# CDEGS™ Model Matching

Presented by Joshua Rich
for
APEX 2018

Mitton ElectroNet

## Theme: Smarter Solutions

- CDEGS™ Model matching is the smarter solution for the design and maintenance of earthing systems

Mitton ElectroNet

## CDEGS™

- Software package used for Earthing analysis
- Current Distribution, Electromagnetic Fields, Ground and Soil Structure Analysis

Mitton ElectroNet

## Overview

- Earthing Background
- CDEGS™ Modelling
- Model Matching Examples

Mitton ElectroNet

# Earthing Background

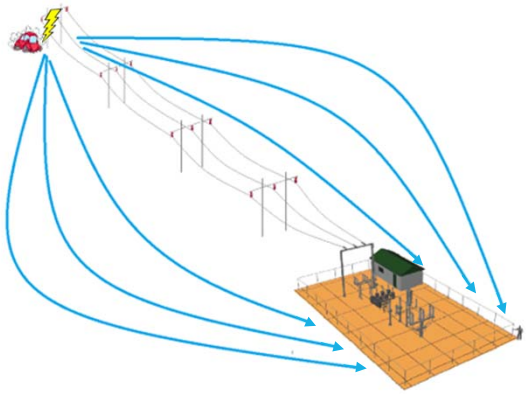
Mitton ElectroNet

## What is the purpose of Earthing?

- Safety of people
- Safety of Assets
- Protection operation

Mitton ElectroNet

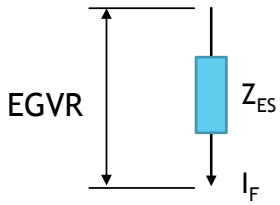
## Earth Fault Conditions



Mitton ElectroNet

## Earth Grid Voltage Rise

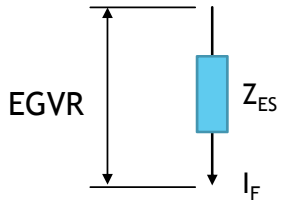
$$EGVR = I_F . Z_{Earth\ System}$$




Mitton ElectroNet

## Earth Grid Voltage Rise

$$EGVR = I_F . Z_{Earth\ System}$$




Example:

$I_F$ = 1,000 A

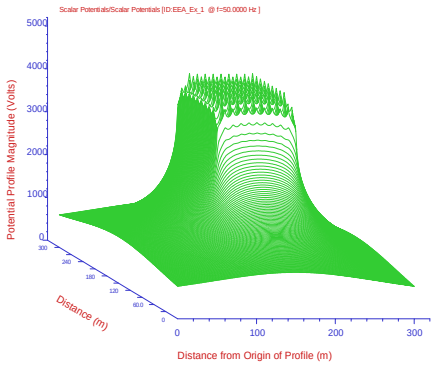
$Z_{Earth\ System}$ = 1 Ω

$EGVR$ = 1,000 V

Mitton ElectroNet

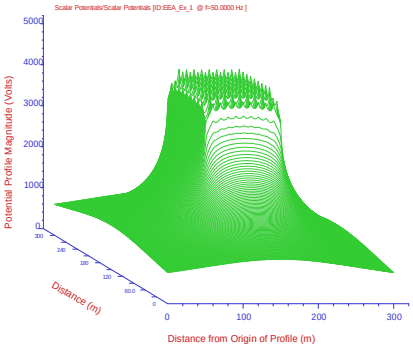
## Earth Potential Rise

- Potential of earths surface at any point relative to remote earth




Mitton ElectroNet

# Earth Potential Rise

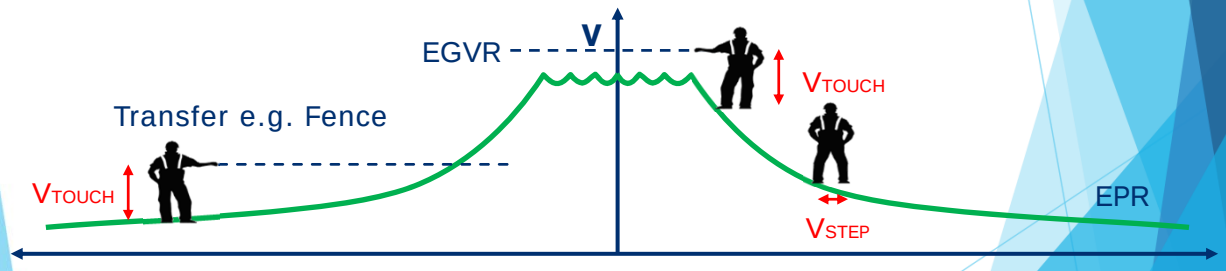




Mitton ElectroNet

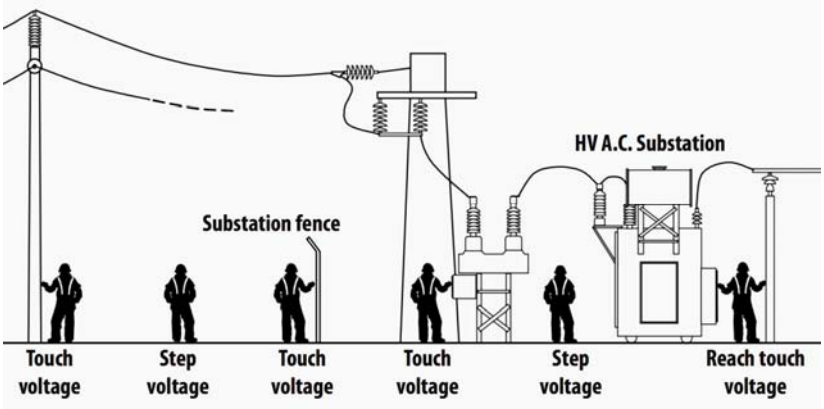
# Why is this of any concern?

- Safety of people




Mitton ElectroNet

## Touch & Step Voltages




Mitton ElectroNet

## Why is this of any concern?

- Safety of Assets
- Ensure that insulation on communication cables are not compromised.
- AS/NZS 3835.1.2006 defines EPR contour limits

Mitton ElectroNet

## CDEGS™ Modelling

- Earthing Drawing
- Site Layout
- Soil Resistivity Structure
- Fault levels and durations

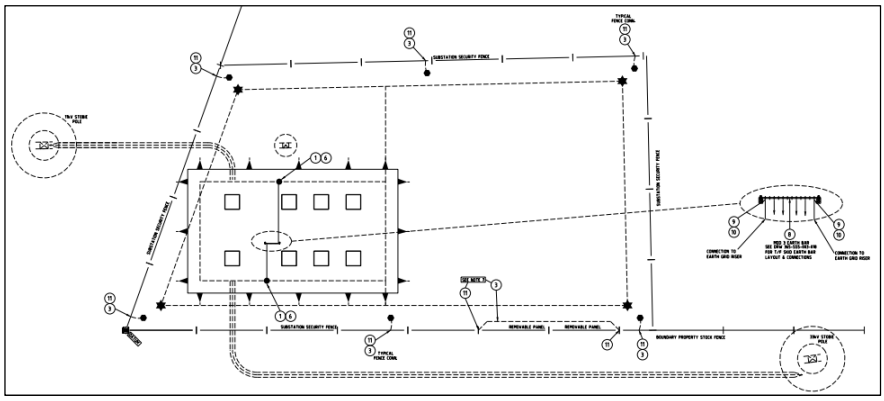
Mitton ElectroNet

## Greenfield - Context

- Greenfield Substation
- Design an appropriate earth grid
- Test the earth grid for compliance.

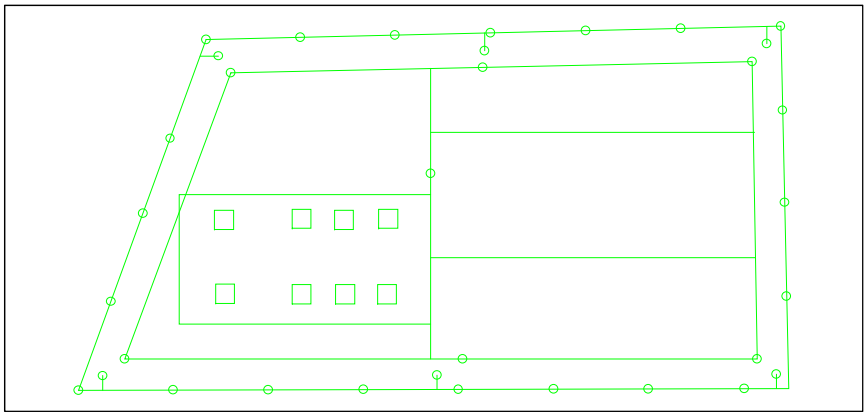
Mitton ElectroNet

## Greenfield - Drawing



Mitton ElectroNet

## Greenfield - Drawing (Traced)



Mitton ElectroNet

## Greenfield - Soil Resistivity Structure

| Layer | Resistivity (Ω-m) | Layer Thickness (m) |
|---|---|---|
| $\rho_1$ | 205 | 0.4 |
| $\rho_2$ | 69 | 12 |
| $\rho_3$ | 31 | ∞ |

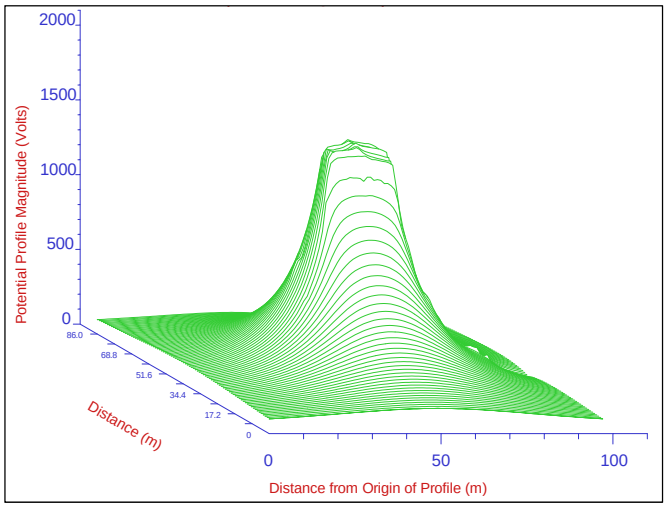
Mitton ElectroNet

## Greenfield – Fault Data

- Earth fault level of 1,039 A for 0.6 seconds.

Mitton ElectroNet

## Greenfield - Earth Potential Rise




Mitton ElectroNet

## Testing Greenfield

Mitton ElectroNet

## Testing Greenfield

- Touch Voltage

- Step Voltage

Mitton ElectroNet

## Testing Greenfield (Earth Potential Rise)

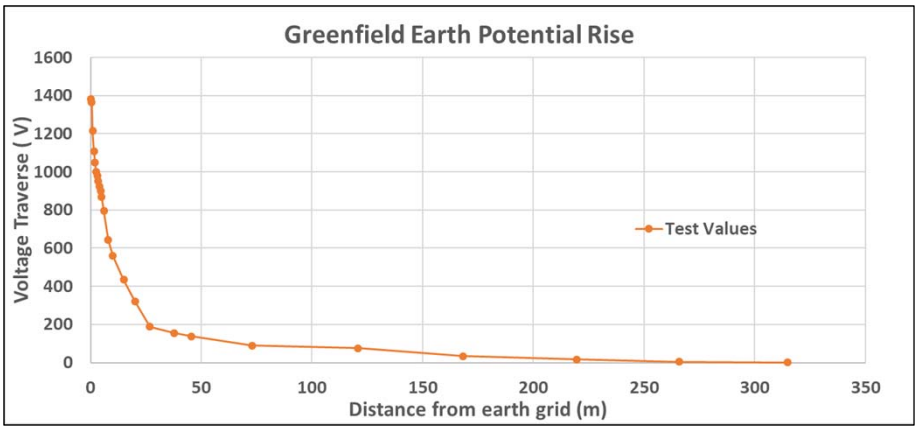
- 0 m

- 6 m

- 121 m

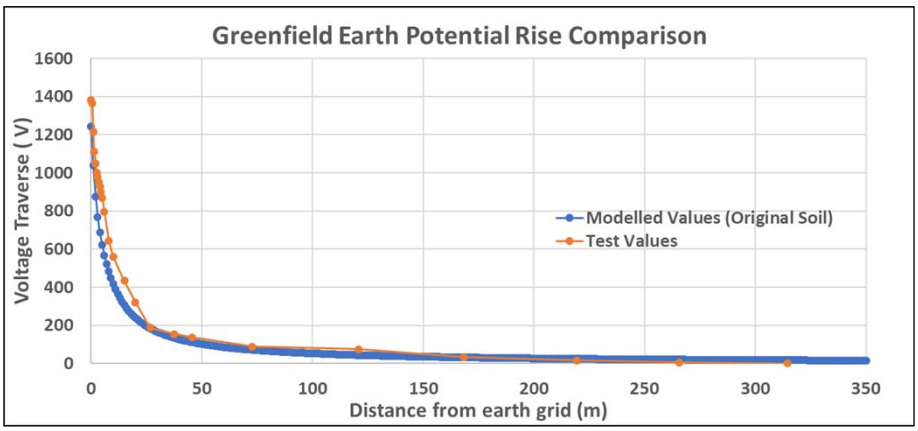
Mitton ElectroNet

# Greenfield – Earth Potential Rise



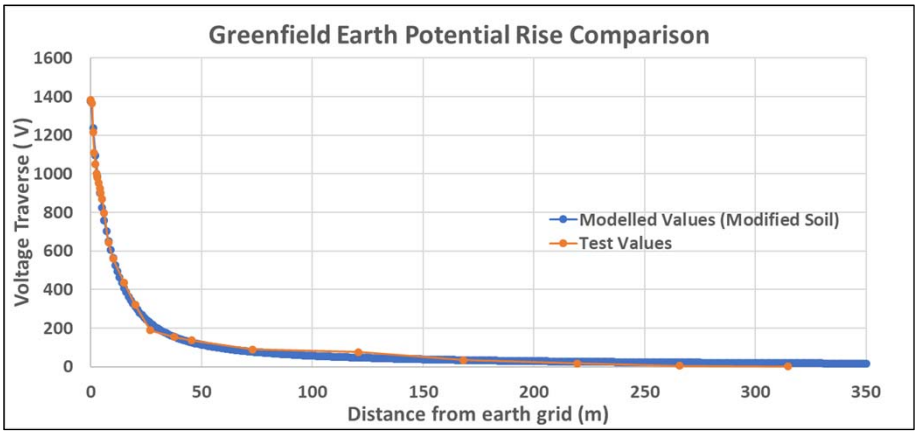

Mitton ElectroNet

# Greenfield – Comparison




Mitton ElectroNet

## Greenfield – Comparison




Mitton ElectroNet

## Greenfield - Soil Resistivity Structure

| Layer | Resistivity (Ω-m) | | Layer Thickness (m) | |
|---|---|---|---|---|
| | Old | New | Old | New |
| $\rho_1$ | 205 | 52 | 0.4 | 1.7 |
| $\rho_2$ | 69 | 598 | 12 | 5.1 |
| $\rho_3$ | 31 | 35 | ∞ | ∞ |

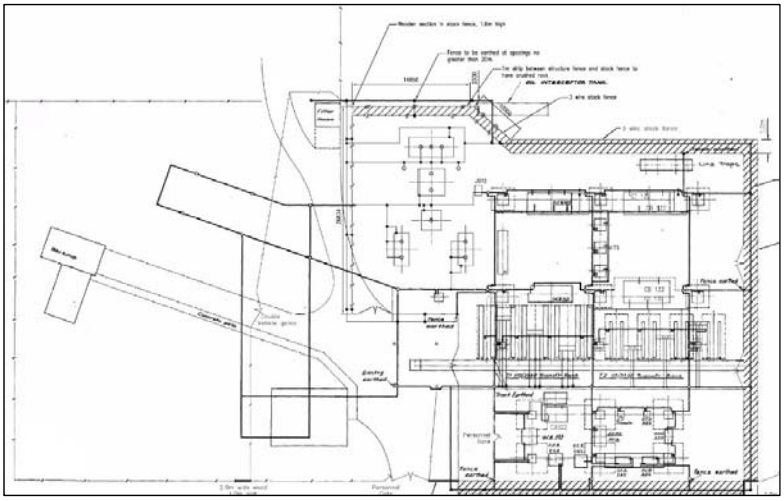
Mitton ElectroNet

## Brownfield - Context

- Brownfield Substation
- Design an appropriate earth grid to accommodate substation upgrades.
- Site has been previously tested in 2014.

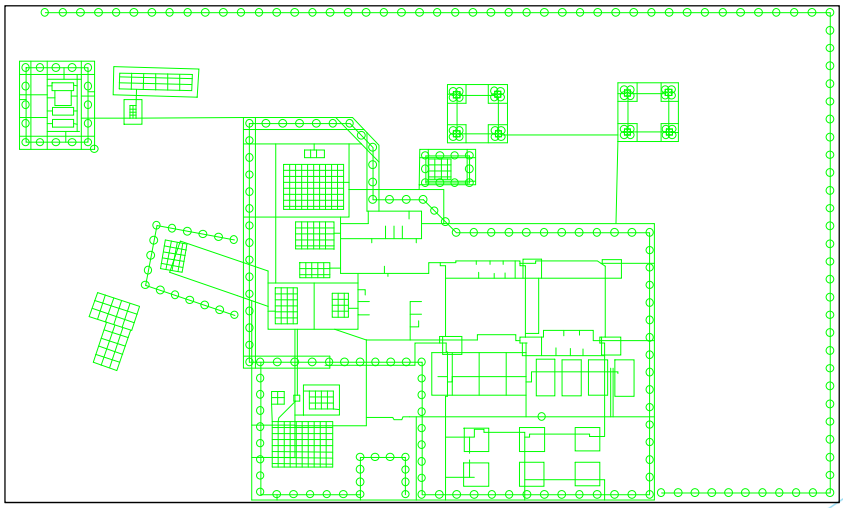
Mitton ElectroNet

## Brownfield - Drawing



Mitton ElectroNet

## Brownfield - Drawing (Traced)



Mitton ElectroNet

## Brownfield - Soil Resistivity Structure

| Layer | Resistivity (Ω-m) | Layer Thickness (m) |
|---|---|---|
| $\rho_1$ | 238 | 0.64 |
| $\rho_2$ | 38 | ∞ |

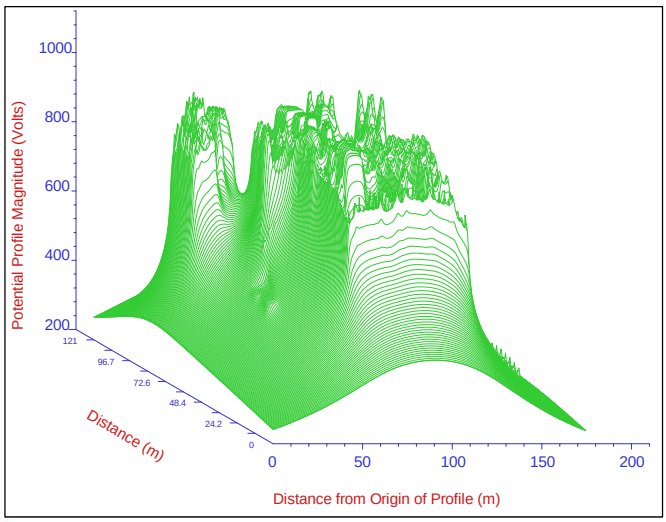
Mitton ElectroNet

## Brownfield – Fault Data

- Earth fault level of 3,268 A for 1.5 seconds.

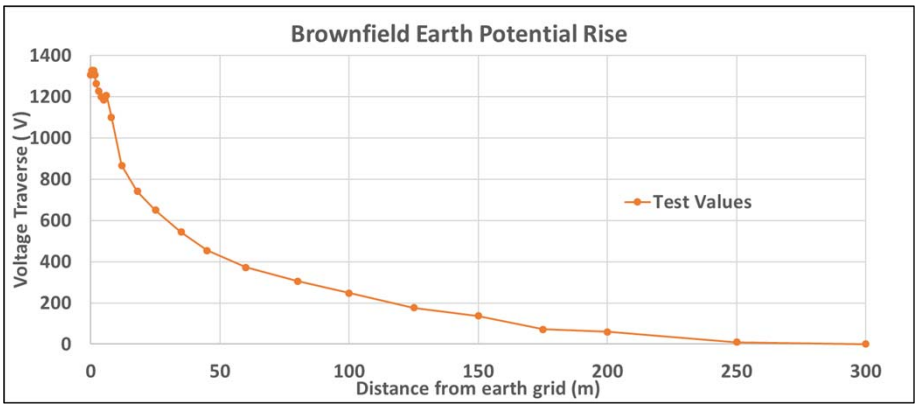
Mitton ElectroNet

## Brownfield - Earth Potential Rise



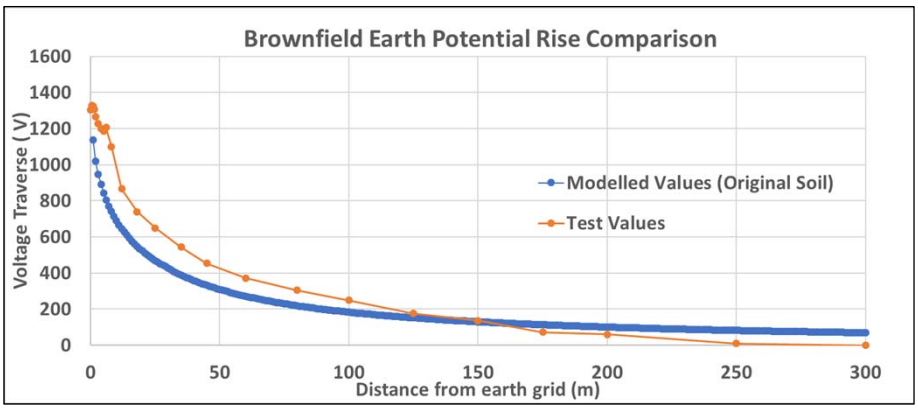

Mitton ElectroNet

# Brownfield – Earth Potential Rise



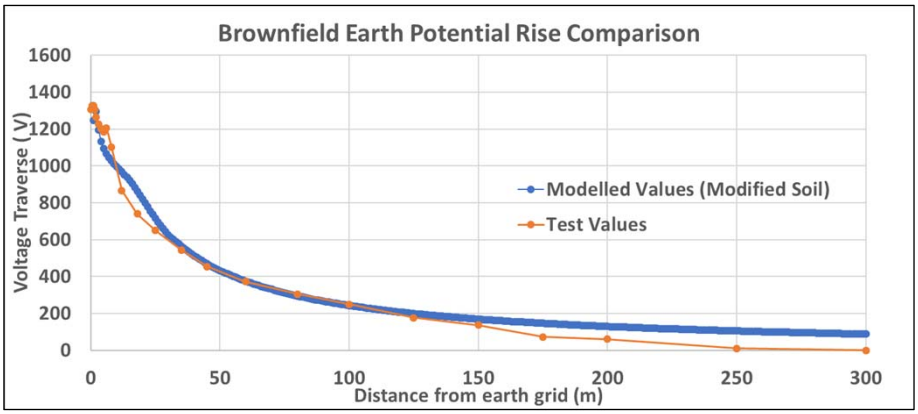

Mitton ElectroNet

# Brownfield – Comparison




Mitton ElectroNet

## Brownfield – Comparison




Mitton ElectroNet

## Brownfield - Soil Resistivity Structure

| Layer | Resistivity (Ω-m) | | Layer Thickness (m) |
|---|---|---|---|
| | Old | New | |
| $\rho_1$ | 238 | 155 | 0.64 |
| $\rho_2$ | 38 | 47 | ∞ |

Mitton ElectroNet

## Summary

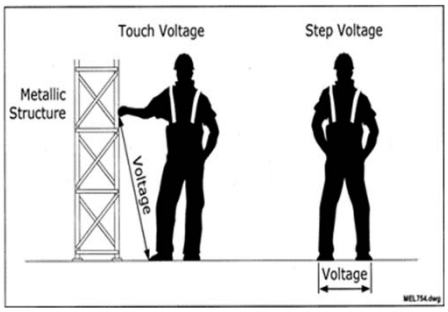
- CDEGS™ Model matching is the smarter solution for the design and maintenance of earthing systems
- Applicable for Greenfield or Brownfield Substations

Mitton ElectroNet

## Questions?

Mitton ElectroNet

# Touch & Step Voltages




- Tolerable Voltage Limits
  - IEC 60479 (based) or IEEE80
  - Based on fault clearing time and soil resistivity

Mitton ElectroNet