8. ECONOMIC IMPACT OF FLOODING

The impact of flooding can be quantified through the calculation of flood damages. Flood damage calculations do not include all impacts associated with flooding. They do, however, provide a basis for assessing the economic loss of flooding and also an objective means of assessing the merit of flood mitigation works such as retarding basins, levees, drainage enhancement etc. The quantification of flood damages is an important part of the floodplain risk management process. By quantifying flood damage for a range of design events, appropriate cost effective management measures can be analysed in terms of their benefits (reduction in damages) versus the cost of implementation. The cost of damage and the degree of disruption to the community caused by flooding depends upon many factors including:

- The magnitude (depth, velocity and duration) of the flood;
- Land use and susceptibility to damages;
- Awareness of the community to flooding;
- Effective warning time;
- The availability of an evacuation plan or damage minimisation program;
- Physical factors such as failure of services (sewerage), flood borne debris, sedimentation; and
- The types of asset and infrastructure affected.

The estimation of flood damages tends to focus on the physical impact of damages on the human environment but there is also a need to consider the ecological cost and benefits associated with flooding. Flood damages can be defined as being tangible or intangible. Tangible damages are those for which a monetary value can be easily assigned, while intangible damages are those to which a monetary value cannot easily be attributed. Types of flood damages are shown in Diagram 4.

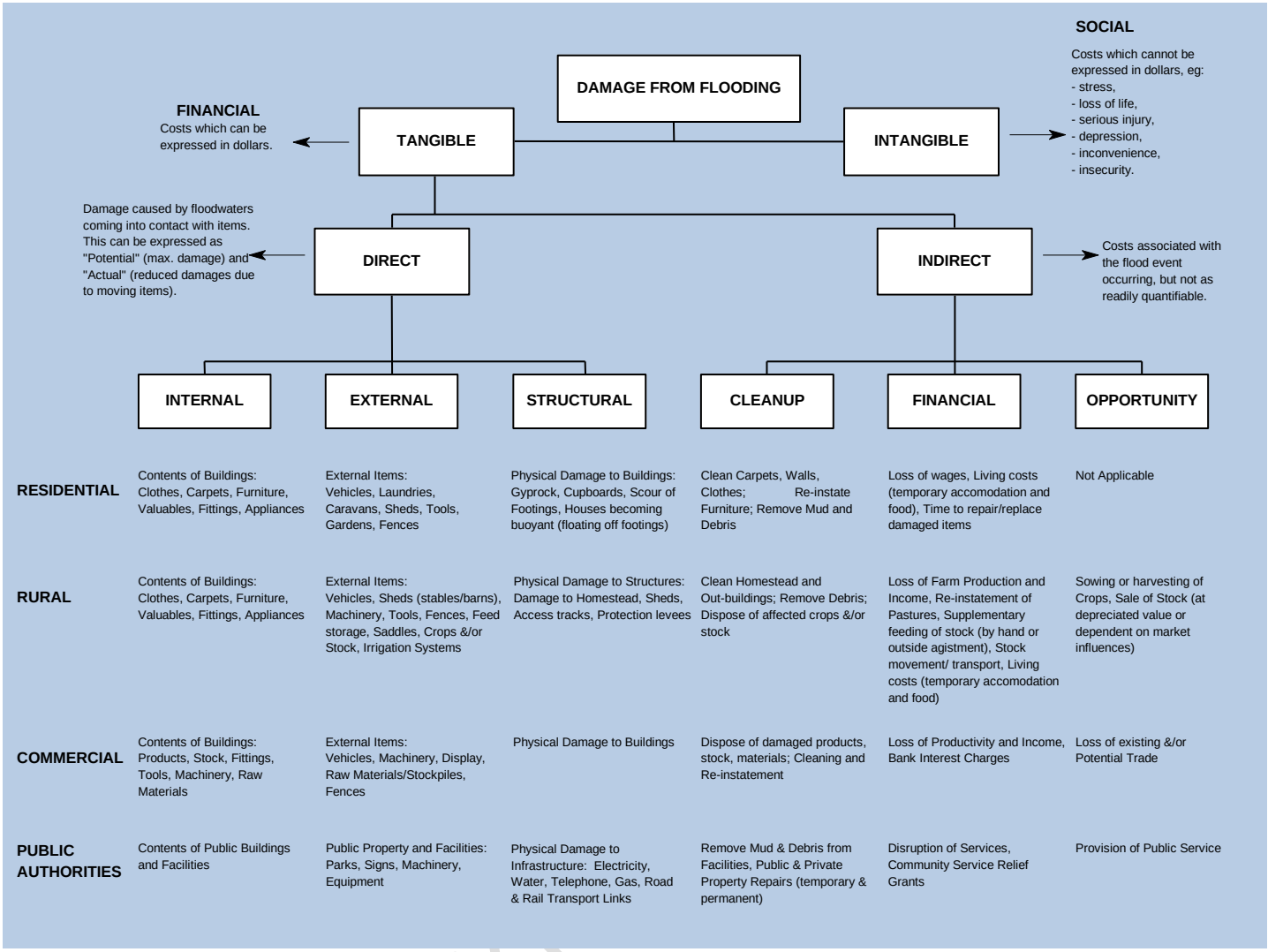

Diagram 4: Flood Damages Categories

8.1. Tangible Flood Damages

Tangible flood damages are comprised of two basic categories; direct and indirect damages. Direct damages are caused by floodwaters wetting goods and possessions thereby damaging them and resulting in either costs to replace or repair or in a reduction of their value. Direct damages are further classified as either internal (damage to the contents of a building including carpets, furniture), structural (referring to the structural fabric of a building such as foundations, walls, floors, windows) or external (damage to all items outside the building such as cars, garages). Indirect damages are the additional financial losses caused by the flood for example the cost of temporary accommodation, loss of wages by employees etc.

Given the variability of flooding and property and content values, the total likely damages figure in any given flood event is useful to get a feel for the magnitude of the flood problem, however it is of little value for absolute economic evaluation. Flood damages estimates are also useful when studying the economic effectiveness of proposed mitigation options. Understanding the total damages prevented over the life of the option in relation to current damages, or to an alternative option, can assist in the decision making process.

The standard way of expressing flood damages is in terms of average annual damages (AAD). AAD represents the equivalent average damages that would be experienced by the community on an annual basis, by taking into account the probability of a flood occurrence. This means the smaller floods, which occur more frequently, are given a greater weighting than the rare catastrophic floods.

In order to quantify the damages caused by inundation for existing development a desktop estimation of floor levels was undertaken using the provided Digital Elevation Model (DEM), aerial imagery and Google Street-view. In addition, field survey for the highest risk properties was also obtained. The survey data was used in conjunction with modelled flood level information to calculate damages. Damage calculations were carried out for all properties within the PMF extent, and floor levels were estimated for these properties.

The damages were calculated using a number of height-damage curves which relate the depth of water above the floor with tangible damages. Each component of tangible damages is allocated a maximum value and a maximum depth at which this value occurs. Any flood depths greater than this allocated value do not incur additional damages as it is assumed that, by this level, all potential damages have already occurred.

The total estimated damages from both residential and non-residential properties are provided in Table 11. Damages were calculated for residential and commercial/industrial properties separately, as well as for the former Warringah and Manly Council LGAs, as discussed in the following sections.

Table 11: Estimated Total Flood Damages (residential & non-residential) for Manly Lagoon catchment

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property
20% AEP	125	62	$8,150,000	$65,200
10% AEP	220	133	$15,492,000	$70,418
5% AEP	274	191	$21,947,000	$80,099
2% AEP	337	251	$29,844,000	$88,558
1% AEP	401	310	$36,880,000	$91,970
0.5% AEP	458	356	$43,578,000	$95,148
PMF	868	765	$136,515,000	$157,275
Average Annual Damages (AAD)			$5,102,000	

The flood damages estimates do not include the cost of restoring or maintaining public services and infrastructure. It should also be noted that damages calculations do not take into account flood damages to any basements or cellars, hence where properties have basements, damages can be under estimated.

8.1.1. Residential Properties

Residential properties suffer damages from flooding in a number of ways. Direct damages include loss of property contents and/or damage to the structure of the property. Indirect damage costs can be incurred when property occupiers live elsewhere while repairs are being made. A flood damages assessment was undertaken for 1457 residential properties. Remote survey using ALS data, street view and site visits was used to estimate the majority of the floor levels in the catchment. 69 high risk properties were surveyed by registered surveyors.

A summary of the flood damages assessment is provided in Table 12 for the Manly Lagoon catchment as a whole. Table 13 presents the results for those properties within Northern Beaches South only and Table 13 for those located within Northern Beaches Central.

Table 12: Estimated Residential Flood Damages for Manly Lagoon catchment

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages*	Average Tangible Damages Per Flood Affected Property*
20% AEP	89	32	$3,303,000	$37,100
10% AEP	164	85	$7,824,000	$47,700
5% AEP	209	135	$12,396,000	$59,300
2% AEP	253	176	$16,934,000	$66,900
1% AEP	304	225	$ 21,749,000	$71,500
0.5% AEP	350	263	$26,167,000	$74,800
PMF	672	582	$87,866,000	$130,800
Average Annual Damages (AAD)			$2,595,000	$3,900

Table 13: Estimated Residential Flood Damages for Manly Lagoon catchment within Northern Beaches South area

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages*	Average Tangible Damages Per Flood Affected Property*	%age of total residential damages
20% AEP	30	14	$1,411,000	$ 47,000	43%
10% AEP	51	22	$2,260,000	$ 44,300	29%
5% AEP	64	38	$3,605,000	$ 56,300	29%
2% AEP	88	55	$5,246,000	$ 59,600	31%
1% AEP	120	85	$8,085,000	$ 67,400	37%
0.5% AEP	151	106	$10,462,000	$ 69,300	40%
PMF	329	299	$ 46,133,000	$ 140,200	53%
Average Annual Damages (AAD)			$929,000	$2,800	36%

Table 14: Estimated Residential Flood Damages for Manly Lagoon catchment within Northern Beaches Central area

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property	%age of total residential damages
20% AEP	59	18	$1,893,000	$32,100	57%
10% AEP	113	63	$5,565,000	$49,200	71%
5% AEP	145	97	$8,792,000	$60,600	71%
2% AEP	165	121	$11,688,000	$70,800	69%
1% AEP	184	140	$13,664,000	$74,300	63%
0.5% AEP	199	157	$15,705,000	$78,900	60%
PMF	343	283	$41,733,000	$121,700	47%
Average Annual Damages (AAD)			$1,666,000	$4,900	64%

8.1.2. Non-Residential – Commercial and Industrial

There are three main pockets of non-residential land use in the catchment, Warringah Mall, Stockland Balgowlah and the Balgowlah Industrial Estate. Non-residential properties are affected either directly by flood damage or indirectly by loss of business due to restricted customer and/or employee access. Costs vary significantly dependent on the type of activity;

- Type of business – stock based or not, costs of damages to goods;
- Duration of flooding – affects how long a business may be closed for not just whether the business itself if closed, but when access to it is restored;
- Ability to move stock or assets before onset of flooding - some large machinery will not be able to be moved and in other instances there may be no sufficient warning time to move stock to dry locations; and
- Ability to transfer business to a temporary location.

A summary of the flood damages assessment for commercial and industrial properties is provided in Table 15 for the Manly Lagoon catchment. Table 16 presents the results for those properties within Northern Beaches south only and Table 17 for those located within Northern Beaches Central. The non-residential damages account for approximately 40% of the total AAD in the catchment.

Table 15: Estimated Non-residential Flood Damages for Manly Lagoon catchment

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property
20% AEP	36	30	$4,847,000	$134,600
10% AEP	56	48	$7,668,000	$136,900
5% AEP	65	56	$9,551,000	$146,900
2% AEP	84	75	$12,910,000	$153,700
1% AEP	97	85	$15,131,000	$156,000
0.5% AEP	108	93	$17,411,000	$161,200
PMF	196	183	$48,649,000	$248,200
Average Annual Damages (AAD)			$2,507,000	$12,800

Table 16: Estimated Non-residential Flood Damages for Manly Lagoon catchment within Northern Beaches South area

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property	%age of total non-res damages
20% AEP	10	8	$1,566,000	$156,600	32%
10% AEP	16	15	$2,608,000	$163,000	34%
5% AEP	18	17	$3,083,000	$171,300	32%
2% AEP	25	24	$4,272,000	$170,900	33%
1% AEP	30	29	$5,153,000	$171,800	34%
0.5% AEP	36	34	$6,291,000	$174,700	36%
PMF	62	60	$15,687,000	$253,000	32%
Average Annual Damages (AAD)			$827,000	$13,300	33%

Table 17: Estimated Non-residential Flood Damages for Manly Lagoon catchment within Northern Beaches Central area

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property	%age of total non-res damages
20% AEP	26	22	$3,281,000	$126,200	68%
10% AEP	40	33	$5,060,000	$126,500	66%
5% AEP	47	39	$6,468,000	$137,600	68%
2% AEP	59	51	$8,639,000	$146,400	67%
1% AEP	67	56	$9,978,000	$148,900	66%
0.5% AEP	72	59	$11,120,000	$154,400	64%
PMF	134	123	$32,962,000	$246,000	68%
Average Annual Damages (AAD)			$1,680,000	$12,500	68%

8.2. Public Infrastructure

Public sector (non-building) damages include; recreational/tourist facilities; water and sewerage supply; telephone and electricity supply including transmission poles/lines, sub-stations and

underground cables; roads and bridges including traffic lights/signs; and costs to employ the emergency services and assist in post-flood clean up. Public sector damages can contribute a significant proportion to total flood costs but are difficult to accurately calculate or predict.

Costs to Councils from flooding typically comprise:

- Clean-up costs;
- Erosion and siltation;
- Removing fallen trees;
- Inundation of Council buildings;
- Direct damage to roads, bridges and culverts, water and sewer infrastructure;
- Removing vehicles washed away;
- Assistance to ratepayers;
- Increases in insurance premiums;
- Closures of streets;
- Loss of working life of road pavements; and
- Operational costs in the lead up to and during flood events.

8.3. Intangible Flood Damages

The intangible damages associated with flooding, by their nature, are inherently more difficult to estimate in monetary terms. In addition to the tangible damages discussed previously, additional costs/damages are incurred by residents affected by flooding, such as stress, risk/loss to life, injury, loss of sentimental items, etc. It is not possible to put a monetary value on the intangible damages as they are likely to vary dramatically between each flood (from a negligible amount to several hundred times greater than the tangible damages) and depend on a range of factors such as the size of flood, the individuals affected, and community preparedness. However, it is still important that the consideration of intangible damages is included when considering the impacts of flooding on a community.

Post-flood damages surveys have linked flooding to stress, ill-health and trauma for the residents. For example, the loss of memorabilia, pets, insurance papers and other items without fixed costs and of sentimental value may cause stress and subsequent ill-health. In addition flooding may affect personal relationships and lead to stress in domestic and work situations. As well as the stress caused during an event (from concern over property damage, risk to life for the individuals or their family, clean up, etc.) many residents who have experienced a major flood are fearful of the occurrence of another flood event and the associated damage. The extent of the stress depends on the individual and although the majority of flood victims recover, these effects can lead to a reduction in quality of life for the flood victims.