A large flood was experienced in the Koo-wee-rup Swamp in 1911, which caused a good deal of damage, especially to the land under tillage, and I was asked to investigate the causes and to formulate a scheme for the complete prevention of a recurrence of the damage.

I found that the causes which had contributed to the flooding were three distinct ones.

(1) The first was the scouring of the Bunyip River, which above the railway in the vicinity of Bunyip township passes through alluvial flats consisting mainly, in the subsoil, of coarse granitic sand. This sand is kept in motion in the upper half of the main drain where the fall exceeds 1 in. per chain, and is deposited partly into Westernport Bay, but a large quantity is also arrested in the lower nine miles of the main drain, and at the 5 miles a deposit of 6 feet of sand is now to be met with, destroying the usefulness of the main drain and blocking the useful section of the side drains which discharge into it.

(2) The second cause I found to be the want of maintenance on the side or secondary drains whereby silt, rushes, and debris had been allowed to block the drains.

(3) The third cause, and a very important one, which contributed to the flooding of the swamp, was the extensive amount of drainage done by private owners adjoining the swamp area, whereby all existing drains had been extended beyond the swamp area.

A scheme was prepared, and it was estimated that by ordinary means the outlay would be £50,500, but I added that by the employment of up-to-date machinery this sum could be reduced by one half.

*Chief Engineer, Victorian State Public Works Department.
On the occasion of my visit to Europe in 1912 I was commissioned by the Hon. the Minister of Public Works, Mr. Edgar, to look for the best machinery for these works, and with this in view I visited Lincoln, Manchester, Frodigam, and Glasgow, not only for the purpose of obtaining information, but also with a view to inducing English firms to tender in response to an advertisement in London "Engineer," and "Engineering," whereby tenders for the supply of a dry earth excavator had been invited by the Agent-General at my suggestion.

Three tenders were received on August 8th, 1912. One, that ultimately accepted, was from the Lubeck Dredge Company; two were from English firms. I found that one of the English tenderers had built a machine previously—a very fine one—but I found that the design had not been altogether perfected in some respects, and therefore hesitated to recommend its adoption, fearing that in Australia the Government might not have the advantage of the designer's further advice should that prove necessary.

Whilst examining the dredge in question Mr. Westwood, the resident engineer of the Frodigam iron mine, gave me the opportunity of inspecting two Lubecker dredges, which had been at work for the last two years. The machines excavate from 35ft. to 40ft. of alluvial deposit over a bed of iron ore 25 feet deep. The excavation is made in 10ft. strips, the dredger resting on the top of the iron ore, and the excavated material is deposited by a conveyor in the worked-out ground beyond the working face. By this process the whole of the level of the country is lowered by 25 feet, and the cost of the excavation by these machines under the ideal conditions mentioned is, exclusive of repairs, .35 of a penny per yard. I append copy of Mr. Westwood's report for the year 1910 for one of the dredges under his charge. See Appendix "A."

I also visited Manchester on the 28th August, 1912, and interviewed Mr. Reid, the Chief Engineer of the Canal, and asked him his experience about the use of the land dredgers in the canal work. He produced a printed report of the work, which dealt with a quantity of subjects, and showed that in that undertaking the Lubecker dredges gave very satisfactory
results. The cost of excavating, lifting, and placing material into trucks was:

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost per yard</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Land Dredger</td>
<td>1½d.</td>
</tr>
<tr>
<td>By Steam Shovel</td>
<td>2d.</td>
</tr>
<tr>
<td>By Priestman Grab</td>
<td>3d.</td>
</tr>
</tbody>
</table>

Mr. Reid stated that so far as he knew no English firm had taken to the construction of land dredgers as a regular line of business. This statement was also confirmed by Mr. Fleming, of Messrs. Ferguson & Fleming, dredge builders, Paisley, near Glasgow, and Messrs. Ruston & Proctor, Lincoln.

I then visited Bremen, Lubeck, and Hamburg, in Germany. It was principally at Hamburg that I saw the machines (4) in use at the Petrol Harbour, which was then in course of construction. The engineer in charge, to whom I had a letter of introduction, showed me the returns for two of the machines. They were working on 4ft. of loam over 8ft. to 10ft. of peat on a clay bed, the excavation was 30ft. deep, and the cost of dredging and lifting into trucks was 2d. per cubic metre. On the excavation of docks the cost of transportation has afterwards to be added, and varies with the lead, but for swamps the material is thrown to spoil in one operation, and no other charge is required.

I was able to fully satisfy myself that in a large number of important instances both in Great Britain and its Dependencies, machines of this type were entirely supplanting hand methods. Another important fact is that the India Office, which before the war could obtain coolies at 2/- per head per week, ordered the first land dredger in 1904, the second in 1908, eight in 1910, and one in 1911.

In consequence of these enquiries I recommended the purchase of the land dredger now at work at Lang Lang. It arrived in the Autumn of 1913, but the winter floods and the fact that the type of machine was new to this country, delayed its reconstruction here, and it was not ready for trial till the summer of 1914. The trials having proved satisfactory, a financial scheme had to be devised between the Government and the Council of Agriculture. This caused more delays, and the order to proceed with the work was not received by me until the 23rd April, 1915.
One important detail of the Tobin Yallock reclamation scheme was that the big embankment of the main drain should be placed on the west side of the cut, so as to protect efficiently 4,000 out of 4,500 acres of the College land. This involved the shifting of the dredge to the west side of the main drain then existing, a process of some difficulty considering the soft nature of the ground and the weight of the machine, about 48 tons. However, this was accomplished in about seven weeks, and on the 23rd of June, 1915, cutting began on the west side of the drain.

The dimensions of the cut are:

- 43 feet at surface level
- 23 feet at bottom
- 9ft. 6in. deep, or about 35 yards to the yard run.

All went well till the 15th October, when 40,280 yards had been shifted at a cost of £397, or 2.4d. per yard. Then the dredge-master reported that the dredge required overhauling. The order to overhaul was given in the middle of October, and in spite of the fact that the dredge-master was a competent engineer and that the Naval Architect had charge of the mechanical arrangements, as soon as the dredge was again put together the conveyor developed defects and the horizontal shaft was twice twisted, as well as the axle of the driving pulley to the conveyor. The gear at the end of the conveyor was smashed, and had to be replaced. Further, the boiler tubes leaked, with the result that practically no useful work was done from the middle of October till January, 1916, when some very good work was again done, averaging for six weeks 1½d. per yard.

But the enforced idleness of the dredge, while the crew had to be paid, and the cost of repairs, amounting to £417, brought up the average for the whole period from 2½d. to 4d. without considering capital charges. These should not exceed 1½d. per yard when the machine is properly handled. Our experience has been valuable for future operations, but in introducing a new tool a certain amount must be paid as the cost of training the workmen. Suggested amendments have proved mistakes and have retarded the work of this implement; but they will be avoided in future.
EARTH EXCAVATORS IN VICTORIA.

In March the dredge reached the margin of the existing drain, which it had to cross diagonally. This section was planted 30 years ago with white willow; some of them had grown to 12in. in diameter, and for about 5 chains the use of the dredge had to be discontinued. But at that point the drainage of 4,000 acres of swamp had been completed, and 2,151 acres were let on May 1st.

While the men were excavating in the willows the dredge was again overhauled, and a bridge constructed to return the dredge on to the east side of the old drain, where it has been at work for the preceding fortnight in the reclamation of the last 500 acres of swamp land.

The particulars of cost, rate of progress and fortnightly average are given in a return attached hereto prepared by Mr. Clark, the Engineer of Reclamation, marked appendix "B."

Briefly put the work lasted 11 months, 1½ miles of Canal were cut, the excavation amounted to 78,320 yards, the wages paid to the crew were £864, the cost of repairs was £418 equivalent to cost of excavation, 2.6d. per yard, repairs 1.3d., capital charge 1d. Total, 5d. per yard.

As for the economic result of the scheme it has been as follows:

Total expenditure to May ........ ........ ........ ........ ........ ........ £2774
Total acreage made available for settlement to date ........ ........ ........ ........ ........ ....... 2151 acres.
Former rental ........ ........ ........ ........ ........ ........ £386 p.ann.
Present rental ........ ........ ........ ........ ........ ........ £1570 2 6 "
Area remaining to be dealt with ........ ........ ........ ........ ........ 500 acres.
Present rental ........ ........ ........ ........ ........ ........ £15 p.ann.
Estimated rental after reclamation ........ ........ ........ ........ ........ £250 "

I also attach a plan of the reclaimed area in which the blocks dealt with are shown with full particulars as to dimensions, areas, and annual rentals per acre. The area yet to be dealt with is only shown in outline, as it has not been resurveyed. The result of this reclamation on the whole area is that the original rental received by the Council of Agriculture, which ruled before the end of May, will be more than quadrupled. The plan is marked Appendix "E."
APPENDIX "A."

Particulars of Work done by Land Dredger for 1910.*

Oiling ........................................ 145$\frac{3}{4}$ hours.
Cleaning ........................................ 157$\frac{1}{4}$ 
Repairing ...................................... 394$\frac{3}{4}$
Weather (time lost) .......................... 21$\frac{1}{4}$ 
Travelling ...................................... 162$\frac{1}{4}$
At Work ........................................ 2116$\frac{1}{4}$ 

Total 2997$\frac{1}{2}$ 

Excavated, 262,408 cubic yards.
Cost of driving ............................... £234 0 11 = .214d. per c.yd.
Cost of moving by railroad .................. £146 13 2 = .134d.
Total £380 14 1 = .348d.

Wages:

Driver, 5/- per day—
Boy (2 boys as a rule, sometimes 3), 2/- to 3/- per day.
Labourer, 3/6 per day.

*Copy of Statement by Mr. Westwood, England.
EARTH EXCAVATORS IN VICTORIA.

APPENDIX "B."

EXTRACTS FROM REPORTS IN CONNECTION WITH LANG LANG DREDGE.

<table>
<thead>
<tr>
<th>Date</th>
<th>Quantity</th>
<th>Wages, Fuel, Oil, etc.</th>
<th>Repairs</th>
<th>Cost per yard.</th>
</tr>
</thead>
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<td>Wages, &amp;c.</td>
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<td></td>
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<td>Repairs</td>
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<td>Total</td>
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| 1915   | 10980    | £113 15 0              | ...     | ...            |
|        | 2240     | 20 9 3                 | ...     | ...            |
| 23/6-27/7 | 4928    | 48 17 10               | ...     | ...            |
| August  3 | 6160    | 40 16 2 £194 19 1     | ...     | ...            |
|          | 7645     | 51 0 2                 | ...     | ...            |
| Oct. 13  | 3280     | 51 2 3                 | ...     | ...            |
|        | 56 15 5  |                        |         |               |
| Nov. 10 | 36 0 11  |                        |         |               |
|        | 8800     | 78 7 0                 | ...     | ...            |
| Dec. 8  | 37 17 11 |                        | ...     |               |
| Dec. 22 | 38 10 6  | £172 17 3 £49 18 4   | ...     | ...            |
| Jan. 5  | 44 6 0   |                        | ...     | ...            |
|          | 44 3 0   | £49 18 4              | ...     | ...            |
| Feb. 2  | 44 15 7  |                        | ...     | ...            |
|          | 7040     | 49 10 5               | ...     | ...            |
| March 1 | 58 12 1  |                        |         | ...            |
| TOTAL ... | 78,320   | £863 19 4 £417 14 8   | 2.6478 1.2800 3.9278 |

DISCUSSION.

The PRESIDENT said all would agree they had listened to an interesting explanation of an important operation being carried out by the Public Works Department. Mr. Catani had charmed them with his very detailed interpolated explanation of the way in which he was tackling the job. It was an interesting plant. A plant like that might be useful in removing the overburden on a large coalfield, where the coal was only
25 or 30 feet below the surface, which condition would apply to a large part of the Victorian brown coal deposits. He was interested in the account of Mr. Catani's breakdowns. He would suggest it was not a British-made machine, for they were used to the mild criticism of the British machines—that they were made too heavy and to last too long.

Mr. Catani said he was obliged to members for the kind reception given to his paper. The dredge had reached within a mile of Carrum. The train reached there every morning at 9 o'clock, and anyone could visit it; or anyone with a motor car could reach it in two hours' drive over a pleasant country road.

The President said he thought Mr. Catani's remark would make it necessary for them to visit the place, and witness the operations of the plant. He thought the Council would take it into consideration, and with Mr. Catani arrange a visit.

Mr. Jas. Alex. Smith said he had had the pleasure of seeing the dredge in action. If they visited it they must be impressed with the great work Mr. Catani was doing. The author had not explained to them the extremely difficult nature of the country over which he had taken that dredge. When he visited the work, they were on one side of the drain, and crossing to the other side on a long slant. One could not stand a moment on that soft mullock without sinking into it. It was a difficult matter indeed to take a dredge weighing something like 50 tons over such country. The operations were of an unusual nature here, and Mr. Catani was adding almost a new county to Victoria. The swamp was not swamp at all in the ordinary sense. Much of it was beautiful land, capable of yielding, when drained, heavy crops. It was largely covered with a growth of land scrub and gave the impression of being high above sea level. It was only when they found marine drift in the foliage that they fully realised that much of the area was completely submersed by infrequent, exceptionally high tides. Mr. Catani was adding considerably to the national wealth of Victoria.
DISCUSSION—EARTH EXCAVATORS.

Mr. J. T. NOBLE ANDERSON asked if Mr. Catani could add to the figures already given the depreciation, and interest, and overhead charges?

Mr. C. CATANI said the machine cost £2,000; and £666 had been spent in repairs. Then a good deal of money was spent in putting it together, because they were not experienced. It had cost in all about £3,500. That machine was expected to live 12 years, so that the charge per annum was something like £270. The machine in a little over five months had excavated 78,000 yards. If it worked usefully for twelve months in expert hands it should do 200,000 yards in the year. One penny—which he suggested as the capital charge—added would bring the cost up to 4d.; 1d. on 200,000 yards would be something like £800. Taking it on the work of 12 months it would be a charge of 2d.—making a total of 6d. Anyone who knew anything about such excavation by ordinary means knew it was worth 1s. 6d. The expenditure to date had been £2,770, but only something like £1,200 had gone on the dredge. The other work consisted in putting a bank 3 ft. high along the Western Port Bay, and also along the west end of the excavation to prevent the tide coming up the side. Those banks, by competitive hand labour contracts, cost 10d., 1s., and 1s. 3d. per yard to construct, and they were only 3 ft. high. The bank shown was 10 ft. to 12 ft. high.

Mr. J. S. DETHRIDGE said the machine met conditions which could hardly be coped with by the ordinary means of excavation previously in use in Victoria. In the past 10 years it had been his privilege to see a good deal of "muck-moving" in the northern districts of Victoria. He had seen mechanical appliances. One was developed by Mr. Geo. Dunlop, C.E., who was a member of this Institute in the early days. That machine was of the nature of a large traction engine with winches mounted on top, and drag scoop. The capacity was 5 cubic yards. He finally went in for two engines and dragged his bucket scoop backwards and forwards, and when everything was in full swing they could determine the quantity removed, and sum up the full cost, which came out at between 2d. and 3d. per cubic yard. Owing, however, to the heavy cost in repairs and transference, they tendered at 5d.
per yard. He merely mentioned that as one of the earlier experiences.

In South Australia they had gone in largely for mechanical excavation, but they had not succeeded in getting down the costs to anything like as low as those obtained by Mr. Catani. In regard to the northern parts of Victoria, it was necessary to caution young engineers that before they could touch heavy machinery of 45 tons or so, with its heavy cost of transport, they must have the bulk of work to carry the overhead expenses. If they did not have the bulk they should not estimate on machinery prices. The ruling price for light work was still 4d. to 6d. It meant employing a plough and five horse drag scoop. The work Mr. Catani was doing could not have been done by old-time methods. It would have had to be done by wheelbarrows and shovels at 1s. 6d. per yard. He was sure a visit would be highly interesting.

Mr. J. A. SMITH asked about what horse-power went into the machine at maximum load?

Mr. CATANI said it was about 100. The machine was made in 7 sizes. Theirs was No. 4. No. 6 was extra large, built for special cases up to 300 h.p., whilst the smallest was only 25 h.p. The small one would not be found economical. Where the horse could stand it would easily beat that machine.

The PRESIDENT asked if there was a slipping clutch to prevent damage to the dredge in the event of encountering an obstruction.

Mr. CATANI said there was a clutch. The clutch lasted very well for two months. By lubrication and wear it lost a good deal of its value as a clutch, and it then lacked that safety-valve action that the Americans were fond of introducing into every machine, so that when the maximum intended effort was exceeded, some unimportant part yielded and gave warning that there was something wrong. When they were crossing the cut diagonally, as Mr. Smith had mentioned, they had the experience of meeting some fairly big obstructions. But they got off with a fright, and he decided to do those portions by manual labour. But a
DISCUSSION—EARTH EXCAVATORS.

man was always watching in the cut. There was a little give and take in the ladder, and it would get a jerk. Also the timber that had lain for perhaps thousands of years was generally more or less decomposed. They had had nothing more troublesome than the roots of willows. If the clutch were wooden, instead of metallic, it would be much better, because it would slip, and there would be no damage; and while a piece of wood costing only a couple of shillings could be removed once a month, the permanent metal clutch, which acted well in ordinary circumstances, was too rigid in the case of the buckets coming in contact with a solid body. There were two movements—the longitudinal movement and the transverse movement of the bucket. Virtually it acted in a slanting way, and always struck the obstruction on the edge.

The PRESIDENT asked if the bucket lips were renewable?

Mr. CATANI said he had had no occasion to renew them. In soft material they should be good enough for four years.

Mr. J. T. N. ANDERSON asked if Mr. Catani preferred the chain transmission to the wire rope.

Mr. CATANI said if the pulleys were pitched the chain was ideal.

Mr. ANDERSON said in some machines instead of chain drives they had wire ropes. Had Mr. Catani studied it to see what were the advantages of chain drive over wire ropes?

Mr. CATANI said they had not used a rope.

Mr. HARGRAVE asked if the machine had a belt conveyor.

Mr. CATANI said it had a plate conveyor. There were 56 plates.

The PRESIDENT asked if they caused any trouble.

Mr. CATANI said they had no trouble. The buckets were double-tailed, and had no backs. As they moved they radiated to the axis of the tumbler, and the two horns projecting actually cleaned them out. A visit would give them an opportunity of getting all these details.
Mr. J. A. Smith said he would like to ask one question. Did Mr. Catani actually go through the mass of willow roots he saw them approaching on the occasion of his visit?

Mr. Catani said he stopped at that. They crossed the existing cut at an angle of about 30 deg. It would have been necessary to remove all those logs by pulling them up. So it was just as well to put men on and drag them out of the way. That gave them an opportunity to overhaul the place. The tea-tree had a diameter of 4 inches, which the machine would cut without any difficulty. The tea-tree had plenty of roots at the surface, but there was no big tap-root. Rock or big logs of wood were too much for the machine.

The President said the discussion would not be closed at that meeting, as perhaps some members would have further questions to ask when the paper had been printed.

The President announced that a visit had been arranged to the Working Men's College for Thursday, August 10th, by invitation of the Management of the College. He hoped a large representation of the Institute would be able to attend that evening.

At 10 p.m. the meeting closed.
Plate I.

General View.

First Cut.
Plate II.

Excavation Advanced.

Distribution of Spoil.
Plate III.

DREDGE AT HEAD OF CUT.

COMPLETED CHANNEL.

(40' x 23' x 6' 6"

)
Plate IV.

Plan of reclaimed area at Lang Lang.

Note.—The figures within circles refer to rental per acre per annum.
DISCUSSION—EARTH EXCAVATION.

MODERN METHODS OF EARTH EXCAVATION.
(Paper by C. CATANI.)

Mr. C. CATANI, in replying to the discussion, wrote as follows:—

I have read the discussion as printed, and there seems very little requiring an answer; but a few slips in the print would perhaps be worth correcting. The nearest railway to the dredge was Caldermeade, and not Carrum, as stated on page 130, and the amount of £666 was paid to the Commonwealth for duty, and not for repairs. As regards the criticism proper, I agree with Mr. Dethridge that, unless you have a large quantity of suitable excavation it would not pay to use a heavy machine of the land dredger type. Generally speaking, if the bulk of excavation to do is available and the ground is fairly wet, the land dredger would prove the more economical, and give good work evenly trimmed.

As to the difficulties of transportation, we worked with sleepers spaced 3 feet apart, the load per foot being about 15 cwt., but on a continuous platform of sleepers, the dredge would work on ground capable of bearing 3½ cwt. per square foot.

About the clutch, my meaning was this:—The wooden clutch supplied by the maker became ineffective by wear and careless lubrication. The engineer in charge substituted a metallic clutch, very effective as a clutch, but in case of an obstacle the metallic clutch was not so favourable, as it would not give so easily as the original clutch. I am glad to say that the many mishaps which occurred at the end of 1915 have not been repeated, and no more breakages or torsions of the axis have taken place on the last section.

The lips of the bucket can be renewed if necessary, and they can also be fitted with a pick-point on the side to deal with very hard ground. The effectiveness of the machine in the different kinds of ground, compared with its efficiency in soft material, is as follows:—

Medium ground . . . . 80 per cent.
Hard ground . . . . 60 per cent.

It is to be understood that the machine cannot move rock beyond soft schist.
The experience gained in the past encourages the hope that the more the machine is used, the better will be the results that will be obtained. The machine should be always placed under the best conditions, and a fair quantity of water should be used for lubricating purposes, and for softening the material to be excavated.

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METHOD OF STRENGTHENING IRON AND STEEL BRIDGES.

(Paper by F. K. ESLING.)

Mr. J. S. DETHRIDGE said that Mr. Esling had to be thanked for contributing a paper of much engineering interest. It was doubtful, however, whether the particular case selected for the demonstration of his method was one in which it would meet with popular approval. The reason for this was that it was now coming to be recognised that bridges in close connection with a great city should be designed with such regard to aesthetic considerations as to add to the interest and beauty of their surroundings. Now, whatever the historic or economic merits of the Church Street bridge, it must be conceded that no amount of ingenious effort could make it other than a disfigurement of the part of the river it spanned.

The writer thought the general feeling in respect to this bridge was that it should simply be made to serve traffic requirements until funds were available for a structure in keeping with what at some time in the future will be "our beautiful Yarra."

These considerations did not, however, detract from the value of the paper, both as an engineering study and as regarded the application of the method in suitable cases. Of course the method was specially designed for bridges in which the dead load was very high in proportion to the live load. This would seem to confine it almost entirely to old-fashioned plate girders of uniform cross section, but with provision for holding down the ends of the girders it would appear to be possible to apply it to timber beams jointed together to form a much greater span than would otherwise be possible without trussing. Such a form of construction might have high value in a mountainous district where stone for abutments and
Library Digitised Collections

**Author/s:**
Catani, C.

**Title:**
Earth excavators and their use in Victoria (Paper & Discussion)

**Date:**
1917

**Persistent Link:**
http://hdl.handle.net/11343/24595

**File Description:**
Earth excavators and their use in Victoria (Paper & Discussion)