as a rule, constructed with skill and answer their purpose, but they necessarily require constant repair and there is great loss of water by leakage.

The stone of which they are formed is generally too small, and is readily washed out, leaving the stakes exposed; against these stakes floating trees, &c., lodge; the stakes are displaced if they are strong, or broken off if they are old and decayed, and, to prevent accident, constant watchfulness is necessary.

Sufficient care also is not taken to connect the ends of the dams with ground beyond the level of high floods; as a consequence the river in some cases has a tendency to work round the ends of the dams; that accidents of this nature do not frequently occur is mainly due to the banks of the rivers being overgrown with trees, grass, &c. Still the fall of one tree might lead to a serious breach.



Most of the main dams in the district have just been repaired, the others are being repaired and should be completed before the rains.

The work is apparently good and ought to last for some time, but the defects noted above should be rectified when possible.

Of the channels taken off at these dams but one in the district has any attempt at a regulating work, that is the left channel from the Kyaukse dam.

This head sluice or regulating work would be effective, if it were in good repair, and if there were means of working it; but it has fallen out of order, and in its present state is useless during floods. It consists of a square box of timber built into a bank of stone, stakes, &c., but there are no planks by which to close it, and the whole work, as also the bank on either side, is so low that the river passes completely over it into the channel.

It would cost very little to put it to rights, and, if repaired, it would give complete control of the water-supply of the channel.

Similar sluices at the head of the other channels would be found most useful, and would repay their cost in a season, provided always that there are men on the spot to regulate them as the river rises and falls. Their construction is simple, the only point requiring care being to see that the vent is sufficiently large for the area of land to be supplied.

The irrigation channels led from the dams are laid out with considerable judgment, but have all one great fault, too great a fall: as a result the banks have been eroded on one side, the channel shoaled up on the other side a little lower down, and so no, till in course of years channels which may have been originally laid out with a fairly straight course, have now attained a course so crooked that it is not easy to give an adequate idea of their appearance.

Again, in consequence of the absence of any means of regulating the quantity of water entering the channels, breaches have been frequent, and when they have occurred they have of late years at all events been very badly repaired.

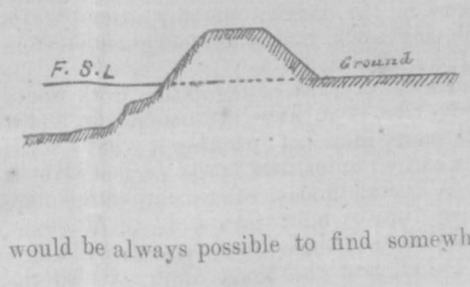
The method of distributing water from the main to the minor channels is rude in the extreme, the practice apparently being that any cultivator who requires water makes a cut through the bank, which is left to widen and become a breach, if unfortunately the channel rises before it occurs to him to close his cut.

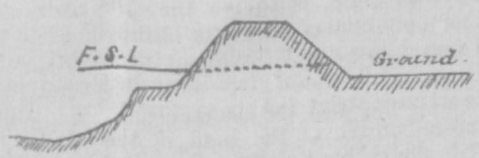
In some cases hollow palmyras, timber sluices, and similar contrivances have been adopted to prevent the breaching of the bank where a distributary takes off; these arrangements answer very well temporarily if properly carried out; but in most cases in this district they are not properly constructed, the timber spout or sluice is generally too short, and the earth has not been made up properly over them, so that though better than a simple cut in the bank, they still leave a weak point, which is certain sooner or later to fail.

If possible no cultivator should be allowed to make a new cut in any bank without permission from some responsible official in immediate charge of the canal, and no cut should be permitted unless the person requiring it is prepared to put in a sound sluice or spout, extending at least 3 feet beyond the toe of the bank on each side; he should also be compelled to make up the bank over the spout a little higher, say 9 inches than the general level of the bank on either side.

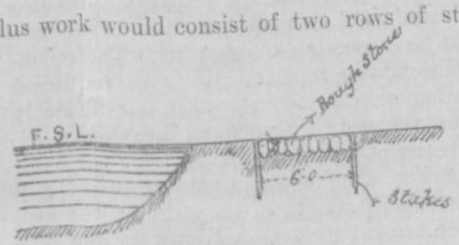
As it is possible that even with regulators at the heads too much water might, either by carelessness, by accident, or from local rainfall, enter the channels, it is desirable that means of escape for this excess water be provided somewhere along the course of each main channel.

The most suitable site for such a work would be at a point when full supply level of the channel coincides with the natural ground level; such a point, otherwise suitable, it might not be possible to find far down all the channels, but it would be always possible to find somewhere near the head of the channel a point where the full supply level of the channel is not much above ground level, and where water might, without damaging the fields, conveniently be discharged back into the river.





In such a situation the surplus work would consist of two rows of stakes six feet apart driven firmly into the ground, the space between the stakes to be filled in for a depth of 1½ feet with stone packed by hand.



The level of the upper surface of the stone packing should never be higher than full supply level of the canal, and the length of the outlet should depend on the size of the channel; the cost would be so small that it would not be a serious matter if the length were somewhat too great; for all the main channels with the exception of the Kyaukse,

Paleik, and the Ngalaingzin channel, a length of 250 feet would probably suffice, but without much more reliable information than is at present available regarding flood levels, rainfall, and the levels of the country, it is not possible to do more than give a rough idea of what may prove sufficient.

The Ngalaingzin channel is already provided with a very long escape.

The circumstances of the Kyauksè-Paleik canal are peculiar and should be noticed more in detail, for though comparatively of minor importance as an irrigation canal, its great importance as a line of navigation has attracted attention to it. It is but one of a great many channels depending on the Zawgyi river, and it would not be wise to treat its improvement as an isolated work; it must be considered in connection with the whole irrigation system of the district; any attempt to deal with it separately would almost certainly lead to disappointment.

The Zidaw dam at Kyauksè is the last on the Zawgyi, and diverts water into the Paleik canal; it is so constructed that water can only pass over it in extraordinary floods, and all the water is thus forced into the Paleik canal which is now virtually the river.

At intervals along its course channels are taken off to the fields, and at Sèdu, seven miles from Kyauksè, the canal bifurcates; the left branch, which is called the Myaungzôn channel, runs in a north-westerly direction, and the right branch goes on to Paleik, throwing off small channels along its course. With a small supply of water in the river there is generally a scarcity of water at Paleik; with a flood there is an excess of water, and there being at present no means of getting rid of it at Paleik, the canal breaches.

The canal is extraordinarily crooked, the banks are very low, the breaches that have occurred have been badly repaired, and the small irrigation channels along the canal have as a rule no proper heads. Obviously the first thing to be done were it proposed to put the canal into thorough order, would be to provide some means of regulating its water level, next its course should be straightened, its banks should be made everywhere 3 feet above full supply level; they are at present very little above water level; the breaches should be strengthened, the distributary channels provided with efficient heads to prevent waste of water, and finally, its fall, which is now about 1 foot 6 inches per mile, should be reduced by the introduction of locks and weirs.

All this would involve complete surveys and levels of the canal and the expenditure of a considerable sum of money; while even as it is the canal does its work very fairly. The following seems all that can be done to improve the Paleik canal, without running the risk of doing work that may hereafter turn out useless.

For the present it would certainly be prudent to do only so much work as may be necessary to remedy serious defects and to prevent the canal from deteriorating, all radical improvements being postponed till a complete scheme for the whole district has been drawn up. This part of the subject will be referred to hereafter.

A bridle path all along, at least one bank of the canal, should be cleared; in many places the bank is overgrown with trees and bushes, and it is impossible to get along it; this path would not only be useful for inspection purposes but would be of service to men towing boats. The trees growing almost in the water should be removed; their overhanging branches collect straw, rubbish, and produce sets on the banks; floating trees, bushes, plantain stems should also be removed; they accumulate in heaps and produce shoals, and they everywhere collect at the bridges.

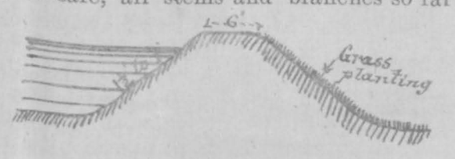
Bridges are very numerous, some very low and most of them obstructive to navigation; it would cost a great deal to improve them, and they might be left as they are till the future alignment of the canal is decided on.

The banks should be everywhere raised to a height of 3 feet above full supply level and the numerous breaches should be properly repaired.

Judging from the appearance of the breaches which have been closed, they seem to have been first roughly stopped with branches of trees, mats, &c., earth being thrown in as soon as the current was sufficiently diminished.

The branches, &c., remain in the bank, and as they decay the bank will subside, leak, and finally breach again.

It would not be possible entirely to re-open and then properly close these breaches, but it is desirable that they be strengthened, and it will probably suffice, if they be cut into as far as is safe, all stems and branches so far removed, the earth heavily rammed, and the bank made up with slopes of not less than 1½ to 1 and a top width of 6 feet; in rear of the breaches grass might with advantage be thickly planted; it costs very little, spreads rapidly, and is most effective in stanching leaks.



The heads of all the irrigation branch channels should be provided with simple regulators, hollowed palmyras, or timber box sluices.

The most serious defect in the canal is the impossibility at present of regulating its water-supply; a head sluice would be very costly as at the only point where it could be placed without interfering with navigation, the canal is 160 feet broad, and receives the whole of the Zawgyi river below the Kyauksè dam.

At first sight it would seem a simple matter to lower the work which now blocks up the old course of the Zawgyi river or to substitute a set of sluices; but apart from the cost of such a work, there is the question whether the old course of the Zawgyi having been blocked for so many years would now carry off all the water without doing damage.

In the town of Kyauksè it has evidently been encroached on, and it would be rash to revive its use till this point has been thoroughly considered.

On the score of cost alone, any attempt at regulation of the canal at its head seems out of the question, and the only alternative is to endeavour to get rid of the water somewhere lower down, where the cost will be small, and where water can be safely disposed of.

At Sèdu, about seven miles from Kyauksè, the Zawgyi river in its windings comes close to the canal; the full supply level of the canal is flush with the ground level, and about two feet higher than maximum flood level of the Zawgyi. A surplus work of stakes and stones could very conveniently be placed at this point, it would cost very little, and the water would run into the Zawgyi, which is there well below the level of the country.

An escape 300 feet long would suffice; its crest level should be about one foot below full canal level, and to maintain the canal at full level a turf bank which the water would wash away if it rose might, if necessary, be erected, care being taken that it is not made unduly strong and that in case of a rise of water it is breached.

It is possible that with improved regulation of the distributaries along the canal, a lower level of water might be found sufficient, in which case no bank along the escape would be necessary, and this would be a great advantage, as such banks, if not frequently carried away by the water, become consolidated and resist the water too long.

On the other hand if it turns out that the present full supply level of water in the canal continues necessary, it is better to keep the crest of the escape low even at the risk of having to allow a bank along it, since with improved means of regulating the irrigation sluices, the cultivators might, in case of heavy rains, close their sluices to prevent their fields being flooded and thus raise the water level in the canal to an extent which would be dangerous were there no escapes.

Again, opposite the village of Zibyugyo another similar escape should be put in; a length of 150 feet would probably suffice, and its crest might be placed six inches below full supply level of the canal.

Finally, a tail escape at Paleik is required to get rid of the water which naturally collects at this the lowest point of the canal; here a length of 50 feet would suffice, and its crest should be placed at canal full-supply level.

With these improvements the canal should do its work quite well enough for the present; no attempt at reducing the fall and velocity of the water seems urgently needed.

The old bed of the Zawgyi, where it passes through Kyauksè village, is very much choked by accretions of sand and silt; it is most desirable that these obstructions should be cleared away at once, and that no further encroachment on the river bank be permitted. Many new houses are being built in the village. If possible no new buildings or enclosures should be permitted within 50 feet of the margin of the river, as it is possible that it may hereafter be necessary to embank it.

In addition to the direct irrigation from the channels, there is a small area of land irrigated from tanks; these tanks, the most important of which is the Minhlakan, require attention; the sluices, where they exist, are in bad order and the banks are low and weak.

Beyond strengthening the banks where weak and repairing the sluices nothing can be done till the tanks and their supply-channels are surveyed and levelled, nor would it be safe to spend much money on them, as with improved channels and water-supply it may be possible to irrigate the present tank cultivation and tank beds direct from channels.

Drainage, which in most irrigated tracts gives so much trouble, is not a serious matter here, and if the main channels leading from the rivers have regulating works constructed at their heads, nothing more than the existing drainage courses will be required for the present; the subject is one, however, which will require attention when the general improvement of the works is under consideration.

All the works referred to above as necessary to maintain the irrigation of the district are of the simplest description, and nothing has been suggested which is new to the country, so that with very little supervision the workmen who now repair the dams and channels could carry them out perfectly.

Some permanent supervising establishment is absolutely necessary, as at present the work falls entirely on the Deputy Commissioner and his subordinates.

There are now certain minor officials whose duty it is to look after the channels and to collect the revenue; they also apparently collect coolies to do repair work, it being the duty of the villagers interested to supply a certain amount of labour annually.

Possibly they do their work as well as can be expected, but some more reliable agency is certainly required; and considering the large area of irrigation and the immense number of channels to be maintained, the district can well afford a small irrigation establishment.

To form an opinion of any value on the best means of improving and developing the irrigation of the Kyauksè district, it is essential that much information which cannot now be obtained should be collected, and that there should be no doubt of its accuracy. Experience has abundantly proved that there can be no more fatal error than to attempt to design hydraulic works of any magnitude on imperfect or doubtful data, for in such works an apparently slight error may produce consequences so far reaching that to correct it would virtually mean recasting the entire scheme.

Too much caution cannot therefore be exercised in dealing with works such as those in this district, which with but trifling repairs can be made to do their work well enough for some years.

There can be no doubt that there is room for great improvement and extension of irrigation, and that in all probability properly designed works would bring in a large return, but in order to lay them out trustworthy information is necessary in regard to—

(1) the quantity of water available for irrigation;
(2) the cultivated and culturable acreage of land commanded by the rivers;
(3) the rainfall.

In regard to the water available, an attempt was made to arrive at its quantity, but not much reliance can be placed on the results obtained. What it is specially necessary to know with accuracy is how much water can be depended on continuously during the cultivation season or for, say, nine months of the year.

In the absence of any data on this subject it was necessary to depend on information supplied by the inhabitants of villages near the river, and such information, at all times vague, failed to afford what was sought; since though it was always possible to get an idea of the height of a maximum flood, there being everywhere some one who knew approximately how deep the water stood in his own house and could point out its marks, it was found quite hopeless to arrive at any satisfactory conclusion as to the average level of the river during the rains.

It is therefore necessary that gauges should be erected at suitable points and the height of the rivers systematically recorded, and, if at all possible, these gauges should be erected at once before the rivers rise.

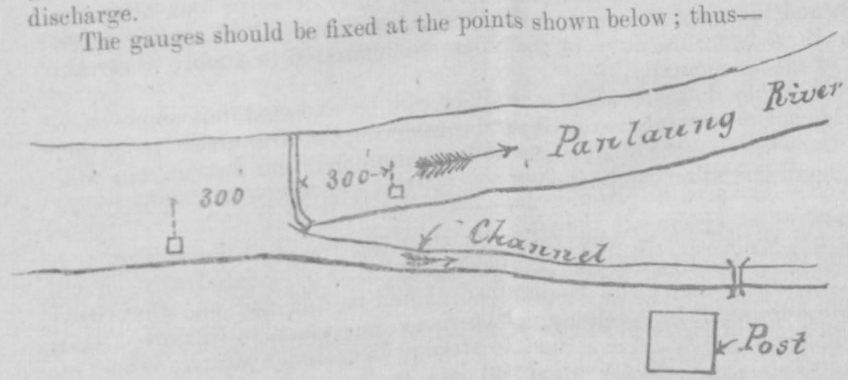
The readings should also, if possible, be recorded twice daily, morning and evening. In order that the record kept may be of value, there should be no doubt of its accuracy; and to secure accuracy it will be probably necessary to place the gauges near some military or police post; if so, gauges might be placed at Kyauksè on the Zawgyi, at Ingôn on the Panlaung, and at Thabyedaung on the Samôn.

At Kyauksè they should be placed one above and one below the dam; the depths of the two channels branching off from the dam should also be recorded daily. This will suffice to admit of the discharge of the river at Kyauksè being calculated, and from this the total discharge of the river must be arrived at.

It would be much more satisfactory if it were possible to obtain a record of the height of the river above the first dam before any water is drawn off for irrigation, but as there is no village near the dam, it is to be feared that this is hopeless.

On the Panlaung there is fortunately a police post quite near the first dam, and it will be possible to obtain data for the calculation of the entire river discharge.

The gauges should be fixed at the points shown below; thus—



The depth of water in the channel at the bridge below the post should also be daily recorded.

The zero of the gauge above the dam should be about two feet below the level of the crest of the dam, and that below the dam should have its zero at about the bed of the river.

At Thabyedaung the gauge should be fixed in the river bed at the point nearest the post, its zero being placed at bed level of the river.

The Samôn is not at present turned to account in this district, but if from the records of its rise and fall it appears that its discharge is considerable, it might be found practicable to extend irrigation to the south of the river.

It is not likely, with so capricious a stream as it appears to be, that it will ever be safe to attempt canal irrigation, but it might be possible to construct

tanks in which its flood waters could be economically stored and gradually utilized.

However this may be, it will cost very little to register the height of the river, and the information is sure to prove of use hereafter.

Two gauges have been made here and will be erected at the (Kyauksè) dam; with these as a guide there should be no difficulty in making the others required.

It was stated above that an endeavour has been made to find approximately the discharge of the Zawgyi. The result as explained is by no means satisfactory, but it may be given for what it is worth.

It was found, from the data obtained, which were of course not accepted without every attempt at verification, that in a maximum flood the Zawgyi discharges 12,700 cubic feet per second over the Kyauksè dam.

Now, assuming that this maximum discharge is something more than double the ordinary discharge, there would appear to be, say, about 5,000 cubic feet of water available for distribution after all the existing cultivation above the dam is supplied, and supposing that one cubic foot of water per second is sufficient for 40 acres, a very moderate estimate of the duty of a cubic foot, the Zawgyi should supply water for 200,000 acres.

The discharge of the Panlaung may be taken about one-and-a-half times that of the Zawgyi, and consequently should suffice for 300,000 acres of irrigated land.

It is next necessary to deal with the subject of the area available for cultivation. This point is also somewhat involved in obscurity. A return drawn up in the office of the Deputy Commissioner and with great trouble, as data had to be collected from the subordinate officials, seems to give the following:—

Name of river.	Royal land cultivated in 1243.	Private land cultivated in 1248.	Waste.	Total.
	Acres.	Acres.	Acres.	Acres.
Zawgyi	14,947	7,229	54,862	77,038
Panlaung	1,349	3,874	15,609	70,832
Total ...	16,296	11,103	120,471	147,870

N.B.—The area is given in the original statement in pès: in the above it is in acres, at $1\frac{3}{4}$ acres to the pè.

If this is correct, there is throughout the whole district but 150,000 acres of cultivable land of which only 27,400 acres have been cultivated; there is some difficulty in ascertaining exactly what these figures do mean. Probably the meaning is that of 148,000 acres once cultivated only 27,400 acres were cultivated in 1248 (A. D. 1886-87).

From the Burmese maps of the district it seems to contain in all about 900 square miles (one daing or Burmese unit of distance being taken as 2·4 English miles), or 576,000 acres. Of this total area a large proportion is necessarily occupied by villages, gardens, rivers, channels, roads, and isolated hills, of which there are a considerable number.

What deduction should be made for these, and for the land too high to be commanded by the water, it is not easy to say, but it would probably be within the mark to put the total cultivable area of the district at 250,000 acres.

It has been shown above that the Zawgyi and Panlaung together are probably capable of supplying water for 500,000 acres, so that they would seem well able to supply all the water that can be used.

These figures are not put forward with any pretension to accuracy as has been explained, and as is evident from the manner in which they are obtained;

there is one fact, however, which it is impossible for any one with a knowledge of the circumstances to doubt and that is, that if with their very imperfect and wasteful system of irrigation, the natives of the country succeeded in irrigating nearly 150,000 acres, with improved works and proper supervision 250,000 acres can certainly be irrigated.

Rainfall registers of course do not exist; some idea of the annual rainfall, and particularly of the heaviest falls within a short period, is desirable.

It is not so much the total rainfall of the year that it is necessary to have information on as the greatest quantity that may be expected to fall, say during 24 hours. Works which might suffer in no way from fall of say one inch a day for a week, might be utterly wrecked by a fall of one inch one day succeeded by six inches during the next 24 hours.

A rain-gauge might with advantage be placed at each of the seven posts in this district; it would be a very easy matter to record the rainfall and specially to note any extraordinary fall of rain.

Care will have to be taken that the gauges are placed clear of trees and buildings.

To complete the information required, a correct survey of the district, showing the rivers, channels, villages, and cultivated land, &c., and lines of levels along the rivers and channels are essential.

There are at present no maps on which reliance can be placed; the Burmese maps, of which there are many, are professedly drawn to scale, but they differ so greatly from one another that the majority of them must be wrong, and very wrong too, the error in some cases extending to miles.

The country (particularly the water-courses) is so overgrown with jungle that it was impossible to do more than to check the accuracy of the maps in their main points; a few attempts to take levels were made, but the progress was so slow owing to the clearing required, that it was given up as hopeless of completion in any reasonable time, and only such levels as were absolutely necessary were taken.

There was also a difficulty in procuring escorts sufficient to admit of such work being carried on rapidly.

What is necessary is to appoint a staff of surveyors to do the work thoroughly and systematically. A survey will eventually have to be made for other purposes, and even if no irrigation works are after all undertaken, the work of the surveyors now recommended will not be thrown away.

For irrigation purposes the survey should show accurately every river, stream, and channel in the district; minor channels, such as field distributaries, need not at first be surveyed, though they might be shown in their approximate positions on the map; longitudinal and cross-sections of the rivers and certain main channels are necessary; village sites and cultivated land also should be shown.

With this and the other information stated to be necessary the problem of how to lay out the irrigation works to the best advantage can alone be successfully dealt with, and with nothing less.

Even with the meagre and doubtful information at present available, there are certain points in connection with the subject on which there can be no doubt.

There can be no doubt for instance that there are now too many dams and too many channels, and that one good dam at the head of each river with a suitable system of channels would probably do all the work of the present dams, would be cheaper to maintain, less liable to accident, and distribute water much more economically. On the Panlaung the dam would be placed at or near the site of the present dam, a mile above Ingôn. The determination of its exact position depends on whether it is possible to take off from its left side a channel to supersede the Natwè channel now taken off at the Natwè dam, six miles lower down the river. So far as the levels are concerned there is nothing to prevent this being done, but there is a spur of hills close to the south bank of the river extending from Ingôn downwards, and it may not be easy to work

in a channel to join the present Natwè channel : to settle this much clearing of jungle and a survey is necessary.

On the Zawgyi the permanent dam would also be placed as near the present first dam (Nadet) as possible, subject to the investigation of a similar point to that referred to in connection with the Ingôn dam, since the dam should, if possible, be so placed as to supply the Ngapyaung channel which now depends on the second (the Thitsè) dam.

Here, however, this is not a matter of very great importance, for the cultivation on the left bank, now depending on the Nadet dam, is commanded by the Ngalaingzin channel from Ingôn, and the permanent dam on the Zawgyi could be placed lower down.

The higher up the river the dam is placed the more land it commands, but the advantage may be too dearly purchased if, for instance, the new channel to be taken off the right bank is found to require rock-cutting.

In order to decide on the style of work to be adopted for the construction of the dams on the rivers, it is necessary to know the greatest depth and velocity of water they will be subjected to, and also to have borings of the river bed ; but though premature it may be well to offer a few remarks on the subject. There are several alternatives :—

(1) There may be no dam at all, simply a flooring of stone across the river bed to prevent its deepening out. This of course would be the cheapest of all, but it can only be adopted if it is found that the river runs with such a depth that it is unnecessary to raise its level : on the other hand, the channels leading from the river would have to be dug proportionately deeper, and the cost of this might be greater than that of a dam : the fall of the country, is however, so great that a channel with a small fall would soon run out of deep cutting.

(2) The dam might be made on the same model as those now existing, but with improvements : this, however, cannot be recommended.

(3) A solid masonry dam may be built, and for this there are exceptional facilities. Stone and lime are abundant quite near the site of the dam ; the main difficulty would be to get skilled labour to blast and work the stone.

So far as can be seen, stone is very seldom used in Native buildings, and it may be doubted whether men could be trained in a reasonable time to do the work. Workmen could be obtained from India, but this would be very costly, and should, as far as possible, be avoided.

The dam might be built of brick ; good bricks could be made on the spot ; brick-making of a sort is quite common, so that it would not be difficult to turn out good bricks after a little experience.

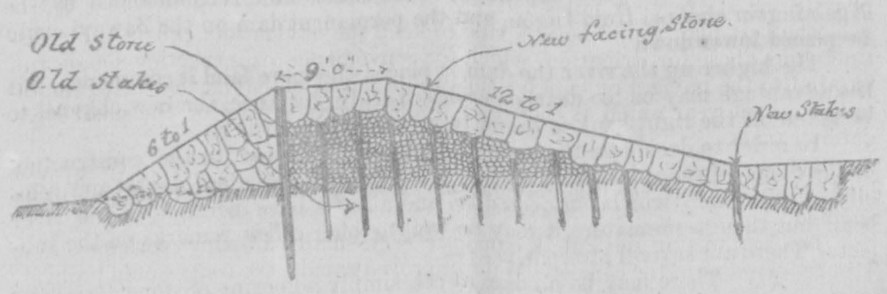
It would still be necessary to face the work with stone, and there would not be much saving in using brick.

If, however, the railway works require much masonry, trained men might be more easily found, but they would certainly be very expensive.

Taking all the circumstances into consideration, and specially that a cheap effective work is what is required, the best plan seems to be to adhere to the present site of the two head dams and to improve them.

Both dams are believed to have been in existence for many years, and though year by year superficially repaired, are doubtless solid within ; they would therefore, it is believed, answer very well as the case of a more substantial work, and might be treated thus : across the river, immediately above and below the present dam, let a row of stout piles, say 8 inches in diameter, be driven well into the river bed, their heads connected by a waling piece, then let the whole surface of the present dam be protected by a layer of heavy stone packed closely, the spaces between being filled in with smaller stones, chips, &c., and above and below the rows of piles let an apron of rough stone be thrown at random into the river bed. Such a work, which the sketch below more clearly explains, would, it is thought, answer every purpose and require very little skilled

labour. Possibly it might be found from borings that there is rock not far below the river bed, in which case piles could not be driven, but in their place two walls of very rough masonry would answer the same purpose, which is simply to prevent the sides of the dams being scoured or slipping away.



The stone used to face the old dam to be as large as can be handled ; none less than 2 feet in length ; they should be set on end, and well rammed into the old work.

At each end of the dam scouring sluices, with their floors at river bed level, would be necessary ; they need not be of great size, their use being simply to prevent an accumulation of sand in front of the entrance to the channels ; at each end three vents of 6 feet by 4 feet would probably suffice ; they should be opened and closed by screws.

Next a regulating sluice at the head of each channel would be required, the size depending on the acreage under the channel ; the vents would be closed by shutters, also worked by screws.

Finally, if it be intended to use the canals for navigation, locks would be required.

The scouring-sluices and head-sluices should, if possible, be of brick or stone ; no doubt they could be constructed in great measure of timber if thought advisable, but it seems doubtful whether for these particular works there would be any ultimate saving by using timber which is by no means cheap even now.

For the locks, if built, timber might be used, but it would be preferable to build the head and tail bays of masonry and have the chambers simply with rivetted sides. Small locks are commonly built in the Madras Presidency for Rs. 18,000 or less, but in this country the cost of masonry is probably four times the Madras cost. A lock, such as that described above, would probably cost in this country not less than Rs. 40,000. What a timber lock would cost would depend on the rate at which timber might be procurable, but with weir complete it might be put at Rs. 20,000.

The cost of the scouring-sluices and head-sluices would depend on local circumstances, such as subsoil, depth of water, &c.

Before laying out the channels it must be decided to what extent it is desired they should be made navigable, and what their general direction should be so as best to meet the requirements of trade.

With such a very heavy fall in the country as has to be dealt with, the cost of reducing the velocity of the channels so as to adapt them to navigation will be considerable.

A fall in a channel of 8 inches a mile is the very utmost that can be allowed, if it is to be at all navigable ; 2 inches a mile fall gives easy naviga-

tion, and it may be doubted whether a large channel with a fall of 8 inches a mile can properly be called navigable.

Assuming, however, that this 6 inches a mile fall is adopted, the result is that the fall of the country being something more than one foot six inches per mile, it will be necessary by means of locks to eradicate one foot a mile of this fall, and putting nine feet as the maximum drop it would be desirable to give each lock, a lock every nine miles becomes necessary.

It might be cheaper to give less drop and increase the number of locks, placing one at every six miles.

The best plan would be as a rule to keep the navigation canals quite distinct from those for irrigation, which for convenience of inspection should run parallel to the navigation canals; this would admit of navigation being maintained all the year round as the water would always suffice for the small navigation canals.

The size of the irrigation channels would depend of course on the area of land supplied, but for the navigation canals a uniform section might be adopted.

The boats using the Paleik canal are very small, drawing perhaps 1 foot 6 inches of water at the utmost. With improved canals, the boats would probably improve; it would therefore seem desirable to provide for a minimum depth of water of 3 feet 6 inches and a minimum breadth of 25 feet at the water surface.

Such a canal as this would cost approximately Rs. 5,000 per mile, and adding Rs. 3,000 per mile for timber locks, &c., the cost becomes Rs. 8,000 per mile.

For irrigation alone the fall of the canals could be increased to 9 inches a mile, cheap drops of stone and stakes being introduced to bring the fall of the canal to that of the country. The existing channels would be utilized as much as possible, where they can be made serviceable with moderate improvements.

The existing distributaries would be utilized also, their number reduced, and permanent sluices erected to regulate the admission of water; for all such arrangements a correct survey being first necessary.

With the river cleared of all the dams which are rendered useless by the new works, the country would not be so liable to being flooded as at present, and the cultivated land would drain freely, but at some places it might be necessary to embank the rivers, as for instance at the junction of the Panlaung and Samôn, where the country is said to be annually inundated. It is not quite clear whether this is due to the excess of water discharged by irrigation channels or by the river floods; the Natives assert it is due entirely to the rivers, and if so, they will have to be embanked, but this will not be costly.

Similarly, it may be necessary to embank the Chowlay stream, and to give it a proper outlet into the Zawgyi.

Some small drains will be necessary at the ends of the canals, but they will not cost very much.

On the sketch-map the probable alignment of the main canals is shown.

It is assumed that one main line of navigable canal right through the district will be necessary, and that it should be connected with the Panlaung and Myitgnè rivers; it is shownas starting from Ingôn, passing Yewun and Kyaukse, and joining the Myitgnè at Paleik. Ingôn is the natural starting point as the dam is there, and as it seems probable that traffic beyond the hills may enter the district by the Natteik pass; but on such points the opinion of the local revenue officers will be necessary, and probably it is too early to form a correct opinion.

This canal would be entirely for navigation, and on its left side would be an irrigation canal as shown.

From Ingôn also would start a canal along the line of the existing channel running north; no locks would probably be required as it runs transversely to fall of the country; it would enter the Zawgyi above the first dam, and throw off distributaries along its course, thus serving both for irrigation and navigation.

Then from the dâm on the Zawgyi a canal might be taken as shown round by the hills, distributing water as it goes; it also should require no locks, but would answer for navigation.

The other canals and the larger distributaries would also provide navigation of a certain sort, and would certainly be more convenient for carriage than the ordinary village roads, which during the rains must be almost, if not quite, impassable.

The cost of the works necessary to irrigate 250,000 acres, to provide a fairly good irrigation canal from Ingôn to Paleik, 46 miles long, and 134 miles of canals, giving better navigation than the present Paleik canal, including dams and all necessary works, but of the cheapest description, may be roughly estimated as not to exceed 40 lakhs of rupees, and this does not take account of the probable saving by working in parts of the existing canals, which, as the sketch shows, are followed closely wherever possible.

What the return would be cannot be stated, unless it is known at what rate the land will be assessed and on what acreage; that is, whether on the total area irrigated, or only on the acreage in excess of what was formerly cultivated.

Supposing, however, that the 100,000 acres new land only be assessed and at Rs. 6, per acre, the return would be six lakhs of rupees per annum. Putting three-fourth lakh of rupees as the annual cost of maintenance, establishment, &c., and omitting any possible return from license fees for boats, the scheme would seem well worth executing and worth working out in detail: still more so if some credit be taken for the existing works, whose annual cost of maintenance the new works would greatly reduce.

It is most desirable that a small establishment be appointed as soon as possible to look after the irrigation works of the district, and to execute such repairs and small improvements as are necessary.

An expensive establishment is not at all necessary; all that is wanted for the present is a man of about the rank of 1st grade Overseer, who understands surveying, levelling, and has had experience of irrigation works. If such a man cannot be found in Burma, there should be no difficulty, if proper inducement be offered, in obtaining him from Madras.

By preference a man who has had experience in the southern irrigation districts of Madras rather than on the larger works in the northern districts should be selected.

He should not be a Hindu, should be unmarried, and should be engaged for a term of say three years, on a salary of Rs. 200 per month (consolidated), with the ordinary travelling allowance of his grade.

The salary proposed may seem high, but a good man would not come for less. Service in Burma is far from popular in India, or at least at Madras, where the most exaggerated ideas of the discomforts and drawbacks of the country are prevalent. Men on the permanent establishment are besides deterred from coming by the fear that during their absence they may be overlooked, and on their return find themselves superseded by their juniors.

Supposing such a man appointed, his duty would be constantly to move about the district, inspecting the channels, doing here and there such work as seemed necessary to prevent loss or waste of water; he should have nothing to do with payments. The village officers should, under his direction (with the approval of the Deputy Commissioner, except in cases of urgency), supply materials and labour; he should check and sign their bills, which would then be paid by the Deputy Commissioner or his subordinate officers. It is not pretended that such a system would entirely put a stop to peculation, but it would considerably reduce it, and that is all that at present can be expected. Should it be decided to adopt the suggestions offered, and to make a survey of the district, the surveyors would work under the orders of the Overseer, and he should be held responsible that they did their work properly so far as he could see, and should assist them with his advice.

The surveyors should, however, be responsible for the accuracy of their work to the Executive Engineer of the division, to whom they should send their work at least every 10 days.

Three surveyors on Rs. 100 would finish all the essential work in nine months; thereafter one surveyor might be retained to do work from time to time found necessary.

	Rs.
1 Overseer at Rs. 200	200
Travelling allowance, say, 20 days at Rs. 2-4-0 per day ...	45
1 Interpreter and Writer	30
6 Lascars (Burmans), Rs. 10 each	60
Contingencies	10
	345
3 Surveyors at Rs. 100	300
24 Lascars at Rs. 10	240
1 Draftsman	60
Contingencies, pegs, &c., cutting bushes, boats, &c.	50
Total ...	995

To allow of the surveyors doing their work the channels must be cleared of bushes and trees, and in case surveyors are to be appointed, this should be done beforehand. A broad path along the bank of each river and channel of any size would be necessary; in many places there are gardens up to the edge of the river; there it would be necessary to go round.

After the surveyors have been at work for three or four months an Irrigation Officer of some experience might be appointed to this district, and he would have then no difficulty in drawing up a scheme for the permanent improvement of the irrigation; to appoint him earlier would be of little use, as he would have no materials to work on.

In the hope that Government may see their way to take up the maintenance and improvement of the irrigation works of this very promising district somewhat on the lines suggested, a memorandum of instructions for the guidance of the Overseer and surveyors is attached to this report; there is little in the memorandum which has not been stated above; it is added merely to give in a condensed form what has been recommended, and to save trouble.

There is one more point which it may be well to mention, though it scarcely falls within the purpose of this report. If, as seems inevitable, Kyaukse hereafter be the headquarters of an Executive or Assistant Engineer, it seems desirable that a piece of land should be reserved for his residence and office. Building is going on in all directions, and very soon all the best sites will be occupied.

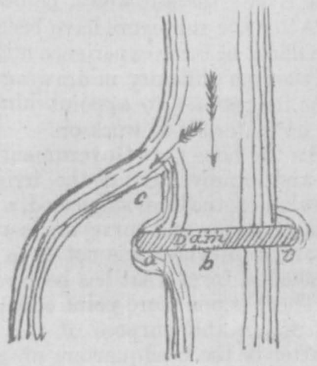
The report cannot be concluded without acknowledgment of the great assistance received from the Engineers of the railway now under construction in this district. The railway traverses the whole district, and the levels and other information kindly supplied by the Engineers has been of great value in giving the fall, &c., of the country.

It remains only to express a hope that this report may be such as is required by Government, and that Government may be pleased to adopt the suggestions made.

APPENDIX A.

INSTRUCTIONS FOR OVERSEER SUGGESTED TO BE PLACED IN CHARGE OF IRRIGATION WORKS IN KYAUKSE DISTRICT.

Dams.—Any trees or bushes growing on the dams themselves should be removed at once, and trees whose branches overhang the dam, and are likely to collect floating bushes, &c., should be pruned or removed, the dam and the river approach to it being always kept quite open.

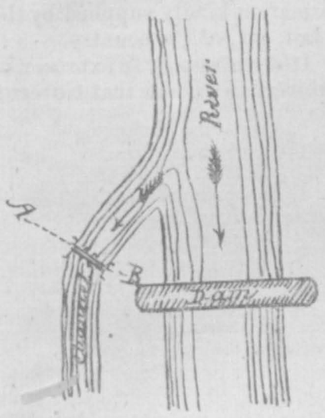


Any stones that may be removed from the surface of the dam should be replaced at the earliest opportunity, stones as large as can be carried being used.

If the river seems to be cutting away the ends of the dam *a a*, or cutting into the down stream side of the dam, stones should be thrown in till the scouring is stopped.

If the river rises over the ground between the ends of the dam and the channel taken off it at C, and thus spills into the river or channel, a bank should be thrown up to stop it.

Channels.—As soon as possible, regulating sluices at the heads of all main channels should be erected; they should not be placed quite at the head of the channel but a little 50 feet or so down the channel, so that there may be less danger of their being cut round by the river. A bank should be made connecting the end of the dam with the ground well above maximum flood level beyond the channel, on the line A B, and the maintenance of this bank should be carefully attended to.

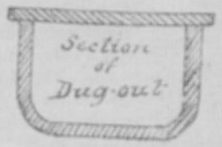


The head of the channel should be always kept clear of trees and floating rubbish.

The size of the sluice at the head of the channel depends on the acreage under it and the depth of water in the river. A table is given showing the approximate size of timber sluices required for different acreages; but after a sluice has been in use for a little time, the depth behind it, which gives sufficient water for the acreage cultivated, should be marked and water not allowed to rise beyond the mark. Where a sluice if square would interfere with navigation, as at the heads of some of the main channels, it can be made not square but oblong in shape, the correct area of opening being preserved.

Distributaries.—The heads of all distributaries should have timber sluices provided as soon as possible, the sizes being taken from the table attached.

For small areas a hollow palmyra 6 feet longer than the bottom breadth of the bank, or better still, an old dug-out boat with planks nailed over the sides, would answer very well; the joints between the planks being caulked with the material used for caulking the boats.



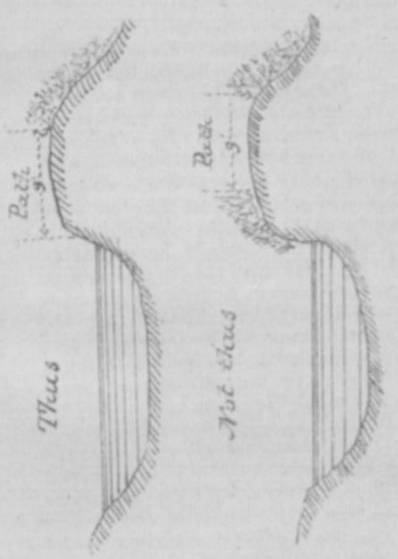
In fixing these wooden sluices the main points are to see that they project at least 3 feet beyond the toe of the bank on both sides, that the earth filling over them is well rammed down, all lumps broken, and no straw, or branches of trees, mixed with the earth; two stout upright posts projecting above the surface of the water, one on each side of the head of the sluice, as a guide to any one who has to stop the water; to do this the opening may be stopped by turf.

For larger areas than 50 acres a properly made sluice of timber, of the design given elsewhere, should be invariably used.

For areas not exactly any of those given the sluice may be made proportionately larger or smaller, but as the discharge can be regulated by the shutters, a sluice may be slightly too large without necessarily leading to loss of water; it is always as well to be prepared for any increased cultivation. The table provides for this by assuming that one cubic foot of water per second will cultivate only 40 acres, whereas 60 is nearer the truth.

As soon as any sluice has been in use for sufficient time to test its efficiency, the depth of water in front and rear, which gives a full and not excessive supply to the fields, should be marked and recorded for future use.

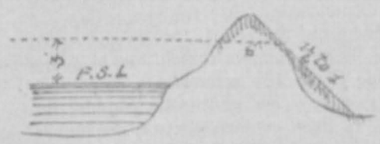
Embankments.—The embankments of all channels, large or small, should be at all times accessible; a bridle-path should as soon as possible be cleared along each channel, and this path should be cleared from the water's edge outwards, so that it may be possible to see completely across the channel. It may give some trouble getting this done to start with, but if properly done, the path will be used by villagers, cattle, &c., and this will help to keep it open. For large channels the top of the bank should be nowhere less than 3 feet above full supply level; for minor channels it may go down to 1 foot 6 inches, but should in no case be less than this.



The top width of the bank, at a height of 3·0 feet above F. S. L., should not be less than 6·0 feet, and for small channels, at a height of 1·6 feet above F. S. L., not less than 3·0 feet.

In many cases the banks are greater than these dimensions, and then of course nothing is required.

Thus a bank may have a section like the sketch in the margin, and though it runs up to a point, may require no work, since at the level of 3·0 feet above F. S. L. it is thick enough, but it might be an advantage to cut off the superfluous height and increase the slope of 1½ to 1, which should be the least slope of any earthen bank.



Breaches.—Where there are old breaches which are leaking and their slopes slipping down, the cause is almost certainly that they contain below the bank quantities of branches, straw, palmyra stems, &c., which are decaying. In such a case cut off as much of the outside of the bank as possible with safety, pull out as many of the branches as possible, tamp the earth well and make up the bank: in rear plant freely, at distances of 9 inches apart, pieces of the grass known in Tamil as "nanel," in Telugu as "rellu," and in Burmese as what sounds like "kaing."

It does not seem to be much used here, but there is nothing better for stopping slight leaks and for holding a bank together or protecting it from the wash of water: its chief drawback is that cattle eat it freely when the shoots are young.

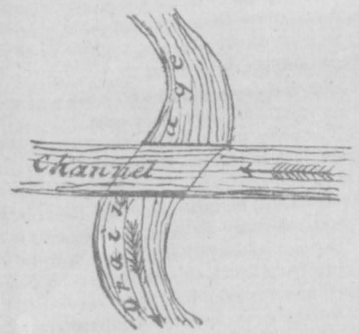
Wherever there are frequent breaches, there must be either excess of water or weakness of the bank; if the banks are generally strong, the breaching must be due to excess of water, and if the regulating sluices do not stop this, it will be necessary to put in an escape.

Escapes.—The length of the escape depends on the quantity of water to be discharged, and may be made double the length of the breaches running open together.

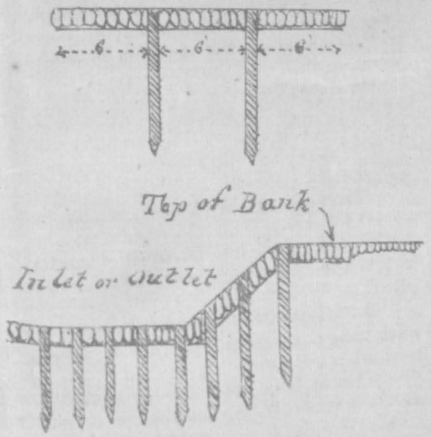
The escape should not be put in at the site of a breach out of the canal, but higher up, and particularly when the outside ground is high.

Its crest should be not higher than the F. S. L. of the channel.

When a drainage breaches into and then out of a channel, an escape on each side may be built, its crest at F. S. L. and its length such that with 1 foot 6 inches on its crest it shall discharge all the drainage water; the outlet for the drainage should be a little lower down the channel than the inlet, thus, so that the drainage water may find its way to the outlet, and not be carried on past it by the current in the channel and thus produce reverse currents.



The inlets and outlets should be simply rows of stakes with stone-packing between; the ends should be carried up to the top of the bank. The cost should be about Rs. 2-8-0 per running foot. As soon as possible, the Overseer should draw up a list of the local cost of every kind of material used, with wages of coolies and workmen of all sorts, and should submit it to the Executive Engineer of the division. Any deviations from these rates should be invariably explained. He should as often as possible inspect any work in progress and use every means of satisfying himself that the labourers shown in the bills have been actually employed, and paid as charged for, and that the materials charged for are of good quality and have been used. He should promptly report to his superior any cases which he thinks require notice, and every 10 days he should send in a journal detailing his movements and the results of his inspection; anything which would not be worth specially reporting should find place in this journal.



As he moves about the district he should, whenever opportunity occurs, note the height of floods in the rivers and record it in such a manner that it can be found again, that is, by reference to some masonry, such as the plinth of a pagoda, &c.

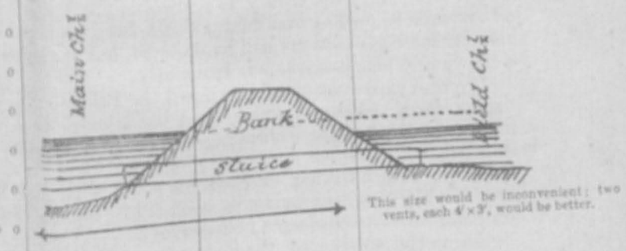
He should endeavour to make himself thoroughly familiar with the irrigation system of the district and its requirements, the cost of labour, and the method of working. With this knowledge it should be possible for him to suggest many improvements to check waste of water and to reduce the cost of maintenance.

J. D. GRANT,
Special Irrigation Engineer.

Table of Sizes of Sluices and Approximate Cost for different Areas.

1 CUBIC FOOT WATER ASSUMED SUFFICIENT FOR 40 ACRES.

Area of land to be irrigated in acres.	Area of vent of sluice in square feet, H=1 foot.	Size of vent, H=1 foot.	Cost per running foot, not including leg cutting and closing bank.	Area of vent of sluice, H=6 in. chs.	Size of vent, H=6 inches.	Remarks.
			Rs. a. p.			
50	A small sprout of hollowed palmyra.					
50 to 100	A large sprout of hollowed palmyra.					
100 to 200	1 sq. ft.	1'0" × 1'0"	3 0 0	1·41 sq. ft.	1'2" × 1'2"	
200 to 300	1·5	1'3" × 1'3"	3 8 0	2·14	1'6" × 1'6"	
300 to 400	2·0	1'5" × 1'5"	3 12 0	2·86	1'8" × 1'8"	
400 to 500	2·5	1'7" × 1'7"	4 0 0	3·57	1'10½" × 1'10½"	
500 to 600	3·0	1'9" × 1'9"	4 4 0	4·28	2'1" × 2'1"	
600 to 700	3·5	1'10½" × 1'10½"	4 8 0	5·0	2'3" × 2'3"	
700 to 800	4·0	2'0" × 2'0"	4 12 0	5·71	2'5" × 2'5"	
800 to 900	4·5	2'1½" × 2'1½"	5 0 0	6·43	2'7" × 2'7"	
900 to 1,000	5·0	2'3" × 2'3"	6 0 0	7·14	2'9" × 2'9"	
1,000 to 1,500	6	2'6" × 2'6"	8 4 0	.....	.....	After 1,000 acres one cubic foot water is assumed sufficient to irrigate 50 acres.
1,500 to 2,000	8	2'10" × 2'10"	9 0 0			
2,000 to 2,500	10	3'2" × 3'2"	10 0 0			
2,500 to 3,000	12	3'6" × 3'6"	12 0 0			
3,000 to 3,500	14	3'9" × 3'9"	14 0 0			
3,500 to 4,000	16	4'0" × 4'0"	15 0 0			
4,000 to 4,500	18	4'0" × 4'0"	17 0 0			
4,500 to 5,000	20	5'0" × 4'0"	19 8 0			
5,000 to 6,000	24	6'0" × 4'0"	24 0 0			
6,000 to 7,000	28	2 vents 3'6" × 4'	28 0 0			
7,000 to 8,000	32	2 vents 4' × 4'	30 0 0			
8,000 to 9,000	36	2 vents 4'6" × 4'	34 0 0			
9,000 to 10,000	40	2 vents 5' × 4'	39 0 0			



This size would be inconvenient: two vents, each 4' × 3', would be better.

Formula.

D in cubic feet per second. } = 5 × area of sluice × $\sqrt{H}$

J. D. GRANT,
Special Irrigation Engineer.

KYAUKSÈ:
The 12th May 1887.

APPENDIX B.

INSTRUCTIONS FOR SURVEYORS SUGGESTED TO BE EMPLOYED ON KYAUKSÈ IRRIGATION WORKS.

ASSUMING three surveyors to be appointed, they should proceed as follows:—

They should go together to Ingôn and first select some bench-mark as near the dam as possible. There are a few deserted pagodas between the river and the channel, on one of which a permanent mark could be cut and accurately described in the field-book. The bench-mark must be in good solid masonry not likely to be injured; and the point where the staff is held should be marked.

Starting from this bench-mark one surveyor should find the value of the crest of the dam: the lowest point of the crest may be taken for this, and the value may be called 300·00 above datum. The bench-mark at the starting-point may then have a value given to it.

From the dam one surveyor (called hereafter No. 1) should carry a line of levels up the river bank for 1½ miles, and take cross-sections of the river at every furlong. He should also take a survey of the river above the dam, and a section along the crest of the dam.

He should then continue his levels and survey down the Panlaung, whose course should be accurately shown. For one mile below the dam cross-sections at every furlong should be taken. Thereafter no cross-sections will be required, merely a correct survey.

The line of levels should be carried down, and the crest levels of all the dams shown. At every mile or so, as convenient, the level of the river bed should be taken.

He should continue up to the Myitgnè river, and on his survey should show at frequent intervals fixed points, such as pagodas, bridges, &c., on the river bank, from which minor surveys can be started. Similarly at every dam, off-take, or inlet some point should be fixed as the commencement of subsidiary surveys, and these points must be minutely described to prevent mistakes.

Having reached the Myitgnè river he should run a check line across to Paleik and fix a bench-mark there, if it has not already been fixed by another surveyor.

No. 2 surveyor should start from Ingôn, go along the Nga Naingngatha (or Ngalaingzin) channel to the Zawgyi, taking a survey and levels with cross-sections at every furlong. He should note and show all channels taking off; all outlets and inlets; fix their levels, and leave bench-marks frequently; at least every mile on permanent buildings. Having reached the Zawgyi river he should survey its course and take levels down to Kyauksè. For 1½ miles above, and one mile below the first dam (Nadet Sè), he should take cross-sections 1 furlong apart: thereafter no cross-sections will be required, but the levels of all dams, channel heads, &c., must be shown and bench-marks left frequently.

From Kyauksè he should go down the Paleik canal, survey and take levels of it with cross-sections every furlong, closing on a bench-mark at Paleik. His survey should be detailed, showing all bends, channels taking off, bridges, villages, &c., also the outside of the bank of the canal.

From Paleik having checked his work with that of No. 1 surveyor he should go north along the Myitgnè, surveying its bank till he reaches the Zawgyi, where he should fix a bench-mark and show its position on his survey.

From the junction of the Zawgyi and Myitgnè he should go up the Zawgyi and join his previous work at Kyauksè. He should take cross-sections of the Zawgyi every mile, and wherever possible note its flood level.

No. 3 surveyor should start from the long outlet on the Nga Naingngatha (or Ngalaingzin) channel about three miles from Ingôn, level and survey down the channel leading from it, the Pyaungbya canal, till it joins the Panlaung at Myittha. Cross-sections every furlong, a detailed survey, and frequent bench-marks are required. At Myittha he would tie on the work of surveyor No. 1.

He should then proceed to the Pyaungbya Sè which he will have already passed, and survey, level, and take cross-sections every furlong down the channel which leads to the Panlaung, when again he would join the work of No. 1 surveyor.

Next he should start from the Natlwè Sè on the Panlaung level, take sections every furlong, and survey down the channel taking off on the left of the Panlaung till he reaches the Samôn; whence he should follow the Samôn till it joins the Panlaung, giving an accurate survey and the level of the river bed at every furlong. At the junction of the Panlaung and Samôn he would tie on to the work of surveyor No. 1 again.

After this he should similarly take up the Kyimyè channel which begins near Kumè and follow it till it reaches the Samôn.

No. 1 having reached Paleik should take up the Myaungzôn, Tamôk, and other channels leading from the left of the Zawgyi, while No. 2 goes on with those from right, and No. 3 fills the branches from the Nga Naingngatha canal.

This will give all the material points of the present irrigation system, and details can be filled in thereafter as necessary.

Sections must always extend at least 100 feet beyond the banks of the river on each side, or 100 feet beyond the level of highest flood. In channels the section must extend 50 feet beyond the outside toe of the bank.

The surveyors must show all gardens, villages, pagodas, &c., on the banks or near the channels and rivers. The position of each sluice, or work of any sort, and its size should also be shown.

The field-book should be inked in daily and the pages all numbered, and the values of all bench-marks should be reported to the Executive Engineer every 10 days.

Note by Major T. GRACEY, R.E., Superintending Engineer, on Report on the Kyauksè District Irrigation Works by Mr. Grant, Special Irrigation Engineer,—dated the 20th May 1887.

MR. GRANT has submitted the above, together with a plan showing the general scheme of irrigation works for the district, with two appendices. Appendix A contains instructions proposed to be given to the Overseer placed in charge of the present irrigation works under the Deputy Commissioner. Appendix B contains instructions for surveyors to be employed on the general survey for new irrigation works if undertaken.

I may here note that I have directed Mr. Grant to leave one of the Overseers he brought over with him from Madras with the Deputy Commissioner, Kyauksè, to carry out the repairs, &c., urgently required in the existing works.

The general tenor of Mr. Grant's report and of the conversation I have had with him is that the existing scheme of irrigation in Kyauksè is far more satisfactory than was at first believed, and that with petty alterations and repairs it can easily be kept in order by the District Officer with his present staff if he had the assistance of a good Overseer from Madras, who would put in escapes and proper sluices where they are required, and who would generally assist with his knowledge of the better systems of distributing water that have gradually come in force in Madras. An Overseer from Southern Madras is recommended because the system of irrigation is very much the same as it is in this country.

As regards the construction of any new project, Mr. Grant is of opinion that it should be postponed till proper surveys and levels have been taken and it is clearly ascertained what amount of water is available for irrigation purposes. A very cursory inspection of the figures given in pages 8 and 13 of the report will show on what uncertain data even a moderate interest on the expenditure of 40 lakhs is founded.

The only points brought out in Mr. Grant's report are—

(1) that an elaborate and fairly workable system of irrigation now exists in the Kyauksè district which can be greatly improved at small cost;

(2) that an improved system could be introduced, but elaborate surveys, plans, and observations must be made before it can be ascertained whether the improved system is financially desirable.

I asked Mr. Grant if he was prepared to stay on and superintend the carrying out of elaborate plans, &c., in the Kyauksè district and elsewhere, but he said that he could not remain longer than the six months he had engaged for, as he proposed to go on furlough at the end of the time and thought it probable he would not return to India.

For superintending these irrigation works we do not want a man who will stay with us for six months only. In that time he has barely had sufficient time to get the work we want done into his head, and then when he is beginning to be useful we lose him. We want a man who will stay with us about five or six years at least, and to whom we would attach two of our smartest young Engineers for instruction. His work would principally be to get out projects for new works or for remodelling old ones, and to assist District Officers with his advice in the maintenance of the existing works by pointing out what repairs were desirable, and by suggesting cheap additions and improvements which would render existing works more efficient. We do not want a very clever man, but rather a hardworking and energetic man, as our object would be to avoid all heavy engineering works and only to carry out what could be done at small cost. There is plenty of such work to be done. I would suggest that we should ask the Government of India to let us have a selected 3rd or 4th grade Executive Engineer from Southern Madras, who would receive a step in promotion to 2nd or 3rd grade for coming here, and who, when here, would get the usual Burmese allowances. The Executive Engineer selected on these terms would probably remain with us altogether, and would become the father of all the irrigation works in Upper Burma, and would consequently have the greatest interest in making his children prosperous.

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5.
PW 4333/87

All communications should be addressed to the Secretary.

19 OCT 87
P.W. DEPARTMENT

No. 2026 G.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

GENERAL.

To

The Secretary to the Government of Madras.
Public Works Department.

Simla, 12th October 1887.

Sir,

With reference to your telegram of the 7th October 1887, regarding Mr Targets employment on irrigation works in Burma I am directed to forward herewith copy of a report by Mr J. D. Grant, Executive Engineer on the irrigation of the Kyaukse District and to request that after perusal of it by the Chief Engineer you will furnish the Government of India with his opinion whether Mr Target is a fit officer to undertake the work or not.

I have the honor to be,
Sir,
your most obedient servant,

G H Walker
Under Secy. to the Govt of India

Document accompanying

P.W.D. 8333

R. 19.10.87

E.3.

(+2 plans)

Note by the Chief Engineer P. W. D. — on letter from the G. of I. No 2026 of 12th October 1887.

After perusal of the report I am of opinion that Mr. Target is perfectly competent to carry out the works suggested therein.

Lt. Col. R.E.
Chief Engineer.
P.W.D.

Madras
Oct. 19. 1887.