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Geodetic Connections to Tide Gauge at Macquarie Island

	MSL HEIGHT (m) [1]								
Station	**Dec-94** [2]	**Jan-96** [3]	**Nov-96** [4]	**1997/98** [5]	**1999/00** [6]	**Feb-02** [7]	**Apr 06** [7]	**Mar 09** [7]	**COMMENTS**
AUS211 HT RM1			12.883				12.8813	12.8810	Stainless steel bolt. Ht ref mark in top of concrete pillar for ARGN GPS.
AUS211 HT RM2	11.681	11.681	11.681	11.681		11.681	11.6810	11.6817	Stainless steel bolt. Ht ref mark on concrete base of pillar for ARGN GPS.
AUS211 RM3						5.598	5.5990	5.5995	New mark established February 2002
AUS211 RM4						5.840	5.8408	5.8413	New mark established February 2002
NM/X/1		10.497	10.494	10.499					Top of Auroral Camera stand (Nth corner Nov 1996).
NM/X/1 RM1	9.162	9.162	9.161	9.161		9.162	9.1626	9.1631	Stainless steel reference mark in concrete base of NM/X/1.
NM/X/14		1.770							
TBM2 MET		5.244							
TBM3 MET		6.514							
AUS156	5.722	5.723	5.723	5.725	5.723			5.7231	Anchor bolt for anemometer tower.
AAE BM1 RM1	1.903	1.903	1.903	1.903	1.904	1.904	1.9027	1.9031	Stainless steel bolt in rock installed in March 1992.
AAE BM1 RM2	2.598	2.598	2.598	2.598		2.599	2.5974	2.5980	Stainless steel bolt in rock installed in 1992.
AUS228	3.297	3.296	3.297	3.297	3.297		3.2960	3.2956	Stainless steel bolt in rock.
AQUATR AKRIM	3.228	3.228	3.228	3.229	3.229	3.227	3.2281	3.2277	Top of brass rim of Aquatrak tide gauge adjacent to ref mark - inside of tide gauge.

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AQUATR AKRM	3.212	3.212	3.212					3.2117	Reference mark on brass interior of Aquatrak tide gauge.
DRUCK RIM		3.351	3.352	3.352	3.353	3.350	3.3512	3.3509	Top of brass rim of Druck tide gauge adjacent to ref mark on inside of tide gauge.
DRUCK RM		3.335	3.336					3.3342	Reference mark on brass interior of Druck tide gauge.
AUS091	3.332	3.332	3.332	3.332	3.332	3.331	3.3313	3.3307	Stainless steel bolt in rock.
AUS092	3.495	3.495	3.495	3.495	3.495	3.494	3.4945	3.4940	Stainless steel bolt in rock. Tide gauge benchmark.
GBAY								6.6011	Stainless steel threaded spigot in rock. Base of thread.

A number of survey marks in the Garden Cove area of Macquarie Island are used to connect the tide gauge bench mark to the permanent Macquarie Island GPS tracker (AUS211) located at the ANARE Base, using both GPS and conventional optical levelling techniques.

Notes:

[1] The MSL heights are based on a MSL height determination for benchmark AAE BM1 RM2.

[2] Class LB* optical levelling by Brolsma using Invar staves. See Antarctic Division 1994 report. All values corrected for thermal expansion/contraction of the staves (King 2000).

[3] Class LB* optical levelling by Boland using Invar staves. See Antarctic Division 1996 report. All values corrected for thermal expansion/contraction of the staves (King 2000).

[4] Class LB* optical levelling by Lemon using Invar staves. See Antarctic Division 1997 report. All values corrected for thermal expansion/contraction of the staves (King 2000).

[5] Class LB* optical levelling by Gordon using Invar staves. See Antarctic Division 1998 report. All values corrected for thermal expansion/contraction of the staves (King 2000).

[6] Class LA* optical levelling by Anderson using Invar staves. See Antarctic Division 1999 report. All values corrected for thermal expansion/contraction of the staves (King 2000).

[7] Class LA* levelling, using the "Leap-Frog" EDM Height Traversing., by Twilley (Geoscience Australia) using a Leica TC2003 Total Station..

[8] AAEBM1 was installed in 1911 and is now missing and replaced by AAEBM1 RM1 & RM2

[9] An Aquatrak tide gauge was installed in an inclined hole drilled through rock in December 1993.

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[10] A Druck tide gauge was installed in an adjacent inclined drill hole in December 1994.

[11] The difference in height between AUS211 Ht RM1 and AUS92 was observed by GPS in 1994/95, 1995/96 & 1996/97. When the GPS ellipsoidal diff heights were reduced for geoid-ellipsoid separation, they agreed with the optically levelled difference in height by 52, 48 and 50 mm respectively. GPS was again observed in February 2002, but the results are not yet available.

- See ICSM Special Publication 1, "Standard Practice for Control Surveys" for an explanation of optical levelling standards.

- King, M (2000), "Report on Temperature Corrections for Levelling Observations made at Australia's Antarctic Bases", An internal report prepared for the Australian Antarctic Division. Prepared June 2000, Revised November 2000.

[12] A survey monument designed to support direct GPS observation in tide gauge calibration surveys, as it allows a GPS antenna to be attached directly to the monument, was installed adjacent to the Macquarie Island tide gauges on the 20th March 2009. GBAY is a stainless steel threaded spigot, which extends into rock approximately 100mm and is held into the rock with epoxy Hit HY adhesive. The height for this monument relates to the base of the threaded spigot.

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