



# **Geoid/Ellipsoid Modeling**

**A Case Study**

## **Ocean Beach, Otago**

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## Presentation Structure

- **Geoid**
  - What is it?
  - Is it important?
- **Geoid/Ellipsoid Modeling**
  - Why bother?
- **Reduced Depth Surveying**
  - What is it?
  - Benefits
- **Innovative Method : Geoid/Ellipsoid Modeling**
- **Questions/Comments**

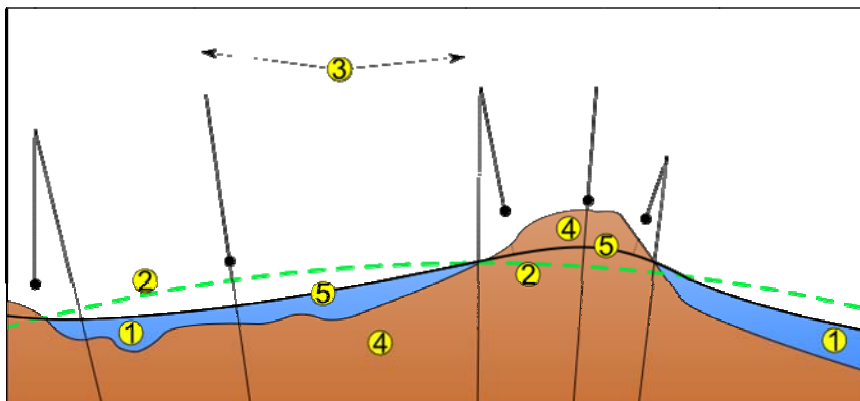
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## Geoid – What is it? (1 of 3)

- MSL extended through the continents
- An equipotential surface
  - smooth but highly irregular

## Geoid – What is it? (2 of 3)



1. Ocean 2. Ellipsoid 3. Plumb-line 4. Terrain 5. Geoid (MSL)

## Geoid – What is it? (3 of 3)

- A local height datum
  - 13 “geoids” in New Zealand
    - One Tree Point 1964
    - Auckland 1946
    - Moturiki 1953
    - Gisborne 1926
    - Napier 1962
    - Taranaki 1970
    - Wellington 1953
    - Nelson 1955
    - Lyttelton 1937
    - Dunedin 1958
    - Dunedin-Bluff 1960
    - Bluff 1955
    - Stewart Island 1977

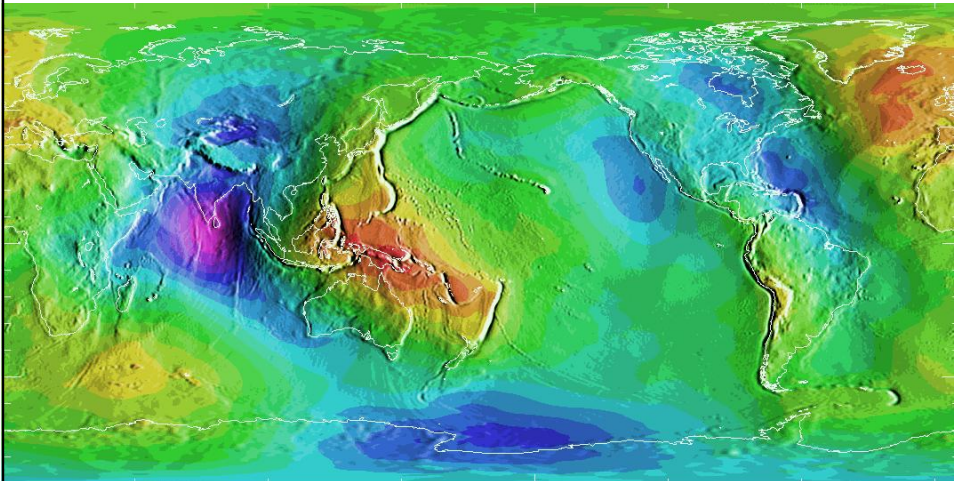
## Geoid – Is it important?

- No
  - not important for conventional surveys that integrate heave and tide
- Yes
  - an understanding is imperative for **GPS RTK reduced depth surveying**

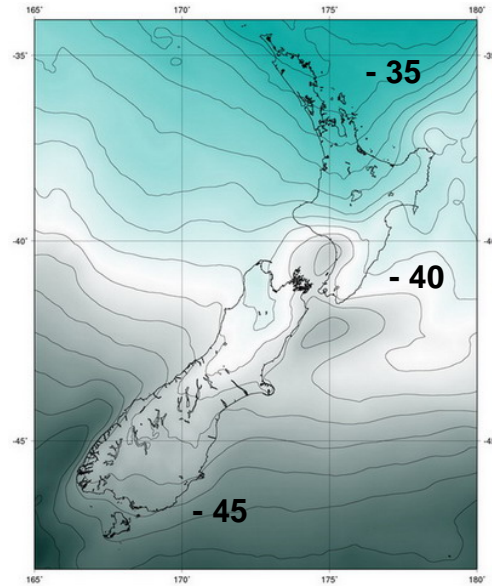
## Where are we at?

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## Geoid/Ellipsoid Modeling



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## Geoid/Ellipsoid Modeling

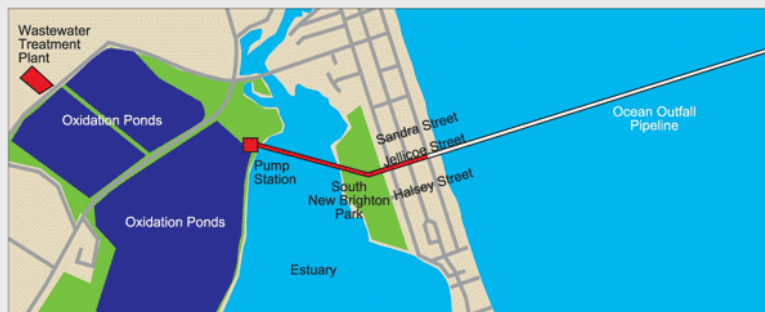
- Local sites
  - often determined by site calibration
- Site calibration consists of:
  - A **Horizontal** calibration and a **Vertical** calibration
- **Vertical calibration determines relationship between Geoid & Ellipsoid**

## Geoid/Ellipsoid Modeling

- Harbours generally surrounded by control
- Offshore projects typically have little or no control (model is extrapolated)
  - e.g. CCC Outfall Project

## CCC Ocean Outfall

- \$87.2 million project
- Biggest project ever undertaken by Council

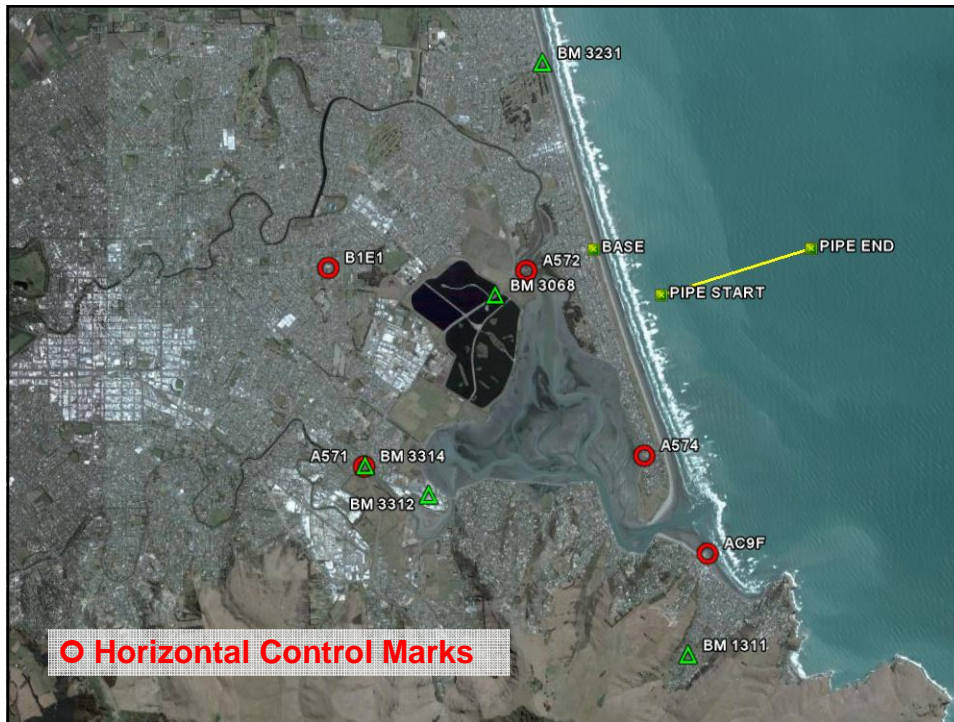


## **Calibration** (1 of 6)

- Horizontal Calibration for NZGD1949
- Vertical Calibration for Drainage Datum

## **Calibration** (2 of 6)

- Horizontal
  - 5 x NZGD1949 control marks (3<sup>rd</sup> order)
  - Maximum residual 0.023m



## Calibration (4 of 6)

- Vertical
  - Measure geoid/ellipsoid separations in west
  - Create model for off-shore works
  
  - 5 x Council benchmarks
  - Maximum residual 0.008m



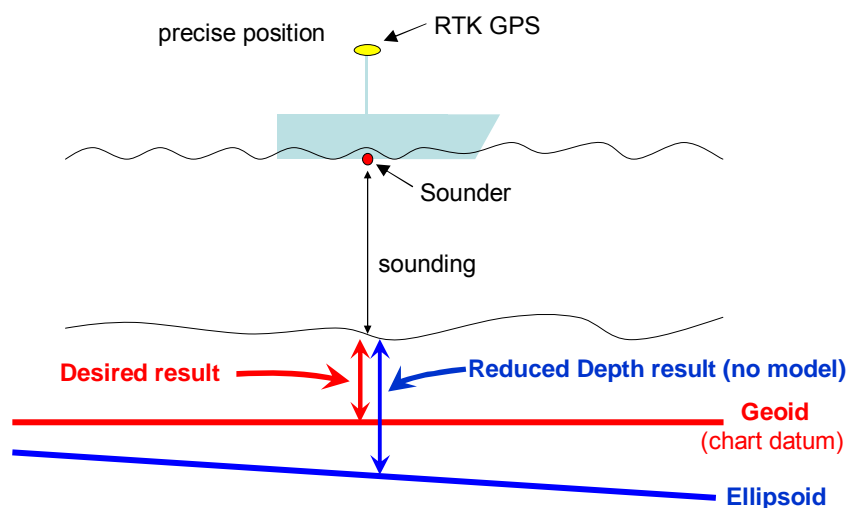
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## Reduced Depth Surveying (1 of 6)

- RTK position
  - based on ellipsoid (HAE)
- Must know relationship between ellipsoid and geoid
  - to “convert” heights

## Reduced Depth Surveying (2 of 6)



## Reduced Depth Surveying (3 of 6)

- Require:
  - RTK positions (fast update/low latency)
  - Soundings
  - HYDROpro
- Position integrated with sounding
- Output
  - Reduced depths in real-time (if model used)

## Reduced Depth Surveying (4 of 6)

- Why?
  - Relatively low cost
    - Only need RTK position and sounding
  - Don't require heave compensator or tide

## **Reduced Depth Surveying** (5 of 6)

- Other benefits
  - Rapid mobilization (less hardware)
  - Reduced cost of “entry”
  - No waiting for tide data
  - No post-processing (just QA)
  - Results to client in less time

## **Reduced Depth Surveying** (6 of 6)

- Difficulties
  - Some sea conditions make it difficult
  - Better to run with swell

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## Case Study :: Ocean Beach

- Project area not surrounded by land based vertical control
- Real-world project
- High energy zone
- 6km x 2km



## **Geoid/Ellipsoid Modeling**

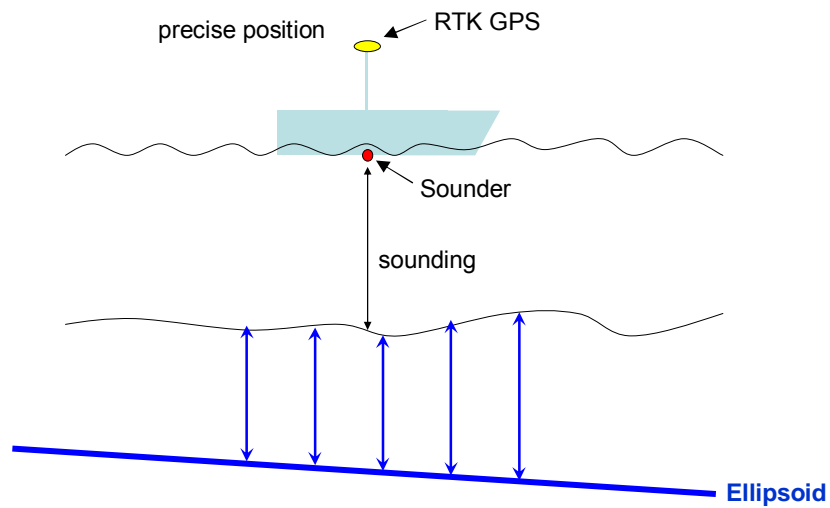
- Innovative method
  - Uses Reduced Depth Surveying
  - Uses Trimble HYDROpro software

## **Geoid/Ellipsoid Modeling**

Process the data twice

1. Process as Reduced Level (no model)
2. Process as conventional survey

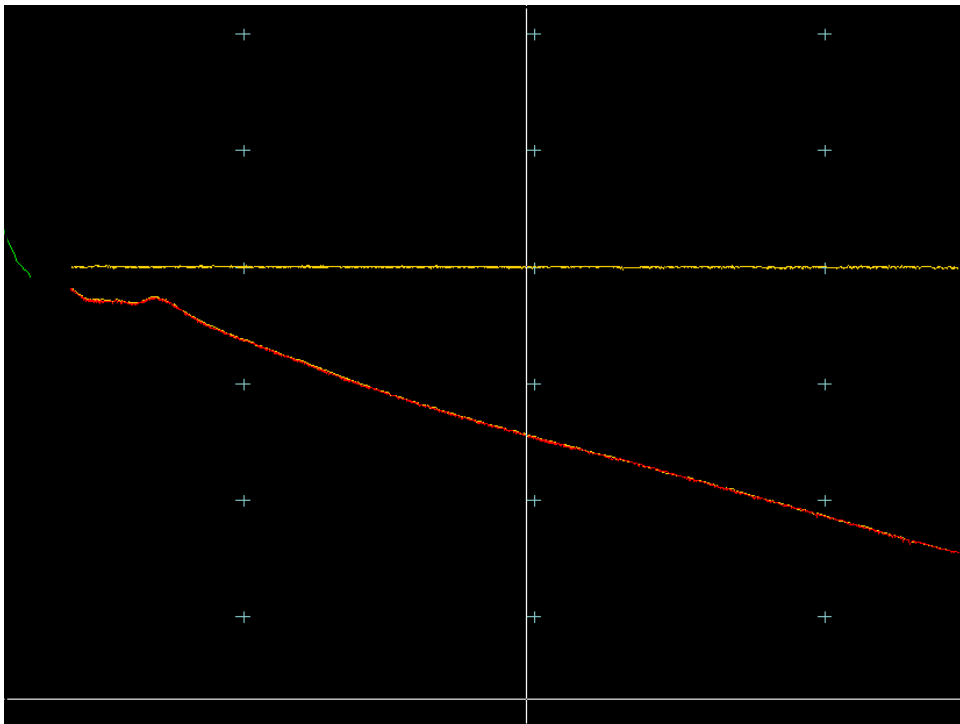
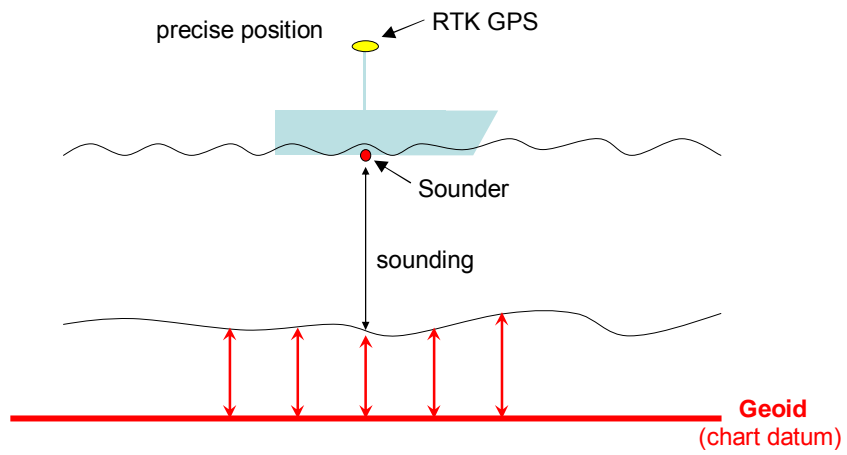
## Reduced Depth Reduction

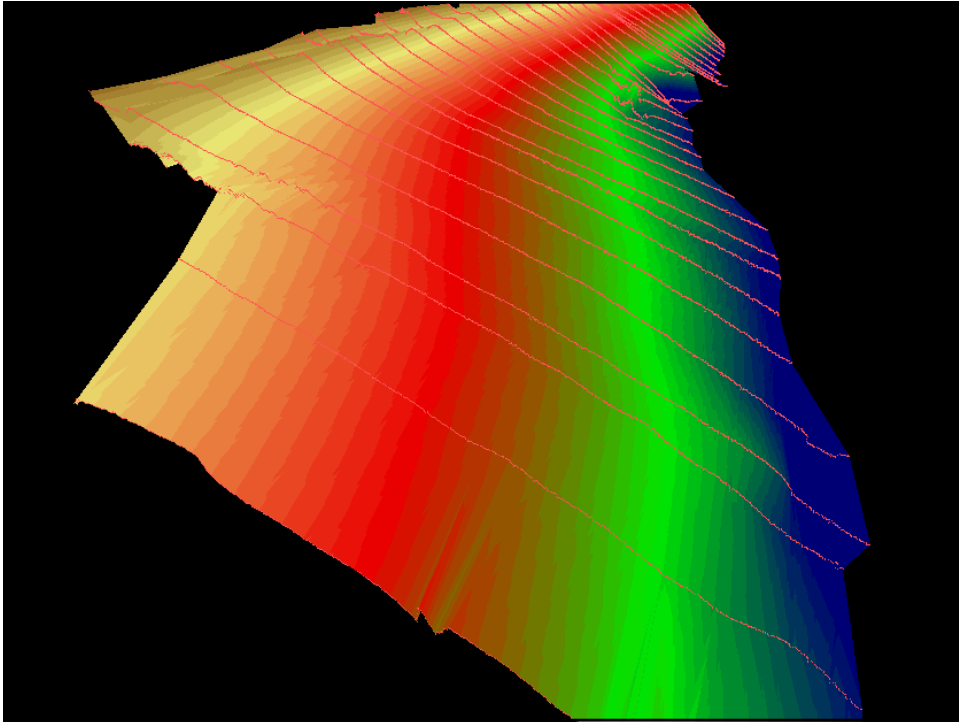


## Conventional Reduction (1 of 2)

- No heave compensator required
  - Used RTK Heave
- Use tide data

## Conventional Reduction (2 of 2)

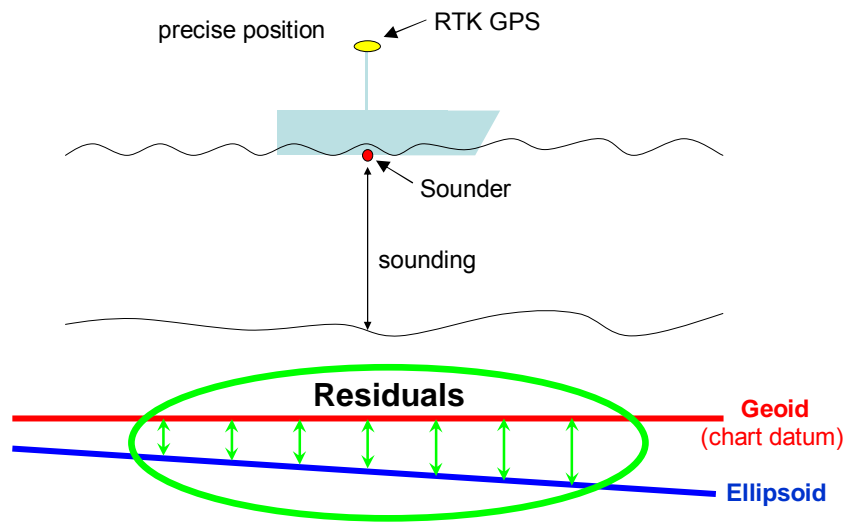




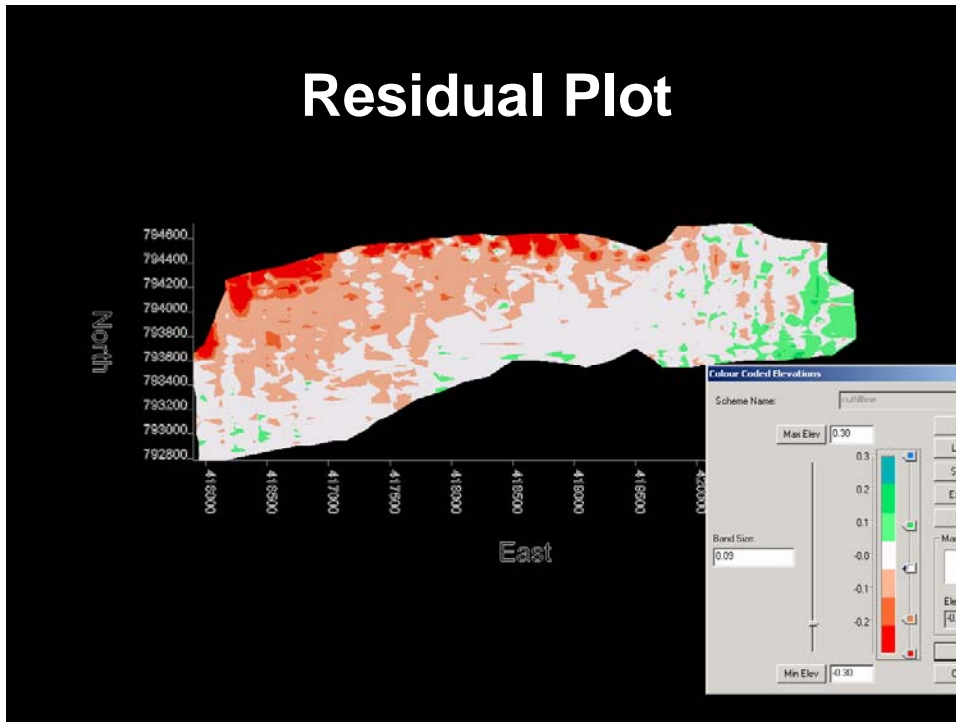
## Compare Results

- Reduced Depth minus Conventional

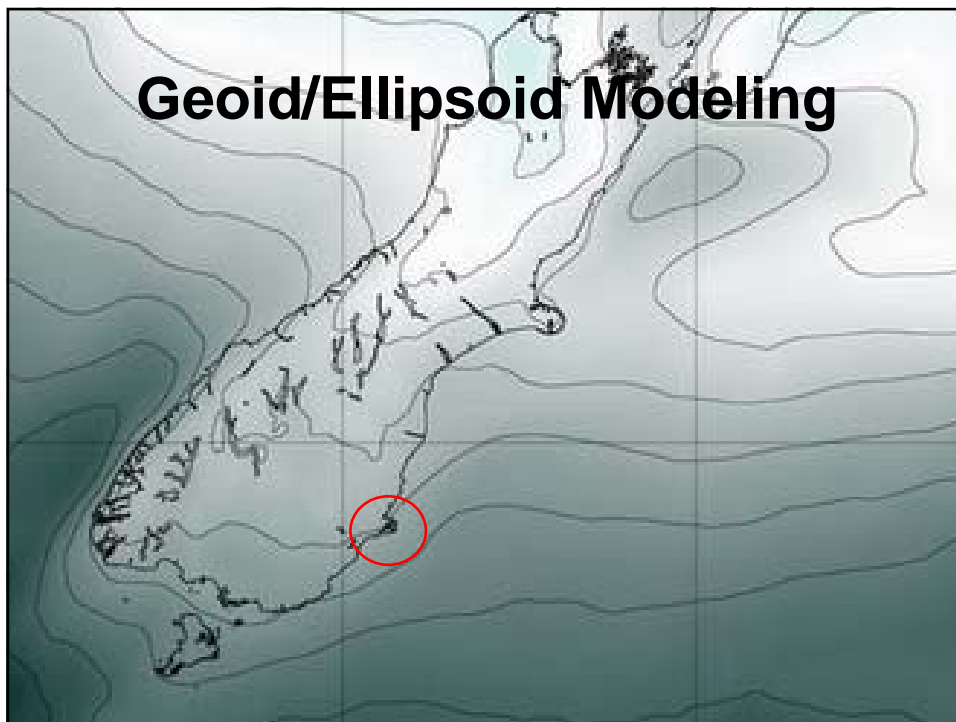
# Reduced Depth Surveying



# Residual Plot



# Geoid/Ellipsoid Modeling



## Geoid/Ellipsoid Modeling

- Benefit
  - Determining magnitude of Geoid/Ellipsoid separation using tide data as “control”

## Geoid/Ellipsoid Modeling

### Where to from here?

- Fit plane to residual plot
- Apply plane to HYDROpro project coordinate system definition
  
- **Another site to be surveyed**
- **White paper to be published**

## **Questions & Comments**

Thank you