Site 037 – Smugglers Creek, Marramarra National Park

Freshwater (Reference) Site
Berowra Creek Catchment

Monitoring Program Timelines

Program Name (site reference)	Sampling Period	Sampling Frequency
Long-term (037)	Jan 1995 – Sept 2017	Monthly
Ecohealth (SMUG1)	Oct 2017 - ongoing	Quarterly
Reference (SMUG1)	Commence 2019/20	To be determined

Key Findings and Recommendations

Condition	Phys-chem: pH, EC and DO consistently comply with REHVs. A long-term increasing trend is evident for pH. Clarity: Turbidity and TSS low and consistently comply with REHVs. Nutrients: Nutrient levels are low and consistently comply with REHVs. Bacteria: Bacteria levels are low and consistently comply with REHVs.
Issues	− Long-term reference site due to undisturbed bushland catchment
Recommendations	− Ongoing monitoring for catchment health assessment via the Ecohealth program − Continued monitoring for local reference conditions − Further investigation of the influence of key SE Australian climate drivers on local reference conditions − Review of REHVs and suitability of long-term reference sites using targeted short-term reference site data

Site Photos

Smugglers Creek looking upstream during high flow

Smugglers Creek looking upstream during low flow

Results of Data Analysis

Table 1 Results of non-conformance calculations and *Kendall Tau* (p<0.05) trend analysis for Site 037

037	REHV	Long-term				2012-2017			
		n	Median	%NCs	Trend	n	Median	%NCs	Trend
Temp (°C)	NA	264	16.12	NA	NS	61	16.69	NA	NS
pH	4.8-7	264	5.47	6	↑	61	5.57	7	↑
DO (%sat)	75-118	238	101.47	7	NS	61	102.40	0	↑
EC (mS/cm)	0.32	263	0.20	4	↓	61	0.21	3	↓
Turbidity (NTU)	8	264	0.6	5	↑	61	0.8	3	NS
TSS (mg/L)	7	270	1	4	↓	61	1	0	↑
TP (mg/L)	0.01	271	0.004	4	↑	61	0.004	5	NS
TN (mg/L)	0.32	271	0.120	4	NS	61	0.110	2	NS
NH_3-N (mg/L)	0.02	271	0.010	3	*	61	0.005	0	NS
NO_x-N (mg/L)	0.05	271	0.010	3	*	61	0.005	2	↑
F.Cols (CFU/100ml)	150	270	12	9	↑	61	14	13	NS

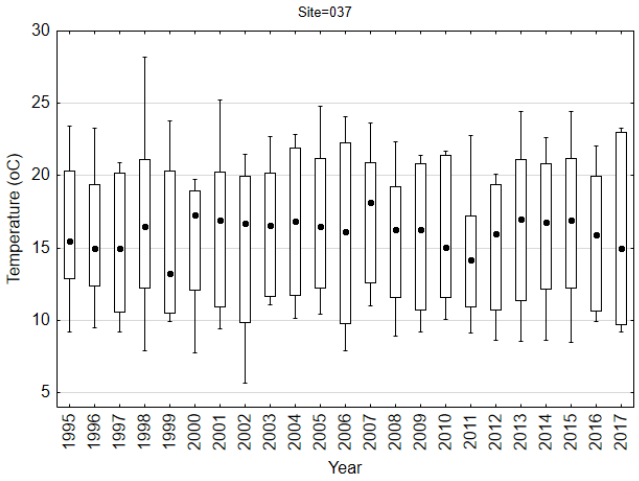
REHV – Regional Environmental Health Value
n - Number of sampling events
%NCs - percent non-conformance based on REHVs
NA - No associated REHV or benchmark value
NS - trend not significant based on Kendall Tau analysis at p<0.05
↑ - significant increasing trend based on Kendall Tau at p<0.05
↓ - significant decreasing trend based on Kendall Tau at p<0.05
** - trend analysis not appropriate due to variation in laboratory detection limit*

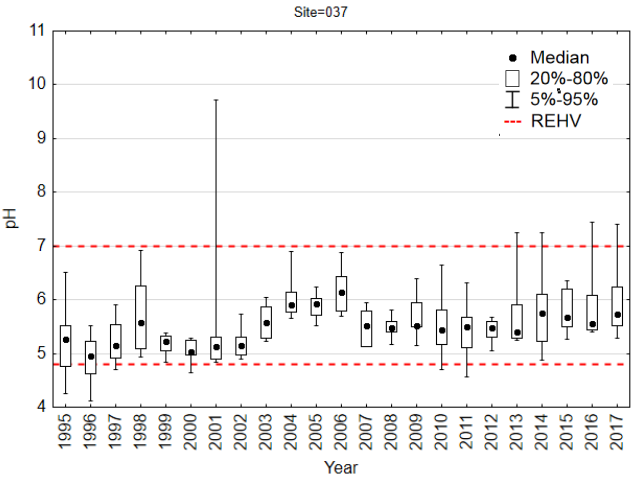
Median	*%NCs*
Within or below REHV	*<25%*
Equal to REHV	*25% to 75%*
Outside or above REHV	*>75%*
No associated REHV	*Not Applicable*

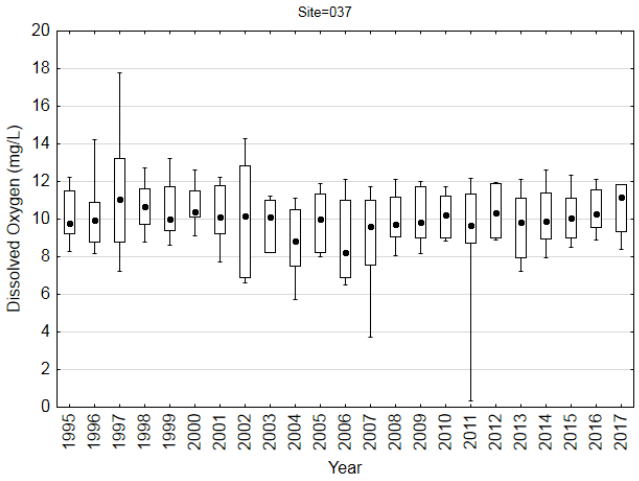
Table 2 Descriptive statistics for variables measured at Site 037 from January 1995 to September 2017

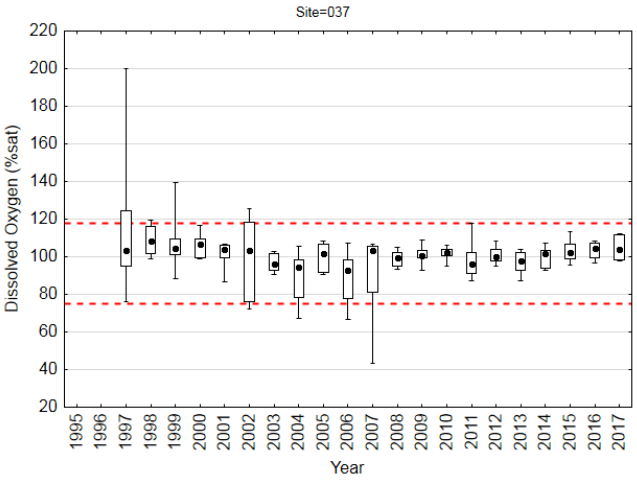
Variable	Valid n	Mean	Median	Minimum	Maximum	20th Percentile	80th Percentile	Std Dev
Temp (°C)	264	15.98	16.12	5.68	28.20	11.29	20.76	4.581
pH	264	5.54	5.47	4.12	9.71	5.13	5.90	0.582
DO (mg/L)	261	10.08	10.00	0.32	17.80	8.85	11.50	1.755
DO (%sat)	238	100.64	101.47	43.30	200.00	95.00	106.00	11.998
EC (mS/cm)	263	0.22	0.20	0.00	0.40	0.17	0.30	0.079
EC (µS/cm)	116	201.04	209.00	56.00	315.00	148.00	250.00	58.643
Turbidity (NTU)	264	1.6	0.6	0.0	33.0	0.0	2.2	3.36
TSS (mg/L)	270	2	1	1	47	1	2	3.8
TP (mg/L)	271	0.006	0.004	0.001	0.307	0.001	0.010	0.0191
TN (mg/L)	271	0.148	0.120	0.025	1.870	0.080	0.200	0.1527
NH_3-N (mg/L)	271	0.009	0.010	0.003	0.108	0.005	0.010	0.0095
NOx-N (mg/L)	271	0.013	0.010	0.001	0.240	0.005	0.010	0.0208
F.Cols (CFU/100ml)	270	71	12	0	1700	1	68	202.2
E.Coli (CFU/100ml)	20	85	10	1	590	3	74	169.7
Entero (CFU/100ml)	31	48	25	1	370	1	50	82.2

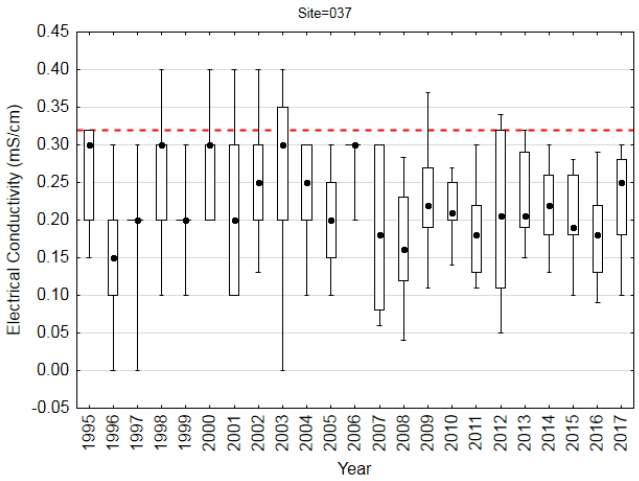
Boxplots showing annual variability for measured variables

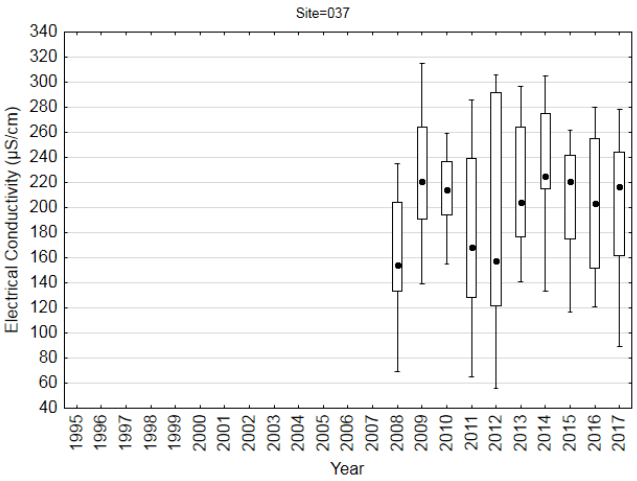


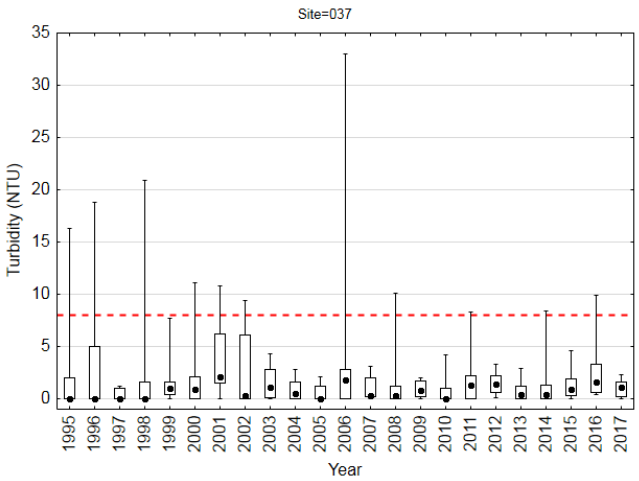


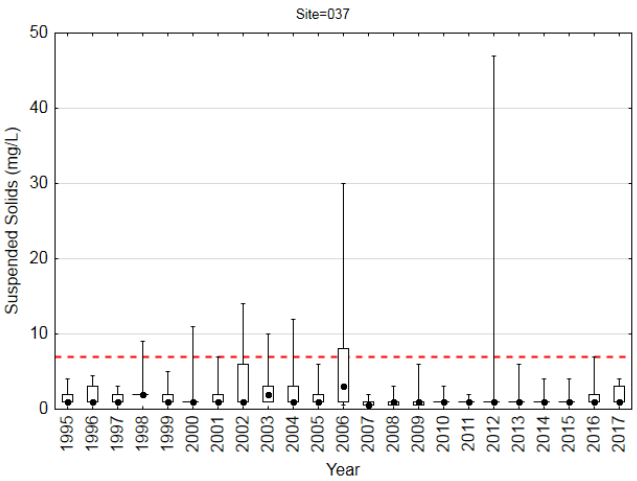


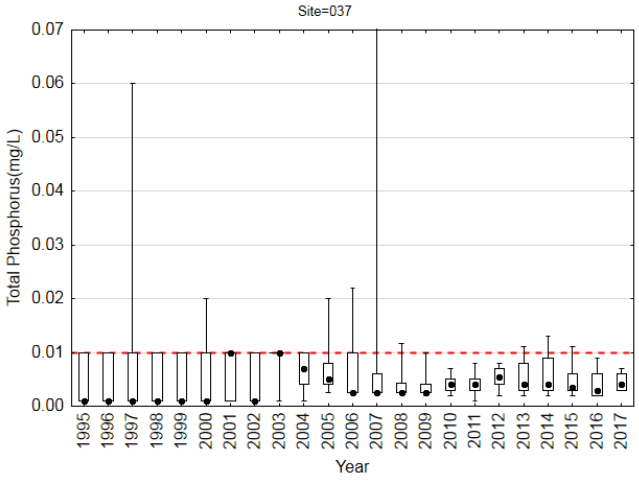


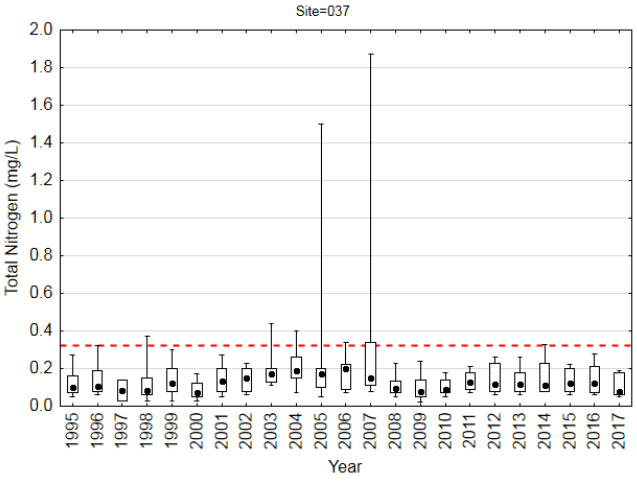


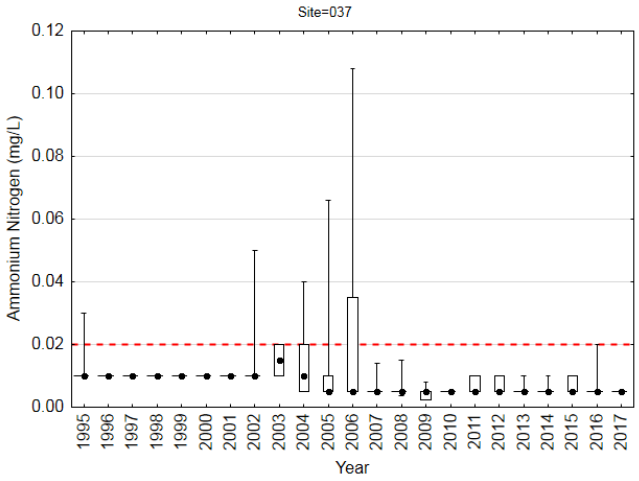


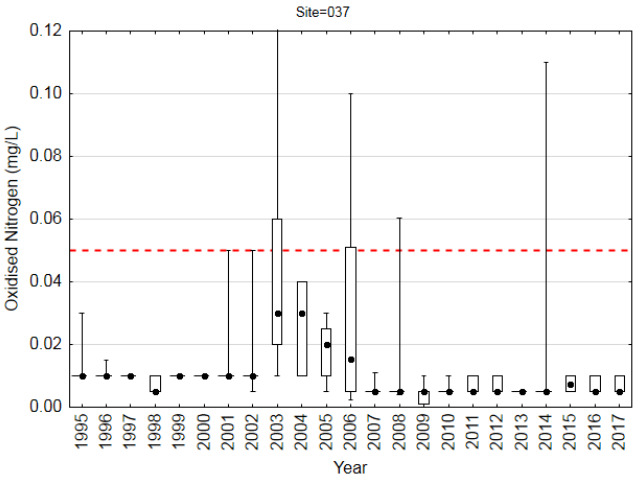


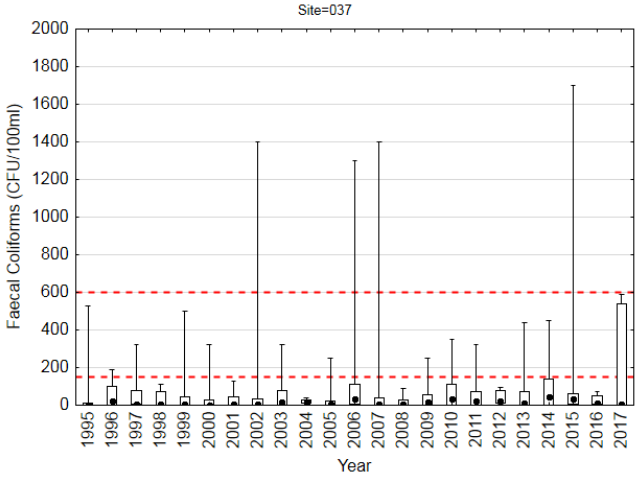


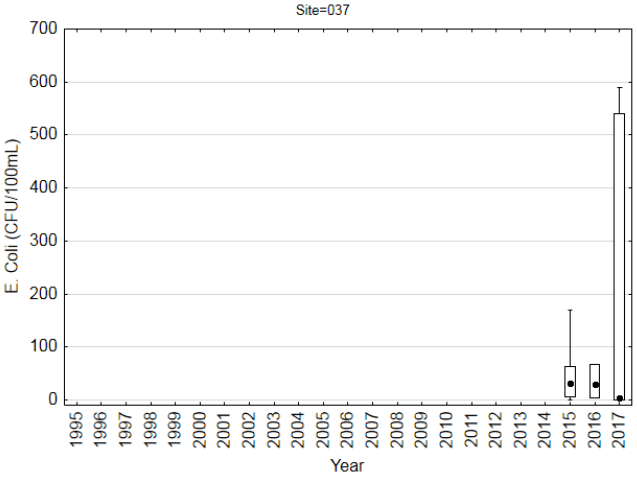

Site=037
Total Phosphorus(mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year

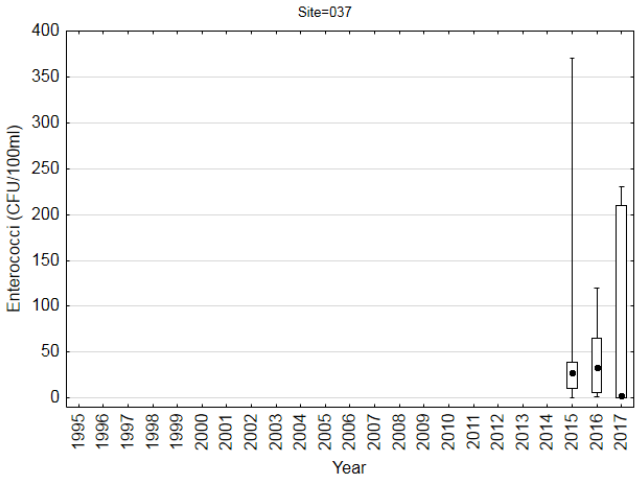

Site=037
Total Nitrogen (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year


Site=037
Ammonium Nitrogen (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year


Site=037
Oxidised Nitrogen (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year


Site=037
Faecal Coliforms (CFU/100ml)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year


Site=037
E. Coli (CFU/100mL)
700
600
500
400
300
200
100
0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year


Site=037
Enterococci (CFU/100ml)
400
350
300
250
200
150
100
50
0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year