# EMULSION CHIPSEALING: GENERATING CONSCIOUS CAPITAL

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# Conscious Capital

**Corporate Social Responsibility**

**Triple Bottom Line Reporting**

**People, Planet and Profit**

- Health, safety and welfare
- Environmental protection, eco-efficiency and sustainability
- Sustainable profitability

**Safe and Sustainable Road Surfaces**

# Health and Safety

## Health and Safety at Work Act (2015)

- … workers and other persons should be given the **highest level of protection** against harm to their health, safety and welfare from work risks as is **reasonably practicable.**
- …the **cost is not grossly disproportionate** to eliminating or minimising the risk.

# Health and Safety

## Penalties under the Health and Safety at Work Act (2015)

| | Individual (Worker) | Individual (Manager) | Organisation |
|---|---|---|---|
| Reckless conduct creating risk of serious injury, illness or death. | 5 years prison or, $300,000 fine, or both | 5 years prison or, $600,000 fine, or both | $3.0 million fine |
| Failure to comply that creates risk of serious injury, illness or death. | $150,000 fine | $300,000 fine | $1.5 million fine |
| Failure to comply with a duty. | $50,000 fine | $100,000 fine | $500,000 fine |

# Chipseal Costs in NZ

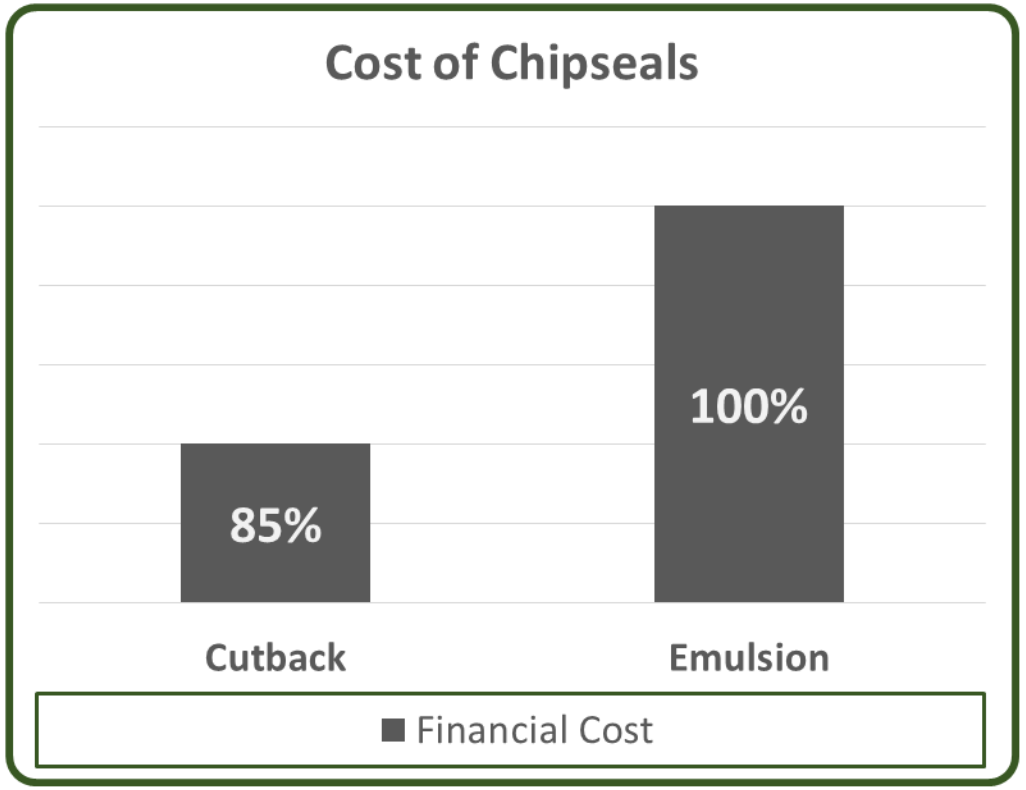
## Chipsealing is cost effective surfacing

- Maintains skid resistance
- Protects pavement from water ingress

## Cost is typically $4.00 - $6.00 /m$^2$

- Materials cost accounts for 50 – 70%
- Bitumen cost is majority of this

## Cutback bitumen chipseals 10 – 15% less expensive than emulsion



# Chipseal Health and Safety Costs

**Accident Rate per 100kT Bitumen**

| | Cutback | Emulsion |
|---|---|---|
| Fatality | 0.2 | 0.0 |
| Serious Harm | 8.7 | 0.0 |
| Minor Harm | 2.8 | 10.6 |
| **TOTAL** | **11.7** | **10.6** |

## Value of Statistical Life (VSL) approach

- $4.06 million in NZ (2015)

## Typical Accident Costs used by NZTA

- Fatality = $4,700,000
- Serious Harm = $500,000
- Minor Harm = $29,000

# Chipseal Health and Safety Costs

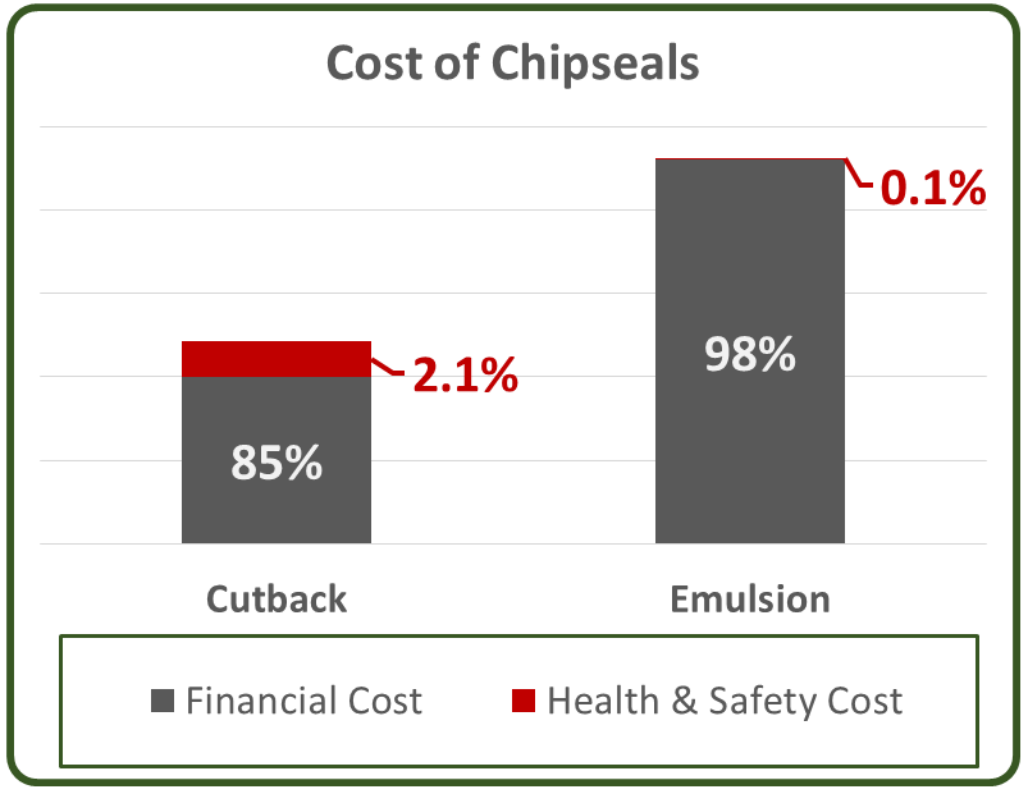
**Estimated Annual Accident Costs Associated with Cutback and Emulsified Bitumen in New Zealand**

| | Cutback | Emulsion |
|---|---|---|
| Fatality | $940,000 | $0 |
| Serious Harm | $4,350,000 | $0 |
| Minor Harm | $81,200 | $307,400 |
| **TOTAL** | **$5,371,200** | **$307,400** |

# Chipseal Health and Safety Costs

## Emulsion generates a risk 17 times lower than cutback bitumen

- Estimated health and safety cost for cutback bitumen in NZ is $5.4 million p.a.
- Estimated health and safety cost for emulsified bitumen in NZ is $0.3 million p.a.

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# Chipseal Quality Costs

**Does emulsified bitumen perform better, worse of the same as cutback ?**

**NZ research is inconclusive**

- Small data sets and large variation in performance throughout NZ.
- Some regions report reduction in life by 6 years, others report increase in life by 7 years
- Emulsions often used in high stress, multicoat applications, where cutback not expected to perform.
- Emulsion is often polymer modified (47%) whereas only 7% of hot bitumen is modified.
- Emulsion tends to be applied at lower residual binder rates (4% less on average)
- Emulsion binders are 15 – 20% stronger than cutback binders

# Chipseal Quality Costs

## Other experience indicates emulsion has performance advantages

- Polymer modified emulsion chipseals has lower rate of texture loss than hot AC15-5GTR in Texas (Gransberg and Carlisle, 2005)
- NZ experience is that there are less early life stripping failures when using emulsion
  - Especially in spring and autumn
  - Prefer emulsion for polymer modified and stiffer binders that are expected to have poorer wetting and adhesion
- Emulsification improves ageing resistance and durability (Zhao et al, 2012).

# Chipseal Quality Costs

## Potential Impact of Emulsion Use

- Emulsion Reduces Low Texture Failures
  - Reduced spray rates
  - Reduces rate of texture loss and stronger binder
- Emulsion Reduces Scabbing
  - Estimated 80% less adhesive stripping failure
  - Estimated 10% less age related scabbing failure
- Emulsion Reduces Low Friction Failures
  - Lower spray rates and stronger binder reduce low friction failure caused by binder tracking

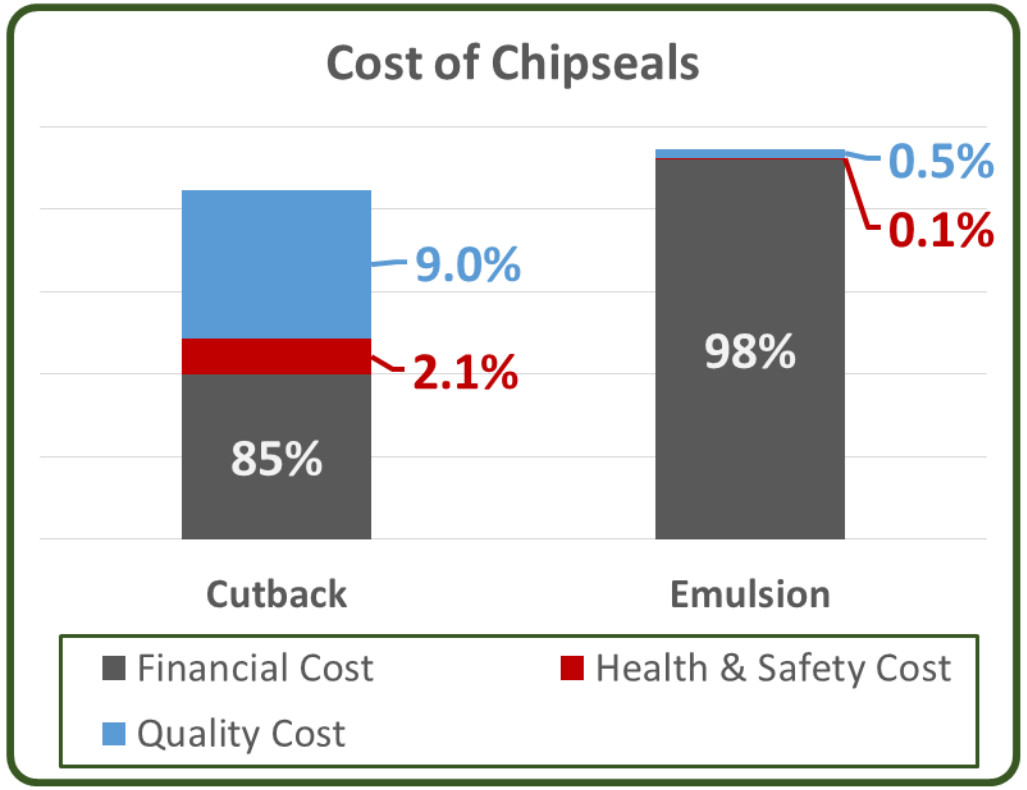
## Estimated Chipseal Failure Rates

| | Cutback | Emulsion |
|---|---|---|
| Cracking | 33% | 33% |
| Low Texture | 42% | 36% |
| Polishing | 20% | 20% |
| Bleeding/Tracking | 1.0% | 0.5% |
| Stripping | 2.0% | 0.4% |
| Scabbing | 2.7% | 2.4% |
| **TOTAL** | | |

# Chipseal Quality Costs

**Estimated that emulsion has potential to improve chipseal life by 5 – 10%**

- Potential saving of $23.5 million p.a. due to increased life if emulsion is used in place of cutback
- Quality cost for emulsion in NZ is estimated at $1.3 million p.a.

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# Chipseal Environmental Costs

## Greenhouse Gas Emissions

- Certified by CarboNZero
- Emulsions produce 49% less $CO_2$ than cutback

## Annual $CO_2$ Cost to NZ

- Cutback produces 142,000 tonne $CO_2$ annually at a cost of $5.7 million
- Emulsion produces 72,300 tonne $CO_2$ annually at a cost of $2.9 million

**Estimated $CO_2$ Emissions (kg $CO_2$-e /tonne of bitumen)**

| | Cutback | Emulsion |
|---|---|---|
| Upstream Processes | 439 | 425 |
| Production | 1 | 5 |
| Distribution | 50 | 65 |
| Operations | 906 | 211 |
| Maintenance/Disposal | 24 | 17 |
| **TOTAL** | **1420** | **723** |

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# Chipseal Environmental Costs

## NMVOC Emissions

- Cutback discharges up to 20,000 L kerosene to air on any typical summer's day in NZ
- Emulsions spills may result in 100 L daily

## Annual Marginal Damage Cost to NZ

- Cutback is estimated to cost NZ $3.3 million annually in NMVOC emissions.

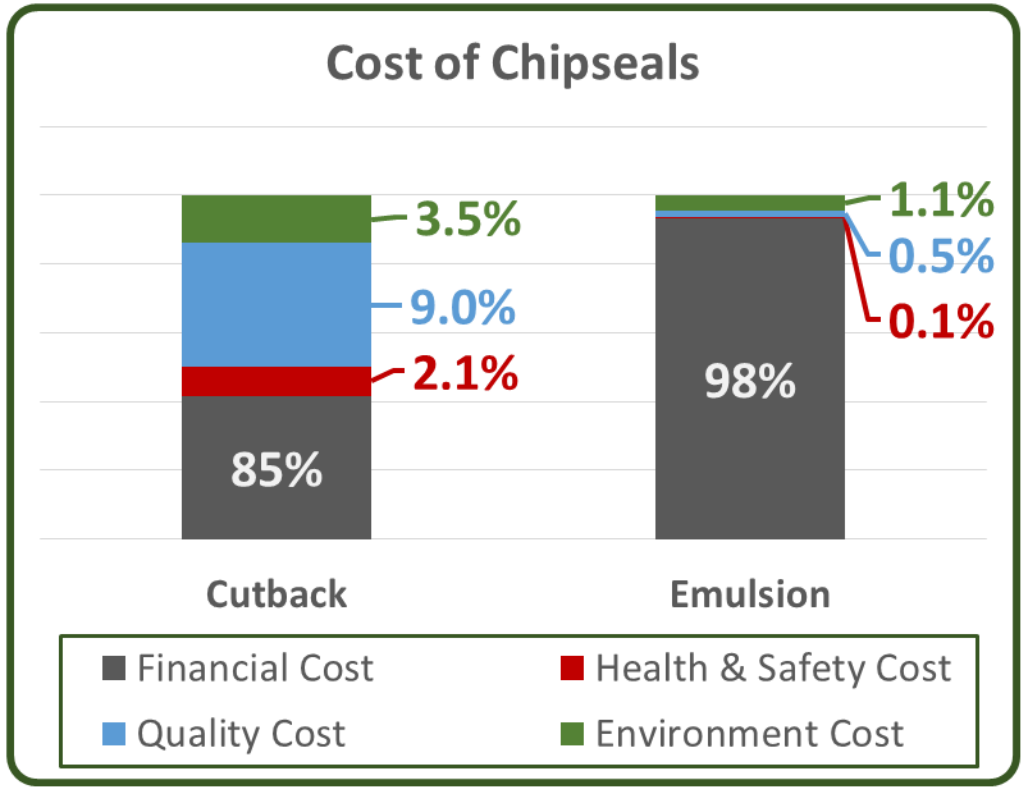
**Marginal Damage Costs for NMVOC Emissions from Cutback Bitumen in NZ**

| | NMVOC Damage Cost | Chipseal Damage Cost |
|---|---|---|
| | ($ /tonne) | ($ /m2) |
| Large City | 4,250 | 0.130 |
| Small City | 2,460 | 0.085 |
| Large Town | 2,150 | 0.082 |
| Small Town | 1,625 | 0.069 |
| Rural Areas | 1,350 | 0.057 |

# Chipseal Environmental Costs

**Estimated environmental benefit to NZ by using emulsion instead of cutback for chipsealing is $6.1 million p.a.**

- Estimated environmental cost for cutback bitumen in NZ is $9.0 million p.a.
- Estimated environmental cost for emulsion in NZ is $2.9 million p.a.

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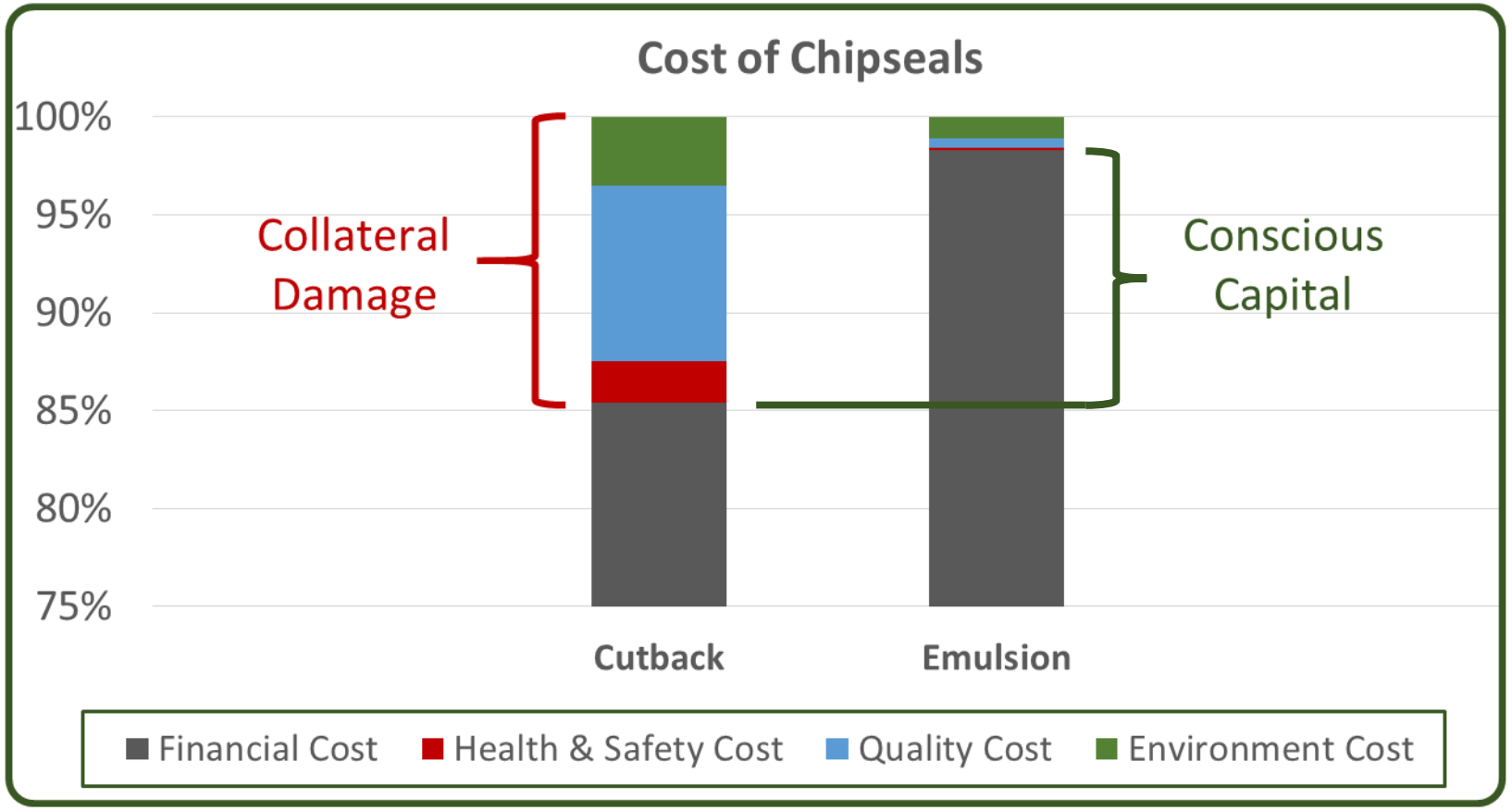
# Generating Conscious Capital

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# Generating Conscious Capital

## Using emulsion instead of cutback for chipseals

- Health and safety costs are 17 times lower
- Environmental costs are 3 times lower
- Estimated reduction in marginal costs for NZ = $33 million
  - Health and Safety Benefit = $5.1 million
  - Environmental Benefit = $6.1 million
  - Quality Improvement Benefit = $22.2 million
- Allows choice between accepting collateral damage or investing in conscious capital
- **Reasonably & practicably meets health & safety obligations at a cost that is proportional to the risk**
- **Emulsion should now be considered best practice**