



ANNUAL ENVIRONMENT REPORT 2011

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Appendix

1. TSF Groundwater Data

List of Abbreviations and Acronyms

AER	Annual Environment Report
AMD	Acid Metalliferous Drainage synonymous with ARD
ARD	Acid Rock Drainage used interchangeably with AMD
CDP	Cyanide Detoxification Plant
CO ₂ e	Carbon Dioxide Equivalent
Cumec	Cubic metre per second (flow rate measure)
DEC	PNG Department of Environment and Conservation
EMP	Environmental Management Plan
ESAP	External Stakeholder Advisory Committee
HCN	Hydrogen Cyanide also known as Free Cyanide
HVGM	Hidden Valley Gold Mine
HVJV	Hidden Valley Joint Venture
HVSL	Hidden Valley Services Limited (operator of HVGM)
kL	kilo-litres (i.e. 1,000 L)
m ³	cubic metres equivalent to kL
ML	Mega Litres (i.e. 1,000,000 L)
Mtpa	Million tonne per annum
MWH	Mega Watt Hours
N	Number (of samples)
NAF	Non-Acid Forming Rock
NTU	Nephelometric Turbidity Unit (water clarity measure)
PAF	Potentially Acid Forming Rock
SD	Standard Deviation
SMEC	Snowy Mountains Engineering Company
STP	Sewerage Treatment Plant
TSF	Tailings Storage Facility
TSS	Total Suspended Solids (mg/L)

1. EXECUTIVE SUMMARY

This is the Annual Environmental Report for the year ended 31 December 2011 for the Hidden Valley Gold Mine (HVGM), submitted by Hidden Valley Services Limited (HVSL) as holder of Environmental Permit WD L3(50).

There is a trend of improving performance from 2010 to 2011 with a lower number of environmental incidents and the elimination of a number of long-term compliance challenges. A number of programmes were implemented to further improve the capacity to manage sediment run-off from HVGM including: targeted rehabilitation programs, stabilisation works, stormwater control systems and the installation of a large scale sediment trap. Improvements in solid waste management, sewage treatment and hydrocarbon management were also significant. HVGM has also undertaken a number of eco-efficiency improvements including sourcing the majority of its power requirements as hydro power from the PNG grid.

Projects implemented through the Watut River Impact Management Program (WRIMP), as guided by both a Technical Advisory Committee and an External Stakeholder Advisory Panel (ESAP) continued to improve the understanding of the river system to assist with the development of more effective mitigation programs. These programs included a joint community patrol to downstream communities with the Department of Environment and Conservation in August 2011. HVGM will continue to work with communities to keep them informed about research programs and the health of the river system and to develop enduring and long term relationships.

The improvement in water quality at the Nauti compliance point and in particular a reduction in levels of suspended sediment and the maintenance of a lime dosing system to mitigate Acid Rock Drainage (ARD) from the waste rock dumps has resulted in signs of early ecosystem recovery in the Upper Watut.

There are further opportunities for performance improvements in 2012. Key priorities for HVSL include:

- Removal of excess ponded water on the TSF in the first half of 2012.
- Constructing of the Nosave Waste Rock Dump to control potential sediment and ARD emissions.
- Ongoing site stabilisation and drainage works to reduce sediment emissions to the river system.
- Establishment an Environmental Management System (EMS) to the ISO 14001 Standard to drive continual improvement in site environmental performance.
- Certification to the International Cyanide Code.
- Implementing an improvement plan for solid waste management.

2. PROJECT DESCRIPTION

2.1 Location and Physical Environment

The Hidden Valley Gold Mine (HVGM) is a nominal 250,000 ounce a year gold mine that commenced construction in 2007 and commercial production in 2010. It is owned by the unincorporated Hidden Valley Joint Venture (HVJV) which is a 50:50 joint venture between subsidiaries of Harmony Gold and Newcrest Mining and operated by Hidden Valley services Limited (HVSL). It is located in the Bulolo District of Morobe Province, 300 km north-west of Port Moresby, 90 km south-west of the Provincial capital of Lae and 15 km south - west of Wau on the divide (Manki Range) of the Upper Watut and Bulolo river catchments (refer Figure 2). These two rivers converge to form the Watut River, which flows into the Markham River.



Figure 1: Mountain Stream near Hidden Valley Gold Mine

HVGM is located at elevations above 1,900 m and within steep mountainous and forested terrain that experiences about 3 m of rainfall per year. Features include narrow streambeds, sharp ridges, and V shaped valleys with grades exceeding 30° (refer Figure 1). Some seismic activity has been recorded and an earthquake exceeding magnitude 7.0 on the Richter scale was experienced in November 2011.

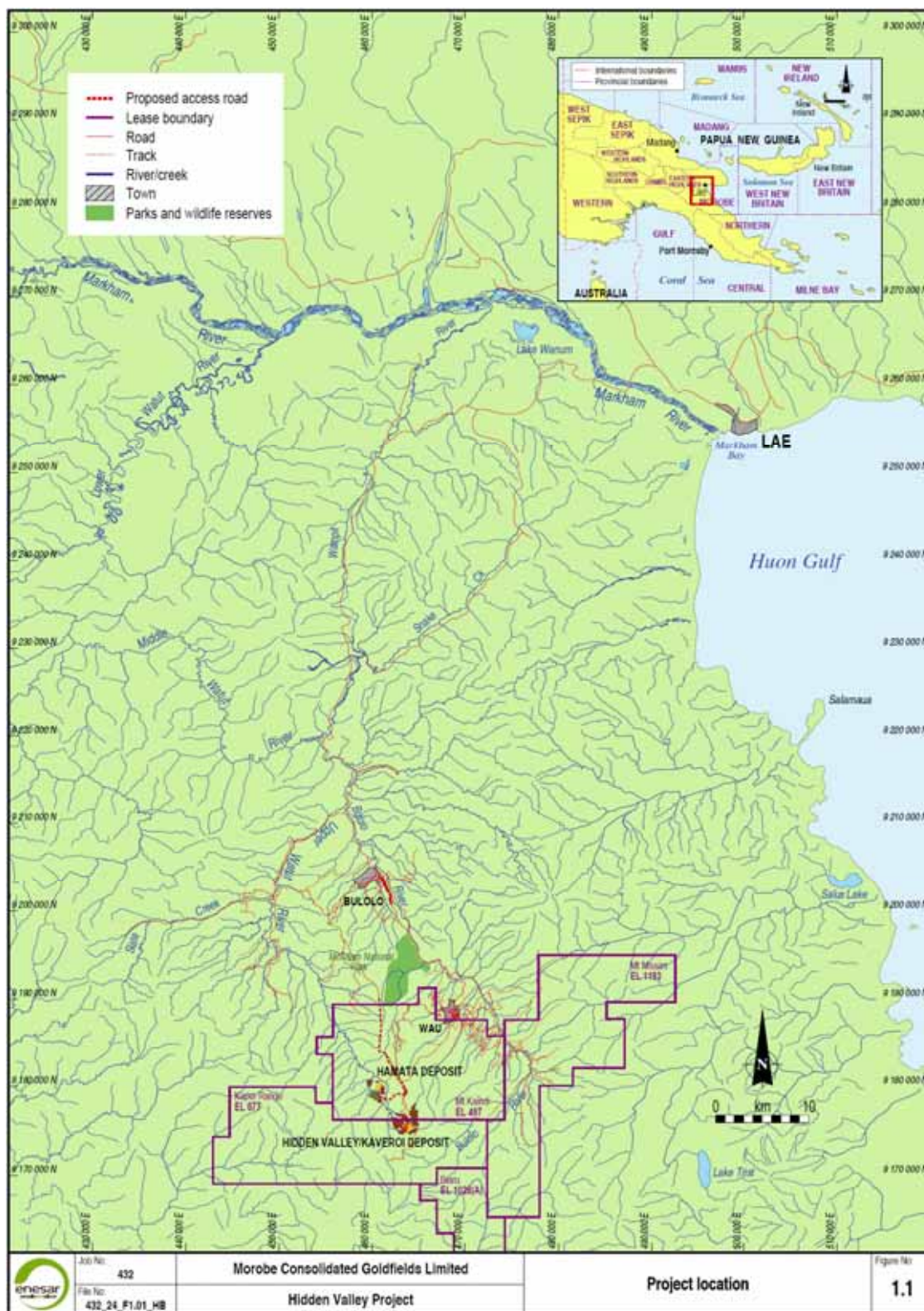


Figure 2: Location of Hidden Valley Gold Mine in Morobe Province

Land-use by the Watut River communities consists primarily of subsistence gardening, hunting and foraging, and small scale alluvial mining. In the 1930's mining occurred in the Bulolo River through large dredging operations. Coffee growing was introduced into the agricultural system in the 1950's and is now well entrenched. The area also supports commercial forestry and intensive poultry farming.

2.2 Operations

The Hidden Valley ore body has three main lodes: Hidden Valley, Kaveroi, and Hamata. The Hidden Valley deposit was discovered in 1984 and, the Hamata and Kaveroi deposits were discovered in 1987 and 1992 respectively. The mine commenced commercial production in September 2010 and is increasing the production rate to the nameplate capacity of 4.2 million tonnes per annum (Mtpa).

Open pit mining is undertaken on the Hamata and Hidden Valley Kaveroi (HVK) orebodies. HVK is the larger of the two with an ore reserve of 37.8 Mt and will be the primary ore source over the life of mine. The Hamata pit has a reserve of 2.8 Mt. Some rock waste from the HVK pit is Potentially Acid Forming (PAF) and is placed in a number of waste rock dumps including South Dump and Nosave Dump adjacent to the pit. Waste rock from Hamata is Non-Acid Forming (NAF) and is used for ongoing construction of the TSF. Small quantities of waste rock unsuitable for the TSF are placed in the Hamata Waste Rock Dump.

The HVK pit is approximately 5 km from the process plant and ore is transported from this pit to the plant by an overland conveyor (refer Figure 5). Tailings are deposited as slurry into the Tailings Storage Facility (TSF) adjacent to the plant and reclaimed water is either used in the process plant or treated in a Cyanide Detoxification Plant (CDP) before release into Pihema Creek.

Ancillary infrastructure includes:

- Site offices
- Accommodation, catering and laundry facilities
- Power generator plant and substation
- Ore processing plant
- Waste water facilities
- Goods storage facilities
- Fuel depot
- Waste dumps
- Explosive manufacture and storage
- Maintenance workshops
- Access and Service Roads

Current indications are that the Hidden Valley mine has sufficient mineral resources to operate until 2025, after which closure, decommissioning, rehabilitation, and re-development activities will be undertaken. HVSL is undertaking progressive rehabilitation. The operations produced 210,000 ounces of gold and 1.7 million ounces of silver in 2011 (refer Table 1).

Table 1: Hidden Valley Production Data for 2011

Ore Milled	3.4 million tonnes
Gold Produced	207,542 oz
Silver Produced	1,688,603 oz
Average Number of persons in camp	1,314 people
Diesel consumption	51,864 kL
Total electricity consumption	96,716 MWH

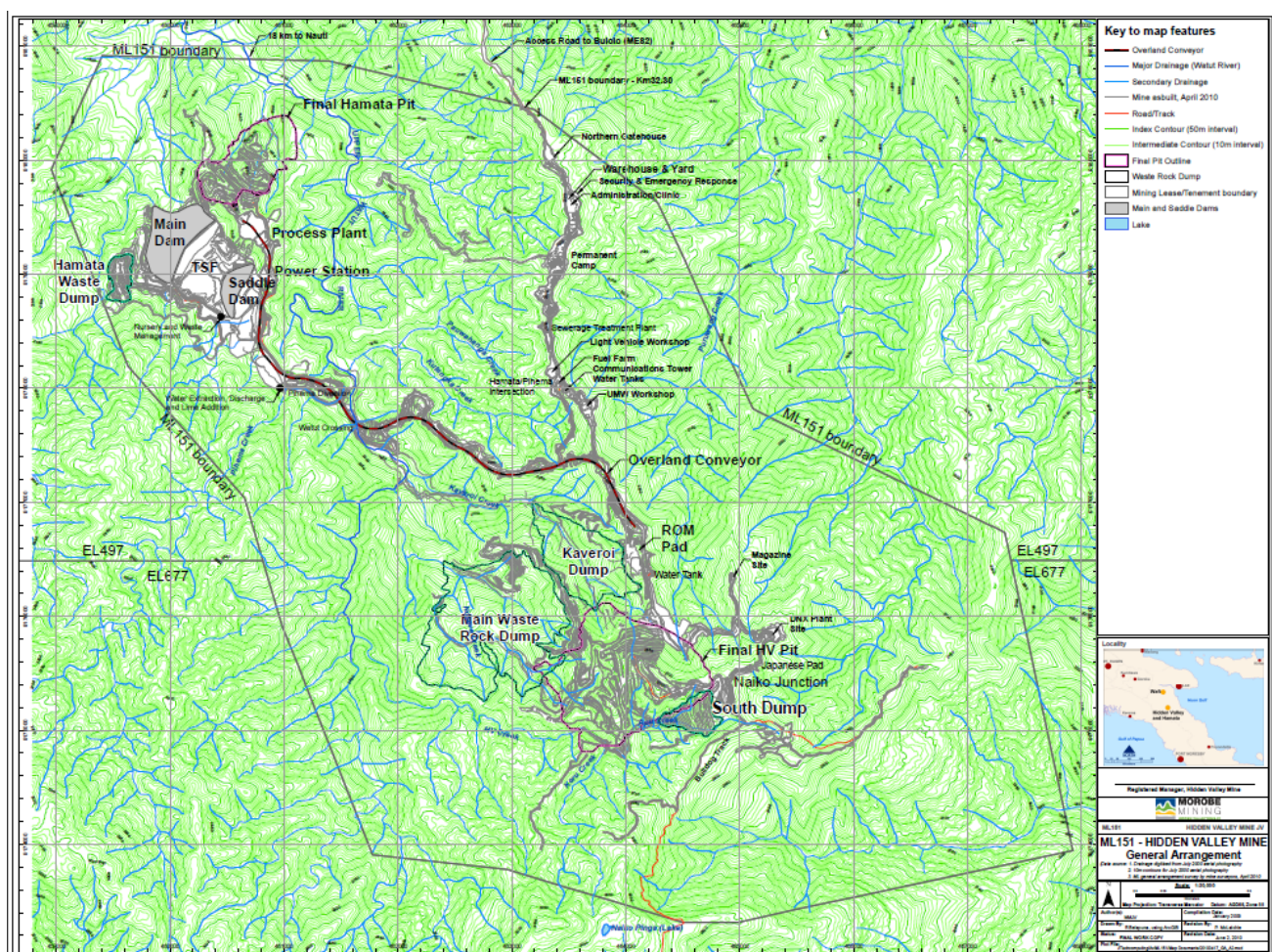


Figure 3: Layout of Hidden Valley Mine Infrastructure



Figure 4: Hidden Valley Pit and Nosave Waste Rock Dump



Figure 5: Hidden Valley Ore Conveyor

3. ENVIRONMENTAL PERMITTING

3.1 Permits and Environmental Management Plan (EMP)

The HV Project Environmental Impact Statement was accepted by the DEC in June 2004 and Environmental Permit WD-L3(50) (Waste Discharge) and Environment Permit WE-L3(38) (Water Extraction) were issued to HVSL in March 2005 and last amended 25 June 2009. The Permits specify environmental performance requirements for the operation and are supplemented by an Environmental Management Plan (EMP) detailing the scope and schedules for monitoring and reporting (refer Section 5). The EMP was approved by the DEC in April 2006 and an updated version was submitted to the DEC in March 2011 to address changes to operational parameters and increasing comprehensiveness of the monitoring program. This expansion of the monitoring program is reflected in increased staffing of the Environmental Department from 23 to 46 employees during 2011.

3.2 Environmental Improvement Plan (EIP)

The DEC commissioned SMEC to undertake an external audit of the environmental performance of HVGM in 2010. The audit identified a number of compliance issues and other performance deficiencies. Following the audit an Environmental Improvement Plan (EIP) was submitted setting out the proposed actions to address the audit findings. The EIP included 40 specific improvement actions. 25 of these actions were complete at the end of the year with significant progress on the others which are largely components of longer-term improvement Projects (refer Section 6).

The work program is supplemented by the use of specialist PNG and international consultants and both PNG and accredited international laboratories for sample analysis. Work programs are reviewed by both a WRIMP Technical Advisory Committee and by an External Stakeholder Advisory Committee (ESAP) established by the HVJV in 2010 and 2011 respectively. These groups in collaboration with other credible professional consultants provide HVJV with expert assistance and guidance to achieve a high standard of environmental performance.

4. ENVIRONMENTAL INCIDENTS

At HVGM environmental incidents are classified on a scale of 1 (low) to 5 (severe) dependent on severity. Low level incidents (i.e. Level 1 and Level 2) are tracked for internal diligence and continual improvement purposes whilst more serious incidents (i.e. Level 4 to 5) including serious Permit breaches are mandatorily reported to the DEC. Minor Permit breaches not resulting in serious or material environmental harm are also reported to the DEC as a courtesy. HVSL places a high emphasis on the reporting and investigation of incidents so that root causes can be addressed to prevent a recurrence. This philosophy is reflected in a no blame culture for reporting and disciplinary action taken in cases of non-reporting of incidents.

HVGM recorded 35 Category 1, 18 Category 2 and 3 Category 3 incidents in 2011 for a total of 53 reported incidents. There were no Category 4 or 5 incidents triggering mandatory reporting to the DEC. In August and September 2011 water quality monitoring at the Nauti compliance point identified instances of elevated HCN content and were reported to the DEC.

The 53 reported incidents in 2011 was a lower incidence than the 83 reported in 2010 (refer Figure 6) but the overall pattern was similar with most relating to minor spills of hydrocarbons and process chemicals.

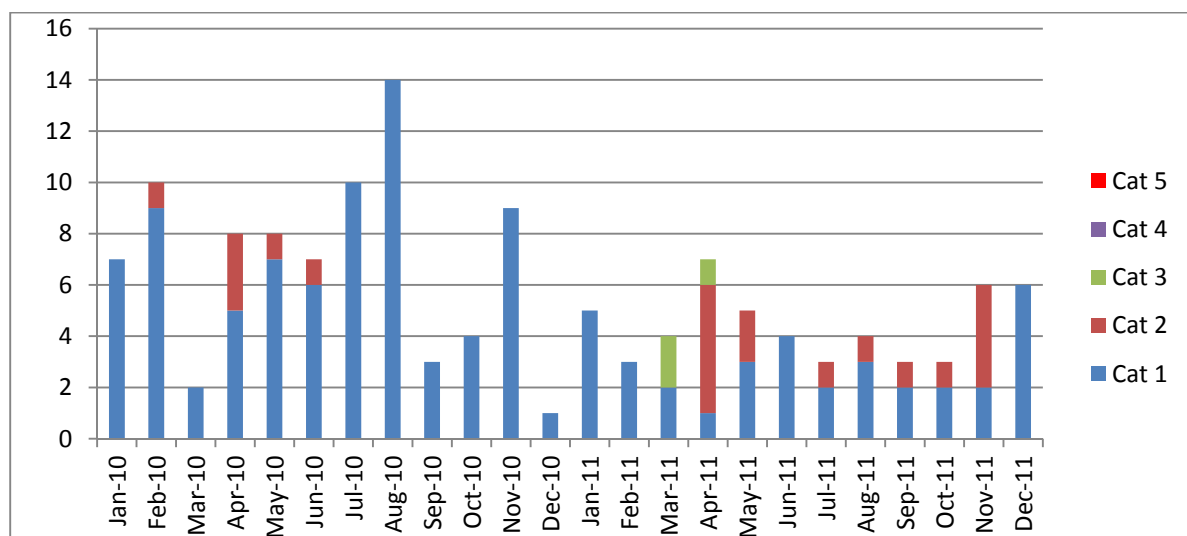


Figure 6: Environmental Incidents in 2010 and 2011

5. ENVIRONMENTAL MANAGEMENT PLAN

HVSL continued to implement a comprehensive Environmental Management Plan (EMP) to monitor, local creeks, operational sites and major river tributaries in the Upper Watut River catchment. The following data collection and storage processes were utilised to facilitate high quality interpretation and reporting.

- Telemetry network
- Meteorological – (Automated Weather Stations and pluviographs)
- Hydrological (Water Level and Discharge)
- Water Quality stations
- Monitoring Data Management Systems
 - HYDSTRA
 - MP5
 - MapInfo
- Integrated Business Information System (IBIS)

5.1 Scope of monitoring

The scope of monitoring is defined in the EMP and includes a large number of on-site (refer Figures 7, 8 and 9) and off-site (refer Figures 10 and 11) sample points on a scheduled sampling regime ranging from daily at some critical local sites, to weekly at the Nauti compliance point and monthly at other locations. Continuous data is collected at key locations in the Watut catchment from a network of nine automated river monitoring stations.



Figure 7: Ridgeline Potable Water and STP Effluent Monitoring

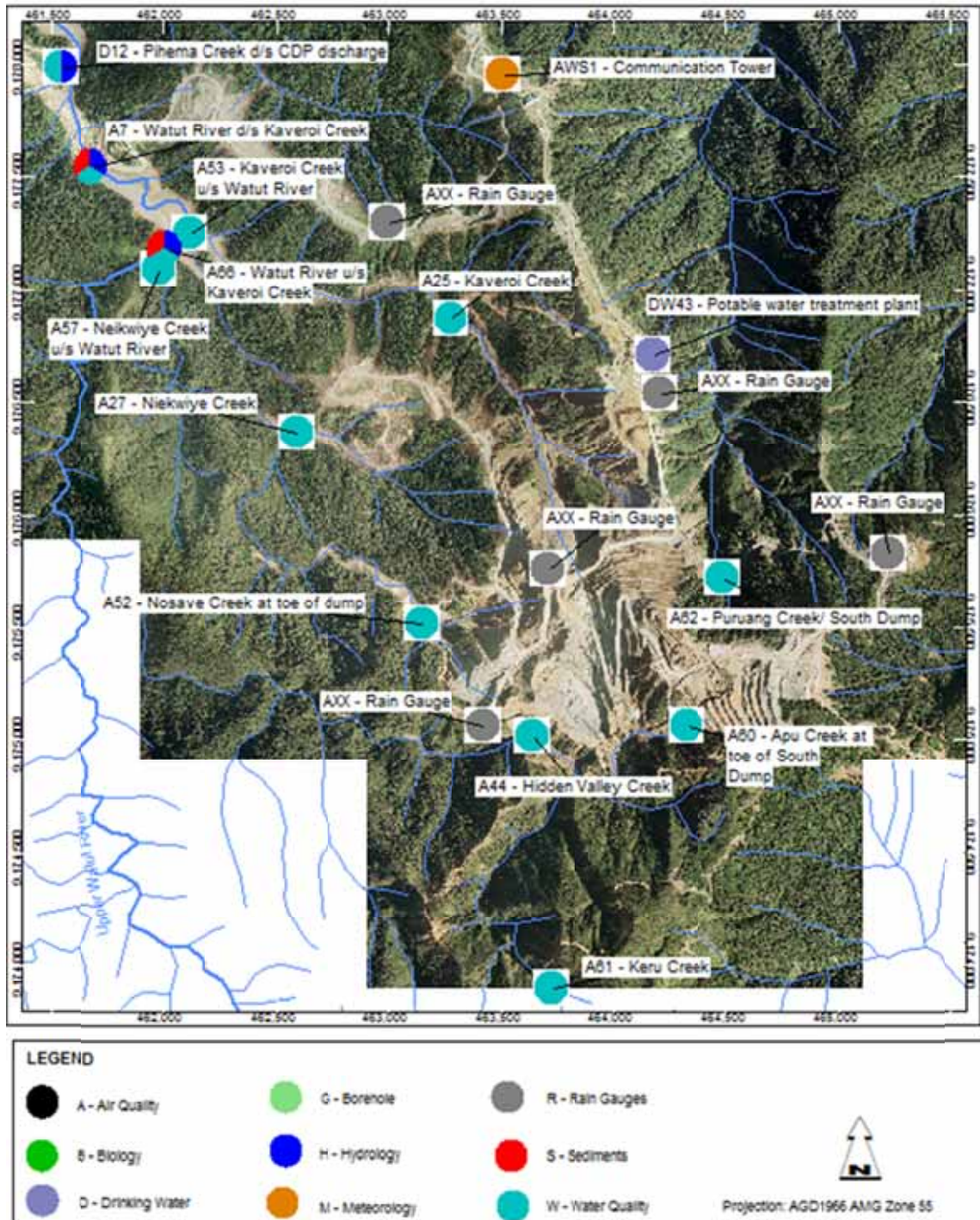


Figure 8: HVK Monitoring Program Sites

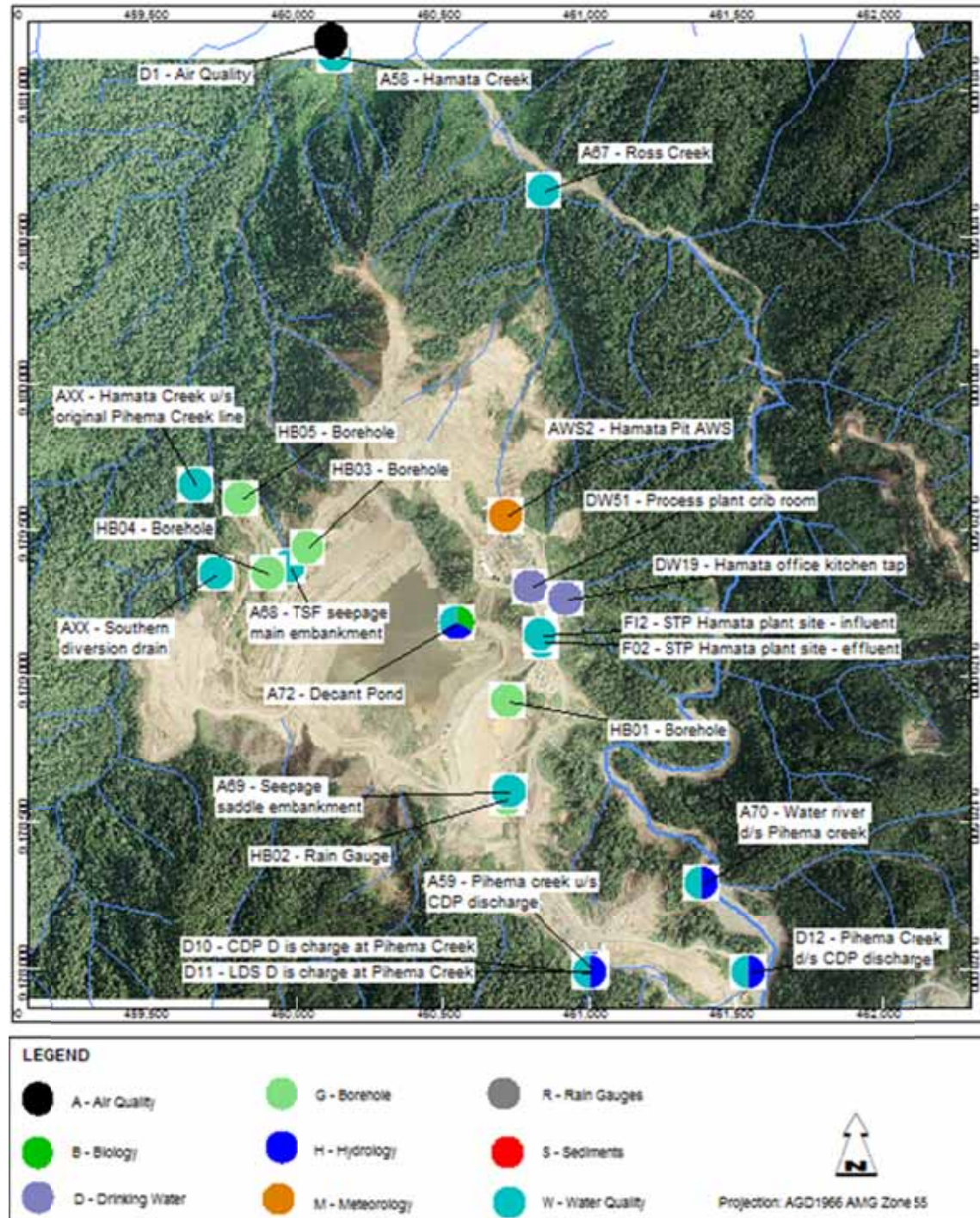


Figure 9: Monitoring Sites near Hamata and TSF

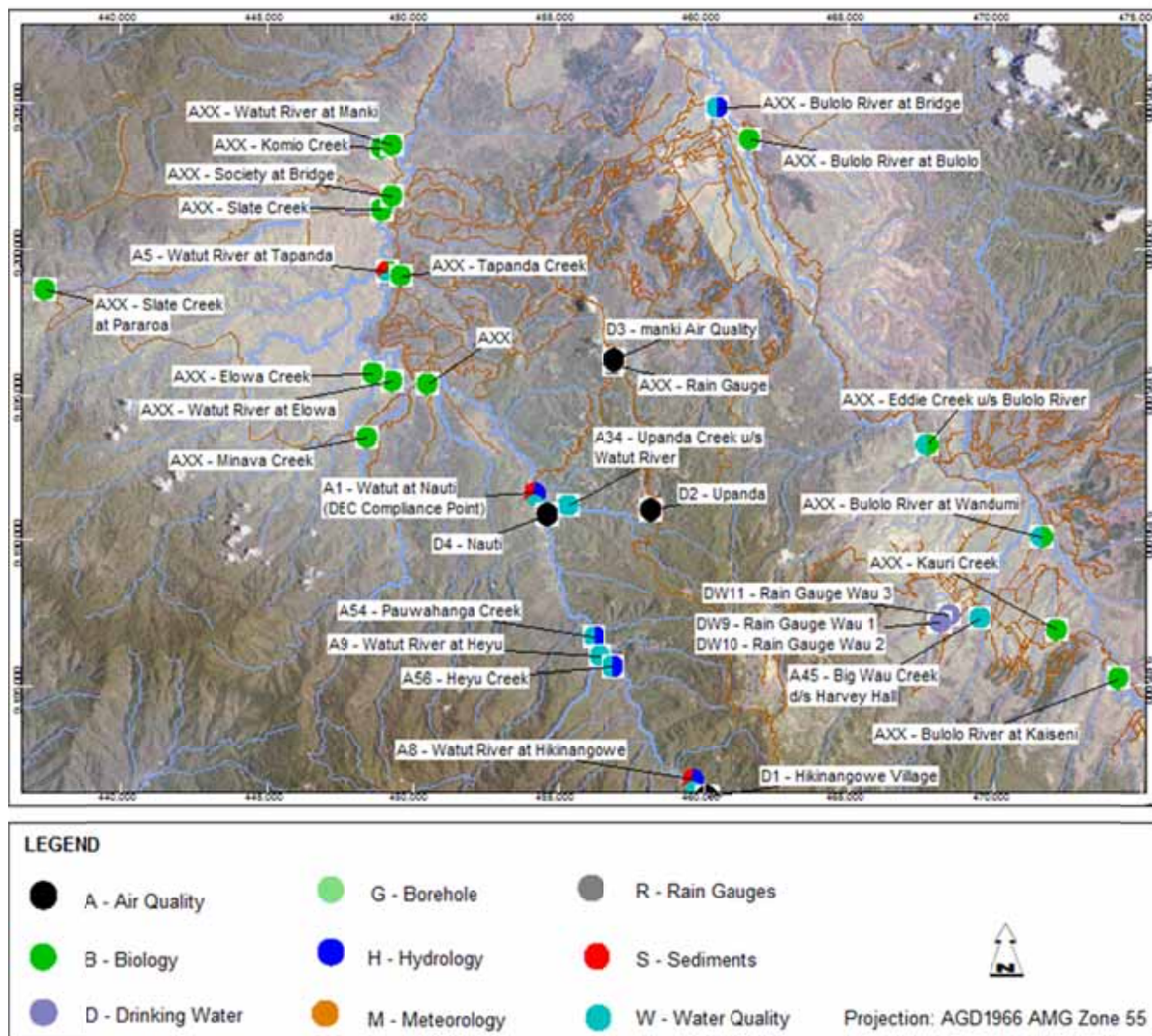


Figure 10: Upper Watut and Bulolo River Monitoring Sites

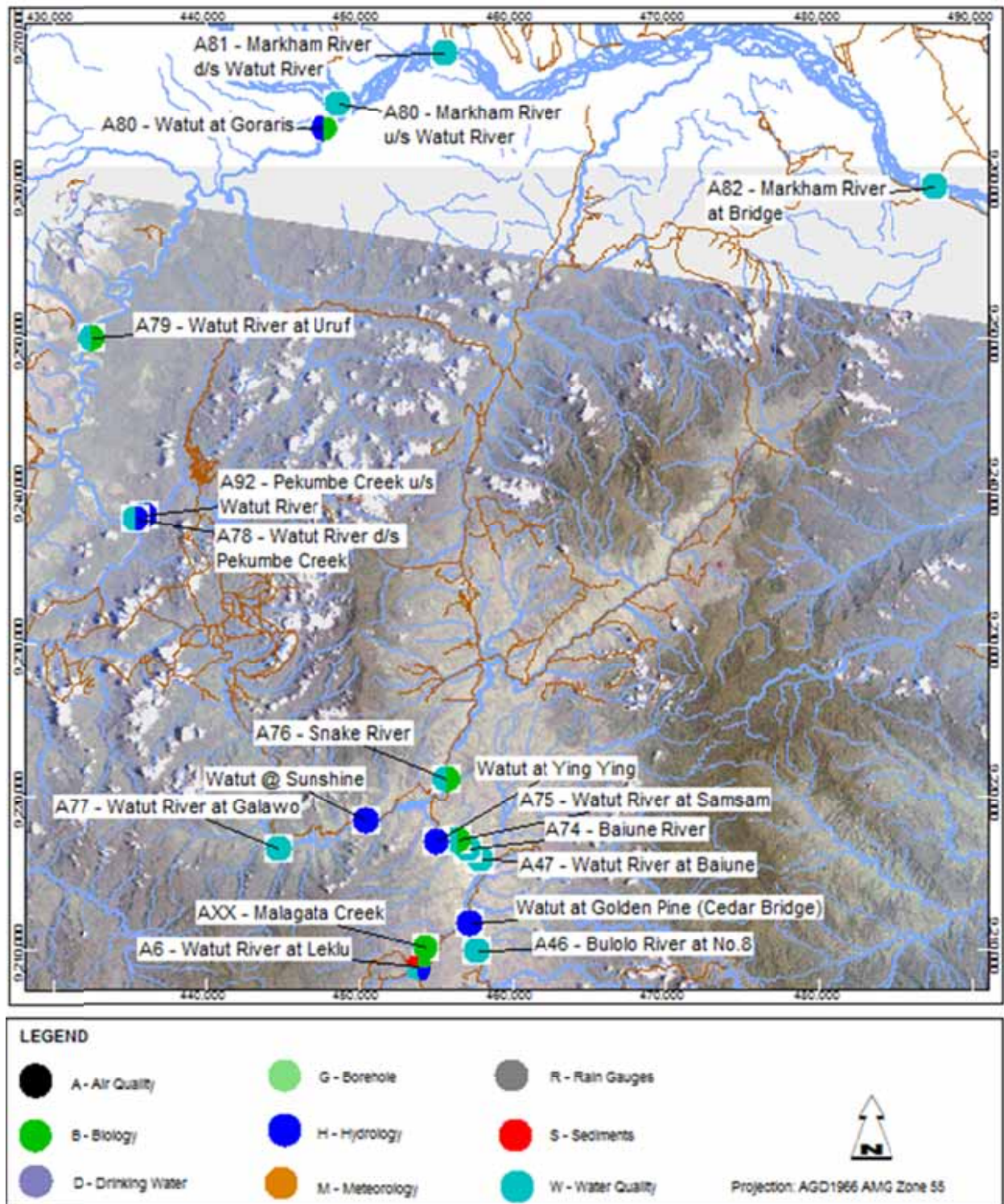


Figure 11: Middle and Lower Watut EMP Sample Sites

5.2 Meteorological Data

Meteorological conditions and particularly rainfall have a large impact on HVGM operations and surrounding areas. The mine has Automatic Weather Stations (AWS) at the Communications Tower on the Ridgeline near the Hidden Valley Pit and at the bottom of the valley near the Hamata Pit and TSF to track weather conditions. These are supplemented with 6 pluviographs continually collecting rainfall data.

5.2.1 General Weather Conditions

General weather conditions at HVGM were similar to previous years (refer Table 2 and Table 3). The average temperature on the ridgeline in the vicinity of Hidden Valley Pit was 14.2 °C which was some two degrees cooler than the 16.3 °C mean temperature recorded at Hamata. The average daily maximum and minimum temperatures were also two degrees cooler on the ridgeline than at Hamata at 16.1 °C and 11.6 °C respectively.

The mean humidity on the Ridgeline was 92.5% compared to the 82.3% at Hamata. There was also slightly less wind in the valley at Hamata with an average wind speed of 1 m/s compared to the 1.3 m/s on the less sheltered ridgeline. The higher temperature and lower humidity at Hamata compared to the ridgeline results in lower levels of evaporation calculated at 2 mm a day on the ridgeline and 2.5 mm a day at Hamata.

Table 2: Meteorological Parameters at the Communications Tower AWS in 2011

Parameter		2011	Long Term Mean
Temperature (°C)	Mean	14.2	14.2
	Mean daily Maximum	16.1	15.5
	Mean daily Minimum	11.6	13.0
Relative Humidity (%)	Mean	92.5	90.7
	Mean daily Maximum	100	96.4
	Mean daily Minimum	66.3	76.3
Barometric Pressure (hpa)	Mean	769.5	769.7
	Mean daily Maximum	771.8	771.2
	Mean daily Minimum	765.3	768.2
Solar radiation (w/m ²)	Mean	140.2	15.2
	Mean daily Maximum	280.7	251.3
	Mean daily Minimum	27.1	66.8
Wind speed (m/second)	Mean	1.3	1.3
	Mean daily Maximum	2.2	2.0
	Mean daily Minimum	0.7	0.9
Calculated Evaporation (mm)	Mean	2.0	2.0

Table 3: Meteorological Parameters at Hamata AWS in 2011

Parameter		2011	Long Term Mean
Temperature (°C)	Mean	16.3	16.4
	Mean daily Maximum	18.0	17.6
	Mean daily Maximum	13.6	15.1
Relative Humidity (%)	Mean	82.3	82.6
	Mean daily Maximum	93.2	90.8
	Mean daily Maximum	60.7	70.9
Barometric Pressure (hpa)	Mean	796.4	799.2
	Mean daily Maximum	801.4	800.6
	Mean daily Maximum	794.0	797.7
Solar radiation (w/m ²)	Mean	175	169.4
	Mean daily Maximum	303.6	258.5
	Mean daily Maximum	27	80.7
Wind Speed (m/second)	Mean	1.0	1.0
	Mean daily Maximum	2.8	1.6
	Mean daily Maximum	0.2	0.6
Calculated Evaporation (mm)	Mean	2.5	2.5

5.2.2. Rainfall

A total 3,211 mm of rain was recorded at the ridgeline AWS (communication tower) in 2011 and included an exceptionally wet December which experienced 580 mm of rainfall which was 200 mm above average (refer Figure 12).

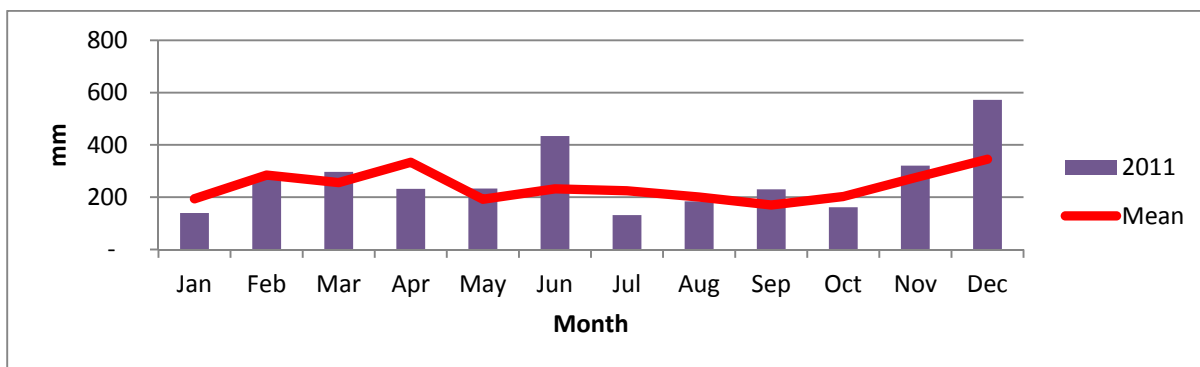


Figure 12: 2011 Ridgeline AWS Rainfall and Long Term Mean

Hamata recorded a total of 2,486 mm in 2011 compared to the long term mean of 2,388 mm (refer Figure 13).

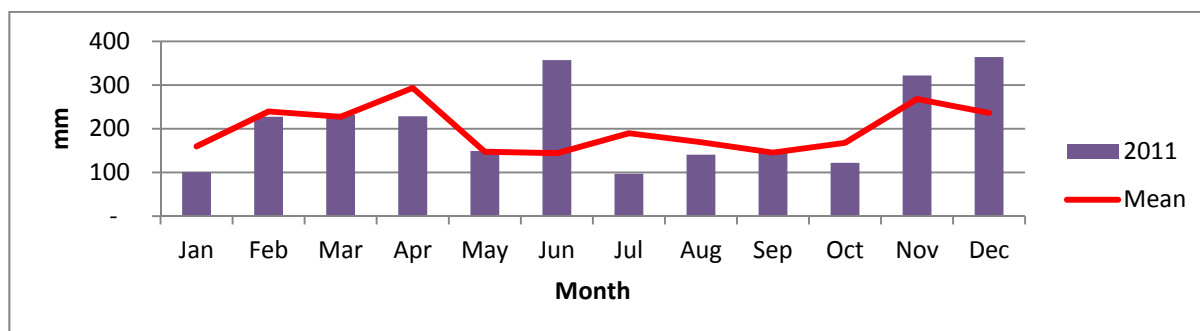


Figure 13: Rainfall at Hamata AWS 2011 and Long Term Mean

5.3 Hydrology and Water Quality

HVSL continued to collect extensive hydro-meteorological, sediment transport and physicochemical data during 2011 with a specific focus on the Watut River system and its tributaries and the upper catchments of the Bulolo River.

5.3.1 Hidden Valley Drainage

Most mine-derived emissions including sediment, ARD and treated water from the TSF enter the Watut River via Pihema Creek and other upstream tributaries. The average Upper Watut River flow downstream of Pihema Creek is 1.3 cumecs. This flow increases four-fold by the Nauti compliance point where the average flow rate is 5.4 cumecs (refer Table 4).

Table 4: Summary of Annual Average Flow Data in Local Creeks in 2011

Site Name	Max. Flow (cumecs)	Min. Flow (cumecs)	Mean Flow (cumecs)	No of Gaugings
Apu Creek	0.195	0.005	0.018	41
Keru Creek	0.166	0.00	0.078	Flow meter
Nosave Creek	0.349	0.005	0.045	12
Kaveroi Creek	0.588	0.044	0.142	30
Pihema Creek	0.579	0.113	0.270	23
Watut u/s Kaveroi	2.507	0.208	1.016	24
Watut d/s Kaveroi	3.001	0.521	1.113	44
Watut d/s Pihema	2.243	0.652	1.327	32
Watut at Hikinangowe	4.401	1.841	2.701	16
Watut at Nauti	10.304	3.538	5.441	21

5.3.2 Water Quality

Water quality monitoring is concentrated on local streams and the main stem of the Upper Watut River between the mine site and the confluence with the Bulolo River. The local streams include creeks that directly drain the active mining areas including the Hidden Valley and Hamata pits and their associated waste rock dumps.

5.3.2.1 Local Sampling Sites

Local sites were monitored to assess the quality of water in local streams potentially impacted by mining activities including Apu Creek at the toe of South Dump, Kaveroi Creek and the Watut River upstream of Kaveroi Creek. This monitoring enables assessment of the health of the Upper Watut River system. Monitoring is undertaken consistent with the HVGM Water Quality Monitoring Schedule. Key parameters include metals (dissolved and total), sulphate, alkalinity and Total Suspended Solids (TSS) along with pH, conductivity, turbidity, and dissolved oxygen (DO).

5.3.2.2 General parameters and turbidity

Table 5 presents the physical parameters measured in routine sampling in 2010 and 2011 of the main tributaries to the Upper Watut River. Apu Creek, which receives South Dump and the discharge from the Hidden Valley Pit, had higher concentrations of suspended sediment in 2011 than in 2010 but appeared to have less ARD as indicated by an increase in pH, decrease in sulphate and a decrease in levels of dissolved metals. This increased sediment load from Apu Creek was, however, balanced by a great reduction in the suspended sediment load in Kaveroi Creek (refer Table 5). The water quality in Nosave Creek, did not exhibit any significant change. The overall situation, therefore, is one of decreasing sediment load in combination with apparently stable levels of ARD. This is consistent with the water quality outcomes at Nauti (refer Table 9) which also show a decreased sediment load from 2010 to 2011 and little obvious change in metal concentrations.

Table 5: Physical Parameters Local Creeks in 2010 and 2011

Parameter		Apu Creek		Kaveroi Creek		Nosave Creek	
		2010	2011	2010	2011	2010	2011
DO ₂ (mg/L)	Mean	5.4	7.08	7.1	8.5	7.47	7.2
	SD	1.98	2.44	2.17	2.1	2.69	3.09
	N	123	186	93	267	14	4
pH	Mean	3.3	4.8	5.64	6.09	3.8	3.9
	SD	0.69	0.55	1.92	0.88	1.04	0.72
	N	125	200	2	333	15	4
SO ₄ (mg/L)	Mean	3,126	1,612	345	387	819	1,279
	SD	1,873	518	254	98	250	313
	N	11	62	18	10	9	9
Acidity (CaCO ₃)/L	Mean	1,898	175	44	24	590	547
	SD	1,221	87	75	35	209	301

Parameter		Apu Creek		Kaveroi Creek		Nosave Creek	
		2010	2011	2010	2011	2010	2011
TSS (mg/L)	N	107	190	257	301	14	3
	Mean	233	4,764	26,923	9,248	213	708
	SD	357	12,282	96,498	4,011	265	1,079
	N	6	32	113	9	14	3

5.3.2.3 Dissolved Metals

The concentration of dissolved metals in local creeks was largely unchanged from 2010 (refer Table 6) and other than a small number of instances of elevated manganese and cobalt were within Permit limits at the Nauti compliance point (refer Section 5.3.3).

Table 6: Comparison of Dissolved Metals (mg/L) 2010 and 2011

Metal		Apu Creek		Kaveroi Creek		Nosave Toe	
		2010	2011	2010	2011	2010	2011
Aluminium	Mean	198.35	7.46	4.92	1.52	43.22	73.89
	SD	125.47	6.26	14.82	2.69	22.00	26.8
	N	13	60	25	8	11	9
Arsenic	Mean	0.346	0.002	0.018	0.009	0.003	0.009
	SD	0.419	0.001	0.046	0.007	0.002	0.013
	N	10	38	20	8	4	8
Cadmium	Mean	0.228	0.059	0.017	0.018	0.052	0.066
	SD	0.126	0.0228	0.013	0.005	0.019	0.020
	N	13	61	24	9	11	9
Chromium	Mean	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	Mean	1.94	0.72	0.16	0.14	0.40	0.50
	SD	0.65	0.31	0.14	0.07	0.12	0.18
	N	13	62	24	9	11	9
Copper	Mean	2.90	0.17	0.11	0.05	0.57	0.77
	SD	2.37	0.10	0.14	0.07	0.28	0.37
	N	13	60	25	8	11	9
Iron	Mean	145.32	26.36	7.91	0.12	9.2	15.00
	SD	158.45	17.87	20.50	0.10	7.49	14.72
	N	13	58	7	6	10	9

Metal		Apu Creek		Kaveroi Creek		Nosave Toe	
		2010	2011	2010	2011	2010	2011
Lead	Mean	0.038	0.012	0.022	0.006	0.007	0.014
	SD	0.014	0.007	0.061	0.008	0.003	0.006
	N	13	57	9	5	10	9
Manganese	Mean	105.04	54.29	14.50	16.02	36.86	43.53
	SD	48.65	19.41	10.88	3.98	10.38	14.83
	N	13	62	25	9	11	9
Mercury	Mean	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	Mean	1.876	0.549	0.141	0.132	0.464	0.621
	SD	0.931	0.220	0.125	0.066	0.168	0.211
	N	13	61	25	9	11	9
Selenium	Mean	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	Mean	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	Mean	37.53	9.75	2.16	1.55	8.08	11.96
	SD	22.45	4.29	2.06	1.38	3.19	4.17
	N	13	61	22	9	10	9

5.3.3 Watut River Sites

Watut River water quality monitoring was completed for metals, oil and grease and general water quality parameters including TSS, sulphate and total alkalinity. The Nauti compliance point was additionally sampled for dissolved metals and general water quality parameters including pH, conductivity, turbidity, dissolved oxygen (DO) and temperature.

Most mine derived emission enters the river system from Apu Creek, Nosave Creek and Kaveroi Creek and water quality outcomes at Nauti are therefore a reflection of water quality in these local creeks. The greatest change at Nauti from 2010 to 2011 is a reduction in suspended sediment. This is also consistent with the general reduction trend in volumes of sediment per mm of rain per day at Hidden Valley (refer Figure 17) as obtained by an integration of the Hydstra continuously recorded turbidity data.

5.3.3.1 Physico-chemical Parameters and Sediment Load

The physico-chemical quality of the river system was similar to 2010 with the exception of suspended sediment loads levels which data shows has halved at both Hikinangowe and Nauti (refer Table 7). These results were, however, based on spot samples which may miss the high sediment peaks associated with storm pulses. Continuous turbidity readings from the river monitoring station at Nauti provide a more accurate picture of sediment loadings throughout

the year. The average sediment load at Nauti in 2010 based on 63,000 readings was 4,732 mg/L compared to 4,239 mg/L in 2011 based on 89,000 readings (refer Table 8) . The highest result in 2010 was close to 100,000 mg/L and 80,000 mg/L in 2011 (refer Figures 14 and 15).

The Environmental Permit level for dissolved Cobalt is stated as “below limit of detection” which is equivalent to 1ppb and is much lower than the current 90 ppb ANZECC trigger level for dissolved cobalt for the protection of Freshwater Aquatic Ecosystems. HVSL has applied to the DEC for an amendment to this condition to 20 ppb which is measurable.

The only other dissolved metal that was occasionally detected at elevated levels at the Nauti compliance point during 2011 was manganese which has a compliance limit of 500 ppb. Manganese is released from carbonates in the waste rock dumps when it is dissolved by ARD and remains an element of concern despite the slight decrease from an average 540 ppb in 2010 to 440 ppb in 2011. Long term control of dissolved manganese will be achieved by effective mitigation of ARD in engineered waste rock dumps.

Table 7: Physico-chemical Parameters in the Upper Watut 2010 and 2011

Parameter		Hikinangowe		Nauti		Permit Criteria
		2010	2011	2010	2011	
DO ₂ (mg/L)	Mean	6.3	7.08	7.3	8.2	> 6 mg/L
	SD	2.1	2.22	1.74	2.6	
	N	198	22	210	249	
pH	Mean	7.02	7.4	7.25	7.4	No Change to Normal
	SD	0.57	0.49	0.47	0.4	
	N	203	26	294	3.1	
SO ₄ (mg/L)	Mean	54.8	72.4	29.4	34.8	No criteria
	SD	21.9	27.7	15.0	20.4	
	N	12	17	23	89	
Alkalinity mg(CaCO ₃)/L	Mean	26.6	25.5	31.3	31.4	No criteria
	SD	16.9	8.8	17.6	16.2	
	N	187	7	259	284	
TSS (mg/L)	Mean	2478	1259	2311	1333	<52 NTU
	SD	3212	424	2013	576	
	N	8	3	13	37	

Table 8: Mean Total Suspended Sediment load at Nauti (mg/L) in 2010 and 2011 (Continuous Data)

Nauti TSS	2010	2011
Mean (mg/L)	4,732	4,239
Standard Deviation	7,181	6,167
N	63,432	89,456

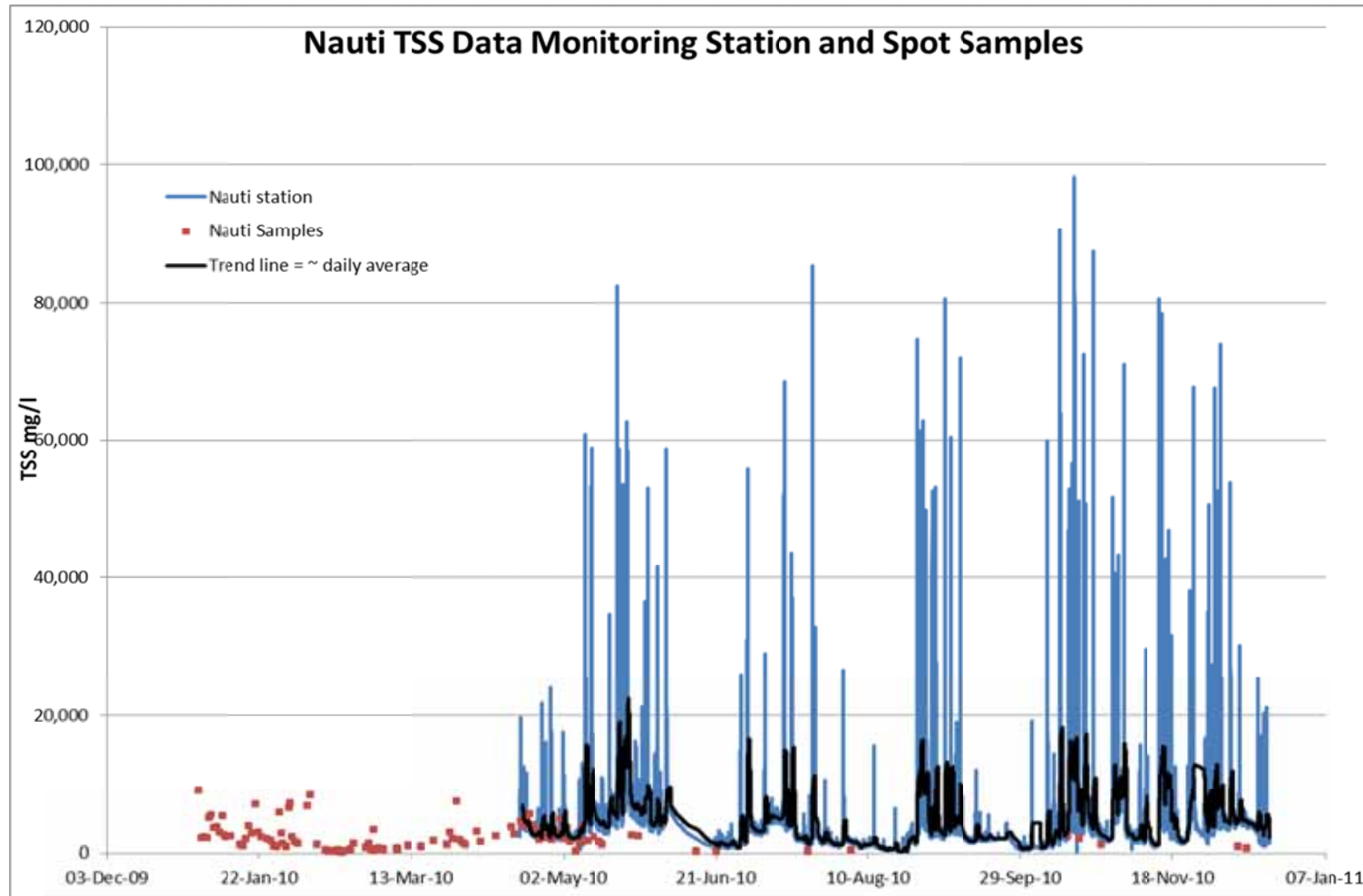


Figure 14: Water Monitoring Station and Spot Sampling TSS Data at Nauti in 2010

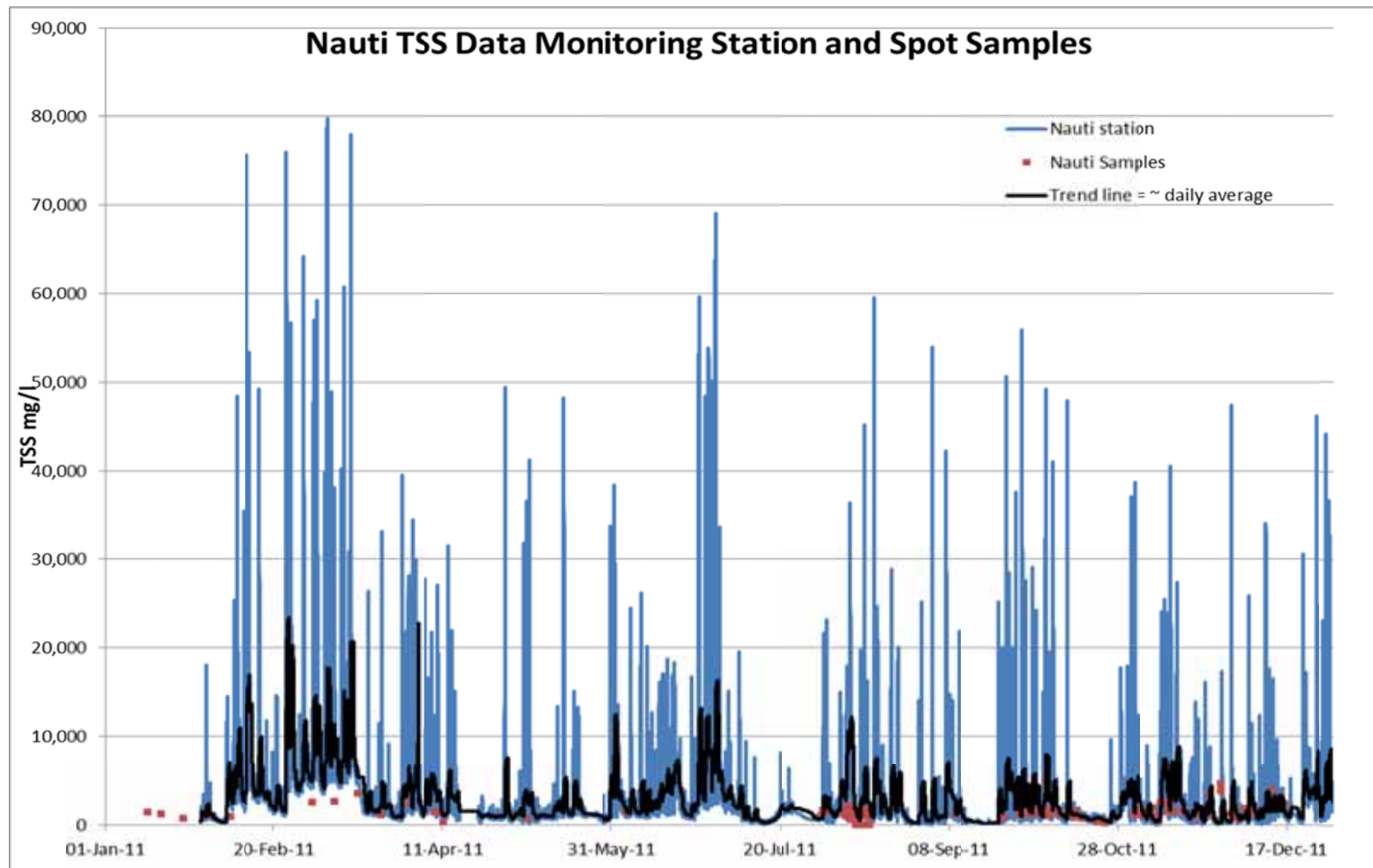


Figure 15: Water Monitoring Station and Spot Sampling TSS Data at Nauti in 2011

Table 9: Dissolved Metals (mg/L) in Upper Watut River

Metal		Hikinangowe		Nauti		Permit Level Nauti (mg/L)
		2010	2011	2010	2011	
Aluminium	Mean	2.74	0.16	0.20	0.11	NA
	SD	6.52	0.23	0.54	0.23	
	N	55	9	80	149	
Arsenic	Mean	0.015	0.005	0.006	0.006	0.05
	SD	0.026	0.003	0.004	0.001	
	N	43	6	60	80	
Cadmium	Mean	0.001	0.003	0.0008	0.0007	0.01
	SD	0.001	0.003	0.0018	0.0008	
	N	44	13	52	121	
Chromium	Mean	<0.001	<0.001	<0.001	<0.001	0.05
Cobalt	Mean	0.016	0.005	0.002	0.001	Limit of detection (0.001)
	SD	0.022	0.005	0.003	0.001	
	N	54	9	75	146	
Copper	Mean	0.031	0.024	0.009	0.006	1
	SD	0.041	0.049	0.013	0.014	
	N	53	8	78	149	
Iron	Mean	4.86	0.19	0.121	0.093	1
	SD	9.38	0.35	0.187	0.17	
	N	40	5	52	78	
Lead	Mean	0.028	0.006	0.001	0.001	0.005
	SD	0.041	0.008	0.001	0.001	
	N	23	2	22	47	
Manganese	Mean	1.97	1.38	0.54	0.44	0.5
	SD	1.66	0.77	0.24	0.15	
	N	56	9	79	149	
Mercury	Mean	<0.0001	<0.0001	<0.0001	<0.0001	0.002
Nickel	Mean	0.007	0.003	0.001	0.0008	1
	SD	0.012	0.003	0.002	0.0004	

Metal		Hikinangowe		Nauti		Permit Level Nauti (mg/L)
		2010	2011	2010	2011	
	N	54	7	67	86	
Selenium	Mean	<0.01	<0.01	<0.01	<0.01	0.01
Silver	Mean	0.005	0.001	0.001	0.0005	0.05
	SD	0.008	0.001	0.002	0.001	
	N	35	3	48	64	
Zinc	Mean	0.127	0.075	0.0164	0.0096	5
	SD	0.239	0.103	0.032	0.011	
	N	42	4	50	79	

5.4 Water Extraction and Discharge

The elevated consumption of potable water (refer Table 10) reflects the larger than anticipated size of the Hidden Valley workforce from the time the Permit was drafted. The total abstraction however, is equivalent to 0.002 cumecs which is a small proportion of the average 0.078 cumec flow in Keru Creek (refer Table 4). Most of the extracted water is discharged back into the environment after treatment to have a low overall impact on river flows. HVSL proposes to seek an amendment to the Water Extraction Permit for potable water to reflect the increased size of the HVGM workforce and to include the Bulldog Creek extraction point. This amendment would have a minor impact on water flows in Keru and Bulldog Creek and the Watut River in general.

The high rate of potable water extraction is also reflected in the high rate of STP discharge (refer Table 11) which at 64,000 m³ was also double the Permitted level.

1.2 million m³ of process water was abstracted from Pihema Creek during 2011 which was within Permit limits (refer Table 10) and 334,000 m³ (refer Table 11) was discharged back to Pihema Creek. The remainder was retained in the TSF and contributed to a positive water balance. The net extraction of 831,000 m³ is equivalent to 0.026 cumecs which is about 10% of the 0.27 cumec flow in Pihema Creek (refer Table 4).

Table 10: 2011 Water Extraction Volumes (m³) and Permitted Volumes

Month	Process Water (m ³)		Potable Water* (m ³)	
	Pihema Creek	Keru Creek	Bulldog Creek	Total
January	93,086	3,292	3,401	6,693
February	99,345	3,292	3,401	6,693
March	114,624	3,292	3,401	6,693

Month	Process Water (m ³)		Potable Water* (m ³)	
	Pihema Creek	Keru Creek	Bulldog Creek	Total
April	125,677	3,292	3,401	6,693
May	104,119	3,292	3,401	6,693
June	106,049	3,292	3,401	6,693
July	80,645	3,292	3,401	6,693
August	85,513	3,292	3,401	6,693
September	92,075	3,931	3,401	7,332
October	101,734	3,250	3,401	6,651
November	89,624	3,250	3,401	6,651
December	73,307	2,738	3,401	6,139
2011 Total	1,165,798	39,507	40,812	80,319
Permitted level	1,226,400	32,856	nil	32,858

* Missing data assumed at monthly mean

Table 11: Water Discharge Volumes (m³) and Permitted Levels

Month	TSF Discharge (m ³)	Ridgeline STP (m ³)	Hamata STP (m ³)
January	19,522	5,317	Unmetered to TSF
February	9,733	5,317	
March	9,540	5,317	
April	19,100	5,317	
May	19,077	5,317	
June	12,912	5,317	
July	25,274	5,317	
August	76,733	5,317	
September	64,874	5,317	
October	35,052	5,317	
November	35,052	5,317	
December	7,850	5,317	
2011 Total	334,719	63,780	
Permitted level	2,800,000	32,850	32,850

5.5 Sewage Treatment

The ridgeline Sewage Treatment Plant (STP) originally constructed at HVGM was found to be under-sized for the large work-force. This was resolved at the end of 2011 with the commissioning of a new high capacity STP expected to be fully commissioned in Quarter 1 2012.

A number of sewage effluent quality parameters were elevated during 2011 (refer Table 12) due to having an undersized treatment system for the larger than expected workforce. This issue was resolved in late 2011 with the commissioning of the higher capacity STP.

Table 12: Sewage Effluent Parameters 2010 and 2011

Sample Point	Year	pH	Turbidity (NTU)	BOD (mg/L)	Nitrate as N (mg/L)	TSS (mg/L)
Final outflow 1	2010	7.04	302	299	2.45	527
	2011	6.94	484	40	51.24	177
Final outflow 2	2010	6.10	83	247	38.81	80
	2011	6.34	81	12	11.42	64
STP Reactor 1	2010	7.05	118	332	4.93	209
	2011	6.84	418	30	49.88	136
STP Reactor 2	2010	6.75	233	183	3.88	314
	2011	6.96	429	32	48.84	189
Permit Requirement		6.8 – 8.5	2-25	<20	<15	<30

5.6 Potable Water Monitoring

Drinking water was free of coliform bacteria and met other potable water criteria during 2011 (refer Table 13).

Table 13: Drinking Water Quality 2010 and 2011

	Dissolved oxygen (mg/L)	EC field (µS/cm)	pH	Temperature (°C)	Turbidity (NTU)
Potable WTP					
2010 Mean	6.8	57	6.91	15.9	89
2011 Mean	6.9	76	7.04	19.5	7
Ridgeline Camp Mess Tap					
2010 Mean	6.6	45	7.04	17.3	52
2011 Mean	7.2	89	7.27	18.2	13
Permit Requirement	<20	None	6.8 – 8.5	None	5 – 25

5.7 Groundwater Monitoring

Groundwater quality in the vicinity of the TSF in 2010 and 2011 was monitored in five groundwater bores (refer Appendix 1). The groundwater was of uniformly high quality with low levels of dissolved metals and cyanide and no sign of deterioration between 2010 and 2011. It is apparent that some seepage of TSF liquors into the groundwater is occurring but it is also apparent that TSF contaminants including dissolved metals and cyanide are being attenuated. The ground-water contained low levels of nitrogenous cyanide break-down products as well as low concentrations of metals such as dissolved copper which are elevated in the TSF liquor. Monitoring Bore HB01 was located adjacent to the saddle dam and was buried under the expanding dam in April 2011.

6. ENVIRONMENTAL IMPROVEMENT PROGRAM

6.1 Managing Sediment

HVGM is implementing a sediment reduction program that has dramatically reduced sediment run-off emissions from those experienced in the construction period from 2007 to 2009. Over 2010 and 2011 there has been a reduction in sediment run-off contribution to the river system as a result of site revegetation programs, the installation of sediment traps and the improved control of rainfall run-off. A reduction from about 30 tonnes TSS load at Nauti per mm of rain per day to the current 10 tonnes TSS per mm of rain per day (refer Figure 17) has been observed. The revegetation program assisted by the establishment of a site nursery (refer Figure 16) and the recent construction of a large sediment trap in the Watut River (refer Figure 18) are examples of this program. The sediment reduction program was previously constrained by a lack of competent Non Acid Forming (NAF) rock necessary for the sheeting of roads and the construction of permanent toes on waste rock dumps but this situation is improving as increasing volumes of competent NAF rock become available from the Hidden Valley Pit.

HVSL is also assessing the movement of the historically contributed sediment load through the river system and its impact on the Middle and Lower Watut River. This work includes assessing the contribution of sediment from other sources including the Snake River which has had a large landslide and the Bulolo River which is being heavily impacted by small scale mining.



Figure 16: Seedlings in HV Nursery

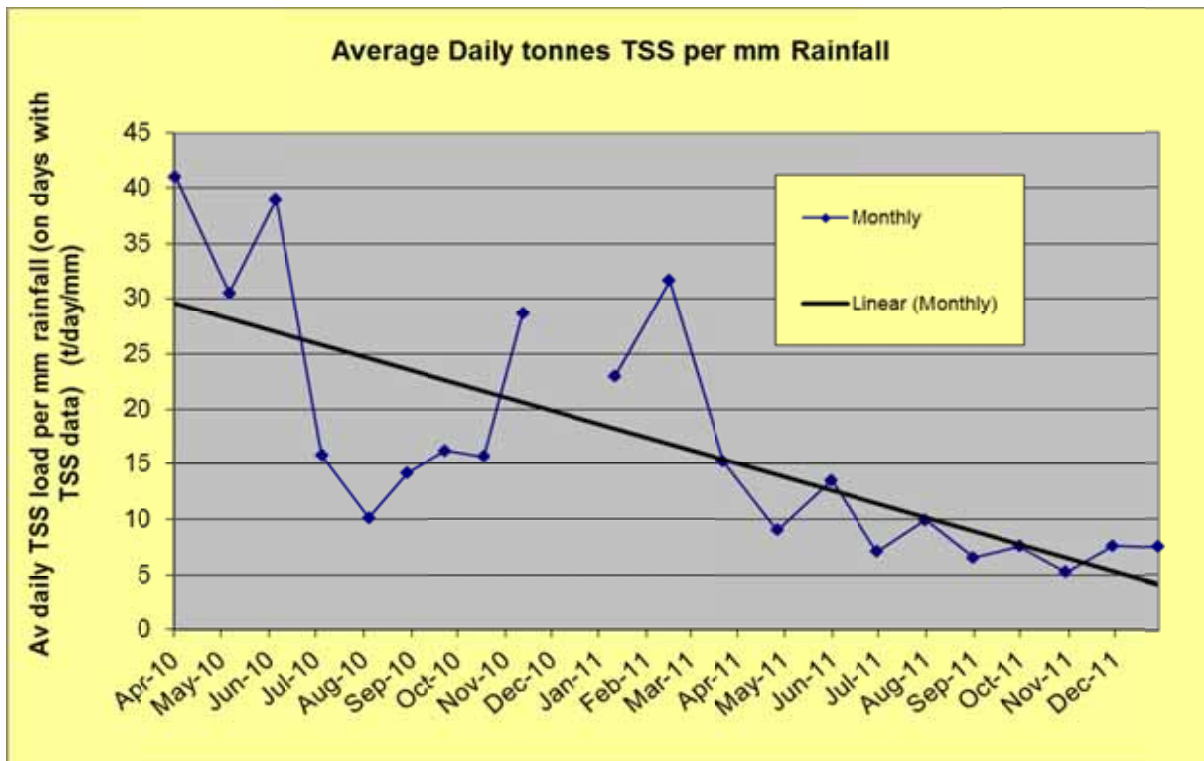


Figure 17: Average Daily TSS Load at Nauti per mm of Site Rainfall



Figure 18: Sediment Trap in the Watut River

Proposed 2012 Sediment Management Program

There are a number of sediment management initiatives planned for 2012 to complement the ongoing stabilization works and continue the sediment reduction trend (refer Figure 17). These include:

- Completion of a stable toe on Nosave Waste Rock Dump. This initiative is also relevant to the control of ARD and will enable the creation of a bottom up constructed stable and engineered waste rock dump.
- Improvement of the HVK pit dewatering system including the installation of ground-water depressurisation pumps and clean water interception sumps that will enable clean stormwater to be discharged and contribute to a drier pit and reduced sediment run-off.
- Ongoing upgrade of drainage and road formations to reduce sediment run-off from haul roads and hard-stand areas.
- Ongoing stabilisation and revegetation of open erosive areas to reduce erosion during rain events.
- Installation of additional sediment traps and improved sediment excavation and disposal strategies.
- Further review and update of the sediment management plan including catchment by catchment sediment reduction targets to enable the establishment of a realistic sediment reduction target at the Nauti compliance point.



Figure 19: Environment Team Stabilizing Steep Slope

6.2 Reducing Dissolved Metals in the River System

A primary source of dissolved metals to the river system is Acid Rock Drainage (ARD) from Potentially Acid Forming (PAF) rock in the waste rock dumps. Discharge of treated water from the TSF is a smaller contributor of metal load. HVGM remains generally in compliance with Permit requirements for dissolved metals at Nauti with the exception of cobalt which has a permit level set as “limit of detection”.

The long term strategy for the management of ARD is to segregate and encapsulate the PAF material under an inert cover. This strategy does, however, require the waste rock dumps to first be stabilised through the construction of competent rock toes followed by bottom up construction. HVGM is currently constrained by a lack of physical access to some dump toes and a shortage of competent rock but a long term waste rock management plan is being implemented. In the short term a lime dosing system has been established in Pihema Creek to counter the acidity of ARD.

The introduction of the Pihema Creek lime-dosing system in 2010 has been effective in counteracting acidity and in attenuating dissolved metals.

Dissolved manganese is currently a metal of concern in the ARD because it was at times elevated at Nauti during 2011. The pattern of falling pH at Nauti under rising river conditions indicate that ARD is flushed from the upper surface of the waste dumps during storm events resulting in a pulse of metals which elevates concentrations at Nauti, despite dilution from the increased river flows (refer Figure 20). It is important therefore to attenuate the ARD at source and lime will be added to South Dump to assess the effectiveness of direct lime dosing to enable the scoping of a more comprehensive program.

Morobe Mining - Hidden Valley Operations

HYPLOT V133 Output 26/05/2011

Period 12 Day Plot Start 00:00_05/02/2011

2011

Interval 30 Minute Plot End 00:00_17/02/2011

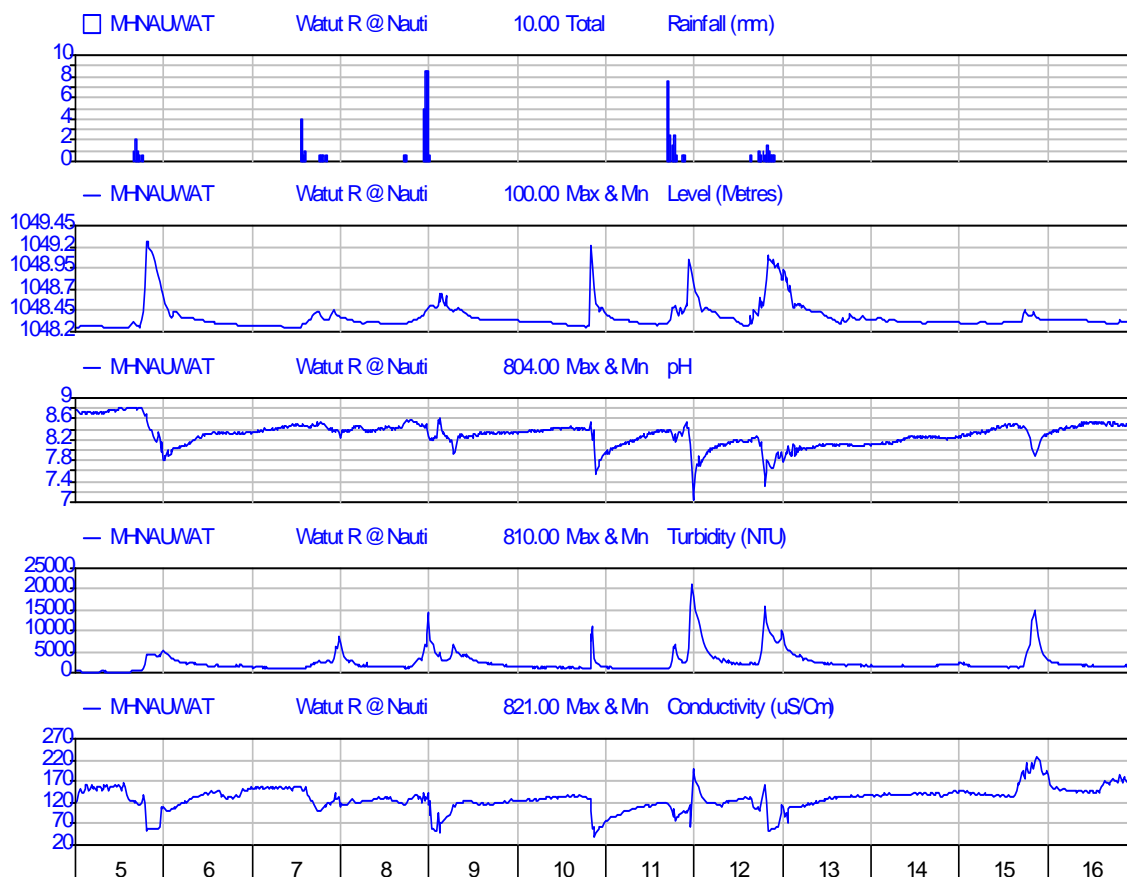


Figure 20: Nauti Monitoring Station Data (example plot 5 to 16 February 2011)

6.3 Optimal Management of the TSF

The HVGM TSF is the only engineered TSF of this size in PNG. It was commissioned in 2009 and contains all of the tailings generated since mining operations commenced at HVGM. Due to high rainfall and process plant operational issues during late 2011 an abnormally large volume of ponded water accumulated on the TSF. In order to comply with the TSF Management Plan HVSL sought an authority to temporarily release the treated excess water at higher discharge rate and higher, though still safe, residual HCN levels. At the same time, initiatives were implemented to rapidly lower the WAD cyanide levels in the TSF pond to facilitate optimal performance of the Cyanide Detoxification Plant (CDP) used to treat the TSF water at HVGM before release.

A *Section 76 Emergency Authorisation* that impose an interim HCN condition of 22 ppb (consistent with the International Cyanide Code for waters outside the mixing zone) and an increase in the discharge volume to 500 m³/hour for a period of up to six months was granted by the DEC on 12th of January 2012.

It is anticipated that the pond volume will have been returned to normal operating size within the 6 month timeframe allowed under this Emergency Authorisation.

6.4 Improving Waste Management

6.4.1 Sewage Treatment Plant (STP)

The commissioning of a new high capacity STP on the ridgeline in December 2011 addressed a significant problem area as the previous STP lacked the capacity to effectively treat sewage generated by the 1,500 person work-force (refer Figure 21).



Figure 21: Hidden Valley High Capacity Sewage Treatment Plant December 2011

6.4.2 Solid Waste

HVSL successfully decommissioned the landfill identified as an issue during the 2010 SMEC audit and commissioned a new facility during 2011. A Waste Management Plan was developed and a capital works program for an integrated waste management facility was finalised. HVJV manage wastes within a Reduce Reuse Recycle framework and are constantly exploring opportunities to eliminate waste and to manage disposal more appropriately. Some recent initiatives include:

- Purchasing grease in plastic bags which can be rolled to remove almost all grease and thereby reducing the production of oily waste and of waste grease drums (refer Figure 22).
- Routine tracking of waste streams to enable the development of improvement targets.
- Establishment of a lime pit to neutralise battery acid and facilitate the recycling of waste batteries.



Figure 22: Grease Bags Used to Reduce Waste and Eliminate Drums

6.4.3 Waste Management Improvement Plan

HVGM generated about 750 tonnes of general waste in 2011, in addition to 9 tonnes of scrap metal, 10 tonnes of drained batteries and 400,000 L of waste oil. The current landfill is within the footprint of the TSF and all wastes with the exception of waste oil are burned. The facility is tidy with no windblown rubbish but there is significant opportunity to improve practices. These opportunities will be advanced during 2012:

- Erection of fencing and under-cover storage areas.

- A composting unit to convert wet waste from the kitchen to compost to be used in gardens.
- Cardboard and paper briquette making machine to convert waste paper and cardboard into fire-bricks which will be given to local communities.
- Phytoremediation for oily soil.
- Turbo-burners to be placed in work-shops and other source to incinerate oil filters, oily rags and grease.
- Incineration area for combustible general waste.
- Waste oil incinerator.

In addition, waste reduction targets will be set as part of the HVGM eco-efficiency improvement program with particular emphasis on high volume and high weight consumables including tyres, waste food, batteries, oil and grease and general consumables (e.g. paper, gloves, boots etc.).

6.5 Rehabilitation and Mine Closure

6.5.1 Rehabilitation

HVSL maintained an intensive revegetation and stabilisation program during 2011 with 4 full time employees supported by a team of 30 local landowners employed on a casual basis. Key activities included stabilisation of steep slopes (refer Figure 19), maintenance of the site nursery (refer Figure 16), progressive rehabilitation of open areas and landscaping programs. The team was also responsible for the control and approval of land-clearing and rehabilitation monitoring including the use of a Map Info GIS to track the status of disturbance and rehabilitation at Hidden Valley. A total of 23.84 ha of new clearing occurred in 2011 and 15.6 ha of new rehabilitation was completed. 18,389 seedlings were planted requiring some 60,000 casual work hours to undertake.

Table 14: Summary of Rehabilitation Activities in 2011

Month	Area Cleared (Ha)	New area rehabilitated (Ha)	Seedlings planted (Nos)
January	0	0	2,481
February	0	0.52	254
March	1.62	1.62	676
April	0.41	0.41	1,181
May	4.11	4.11	3,308
June	0	0	1,050
July	4.78	4.78	652
August	0	0	2,373
September	0	0	5,690

Month	Area Cleared (Ha)	New area rehabilitated (Ha)	Seedlings planted (Nos)
October	12.8	0.32	699
November	0.12	1.46	25
December	0	2.4	0
Total	23.8	15.6	18,389

6.5.2 Disturbance Status

The disturbance footprint at HVGM increased from 654 ha at the end of 2010 to 678 ha at the end of 2011, and cumulative rehabilitation increased from 123 ha to 138 ha (refer Table 15). Cumulative revegetation, however, is still encompassed in the life of mine disturbance footprint in the absence of clear criteria for successful rehabilitation which will be developed during 2012. These criteria will be applied on an assumption that they are met without active intervention for at least 5 years. All rehabilitation areas at HVGM are currently actively maintained including aspects such as supplementary planting and weed control.

Table 15: YTD Categories of Disturbance (hectares)

Aspect	Category	2010	2011
Infrastructure (unavailable)	Total Infrastructure	291.2	315.0
	New disturbance	NA	23.8
Potentially available	New Rehabilitation completed in year		15.6
	Total area available for rehabilitation at end of Year	240.2	224.7
End of year Total Completed LOM Revegetation		123.0	138.6
Total Disturbance Footprint including unavailable areas		654.5	678.3

HIDDEN VALLEY ML151 LAND DISTURBANCE TYPES

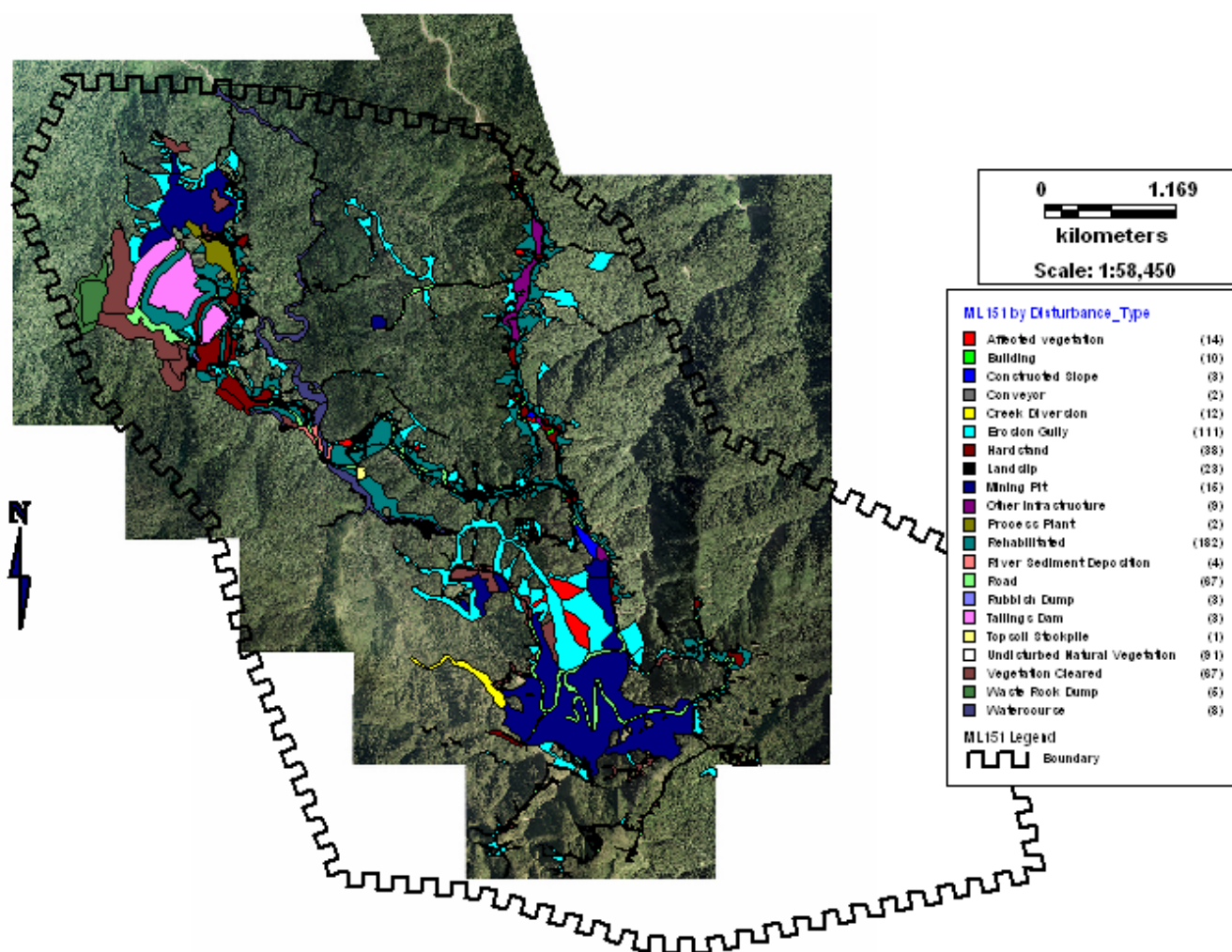


Figure 23: Land Disturbance Map

6.5.3 Decommissioning and Closure

HVJV developed a Conceptual Closure Plan during 2011. Stage one of this process was completed in October 2011 and included a gap analysis as well as defining biophysical and social completion criteria. The developed closure criteria will inform the future mine planning.

In addition to developing a framework for closure planning, HVJV continued to undertake research programs on closure relevant aspects including the design of waste dumps and their covers, the

trialling of different species for rehabilitation and ongoing flora and survey surveys. The HVGM workforce contributed to this process by reporting sightings of fauna which in the past 2 years have included a sighting of the Rare and Endangered Long Beaked Echidna on the Ridgeline, A New Guinea Quoll on the Ridgeline and a sighting of Doria's Tree Kangaroo crossing the Hamata access road near its intersection with the Ridgeline.

6.6 Improved Environmental Monitoring

The SMEC audit identified areas for improvement with regard to data collection, data management and quality assurance (QA). The situation has significantly improved in the past 12 months with greater management focus and the development of the Hydstra water quality data management system. This has been particularly significant in enabling real time tracking of key hydrological parameters such as rainfall, river turbidity and water flows throughout the Watut River Catchment. In addition to this, a comprehensive routine on-site and offsite water and sediment sampling program along with routine waste tracking, sewage effluent monitoring, CDP discharge monitoring and rehabilitation monitoring is in place.

The in-house monitoring program is being supplemented by a number of campaign studies using specialist experts.

A predictive model for water quality outcomes at Nauti continues to be refined and is routinely used to inform decisions on the volume of treated water to be discharged from the TSF and lime dosing into Pihema Creek to maintain water quality within Permit criteria.

6.7 Monitoring River Ecology

An ongoing assessment of the aquatic biology of the Watut River has indicated that populations of fish and prawns in the upper Watut collapsed during 2007 to 2009. It is likely that most of this impact was associated with physical sedimentation. To date there is little evidence populations of fish and prawns are recovering despite lower sediment levels, however, populations of diatoms, which are at the base of the food chain for fish, are recovering. Investigations are continuing to assist with understanding the conditions necessary for the return of healthy populations of fish and prawns into the upper Watut and its tributaries. The return of native fish species to the river system is dependent on a recruitment source and the prevention of invasive feral species establishing in the absence of competition and preventing native fish recruitment. The two native species of concern are the Sepik Grunter and the Blue Rainbow Fish (refer Figure 24). The Sepik Grunter (*Hephaestus transmontanus*) was once common in the Ramu and Sepik Rivers but has experienced a dramatic population collapse possibly due to competition from invasive fish species which have established in the river systems. The recent rediscovery of Sepik Grunter in the Watut River catchment in November 2011 survey is promising. Surveys will be undertaken within other catchments to source an intact population of Sepik Grunter for use in future reintroductions once conditions are suitable. Surveys are also being undertaken to locate intact populations of Blue Rainbow Fish in ox-bow lakes following the collapse of known populations possibly

due to over-fishing. Local species aquaculture support will be considered in 2012 to promote a native species fish industry.



Figure 24: The Blue Rainbow Fish

6.8 Environmental Management System (EMS)

The EMS at HVGM has developed significantly since the SMEC audit and assisted through the development of an upgraded Environmental Management Plan (EMP) submitted to DEC in March 2011. Standards for facilities and equipment are being developed and maintained through inspection and monitoring regimes and appropriate operating procedures continue to be developed. The competence of the HVGM employee and contract workforce also continues to improve through an ongoing program of training and coaching by the environmental team particularly with respect to key processes including waste management, hydrocarbon management, the operation of the CDP and the maintenance of sediment and drainage controls. Monitoring, surveillance and action management systems have also improved and the IBIS system is being routinely used to track the progress of preventative and corrective actions and the management of incidents. The improved functionality of the EMS is delivering improved performance outcomes. HVSL will continue to develop the functionality of the EMS and its Plan Do Review framework. Key supporting documents in development include:

- Aspects and Impacts Register
- Environmental Obligations Register (in draft)
- Conceptual Closure Plan (Stage 1 complete)

- Environmentally Relevant SOP's (ongoing development)
- Emergency Management Plan (ongoing review and training)
- Training Needs Analysis and Training Modules (in development)
- Facility Standards (e.g., waste disposal, hydrocarbon storage, waste rock dumps, TSF) (in development)
- Monitoring Manual (to be developed from the EMP)

6.9 Engaging Stakeholders on River Impacts

HVJV is committed to effective engagement with stakeholders and a philosophy of transparency and openness. This is particularly important with downstream communities on the Watut River. HVJV is implementing the Watut River Impact Management Program (WRIMP) to reduce mine related impacts on the Watut River and its communities in addition to directly engaging the communities. The appointment of an External Stakeholder Advisory Panel of prominent PNG citizens and expert international specialists in June 2011 was particularly relevant to this program. The ESAP endorsed the general approach of HVGM with respect to technical improvement programs but advised that a greater degree of engagement was necessary with downstream communities. This resulted in the organisation of a down-river patrol including representatives of the Hidden Valley Environment and Community Affairs Departments and the DEC to discuss issues with downstream communities in August 2011 (refer Figure 25). This patrol greatly strengthened the relationship between HVGM and the local community as well as ensuring that communities were much better informed about the scope and scale of mine related impacts on the river systems and the mitigation programs that HVJV were implementing. This in turn reduces the scope of misunderstandings and conflict and the potential of communities to disrupt monitoring programs necessary to secure the long term health of the river.

The ESAP advice supplements ongoing advice and direction from the WRIMP Technical Advisory Committee that has been in place for several years. This group provide direction and technical oversight for all WRIMP programs and hold regular workshops with the internal HVJV program specialists.



Figure 25: Hidden Valley Environment Manager Meeting with Local Communities

6.10 Eco-efficiency

HVSL will increase the focus on eco-efficiency improvement in 2012 including water efficiency greenhouse gas emissions and solid wastes as discussed previously. The focus will be on close tracking of performance in combination with capitalising on improvement opportunities.

6.10.1 Greenhouse gas emissions

The main sources of greenhouse gasses at HVGM are combustion of diesel fuel in mining machinery and power generators as well as CO₂ released from explosives.

HVGM released about 142,000 tonnes of CO₂e in 2010 to produce 197,000 ounces of gold equivalent (i.e. gold plus equivalent value of silver). Emissions in 2011 increased to about 192,000 tonnes of CO₂e for the production of 246,000 ounces of gold equivalent. This represents a slight decrease in emissions efficiency to about 0.78 tonnes of CO₂e per ounce of gold equivalent from the previous 0.72 tonnes of CO₂ per ounce of gold equivalent despite sourcing a proportion of the site power as hydro-power (with zero emissions) from the PNG National grid. The decrease in emissions efficiency was largely the result of more than doubling the volume of ore and waste rock (refer Table 16).

Table 16: Greenhouse Gas Emissions 2010 and 2011

Parameter	2010		2011	
	Quantity	CO ₂ e*	Quantity	CO ₂ e
Ore mined	3,954,153 t		3,017,488 t	
Waste rock mined	11,055,822 t		16,815,094 t	
Diesel Power	66,074 MWH		64,778 MW	
Grid Power (Hydro)	4,067 MWH	0	32,838 MWH	0
Total Power	70,141 MWH		96,716 MWH	
Diesel for Power	17,194 kL	63,618 t	27,699 kL	102,486 t
Mining diesel	21,320 kL	78,884 t	24,165 kL	89,410 t
Total diesel	38,514 kL	142,502 t	51,864 kL	191,889 t
Gold production (oz)	169,241		207,542	
Silver production (oz)	1,047,474		1,688,603	
Gold equivalent (oz)	197,065		241,208	
t CO ₂ e/ounce of gold equivalent	0.72		0.78	

*Assume 3.7 tonne CO₂e/kL of diesel combusted

6.10.2 Reagents

The tonnes milled in 2010 and 2011 were similar as was the reagent use with the exception of peroxide and Sodium Meta Bi Sulphide (SMBS) used in the INCO cyanide destruct circuit (refer Table 17). Cyanide use between the two years was similar despite an increase in gold production.

Table 17: Reagent Usage 2010 and 2011

Reagent	2010	2011
Tonnes Milled (t)	3,426,439	3,431,457
Cyanide (t)	3,429	3,527
Peroxide (t)	379	714
Sulphuric Acid (t)	915	919
Caustic (t)	1,265	1,591
SMBS in INCO CN destruct circuit (t)	1742	4301
Chlorine (t)	14	4

APPENDIX 1: GROUNDWATER QUALITY NEAR TSF

Refer Figure 9 in main body of report for locations of groundwater monitoring wells.

Table 1: Comparison of groundwater quality between 2010 and 2011 at Monitoring Bore HB01

	2010				2011			
Key Parameter	n	Range	Mean	Std	n	Range	Mean	Std
pH-field (pH Units)	3	6.24 - 6.69	6.46	0.17	1	6.53 - 6.53	6.53	-
Temperature (°C)	3	16.7 - 19.6	18	2	1	20.3 - 20.3	20	-
Dissolved Oxygen (mg/L)	3	1.71 - 2.39	1.97	0.08	1	6.25 - 6.25	6.25	-
EC field (uS/cm)	3	104 - 136	124	2	1	163 - 163	163	-
Free cyanide (mg/L as CN)	4	<0.004 - <0.004	<0.004	0.000	0	-	-	-
Weak acid dissociable cyanide (mg/L as CN)	4	<0.004 - <0.004	<0.004	0.000	0	-	-	-
Total Cyanide (mg/L as CN)	4	<0.004 - <0.004	<0.004	0.000	0	-	-	-
Acidity - Measured (mg/L CaCO ₃)	0	-	-	-	0	<1 - <1	-	-
Hydroxide Alkalinity as CaCO ₃ (mg/L CaCO ₃)	5	<1 - <1	<1	0.0	1	<1 - <1	<1	-
Carbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	5	<1 - <1	<1	0.0	1	<1 - <1	<1	-
Bicarbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	5	59 - 70	65	5.5	1	86 - 86	86	-
Total alkalinity as CaCO ₃ (mg/L CaCO ₃)	5	59 - 70	65	5.5	1	86 - 86	86	-
Dissolved Sodium (mg/L)	3	9 - 10	10	0.6	1	11 - 11	11	-
Dissolved Magnesium (mg/L)	3	3 - 3	3	0.0	1	4 - 4	4	-

Dissolved Potassium (mg/L)	3	1 - 1	1	0.0	1	<1 - <1	<1	-
Dissolved Calcium (mg/L)	3	12 - 14	13	1.2	1	18 - 18	18	-
Chloride (mg/L)	5	<1 - 1	<1	0.3	1	<1 - <1	<1	-
Dissolved Sulfate as SO ₄ 2- (mg/L)	5	2 - 5	3	1.5	1	1 - 1	1	-
Dissolved aluminium (mg/L)	5	<0.01 - 0.198	0.073	0.1081	1	<0.01 - <0.01	<0.01	-
Dissolved antimony (mg/L)	5	<0.001 - <0.001	<0.001	0.0002	0	<0.001 - <0.001	-	-
Dissolved Arsenic (mg/L)	5	<0.001 - <0.001	<0.001	0.0001	0	<0.001 - <0.001	-	-
Dissolved Cadmium (mg/L)	5	<0.0001 - 0.0009	0.0003	0.0005	1	<0.0001 - <0.0001	<0.0001	-
Dissolved Chromium (mg/L)	5	<0.001 - <0.001	<0.001	0.0002	0	<0.001 - <0.001	-	-
Dissolved Copper (mg/L)	4	0.0056 - 0.033	0.019	0.0194	1	0.021 - 0.021	0.021	-
Dissolved Iron (mg/L)	5	<0.05 - 0.34	0.16	0.1519	0	<0.05 - <0.05	-	-
Dissolved Lead (mg/L)	5	<0.001 - <0.001	<0.001	0.0003	0	<0.001 - <0.001	-	-
Dissolved Cobalt (mg/L)	5	<0.001 - 0.003	0.001	0.0014	1	<0.001 - <0.001	<0.001	-
Dissolved Manganese (mg/L)	5	0.067 - 0.314	0.199	0.1050	1	0.54 - 0.54	0.540	-
Dissolved Mercury (mg/L)	4	<0.0001 - <0.0001	<0.0001	0.0000	0	<0.0001 - <0.0001	-	-
Dissolved Nickel (mg/L)	5	<0.001 - 0.001	<0.001	0.0004	1	<0.001 - <0.001	<0.001	-
Dissolved Selenium (mg/L)	2	<0.01 - <0.01	<0.01	0.0000	0	<0.01 - <0.01	-	-
Dissolved Silver (mg/L)	5	<0.001 - 0.002	<0.001	0.0011	1	<0.001 - <0.001	<0.001	-
Dissolved Zinc (mg/L)	5	0.008 - 0.016	0.015	0.0010	0	<0.001 - <0.001	-	-

Table 2: Comparison of groundwater quality between 2010 and 2011 at Monitoring Bore HB02

	2010				2011			
	n	Range	Mean	Std	n	Range	Mean	Std
pH-field (pH Units)	2	6.22 - 6.98	6.60	-	20	5.91 - 7.23	6.57	0.38
Temperature (°C)	2	16.9 - 17.2	17	-	20	15 - 21	18	2
Dissolved Oxygen (mg/L)	2	0.9 - 6.54	3.72	-	17	1.49 - 10.74	4.30	2.66
EC field (uS/cm)	2	136 - 179	158	-	20	127 - 247	162	24
Free cyanide (mg/L as CN)	3	<0.004 - <0.004	<0.004	-	3	<0.004 - <0.004	<0.004	0.000
Weak acid dissociable cyanide (mg/L as CN)	4	<0.004 - <0.004	<0.004	0.000	3	<0.004 - <0.004	<0.004	0.000
Total Cyanide (mg/L as CN)	4	<0.004 - 0.037	0.020	0.025	3	<0.004 - 0.007	<0.004	0.003
Ammonia as N (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	3.8E-18
Total Kjeldahl Nitrogen as N (mg/L)	0	-	-	-	6	<0.05 - 0.17	0.081	0.05
Nitrate as N (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	3.8E-18
Nitrite as N (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	0.00
Total Oxidised Nitrogen as N (NO ₂ +NO ₃) (mg/L) (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	3.8E-18
Total Nitrogen (mg/L)	0	-	-	-	6	<0.05 - 0.17	0.081	0.052
Acidity - Measured (mg/L CaCO ₃)	0	-	-	-	2	11 - 16	14	3.4
Hydroxide Alkalinity as CaCO ₃ (mg/L CaCO ₃)	4	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0
Carbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	4	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0
Bicarbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	4	98 - 115	100	2.8	9	71 - 91	80	6.2

Total alkalinity as CaCO ₃ (mg/L CaCO ₃)	4	98 - 115	100	2.8	9	71 - 91	80	6.2
Dissolved Sodium (mg/L)	2	12 - 12	12	0.0	9	8 - 11	10	1.0
Dissolved Magnesium (mg/L)	2	4 - 4	4	0.0	9	3 - 4	4	0.3
Dissolved Potassium (mg/L)	2	<1 - <1	<1	0.0	9	<1 - 1	<1	0.2
Dissolved Calcium (mg/L)	2	23 - 26	25	2.1	9	16 - 20	18	1.3
Chloride (mg/L)	4	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0
Dissolved Sulfate as SO ₄ ²⁻ (mg/L)	4	<1 - 1	<1	0.0	8	<1 - 1	<1	0.2
Dissolved aluminium (mg/L)	4	<0.01 - 0.07	<0.01	0.0000	10	<0.01 - 0.03	0.012	0.0104
Dissolved antimony (mg/L)	4	<0.001 - <0.001	<0.001	0.0000	10	<0.001 - 0.0015	<0.001	0.0003
Dissolved Arsenic (mg/L)	4	0.001 - 0.002	0.00105	0.0001	10	<0.001 - 0.002	<0.001	0.0005
Dissolved Cadmium (mg/L)	3	<0.0001 - <0.0001	<0.0001	-	10	<0.0001 - 0.0002	<0.0001	0.0000
Dissolved Chromium (mg/L)	4	<0.001 - <0.001	<0.001	0.0000	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Copper (mg/L)	3	0.002 - 0.004	0.002	-	10	<0.001 - 0.016	0.006	0.0061
Dissolved Iron (mg/L)	4	0.329 - 1.39	0.64	0.4448	10	<0.05 - 3.02	0.75	0.9630
Dissolved Lead (mg/L)	4	<0.001 - <0.001	<0.001	0.0000	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Cobalt (mg/L)	4	<0.001 - 0.001	<0.001	0.0001	10	<0.001 - 0.001	<0.001	0.0002
Dissolved Manganese (mg/L)	4	0.452 - 0.478	0.454	0.0021	10	0.266 - 0.598	0.384	0.1012
Dissolved Mercury (mg/L)	3	<0.0001 - <0.0001	<0.0001	-	10	<0.0001 - <0.0001	<0.0001	0.0000
Dissolved Nickel (mg/L)	4	<0.001 - <0.001	<0.001	0.0000	10	<0.001 - 0.004	<0.001	0.0011
Dissolved Selenium (mg/L)	2	<0.01 - <0.01	<0.01	0.0000	1	<0.01 - <0.01	<0.01	-
Dissolved Silver (mg/L)	4	<0.001 - <0.001	<0.001	0.0001	9	<0.001 - <0.001	<0.001	0.0000

Dissolved Zinc (mg/L)	4	0.008 - 0.009	0.009	0.0000	10	0.0025 - 0.006	0.0036	0.0014
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Table 3: Comparison of groundwater quality between 2010 and 2011 at Monitoring Bore HB03

	2010				2011			
	n	Range	Mean	Std	n	Range	Mean	Std
pH-field (pH Units)	4	6.1 - 6.79	6.43	0.22	3	6.1 - 6.18	6.15	0.04
Temperature (°C)	4	18 - 20.2	19	1	3	19.2 - 20.2	20	1
Dissolved Oxygen (mg/L)	4	1.53 - 6.4	3.48	2.50	2	4.48 - 6.39	5.44	1.35
EC field (uS/cm)	4	69 - 94	86	4	3	68 - 103	86	18
Free cyanide (mg/L as CN)	6	<0.004 - <0.004	<0.004	0.000	2	<0.004 - <0.004	<0.004	0.000
Weak acid dissociable cyanide (mg/L as CN)	7	<0.004 - <0.004	<0.004	0.000	2	<0.004 - 0.009	0.0055	0.005
Total Cyanide (mg/L as CN)	7	<0.004 - <0.004	<0.004	0.000	2	<0.004 - 0.024	0.013	0.016
Acidity - Measured (mg/L CaCO3)	0	-	-	-	0	<1 - <1	-	-
Hydroxide Alkalinity as CaCO3 (mg/L CaCO3)	7	<1 - <1	<1	0.0	2	<1 - <1	<1	0.0
Carbonate Alkalinity as CaCO3 (mg/L CaCO3)	7	<1 - <1	<1	0.0	2	<1 - <1	<1	0.0
Bicarbonate Alkalinity as CaCO3 (mg/L CaCO3)	7	47 - 63	53	3.4	2	43 - 45	44	1.4
Total alkalinity as CaCO3 (mg/L CaCO3)	7	47 - 63	53	3.4	2	43 - 45	44	1.4
Dissolved Sodium (mg/L)	5	8 - 9	9	0.4	2	9 - 9	9	0.0
Dissolved Magnesium (mg/L)	5	1 - 1	1	0.0	2	1 - 1	1	0.0
Dissolved Potassium (mg/L)	5	<1 - <1	<1	0.0	2	<1 - <1	<1	0.0

Dissolved Calcium (mg/L)	5	9 - 10	9.8	0.4	2	10 - 11	10.5	0.7
Chloride (mg/L)	7	<1 - 2	<1	0.7	2	<1 - <1	<1	0.0
Dissolved Sulfate as SO ₄ ²⁻ (mg/L)	7	<1 - 7	2	2.9	2	<1 - <1	<1	0.0
Dissolved aluminium (mg/L)	7	<0.01 - 0.24	0.013	0.0178	2	0.01 - 0.02	0.015	0.0071
Dissolved antimony (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Arsenic (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Cadmium (mg/L)	6	<0.0001 - 0.0001	<0.0001	0.0000	2	0.0002 - 0.0002	0.0002	0.0000
Dissolved Chromium (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Copper (mg/L)	6	0.0032 - 0.01	0.005	0.0031	2	0.002 - 0.003	0.003	0.0007
Dissolved Iron (mg/L)	7	<0.05 - 0.31	<0.05	0.0204	2	<0.05 - <0.05	<0.05	0.0000
Dissolved Lead (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Cobalt (mg/L)	7	<0.001 - <0.001	<0.001	0.0001	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Manganese (mg/L)	7	0.0554 - 0.0838	0.068	0.0106	2	0.077 - 0.086	0.082	0.0064
Dissolved Mercury (mg/L)	6	<0.0001 - <0.0001	<0.0001	0.0000	2	<0.0001 - <0.0001	<0.0001	0.0000
Dissolved Nickel (mg/L)	7	<0.001 - <0.001	<0.001	0.0001	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Selenium (mg/L)	4	<0.01 - <0.01	<0.01	0.0000	0	<0.01 - <0.01	-	-
Dissolved Silver (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	2	<0.001 - <0.001	<0.001	0.0000
Dissolved Zinc (mg/L)	7	0.005 - 0.012	0.0078	0.0026	2	0.0025 - 0.0025	0.0025	0.0000

Table 4: Comparison of groundwater quality between 2010 and 2011 at Monitoring Bore HB04

	2010				2011			
	n	Range	Mean	Std	n	Range	Mean	Std
pH-field (pH Units)	4	6.5 - 7.31	7.00	0.18	21	5.45 - 7.12	6.44	0.41
Temperature (°C)	4	17.8 - 19.8	19	0	21	16 - 22	19	1
Dissolved Oxygen (mg/L)	4	3.6 - 4.09	3.84	0.26	18	3.09 - 13.19	6.09	2.64
EC field (uS/cm)	4	54 - 93	77	10	21	37 - 613	77	123
Free cyanide (mg/L as CN)	6	<0.004 - <0.004	<0.004	0.000	3	<0.004 - <0.004	<0.004	0.000
Weak acid dissociable cyanide (mg/L as CN)	6	<0.004 - <0.004	<0.004	0.000	3	<0.004 - <0.004	<0.004	0.000
Total Cyanide (mg/L as CN)	6	<0.004 - 0.014	0.005	0.006	3	<0.004 - <0.004	<0.004	0.000
Ammonia as N (mg/L)	0	-	-	-	6	<0.05 - 0.12	<0.05	0.039
Total Kjeldahl Nitrogen as N (mg/L)	0	-	-	-	6	0.11 - 0.66	0.275	0.194
Nitrate as N (mg/L)	0	-	-	-	6	<0.05 - 0.23	0.077	0.081
Nitrite as N (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	0.001
Total Oxidised Nitrogen as N (NO ₂ +NO ₃) (mg/L) (mg/L)	0	-	-	-	6	<0.05 - 0.23	0.08	0.08
Total Nitrogen (mg/L)	0	-	-	-	6	0.2 - 0.77	0.34	0.22
Acidity - Measured (mg/L CaCO ₃)	0	-	-	-	2	10 - 13.4	12	2
Hydroxide Alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0
Carbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0
Bicarbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	42 - 80	54	17.7	9	18 - 32	26	4.6
Total alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	42 - 80	54	17.7	9	18 - 32	26	4.6

Dissolved Sodium (mg/L)	4	10 - 17	12	3.2	9	5 - 7	6	0.7
Dissolved Magnesium (mg/L)	4	<1 - 2	1.125	0.6	9	<1 - <1	<1	0.0
Dissolved Potassium (mg/L)	4	<1 - <1	<1	0.0	9	<1 - 1	<1	0.2
Dissolved Calcium (mg/L)	4	7 - 14	9	3.4	9	3 - 5	4	0.6
Chloride (mg/L)	6	<1 - 3	1.875	1.0	9	<1 - 1	<1	0.2
Dissolved Sulfate as SO4 2- (mg/L)	6	<1 - <1	<1	0.0	8	<1 - 2	1.0625	0.8
Dissolved aluminium (mg/L)	6	<0.01 - 0.06	<0.01	0.0040	10	<0.01 - 0.04	0.013	0.0113
Dissolved antimony (mg/L)	6	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - 0.0015	<0.001	0.0003
Dissolved Arsenic (mg/L)	6	<0.001 - <0.001	<0.001	0.0001	10	<0.001 - 0.0015	<0.001	0.0003
Dissolved Cadmium (mg/L)	5	<0.0001 - 0.0007	0.0005	0.0004	10	<0.0001 - 0.0001	<0.0001	0.0000
Dissolved Chromium (mg/L)	6	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Copper (mg/L)	5	0.0023 - 0.01	0.004	0.0019	10	0.001 - 0.066	0.012	0.0193
Dissolved Iron (mg/L)	6	<0.05 - 0.062	<0.05	0.0154	10	<0.05 - <0.05	<0.05	0.0063
Dissolved Lead (mg/L)	6	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Cobalt (mg/L)	6	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Manganese (mg/L)	6	0.01 - 1.48	0.456	0.6891	10	0.002 - 0.047	0.017	0.0133
Dissolved Mercury (mg/L)	5	<0.0001 - <0.0001	<0.0001	0.0000	10	<0.0001 - <0.0001	<0.0001	0.0000
Dissolved Nickel (mg/L)	6	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - 0.001	<0.001	0.0002
Dissolved Selenium (mg/L)	3	<0.01 - <0.01	<0.01	0.0000	1	<0.01 - <0.01	<0.01	-
Dissolved Silver (mg/L)	6	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - <0.001	<0.001	0.0001
Dissolved Zinc (mg/L)	6	0.0025 - 0.014	0.004875	0.0017	10	0.014 - 0.082	0.039	0.0229

Table 5: Comparison of groundwater quality between 2010 and 2011 at Monitoring Bore HB05

	2010				2011			
	n	Range	Mean	Std	n	Range	Mean	Std
pH-field (pH Units)	3	6.7 - 7.13	6.92	0.13	21	5.58 - 6.72	6.30	0.31
Temperature (°C)	3	17.2 - 21.2	20	0	21	11 - 22	19	2
Dissolved Oxygen (mg/L)	3	4.46 - 4.75	4.58	0.16	18	3.25 - 12.56	6.75	2.61
EC field (uS/cm)	3	68 - 137	111	6	21	109 - 197	132	22
Free cyanide (mg/L as CN)	7	<0.004 - <0.004	<0.004	0.000	3	<0.004 - <0.004	<0.004	0.000
Weak acid dissociable cyanide (mg/L as CN)	7	<0.004 - <0.004	<0.004	0.000	3	<0.004 - <0.004	<0.004	0.000
Total Cyanide (mg/L as CN)	7	<0.004 - 0.025	0.007	0.010	3	<0.004 - <0.004	<0.004	0.000
Ammonia as N (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	3.8E-18
Total Kjeldahl Nitrogen as N (mg/L)	0	-	-	-	6	<0.05 - 2.8	0.5925	1.087
Nitrate as N (mg/L)	0	-	-	-	6	<0.05 - 0.06	<0.05	0.014
Nitrite as N (mg/L)	0	-	-	-	6	<0.05 - <0.05	<0.05	0
Total Oxidised Nitrogen as N (NO ₂ +NO ₃) (mg/L) (mg/L)	0	-	-	-	6	<0.05 - 0.06	<0.05	0.014
Total Nitrogen (mg/L)	0	-	-	-	6	<0.05 - 2.86	0.603	1.111
Acidity - Measured (mg/L CaCO ₃)	0	-	-	-	2	16 - 16.4	16	0
Hydroxide Alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0
Carbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	<1 - <1	<1	0.0	9	<1 - <1	<1	0.0

Bicarbonate Alkalinity as CaCO ₃ (mg/L CaCO ₃)	6	66 - 76	71	4.0	9	57 - 78	70	5.9
Total alkalinity as CaCO ₃ (mg/L CaCO ₃)	7	42.021 - 76	67	4.0	9	57 - 78	70	5.9
Dissolved Sodium (mg/L)	5	8 - 10	9	0.7	9	7 - 10	9	1.0
Dissolved Magnesium (mg/L)	5	2 - 2	2	0.0	9	2 - 3	2	0.4
Dissolved Potassium (mg/L)	5	<1 - 3	1.2	1.0	9	<1 - 2	1	0.6
Dissolved Calcium (mg/L)	5	15 - 20	17	2.1	9	14 - 21	17	2.0
Chloride (mg/L)	6	<1 - 3	1.2	1.0	9	<1 - 1	<1	0.2
Dissolved Sulfate as SO ₄ ²⁻ (mg/L)	6	<1 - 10	3	4.0	8	<1 - 6	1	1.9
Dissolved aluminium (mg/L)	7	<0.01 - 0.13	0.031	0.0490	10	<0.01 - 0.02	<0.01	0.0048
Dissolved antimony (mg/L)	7	<0.001 - 0.002	<0.001	0.0008	10	<0.001 - 0.0015	<0.001	0.0003
Dissolved Arsenic (mg/L)	7	<0.001 - 0.001	<0.001	0.0003	10	<0.001 - 0.0015	<0.001	0.0003
Dissolved Cadmium (mg/L)	6	<0.0001 - 0.001	0.0003	0.0004	10	<0.0001 - 0.0001	<0.0001	0.0000
Dissolved Chromium (mg/L)	7	<0.001 - 0.0028	<0.001	0.0010	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Copper (mg/L)	6	0.0051 - 0.016	0.009	0.0043	10	<0.001 - 0.029	0.005	0.0086
Dissolved Iron (mg/L)	7	<0.05 - <0.05	<0.05	0.0090	10	<0.05 - <0.05	<0.05	0.0071
Dissolved Lead (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Cobalt (mg/L)	7	<0.001 - 0.022	0.004	0.0089	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Manganese (mg/L)	7	0.013 - 2.64	0.461	1.0675	10	0.0025 - 0.022	0.008	0.0057
Dissolved Mercury (mg/L)	6	<0.0001 - <0.0001	<0.0001	0.0000	10	<0.0001 - <0.0001	<0.0001	0.0000
Dissolved Nickel (mg/L)	7	<0.001 - 0.006	0.001508	0.0022	10	<0.001 - <0.001	<0.001	0.0000
Dissolved Selenium (mg/L)	4	<0.01 - <0.01	<0.01	0.0002	1	<0.01 - <0.01	<0.01	-

Dissolved Silver (mg/L)	7	<0.001 - <0.001	<0.001	0.0002	10	<0.001 - <0.001	<0.001	0.0001
Dissolved Zinc (mg/L)	7	0.0025 - 0.054	0.021417	0.0111	10	0.0025 - 0.094	0.02515	0.0269