Control of Future Floods.

Alex Stoney, 24 February 2011
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This paper has been prepared for submission to the Queensland Floods Commission of Inquiry. A list of Subject Headings, and a list of Illustrations is on Page 15 at the end of this paper.

1. River Management Authority.

When the floods, which have recently ravaged much of Queensland and N.S.W. (and since then, Victoria), have subsided and gone away, and the enormous expense of recovery has been expended, we can all go away happily and concentrate on other more immediate business. Can't we ?

Yes, we can, and probably will. But wouldn't it be better to do something to reduce the colossal cost of damage, done by the inundation and flooding.

My submission of this paper deals, not so much with the floods which have recently passed, as with the future floods, which are coming, with certainty, and probably sooner than you think.

Figure 1. Brisbane. (Photo from Sydney Morning Herald, 15 January 2011)

I therefore propose that the Queensland Government (with the other States following the example) appoint a **River Management Authority**, charged with:-

1. Ensuring that the future floods are foreseen and provision made in each river to accommodate a flow of water equal to the highest recorded flood.
2. Correcting the serious past neglect of our rivers, and particularly removing the silt which has accumulated over the past century and more.

If it is alright to spend several billion dollars on recovering from the devastation (and death-roll) of the recent flood, why is there a problem with spending a fraction of that sum on avoiding having to spend it all over again ?

2. Map of Brisbane..

To assist the understanding of this proposal, a map of Brisbane is included, showing the very meandering nature of the Brisbane River, which is even more pronounced further upstream. The Bremer River meanders even more.

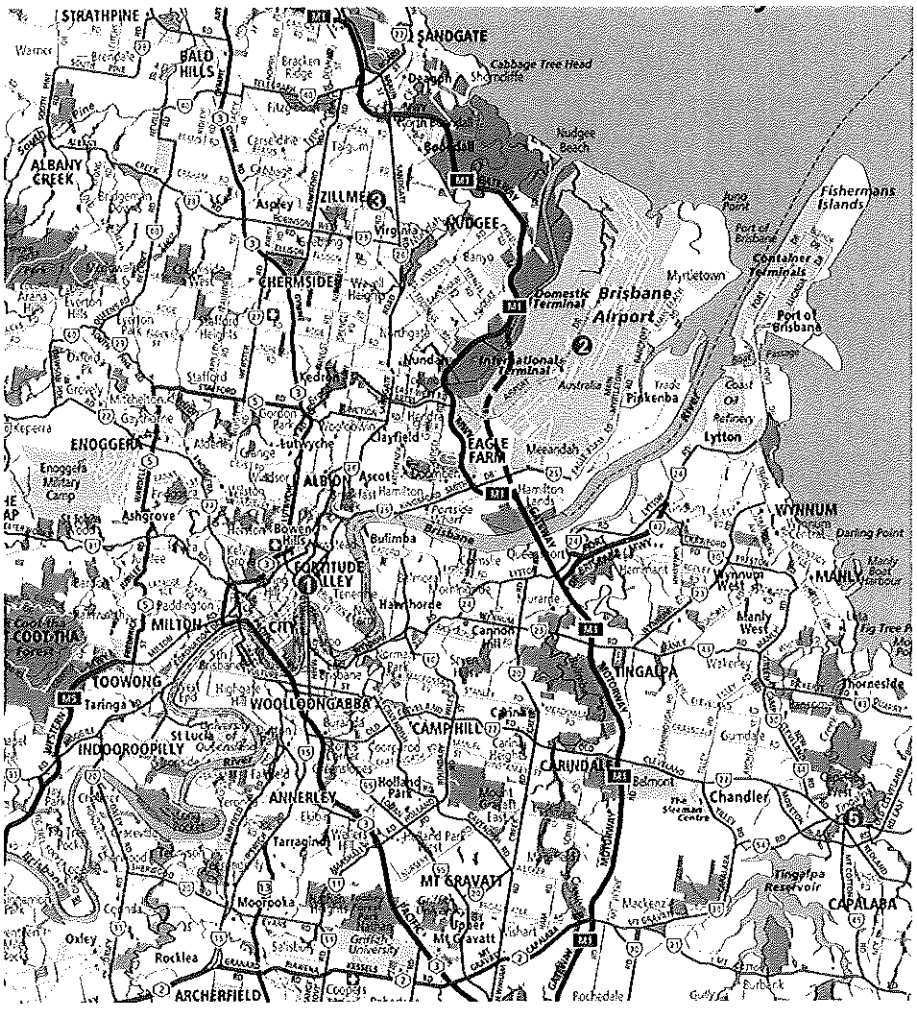


Figure 2. Map of Brisbane and inner suburbs (Courtesy of Avis and UBD)

3. Sequence of Floods,

Major floods have been part of the earth's landscape, since Biblical times and long before. They are a normal part of Nature's creation of the earth's biosphere. Unfortunately, the effects of floods are incompatible with the present Civilisation's way of life. They are just as incompatible as smallpox, malaria and the common cold. One of these has been defeated, and measures to combat or control the others are in place. Why can't the human race take the control of floods seriously?

Every flood has a **cause** and an **effect**. The major cause is heavy rain, which provides more water than the river(s) have capacity to carry to the sea. This is accentuated when the river is heavily filled with silt, which mainly results from agricultural activities upstream. Since farmers already recognise the value of their top-soil, and attempt to minimise its loss by erosion, any attempt to further reduce the movement of soil into the rivers is unlikely to be productive.

We have little control over the **cause**, but we have the ability to reduce and control the **effects**. It may not be easy, but it may save millions of dollars, and avoid the widespread misery of inundation and devastation.

History records the massive Brisbane flood of 1893, which swept away the Victoria Bridge, and flooded the Central Business District and suburbs. It was followed by another massive flood the same year. In one of these, a metre of rain fell in one night in the Stanley River catchment area.

To reduce the risk of a recurrence, the Somerset Dam was built , on the Stanley River, a tributary of the Brisbane River, principally for flood control, and secondly for water supply. It also included a hydro-electric generating station. It was successful in moderating smaller floods, but failed to prevent the massive 1974 flood. Note the gap of 84 years between the big ones.

To further reduce the flood risk the Wivenhoe Dam was built. It also was successful in moderating the frequent changes in river water flow, but it failed to control the 2011 flood. This time the gap between big ones was 37 years. Note the reduction in periods between major floods.

The next one is coming; we don't know when, but it could be this year. We cannot afford the risk of ignoring the coming flood, just because we are too busy dealing with the last one.

Figure 3. Brisbane, (Photo from Sydney Daily Telegraph, 14 January 2011).

4. Urgency.

In Australia, we always seem to ignore the "Great Australian Question", which is:- "Whether to Plan without acting, or to Act without planning." A great amount of time and money is spent on planning for some future activity, but so often that plan finishes up in the pidgeon-hole and is forgotten. If you wonder about the false value of planning, just look at the many proposals for building the very-necessary Melbourne-to-Brisbane Inland Railway, which has finally reached a conclusion that nothing should be done on constructing it till after 2020 or 2030, and perhaps not then. (See http://www.artc.com.au/Content.aspx?p=175).

I believe that Leadership would produce much better outcomes if the decision to Act was taken before the long-drawn out Study and budgetary details, and that if the decision is negative then the funds expended on this Study and budgetary planning could be used on something more useful.

Despite the good intentions of this Inquiry, of which I have no doubt, nevertheless on the basis of the record of past Inquiries and plans, the most likely outcome (on my proposal that the future floods should be provided for) is lengthy procrastination, and no action.

To illustrate the probable outcome, I include the following transcript of my 1999 letter to the Mayor of Cooloola Shire Council, (i.e. Gympie), which had then suffered a serious flood of the Mary River. Predictably, no action appears to have been taken to follow my advice. More recently, in the 2011 floods both Gympie and Maryborough, were inundated again by the same river.

[redacted]

5 March 1999

[redacted]
Mayor, Cooloola Shire Council,
[redacted]
Gympie, Queensland, 4570

Dear Sir,

Flood Prevention.

Please allow me to express my sympathy to you and your residents in the aftermath of the recent severe flooding. This calls for an early priority for (a) re-building and repairing the extensive damage and (b) making provision to ensure that such severe flood damage does not occur again. This calls for a program of flood control measures.

These measures could include:-
(a) Retention of floodwaters in upstream dams and ponds,
(b) increase in downstream runoff capacity of your rivers.

Of these, only the second, increasing the flow capacity of the river, is a practical answer to this expensive problem, since it is the correcting of a man-made problem of silting, due to upstream activities such as agriculture.

The solution to future flood devastation lies in dredging, from the bed of the river, the silt and other matter deposited due to upstream erosion. This will increase the flow capacity of the river thus allowing the runoff to be discharged with a lower water velocity, resulting in a lesser surface gradient.

Although fluid mechanics calculations of water discharge rates are very complicated, it is sufficiently accurate to say that the water velocity will be proportional to the surface gradient, that is, proportional to the difference of depth over the length of the river in question.

In other words, dredging so as to double the cross sectional area of the river, between the coast and the city, will halve the river's flood height above its normal level at the city, on the next occasion rain.of similar heaviness occurs. Records appear to show that near-similar floods occur at about five year intervals, so there is no time to lose if a dredging program is to prevent similar flood damage next time.

Rough Calculation.
If your river is 290 metres wide and 3 metres deep (with 1 in 10 bottom gradient on each side) this gives a cross sectional area of 780 square metres. If the bottom is dredged to an additional depth of 4 metres (with the same bottom gradient of 1 in 10 at each side) this will add 780 square metres to the cross section. This will double the cross sectional area, and actually may more than double the flow capacity, due to the reduced influence of bottom friction on the water flow.

If this were applied to your recent flood, the required water flow would be achieved with only half the "head" at the city. In other words, instead of the f lood being 8 metres deep in the city, it would have been only 4 metres above normal level, in which case flood damage would probably have been insignificant.

Assuming this dredging is required over a river length of 10 kilometres, a quantity of 7.8 million cubic metres of silt would require to be removed. This might be expensive, but probably a lot less expensive than the flood damage your city has recently suffered, or would suffer again in the next similar flood. Thus it would be a profitable exercise to carry out this program as soon as possible (like immediately; a flood could happen again tomorrow. Remember that Brisbane had its worst flood in 1893, and another severe one the same year). These calculations apply more to Maryborough than to Gympie, but similar results would apply with adjusted figures.

The large quantity of spoil will require to be disposed of with environmental responsibility. The material at the mouth of the river is likely to consist partly of beach-quality sand. It could possibly be barged to any nearby depleted beach, and dumped in shallow water, where normal wave action would dispose of the fines while moving the sand onto the beach.

Further upstream (since ocean dumping is probably environmentally unacceptable) the spoil should be disposed of on land. Several square kilometres of nearby coastal flats would be ideal if they could be found, but this is unlikely and suitable disposal areas must be located.

There are some problems in this project, and certainly some expense, but unless urgent attention is give to removing the siltation of our rivers, then the consequence must be a progressive worsening of future flood damage. Some contributions from Governments might be sought, but politics of this sort can be time wasting. More promising is the possibility of contributions from insurance companies, due to the reductions in pay-outs that can result from removing the risk of future flood damage.

Perhaps this matter should be referred to the Mary River Catchment Co-ordinating Committee, but buck-passing is a dangerous practice when a flood could be coming again. I trust that your consideration of this matter will lead to action which will protect your area from similar damage in the future.

Yours faithfully,

Alex B. M. Stoney.

5. Victoria's Mistake.

I was somewhat appalled at the Victorian Bushfire Inquiry, which paid so much attention to locating scapegoats to blame for providing insufficiently detailed warnings of the approaching disaster, but gave very little attention to the important subject of preventing or avoiding the next year's bushfires.

I would not like to see this present inquiry (into Queensland's 2011 floods) ignore the very real risk of the next flood, and treat it as casually as the Victorian Inquiry appeared to treat the future problem.

We should be making provision to ensure that such severe flood damage does not occur again. This calls for a program of flood control measures, as part of river maintenance, which has so far been completely neglected.

In particular, no future housing should be permitted in areas where the record flood level is higher than the floor level of the new houses.

6. Methods of mitigation of the disastrous effects include:-

6.1 **Upstream dams and retention ponds.** These are effective only until they are full, and have no beneficial effect after that, if the heavy rain continues. Since they give a delay to the occurence of flooding, they permit endangered residents to escape, but make little difference to the most severe flood risks. It has been claimed that 15 extra Wivenhoe Dams would have been needed, if they were to control the 2011 floods. As a sole means of controlling floods, dams have been proven a failure. Fairbairn Dam didn't give much protection to Emerald this time. It was a bad mistake to assume that the existence of Wivenhoe Dam would protect Brisbane, where many homes were permitted in areas which, in retrospect, should never have been built on.

6.2 **Levees.** In some river systems levees are a natural result of minor floods carrying silt to the banks of the rivers, where the reducing velocity of the water allows the silt to precipitate to the bank and build up the levee. This helps to protect the surroundings from following floods. However, natural levees take a long time to grow, and are not common in some river systems. Man-made levees are useful in combating the spread of floodwaters over the surrounding areas, but the failure of a levee under the pressure of flood may be catastrophic. Thus their usefulness is limited, but I recommend that every town that has been flooded should have a levee around it at maximum recorded flood level.

6.3 River diversion can sometimes be used to reduce the river length. In Australia's very flat landscape, there is a tendency for rivers to "meander", which means that, over the centuries, the bends of the river move outward due to erosion on the outer side of the bend and silt deposition on the inner side of the bend. In some cases, excavating a channel, across the "neck" of the meander, will reduce the river length by up to several kilometres. It will also encourage a higher water

velocity, allowing floods to escape more quickly and with lower depth. Moreover, the separated curve of the river is a large space in which to dispose of excavated mid-river silt.

6.4 **Deepening the river.** The most useful solution to future flood devastation lies in maintaining the river to their original natural depth or deeper, by dredging, from the bed of the river, the silt and other matter deposited due to upstream erosion. This will increase the flow capacity of the river thus allowing the runoff to be discharged with a lower risk of the flow exceeding the capacity of the river.

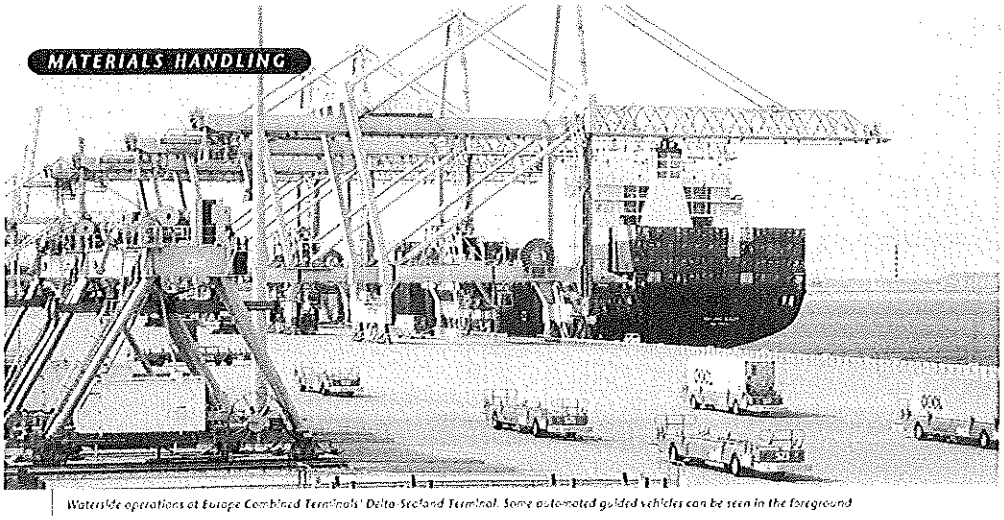
How is this dredging to be performed? In coastal areas, dredge boats are an option, both suction dredges, which use the flow of water into the piping to carry the silt to its area to be filled, and bucket dredges which use an inclined bucket conveyor to lift the silt and deposit it usually to a barge alongside for disposal on land. Perhaps a floating conveyor belt, on pontoons, could carry the excavated silt to the banks to form the future levees. The Port of Brisbane have 4 dredges, only one, a suction dredge, of large capacity.

A flood control program will involve considerable expense, but unless urgent attention is given to removing the siltation of our rivers, then the consequence must be a progressive worsening of future flood damage. Some contribution from Governments might be sought, but politics of this sort can be time wasting, while Governments "pass the buck" to each other. More promising is the proposal that each City, Town or Shire Council decides to provide its own protection, despite the cost, since the cost is expected to be much lower than the billions of dollars of damage which has been caused by the current flood. Contributions from Insurance companies are a possibility, due to the reduction in pay-outs which can result from removing or reducing the risk of future flood damage.

This program should be carried out as soon as possible, Remember that Brisbane had its worst flood in 1893, and a second severe one the same year. Rockhampton's flood in 1991 was apparently nearly as bad as the present one, and should have been taken as a warning. Why was the warning so neglected?

7. Placing of Dredged Silt.

The quantity of silt to be dredged from any river is enormous, and where is it to be put? The large quantity of spoil will require to be disposed of with environmental responsibility. Perhaps the best place to put it is on the farmers' fields, where it came from in the first place. Consideration could be given to equipping the barges, accompanying the dredge, with lift-out open-top containers, of standard 6 metre length, (se Figure 4) which when filled can be lifted out by cranes on wharves such as the Port of Brisbane, and placed on trucks or trains for transport to agricultural areas, where the silt can be returned to its origin. For this purpose, a container transfer port could be established on Gibson Island, which already has (or at least had) a rail connection serving the former power stations.



Waterside operations at Europe Combined Terminals' Delta-Sealand Terminal. Some automated guided vehicles can be seen in the foreground

Figures 4 (previous page), 5 and 6. Various suitable container handling items.

For coastal rivers, the material near the mouth of the river is likely to consist partly of beach-quality sand. It could possibly be barged to any nearby depleted beach, and dumped in shallow water, where normal wave action would dispose of the fines, while moving the sand onto the beach. If this is not acceptable the spoil should be disposed of on land, since dumping at sea, although possible, is unlikely to be acceptable.

In every town, any park which has ever been submerged should be filled with dredged material, to a level exceeding the record flood level, so as to provide a safe haven to which local residents can escape from a quick flood.

Wherever possible the dredged material should be placed on the river banks, so as to create levees, giving some additional protection from future floods. The spoil should be drained, compacted by vibration and rolling, and if necessary could be treated with cement or chemical additives to ensure adequate resistance to erosion.

Any low-lying land is a possible candidate for filling, although if it is a wetland for native birdlife, then its environmental importance must be taken into account.

8. Dredged Silt Transport.

The attached diagram shows a suggested container and semi-trailer for transport of silt from the wharf, where the barges from the dredge are unloaded, to the destination, which is to be filled. This uses a shipping container, built for the purpose, of standard dimensions of 20 feet (6 metres) length, and 8 feet high (2.438 metres), of open top with no doors. The dimensions will suit a load of 30 tonnes. The semi-trailer is arranged to unload the container by tipping it sideways, under the control of the truck driver, who does not need to leave his cab. Outrigger arms, also controlled by the driver, are lowered before unloading, to ensure the stability of the vehicle during this operation.

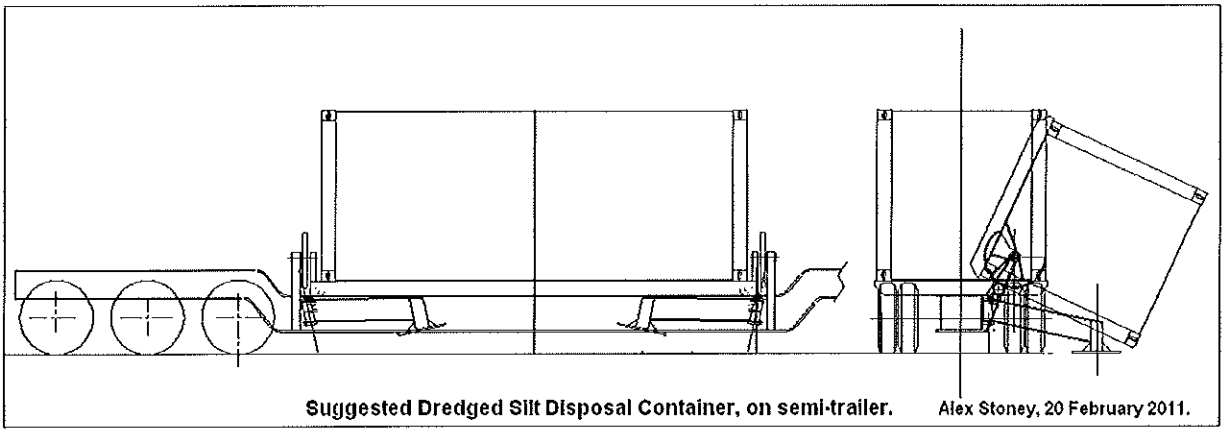


Figure 7. Suggested Dredged Silt Disposal Container.

Assuming that the unloading wharf. for the lower reaches of the Brisbane River, will be in the Gibson Island area, and will be equipped with a ship-unloading crane, this container system will

give an efficient and versatile form of silt disposal. The containers could be moved by semi-trailer to the Hemmant area (see below) for reclamation of this lowland, or by train for disposal on the farmsites where much of the silt has originated. Gibson Island has (or at least had) a railway siding, serving the power stations.

9. Recommended Program of Works.

The program of flood preventive works which I propose is not going to be cheap or easy, but I expect it will be a lot less expensive than the cost of recovery from the next flood. Much of what I will say may appear to relate to Rockhampton and Brisbane, both of which I have lived in and seen in flood (twice in both cases), but is equally applicable to many other towns and cities, and to rivers outside populated areas.

The basic procedure in Control of Floods must be to "Maintain the Rivers", by correcting the neglect of past ages, which have filled the river beds with silt. Recommendations of the work to be done are given below, and several rivers are given as examples, using dimensions which have not been confirmed, but are not unreasonable. They assume that the silt deposited by the recent flood has been removed before the suggested program starts, but should be combined with it. However, the basic principles of deepening the rivers need to be applied, as necessary, to all rivers in Eastern Australia (and perhaps to the West as well).

To validate the dredging of each river, a survey should be done, measuring the depth from an established datum, presumably Mean Sea Level. This should be done across the river, at intervals along the river of perhaps a kilometre, and also along the river probably at its midpoint. These figures could be adjusted, based on the data found in the early plots. Great precision is not needed, as the river bottom moves with tides and floods, and a launch with a depth sounder, and a GPS instrument to determine locations, could produce the required results.

9.1. Brisbane River (Downstream from CBD).

With its high public profile, the program should start with the Brisbane River, although many others have as great a need.

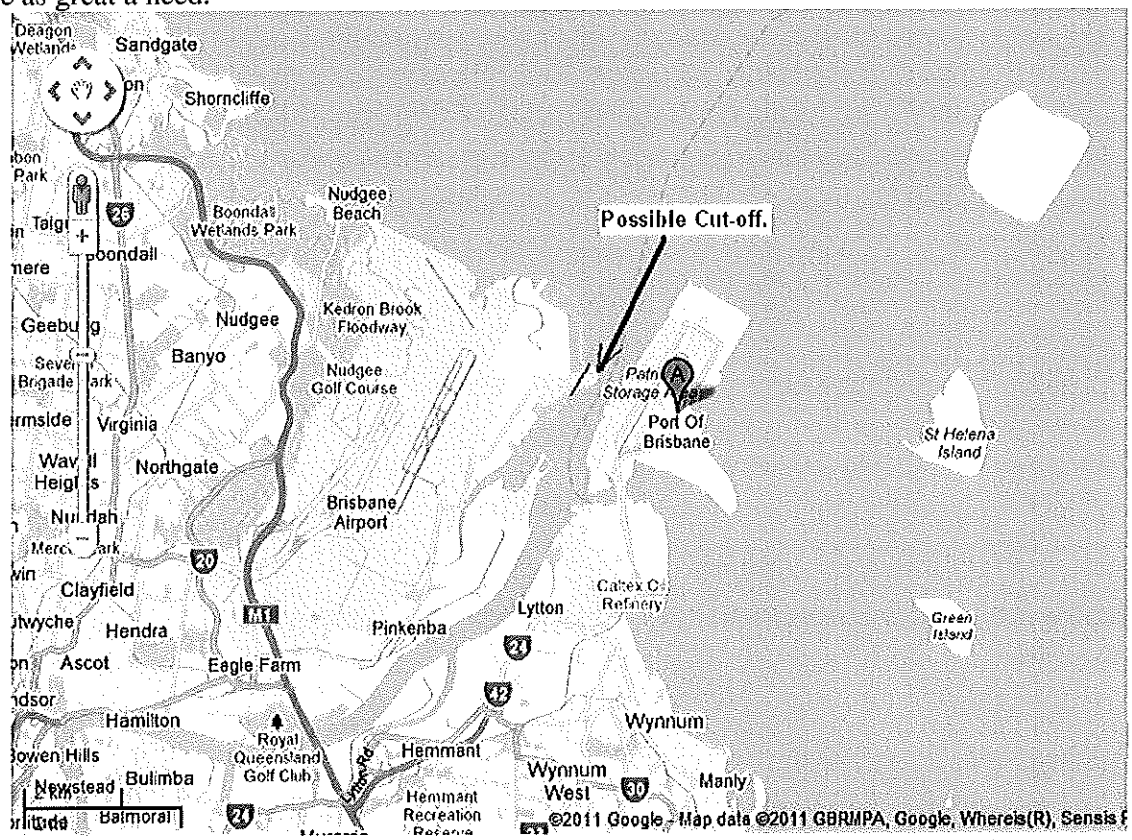


Figure 8. Possible cut-off of Luggage Point, to increase flood flow rate at river mouth.

To reduce the height of future floods in the Brisbane River and the Bremer River, a large program of dredging the river silt should be started as soon as possible. Dredging of the Brisbane River is not new. Fishermans Island, the present Port of Brisbane, is an artificial island, originally formed over a century ago, when the bar at the mouth of the Brisbane River was removed to permit navigation by large ships. In 1955, (when I camped on it with bushwalkers), it was about the size of a football field, and not much above high tide height. Today it is much larger, and it is being enlarged. This should be accelerated to consume fill from the river..

It could be said that Fishermans Island is in the wrong place, since it constricts the mouth of the river, and thus, during high water flows, causes an increase in flood level for all lower reaches of the River. However its commercial value would preclude any possibility of its removal. The existence of Luggage Point, on the northern side of the river, 650 metres wide at this point, offers the opportunity to gain a useful increase in stream flow if it is cut back by perhaps 100 metres, (soo Figure 8) making it the same width as the river between there and 3 km further up.

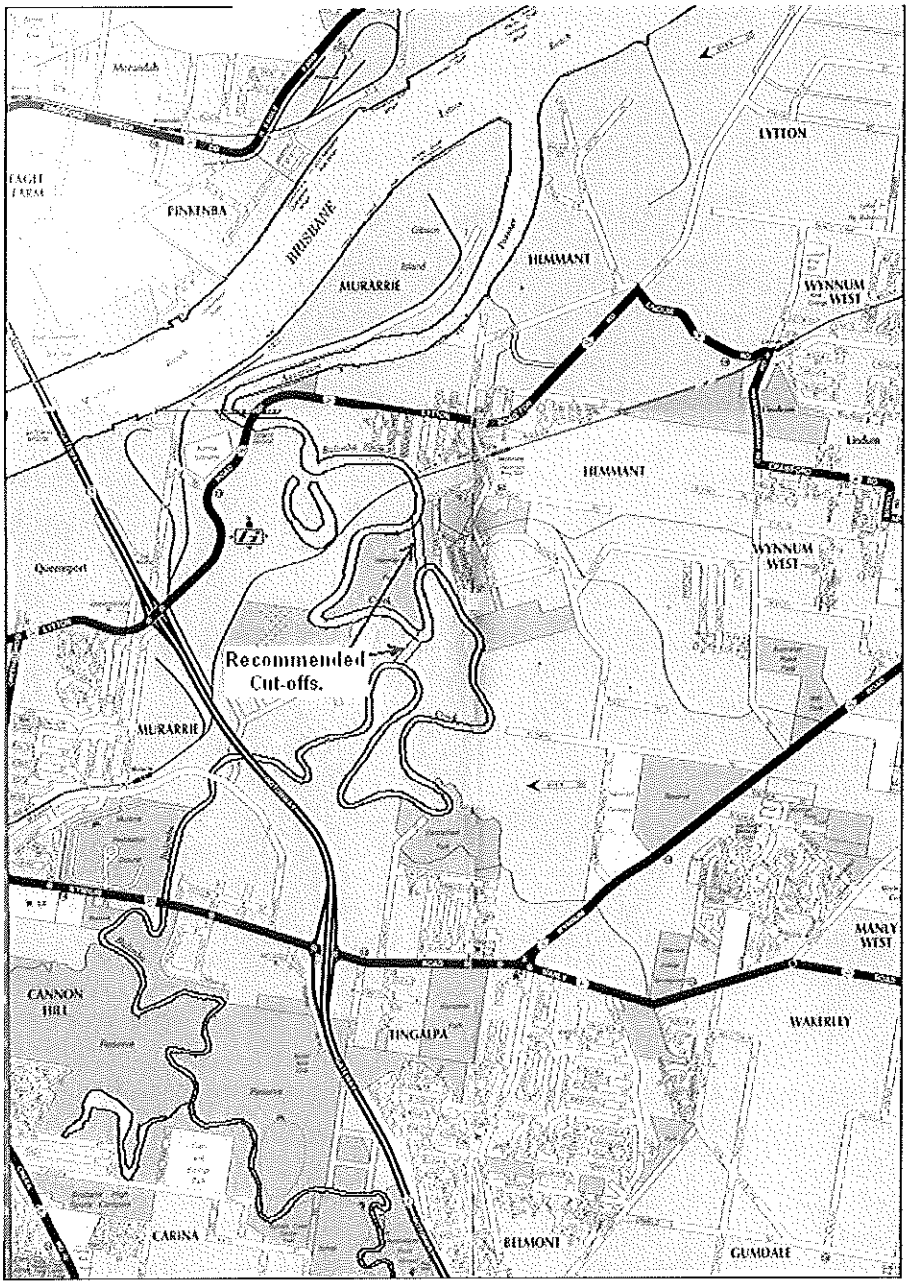


Figure 9 . Possible silt disposal area, at Hemmant, around Bulimba Creek..

The whole of the Brisbane River, for the 20 kilometres from the river mouth to the area of Southbank, should be deepened by dredging, say two metres of silt, for a width of 300 metres. This would need the disposal of 12 million cubic metres of silt, (a trivial amount about equal to the amount of coal being exported from further north each fortnight). This material could be disposed of in the area between Hemmant and Murrarie, which includes the Hemmant Recreation Reserve. This is in the area of Bulimba Creek, which should also be straightened by cutting a new course as shown (on map, Figure 9, copied from page 253 of 1996 Refidex) to protect the upstream suburbs from flooding due to local heavy rain. The two recommended cut-offs total about 600 metres, which could shorten the creek by about 6 kilometres. Several square kilometres of low-lying land, could be converted into valuable real estate, while leaving enough area to protect its environmental value. This would also improve the flood protection for the upstream suburbs, since this creek drains suburbs as diverse as Salisbury and Runcorn.

The shipping channel, from Fishermans Island to Hamilton wharf, passes under the Gateway Bridge, and is (or at least was) at least 8.5 metres deep.

9.2. The Effect of Dredging.

With the recent Brisbane River flood peak of 4.6 metres, this height corresponds to a velocity (caused by a gravity fall of that dimension) of 9.5 metres/second (= 34.2 km/hour). (This calculation method is not particularly precise, but is useful for a before-and-after comparison). On the assumption that the Brisbane River (at, say, the Gateway Bridge) is 450 metres wide and averages 6 metres deep, this gives a flow cross section of 2700 square metres. With my recommended deepening of 2 metres, over a width of 300 metres, this increases the flow area to 3300 square metres. This would allow the same volume of water flow to occur at a velocity of (9.5 x 2700)/3300 = 7.77 metres per second (= 28 km/hour). This corresponds to a gravity fall of 3.08 metres, leaving a flood peak reduction of 1.52 metres.

Since most of the damage is done by the top of the flood, this reduction would ensure the safety of the CBD of Brisbane, and of much of is suburbs.

Consideration could be given to a diversion tunnel, to shorten the distance of flow, from Dutton Park to Mowbray Park (near the junction of Norman Creek), a distance of approximately 2 km., compared with the distance along the river of over 6 km. Despite its relatively small cross section, this tunnel should carry part of the flood waters at about 3 times the velocity of the main river, and thus lower the flood levels. Whether this tunnel would intersect the Clem7 tunnel, which already exists or the planned Cross City Rail tunnel, may control this possibility.

A significant reduction in local flood risk, for residents of Coorparoo, Greenslopes and surrounding suburbs, might be achieved by cutting off the neck of the area of Norman Creek, in the grounds of the Anglican Church Grammar School, where a neck of about 60 metres separates two parts of the Creek about 1.8 kilometres apart (measured along the creek). Since both sides of the neck are occupied by School activities, a bridge should be included in this part of the project.

9.3. Brisbane River, upstream of CBD.

Dredging of the river depth should be continued by say 2 metres, with gradual reduction of width from 200 metres to 100 metres, for the next 40 kilometres to the junction of the Bremer River This would require the movement of 12 million cubic metres of silt. Much of this material could be used to raise large areas of the flood-plain of Oxley Creek where some severe straightening of the meandering creek may be appropriate, as is obvious in this map. (See Figure 10, next page.)

Straightening the creek would, during floods, increase the velocity of the water, both above and below the area which is straightened, and allow the volume of water to be transported at a lower depth, and thus lower the flood peak level

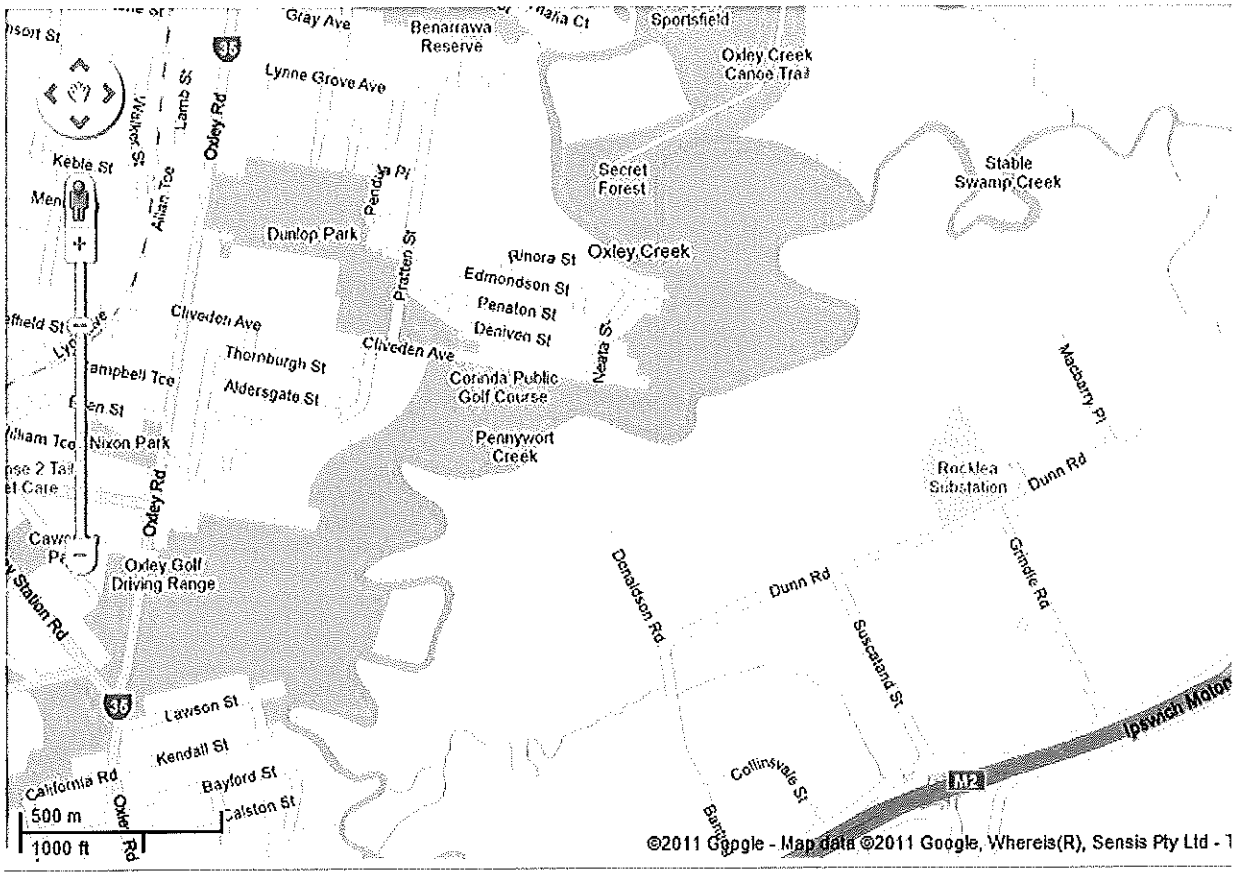


Figure 10. Oxley Creek, in the suburbs of Corinda and Rocklea.

Removal of the Seventeen Mile Rocks, from the river, in the vicinity of the suburb of Sinnamon Park, would appear to be a priority work, to give some protection to the suburbs of Gailes and Goodna, which suffered severely from inundation.

9.4. Fitzroy River.

Wading through life ... Depot Hill before the flood peak, above; Fred and Del Moss wait it out, below left; a rose bush is belatedly rescued, below right; and a man takes a boat where no car will go, bottom. Photos: Reuters; Janie Barrett

Figure 11. Depot Hill, Rockhampton.

The Fitzroy River floods frequently, with great costs incurred in recovery. This year's Fitzroy River flood has probably been the highest on record, and much publicity was given to the flooding of Emerald and then Rockhampton, before the threats to Toowoomba, Ipswich and Brisbane diverted the publicity.

Figure 12. Fitzroy River. (Photo from Google World)

Attempts to make Rockhampton (60 km up the river) an important river port, a century and more ago (See "Ghost Ports of Australia", by Jeff Toghill), were defeated by the frequent floods and shifting of shoals and sandbanks. The amount of silt and sand which should be removed from the river bed was considered then to be enormous, but is not beyond the capabilities of today's technology.

Figure 13. A large "billabong" on the lower Fitzroy River, which could be straightened.

There appears to be a large u-shaped curve in the lower Fitzroy River, as shown in Figure 5, which could be by-passed by a new river path, giving faster flow to the water of major floods, thus lowering the flood level. This might shorten the river by about 10 km, and filling it might accept 5 million cubic metres of silt. To add to this, in the lower reaches of the Fitzroy River around Port Alma, the river delta holds large flat areas with a near-desert climate. Here the creation of a large mountain of excavated river silt could possibly have favourable climatic effects.

Figure 14. Rockhampton, with a large loop on the Fitzroy River, which might be straightened.

The illustrated possible straightening of the Fitzroy River, just below Rockhampton, might need an excavated canal two kilometres long, to shorten the river by one kilometre, and by-passing the bend would increase water velocity significantly. The by-passed river bed could accommodate a large part of the dredged silt from the nearby parts of the river. Between these two suggested river changes, consideration could be given to building a temporary railway along one side of the river, to carry trainloads of silt to any convenient open-cut coal mine, which is due for filling and re-vegetation. This method of removing silt could be continued right up to the town of Emerald to protect it from the next severe flood.

9.5. Bremer River.

Upstream in the Bremer River, a tributory of the Brisbane River, dredging should continue, but to a lesser width, and a study of straightening the very winding nature of this river could provide a valuable degree of safety to the city of Ipswich. A procedure which appears to be worth considering is to use parkland in Ipswich to form a bypass flood-way, which would divert flood waters from the Central Business District, while allowing these parks to act as community facilities, at times of normal river flow. Starting st the Jim Finimore Sportsground, a floodway could be excavated through the Limestone Park and Queens Park, between the Ipswich Special School and Ipswich Girls Grammar School, through the Hockey Ground and across Moores Pocket, just below Boundary Street. Almost the whole of this path is parkland, but a few properties would need to be resumed. The floodway could be excavated to a depth a little (less than a metre) above the normal level of the river, and grassed to allow the normal park activities to continue, at times of normal river flow. At the upper end of this floodway there could be floodgates (a miniature London Barrage, perhaps) to keep out minor floods, while allowing major floods free flow through this shortened path.

9.6 Grantham Bridge.

From the attached photograph (Figure 15) of the railway bridge at Grantham, it appears that the bridge formed a serious obstruction to the flow of flood waters, and it almost certainly caused the upstream flood height to be higher than it would have been if the bridge had not been there. This suggests that the bridge, both tracks, should be replaced with a higher one, which is high enough to be flood free, and which does not have support structures in the flow path. Since this is now an export coal train route to the Port of Brisbane, finance for this should be available from either Government or private sources.

Figure 15. Grantham Bridge.

9.7. Inland towns, such as Goondiwindi and St George.

There would be over a hundred inland towns in Queensland and N.S.W. which have suffered from recent flood damage, and could be protected by deepening their rivers by sufficient to accommodate the necessary flood water flow.

The list of towns requiring flood protection is formidable, and includes the following (based on those mentioned in the Press) :- (in Queensland) Brisbane, Rockhampton, Emerald, Bundaberg, St George, Theodore, Condamine, Ipswich, Toowoomba, Gympie and Maryborough, (and in NSW) Brewarrina, Bourke, Louth, Walgett, Pilliga, Wollar, Carinda, Warren, Tilpa, Wilcannia, Condobolin, Carrathool, Hay, Darling Point, Narrandera, Wakool Junction, Deniliquin, Moama, Smiths Road. There are many others.

In inland rivers, mobile excavating machines or cranes with "clam-shell" grab buckets could lift the silt in bucket-loads and place it on the banks within the radius of the crane arm, or in piles for removal later. A mobile crane with a "drag-line" bucket would leave a more even surface to the bottom of the river, which could be advantageous for the water flow next flood. Excavation should continue downstream from the town, as deepening here is likely to be even more beneficial that deepening the area within the town.

On some occasions, a flood protection program could be arranged by a Local Council, assisted by volunteers perhaps, to carry out this work without the bureaucracy which will infest this program. Local Service Clubs such as Rotary, Lions and Apex, could organise a program of small scale dredging which could protect their own homes and families.

10. Insurance.

To avoid the misunderstanding of Insurance contracts, I recommend that the Insurance Companies should be required to include "Damage caused by Inundation by Water, from all Sources.", since the insurance should cover the damage done, not the source of the cause.

List of Subject Headings.

List of Illustrations.

Disclaimer.

This proposal is suggested by Alex Stoney, a retired professional mechanical engineer, who was born and educated in Brisbane, resided for a time half a century ago in Rockhampton, and now in Sydney. He is not professionally qualified in flood control. It is made as a private person, and is suggested for the benefit of all persons who are affected by flood disruption. I am grateful (in their absence) to Google, Sydney Morning Herald, Daily Telegraph, Refidex, Avis, and others for sources of illustration for this proposal.

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