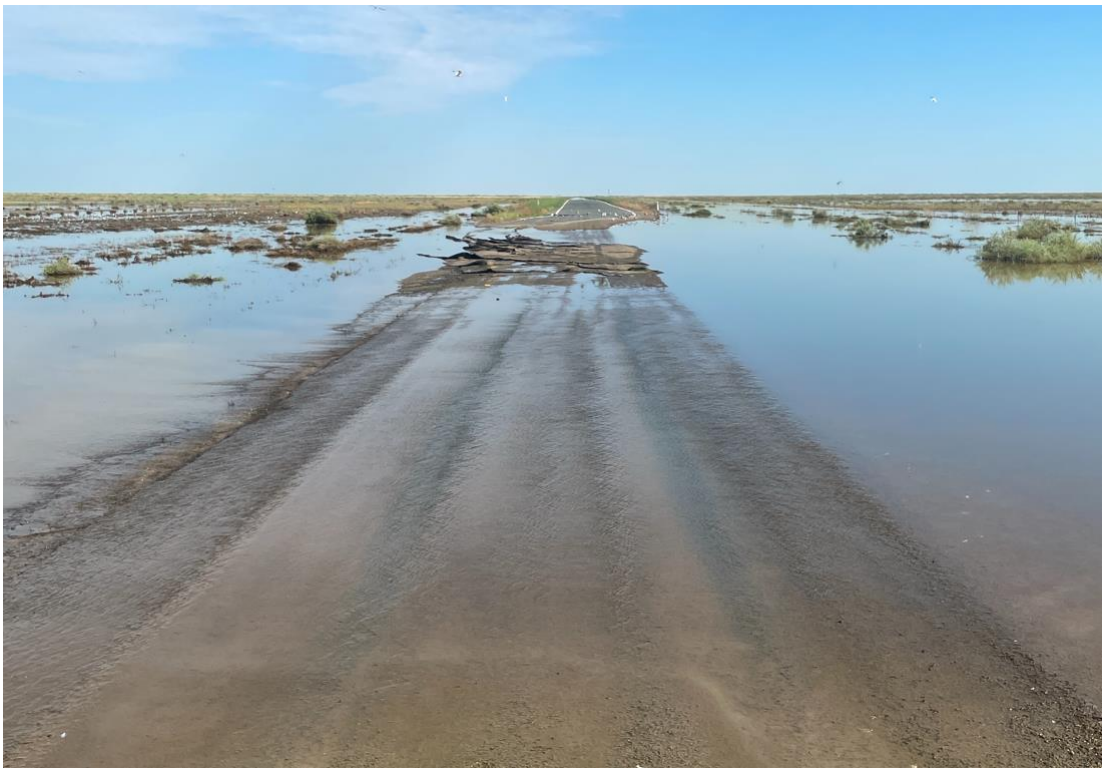
Transport for NSW

TfNSW Natural Disaster Pavement Saturation Damage Assessment Guide

June 2023



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1. Purpose

The purpose of this Guide is to provide assessors with practical advice and examples of saturation damage to road pavements and subgrades to determine whether repair works meet the requirements of the NSW Government Essential Public Asset Restoration Guidelines and are therefore eligible under the Disaster Recovery Funding Arrangement (DRFA). (Saturation damage caused to cut batters and embankments is dealt with in TfNSW's Interpreting Natural Disaster Slope Damage Restoration Requirements.)

2. Introduction

The damage caused to roads from disasters is typically evident shortly after the event. However, 'saturation damage' may only become apparent well after the event. Apart from the usual evidence requirements, eligible claims for saturation damage should also demonstrate that the damage was

- a direct result of the declared disaster and
- not caused by poor maintenance and/or construction practices

3. Background

3.1 What is saturated subgrade or pavement?

Saturated materials contain no air voids and consequently cannot absorb any more liquids. In 'soil engineering' terms, the liquid will normally be water and the solids will be inert particles with sizes varying from clays and sands to gravels and rock. When the voids in a material are filled, run-off occurs.

When a material is saturated, it has a Degree of Saturation (DoS) equal to 100%.

3.2 What are the effects of saturated subgrade or pavement?

Both laboratory testing and field investigations of flood-affected pavements[1] have shown a loss in structural strength and an accelerated rate of deterioration in pavements, which have been trafficked, and have moisture contents between 75% and 100% DoS i.e. in a partially or fully saturated state.

For example, strength parameters such as subgrade CBR and pavement Resilient Modulus decrease with increasing DoS. Similarly, permanent plastic strain increases, under traffic, at higher DoS.

[1] See Reference section at end of document

4. Relevant Provisions of Natural Disaster Guidelines

4.1 Essential Public Asset Restoration Guidelines (EPARG) provisions

Ineligible Restoration Works (3.5.3)

- Damage to pavements and subgrades that is caused by prolonged wet weather. This type of deterioration is considered to be a normal maintenance liability.
- Saturation damage where:
  - Water fills the table drain and is unable to drain away because of poor construction or a lack of proper maintenance; or
  - Extensive ruts, cracks, potholes and heave were in evidence prior to the eligible disaster event; or
  - It is a result of the diversion of water from adjacent land or irrigation canals

4.2 Disaster Assistance Guidelines (DAG) provisions

Assistance for Public Roads (IRW) (B.2.16)

- May include permanent repair of saturation damage under certain circumstances

Exclusions (IRW) (B.2.18)

- Structures damaged by prolonged exposure to the weather and not as a direct result of a disaster

No assistance for (IRW) (B.2.20)

- Damage caused by prolonged wet weather

Assistance for Public Roads (EPARW) (B.3.15)

- May include permanent repair of saturation damage under certain circumstances

Exclusions (EPARW) (B.3.17)

- Structures damaged by prolonged exposure to the weather and not as a direct result of a disaster

No assistance for (EPARW) (B.3.19)

- Damage caused by prolonged wet weather

5. Assessment Principles

5.1 Was the damage caused by the declared disaster?

The saturation of subgrades and pavements is time dependent. For saturation to occur, pavements need to be inundated or immersed for long enough to allow water to fill any voids in their matrix. Materials with high permeability may saturate relatively quickly. Most gravels used on unsealed roads are likely to become saturated when inundated for more than a day or two. However, the saturation of sealed roads may take much longer provided there are few defects in the surface.

The saturation of the subgrade or pavement by a spring, a rise in the water table, or other seepage is also time dependent. Intermittent springs and water table fluctuations are dependent on seasonal and prevailing rainfall patterns. It is therefore unlikely that saturation damage from these causes will be eligible for funding.

5.2 Was the damage caused by poor construction or lack of maintenance?

Sites where poor construction or maintenance practices may have contributed to saturation damage should be inspected instead of relying on photographic evidence only. There may be conditions at the site which are not apparent in the photos.

Consideration should also be given to the usual maintenance interval between the programmed council works on the road. This maintenance interval may be much longer than desirable but it may be all the council can afford. However, poor maintenance practices should be obvious. For example, where a low spot has been left in a table drain or where a windrow obstructs a drainage path.

5.3 Evidence

The most likely eligible claim for saturation damage is for unsealed roads in floodplains or in other flat terrain. In this case, councils should take photos of the flooded roads, or otherwise justify the time the roads were inundated, and also take photos of the damage after the floodwaters have receded. These photos should be supported by the usual maintenance and re-sheeting records to determine an eligible gravel loss resulting from the saturation damage. Flood maps are only useful if they record the actual heights and locations of the flooding caused by the declared disaster.

For saturation damage claims on sealed roads, the duration of inundation should be established, as above, supported with photos. Photos should be taken immediately prior to the road being opened to traffic to establish whether damage was caused by the inundation or whether it will become subsequently damaged by traffic. Immediate damage, such as seal stripping, becomes the primary damage for which the council should submit an IRW or EPARW claim.

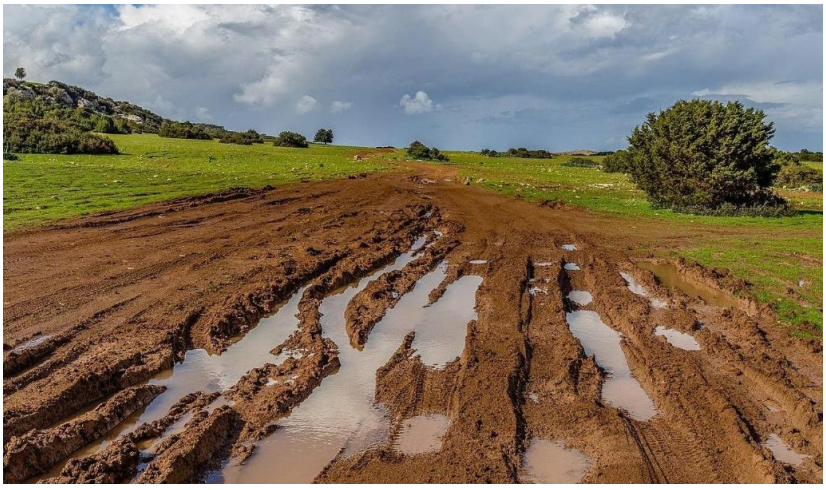
If there is no immediate damage, then the council should monitor the previously inundated sections of road for signs of any new damage. The monitoring should include photo evidence and base and sub-base moisture content sampling. The expected damage from pavement saturation is excessive rutting of the base layer,[2] with associated seal damage, caused by heavy vehicle traffic. Potholing would also be expected in seals with some existing cracking. The restoration of any subsequent damage of this type can be submitted by the council as IRW or EPARW.

For eligible saturation damage claims, pre-disaster evidence should show sealed roads in good to excellent condition with very few existing defects otherwise TfNSW will consider the age and design life of the asset, the extent and appropriateness of maintenance undertaking, the original design and construction of the asset, and other factors that may be relevant. Funding may be rejected or reduced based on this information.

6. Examples

6.1 Example 1

- An unsealed road is inundated by floodwater for 3 days.
- The council provides evidence of the inundation (such as photos).
- The road is opened just before all floodwater has receded.
- Traffic damages the saturated pavement by heavily rutting the surface.
- The council claims a 100mm re-sheet for a 200m length. However, the evidence shows that only 50m has rut depths between 75mm and 100mm and the remaining section has an average rut depth of 40mm.
- The pre-disaster evidence shows that the road was re-sheeted six months prior to the flooding.
- The eligible claim is therefore a 100mm re-sheet for 50m and a 40mm gravel allowance for 150m.

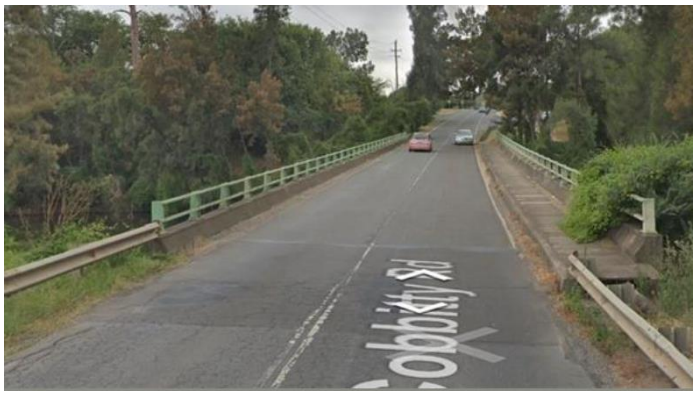


6.1.1 Example only – not actual evidence

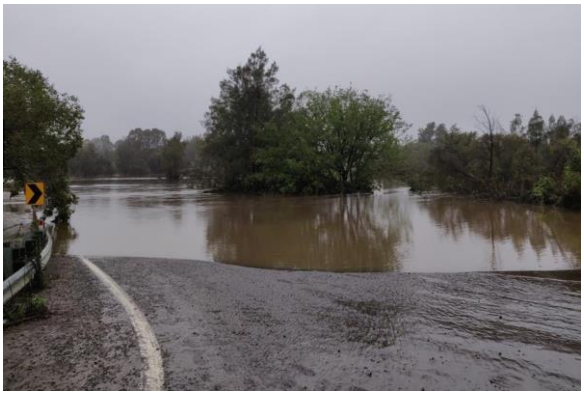
[2] See Reference Section at end of document for definition

6.2 Example 2

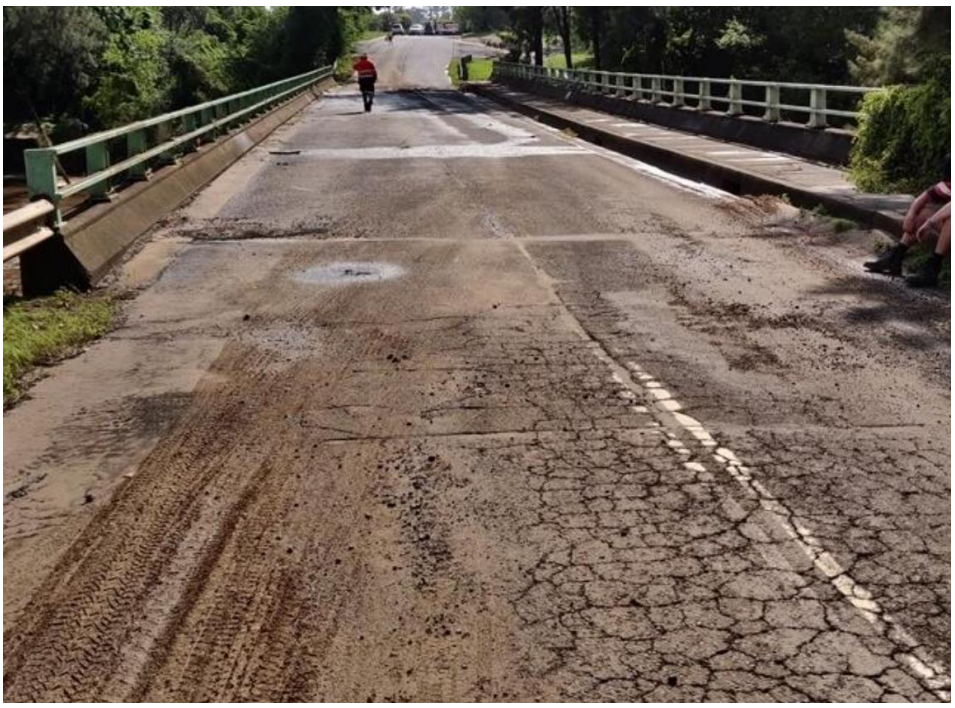
- A bridge and its approaches are flooded for 48 hours.
- The council provides evidence of inundation. (See 2.2 below)
- After floodwaters recede, the council claims saturation damage at the approach and proposes heavy patching of the area which contains 'crocodile cracking'. (See 2.3)
- The pre-disaster evidence shows extensive existing crocodile cracking. (See 2.1)
- As the damage was not caused by the declared disaster, its restoration is not eligible for funding.



6.2.1 Pre-disaster condition

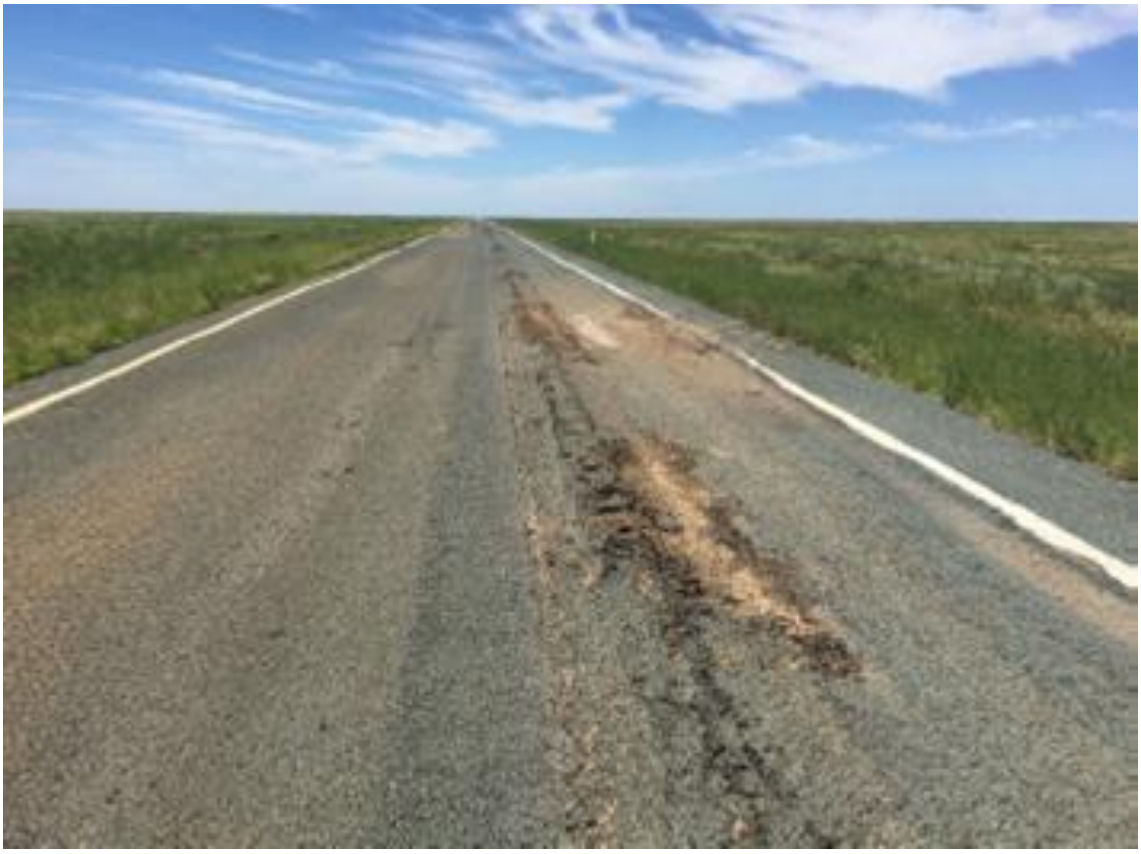


6.2.2 Inundation Evidence



6.2.3 Damage evidence

6.3 Example 3



6.3.1 Rutting after saturation

- A 6m sealed road is inundated for 3 weeks.
- The council provides evidence of inundation.
- The road is opened just as floodwater has receded from the travel lanes.
- There is no “immediate” damage evident and the council monitors the road, daily.
- After four days, rutting appears in the outer wheel path.
- After 10 days, rutting also appears in the inner wheel path.
- The council claims full width (9m) ripping, re-compaction and sealing as the required restoration treatment.
- The pre-disaster evidence was a laser profilometer survey undertaken 12 months before the flooding. The survey recorded minor rutting (<3mm) and negligible cracking and other defects.
- It was accepted that the ‘fresh’ rutting was caused by traffic on a saturated pavement so that the proposed treatment is eligible for funding, except for the additional 3m of sealing which would require complementary funding.

6.4 Example 4

- A road with sealed lanes and shoulders is inundated for 1 day.
- The council provides evidence of inundation.
- Floodwaters recede to a level about 300mm below the 'edge of bitumen' and remain there for two weeks.
- There is no immediate damage but there is some existing 'wide bowl' rutting in the outer wheel path.
- The council monitors the road and after two weeks the rut depth has increased from 10mm to 20mm.
- The council claims for ripping, re-compaction and sealing of half a lane width in both directions to address the increased rutting.
- The type of rutting evident in this case is typical of subgrade deformation being reflected at the surface. Rapid deformation may be indicative of subgrade saturation caused by a rise in the water table.
- The claim can be rejected as the damage: could not be attributed to the declared disaster; was likely to have been caused by prolonged wet weather; and rutting was a pre-existing defect.

7. References

1. **Influence of Degree of Saturation (DOS) on Dynamic Behavior of Unbound Granular Materials**

by Junyu Sun * , Erwin Oh and Dominic Ek-Leong Ong

School of Engineering and Built Environment, Griffith University, Southport, QLD 4222, Australia

2. Austroads Guide to Asset Management Part 5C: Rutting (Section F1) states., *"Structurally, rut depths (based on a 2 m straight edge) below 10 mm are regarded as not significant. At 10 mm, and under conditions of high vehicle speed and water ponding, rutting is regarded as potentially significant for safety reasons and most MAs use this as a range limit. Rutting becomes a critical structural problem at around 20 - 25 mm, and a depth of 20 mm (based on a 2 m straight edge) is used uniformly across Australia for investigation purposes."*