GATSUURT MINE ENVIRONMENTAL IMPACT ASSESSMENT

Project Description and Environmental Assessment components of the Gatsuurt Project Feasibility Study, 2014.

ABSTRACT

The Gatsuurt Project revised feasibility study, 2014, included detailed project descriptions, environmental baseline, assessment and mitigation planning. This report is extracted from Centerra Gold Mongolia's Gatsuurt Project Feasibility Study, 2014.

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1 Project description

1.1 Project title

Gatsuurt Mine Project

1.1.1 Project objective

Project main objective is gold production by means of mining oxide, sulphide and transition ore, to join in "Gold" program of Mongolian Government, contribute its part to increase State Monetary reserves, provide more workplaces and reduce unemployment.

1.2 Project operator

"Centerra Gold Mongolia" Inc
State registration No 9019016071
Company registration No 2108291

1.3 Project operator`s address

Bodi Tower 11th floor, Sukhbaatar square, 1st khoroo, Chingeltei district, Ulaanbaatar city

CEO: John Kazakoff.
Telephone: 976-11-317798,
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1.4 Project location

The Gatsuurt mine is located the area Gatsuurt, approximately 90 km north of Ulaanbaatar in the Mandal Soum of Selenge Aimag (municipality) central northern Mongolia. The Gatsuurt Project area is held under Mining Licences 372A with 1,820 hectares and 431A with 416 hectares, which is totally 2236 hectares. Land utilization right for mine exploration is approved by Governor of Mandal soum of Selenge aimag in 30 June, 2005. Coordinates of licenced areas is enclosed.The project location is illustrated in Figure 1.1-1.2

1.5 Project capacity

Gatsuurt gold mine is consisted Central and Main zones. Mineral resource and reserve of Gatsuurt project is illustrated in the Table 1.1.

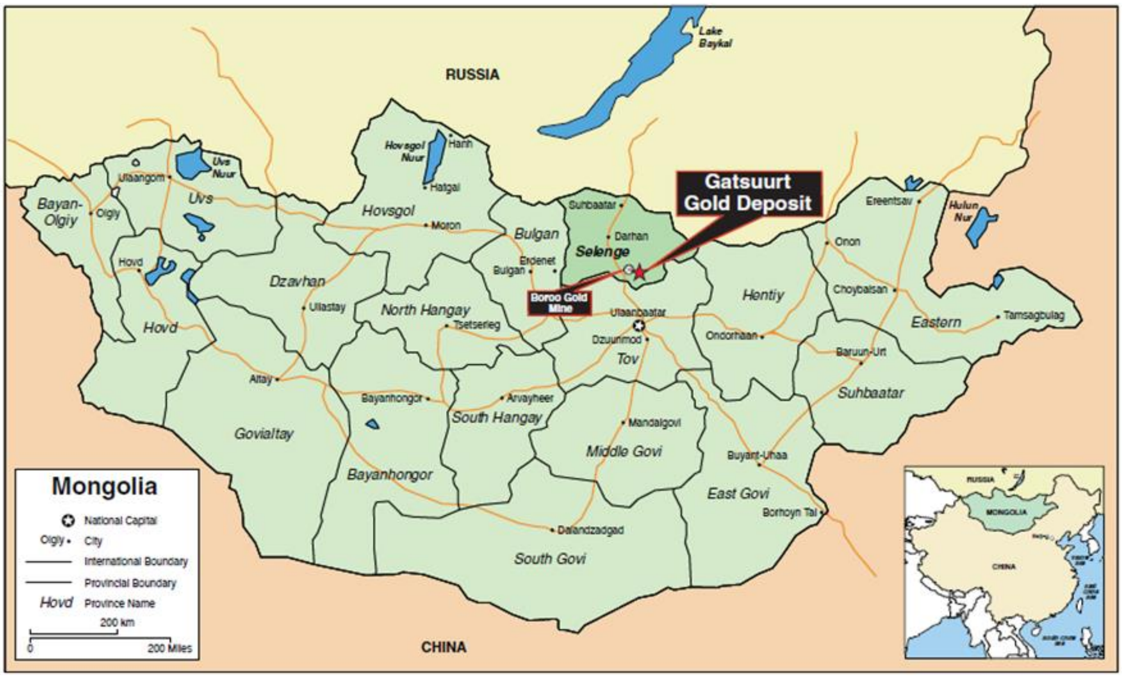


Figure 1.1 Project location map

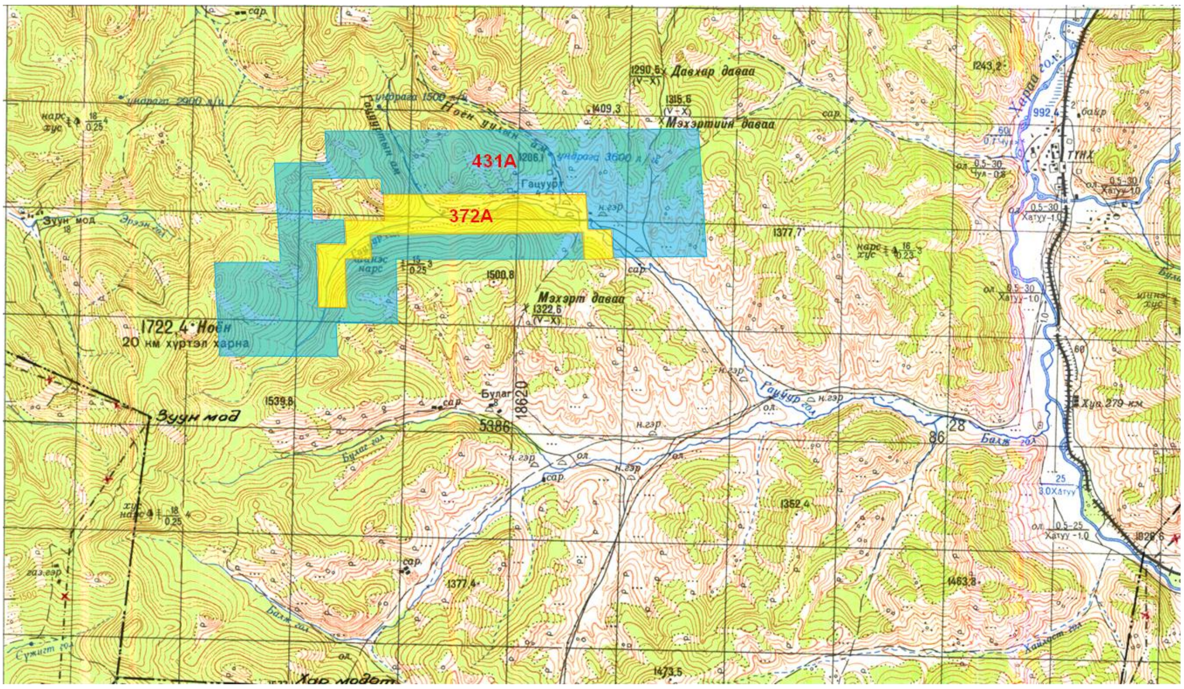


Figure 1.2 Gatsuurt Gold mine licensed areas

1.6 Mineral Resources and Mineral Reserves

Mineral resources for the Gatsuurt Central and Main Zones are summarized in Table 1.1. The estimate was completed in July 2013 and was prepared by Centerra. The effective date for the resource estimate is July 4, 2013.

Table 1.1 Gatsuurt Project – Summary of Resources (December 31, 2013)

Resource Class	Tonnes (kt)	Grade (g/t Au)	Contained Au (koz.)
Measured	-	-	-
CZ Indicated-CIP	3,748	2.93	353
CZ Indicated-BIOX	7,618	3.28	803
MZ Indicated-BIOX	5,748	2.44	452
Total M+I	**17,114**	**2.92**	**1,608**
CZ Inferred-CIP	206	2.73	18
CZ Inferred-BIOX	31	3.91	4
MZ Inferred-BIOX	36	2.35	3
Total Inferred	**273**	**2.81**	**25**

For both the Central and Main Zones, the mineral resources are based on a cut-off grade of 1.37 g/t Au for ore that will be processed through the existing Boroo Mill and 1.42 g/t Au for ore to be processed through the BIOX® process. The mineral resource tonnes and contained gold have been rounded to reflect the relative accuracy of the estimates.

Since there has been no mining of in-situ mineralization in the Gatsuurt area, the resource models for the Central and Main Zones represent the mineralization below the present natural topography and are based on data from the drilling which was completed in 2010.

Mineral reserves and mine production schedules were constructed for both the Central and Main Zones using Gemcom mine planning and Whittle 4X pit optimization software.

Table 1.2, below, outlines the updated mineral reserves and resources for the entire Gatsuurt project. It should be noted that the mineral resources, as stated, are exclusive of mineral reserves.

Table 1.2 Gatsuurt Project – Summary of Reserves and Resources (December 31, 2013)

Pit Name	Oxide			Sulphide			Total Ore (kt)	Waste (kt)	Total Material (kt)	Stripping Ratio (W:O)
	Quantity (kt)	Grade (g/t Au)	Contained Metal (oz. Au)	Quantity (kt)	Grade (g/t Au)	Contained Metal (oz. Au)				
Shell 30, 46°	4 179	2.93	394	13 813	3.16	1,401	17 992	77 166	95 188	4.29
Shell 30, 40°	4 155	2.93	391	11 613	3.14	1,171	15 768	74 073	89 841	4.70
Shell 36, 46°	4 279	2.91	401	15 329	3.11	1,534	19 608	93 362	112 970	4.76
Shell 36, 40°	4 290	2.91	401	14 107	3.13	1,420	18 397	111 048	129 445	6.04

1.7 Project equipment

Mining is planned to be carried out using conventional open pit method and primary equipment includes excavator and dump trucks. The primary excavator for the loading is planned to be a 7.6 m^3 two of hydraulic excavator in a backhoe configuration. This machine will load a fleet of 50-tonne; mechanical drive haul trucks that will deliver ore and waste rock materials to the respective stockpile and dump locations. Also a 6.9 m^3 loader will be stand ready for operate during unexpected delay. Drilling and blasting operations will be carried out using two blasthole drill with 127 mm and borehole grid size is 4 x 4 meters. Borehole depth is 5.5 meters. Blasting will be conducted by a contractor once a week. Loading will be with locally available packaged emulsion due to expected wet conditions below the valley floor.

Wherever possible, an ammonium nitrate/fuel oil mixture [ANFO] will be used. Initiation will be non-electric using materials of Russian or Chinese manufacture. The design powder factor is 0.43 kilograms per bank cubic meter.

Primary loading will be performed by two 7.6-cubic meter hydraulic excavators in backhoe configuration. The excavators will load a fleet of six 50-tonne rigid-frame haul trucks. A 6.9-cubic meter front-end loader will provide back-up for the excavators.

Ore will be stockpiled near the CZP entrance for loading into highway trucks. A fleet of 26 30-tonne trucks will haul oxide and sulfide ore from the Gatsuurt Mine to the BGM mill for processing. Each truck is expected to haul 200 tonnes of ore during a 24-hour period.

Two bulldozers will provide support for waste rock dump construction and maintenance, floor maintenance, blast pattern preparation, and wall cleanup. In the initial year, the dozers will be used to push material from the narrow upper benches to the lower levels. This assists in reducing the haul road requirements to access these upper benches. An ore cleaning backhoe will be equipped with a rock hammer to reduce oversized boulders where required. A compactor will assist in the construction of the haul roads and the diversion dams.

A fleet of nine light vehicles will also be utilized at and around the mine site. This includes seven trucks and two vans.

Project equipment are listed in the below table. (Table 1.4).

Table 1.2 Open pit equipment

Process	Equipment	Quantity	Comment
Drilling	Tamrock D45K (Ingersol-Rand DM45)	1 pcs	
Blasting	10-t Chinese-manufactured mobile mixing	1 pcs	
Loading	Excavator O&K RH120E (Libherr R994B) Shovel loader CAT 992D	1 pcs 1 pcs	
Mine Haulage	Haul trucks CAT 777B (Komatsu HD85)	4 pcs	
	China as a joint venture between Mercedes-Benz Trailer	26 pcs	
Dump, stockpile	230-kW bulldozer	1 pcs	
Haul road and support	160-kW grader	1 pcs	
	$3m^3$ shovel excavator	1 pcs	
	Water auto tank	1 pcs	Rent
	Fuel auto tank	1 pcs	Rent

1.8 Site infrastructure

Road and Rails: The Gatsuurt Project area lies 14 km west of the Tunkhel railway station on the Ulaanbaatar-Irkutsk railway. Access to Tunkhel, Bayangol soum and Mandal soum involves travel over unimproved dirt roads.

Ore Haulage

All ore mined from the open pits will be delivered to the ore stockpile located adjacent to the Central Zone pit. There, ore will be re-handled by a small (1-m3) excavator into 30-t tractor-trailer units for haulage to the Boroo process plant. At full production of 5 000 t/d, a fleet of 26 units will be required for ore haulage on a continuous 12-h shift basis. Trucks will cover the 54-km route 6 to 7 times daily, each delivering approximately 200 t/d.

Table 1.3 Gatsuurt Life of Mine Production Schedule (Central and Main Zones)

Gatsuurt		year 1	year 2	year 3	year 4	year 5	year 6	year 7	year 8	Total
Mining										
Ore	Thousand t	70	792	1 596	1 469	2 100	1 480	1,452		8 959
Waste	Thousand t	933	11 243	10 434	10 562	9 952	5 171	2 969		51 264
Total	Thousand t	1 003	12 035	12 030	12 031	12 052	6 651	4 421		60 223
Strip Ratio (w:o)		13.3	14.2	6.5	7.2	4.7	3.5	2.0		5.7
Oxide Processing										
Throughput	Thousand t	70	682	893	173					1,818
Grade	g/t	2.59	2.02	2.50	1.96					2.27
Feed	Thousand oz	6	44	72	11					133
Recovery	%	92	92	92	92					92
Metal	Thousand oz	5	41	66	10					122
Sulfide Processing										
Throughput	Thousand t				1 094	1 750	1 750	1 750	797	7 141
Grade	g/t				3.94	4.22	3.98	3.29	2.66	3.72
Feed	Thousand oz				139	237	224	185	68	853
Recovery	%				87.6	87.6	87.6	87.6	87.6	87.6
Metal	Thousand oz				121	208	196	162	60	747
Total Processing										
Throughput	Thousand t	70	682	893	1 267	1 750	1 750	1 750	797	8 959
Grade	g/t	2.59	2.02	2.50	3.67	4.22	3.98	3.29	2.66	3.42
Feed	Thousand oz	6	44	72	149	237	224	185	68	986
Recovery	%	92	92	92	87.9	87.6	87.6	87.6	87.6	88.2
Metal	Thousand oz	5	41	66	131	208	196	162	60	870

Loading and haulage of ore will be a contract operation. The contractor will provide supervision in addition to Centerra supervision and security patrols.

Communication: The main communication links for telephone and data will be provided via a satellite link up. In addition, radio repeaters will be installed between the Gatsuurt and Boroo facilities to allow vehicles on the haul road to be in constant communication with mine operations and security.

Power supply:

The existing substation at Boroo will be upgraded to include parallel 15-MW transformers with tie breakers installed to provide flexibility and backup to run the plant on a reduced rate in the event of a transformer failure. In addition, a second 6-km, 110-kV power line to Boroo will be installed in parallel with the existing line, as well as the necessary low voltage power distribution system to provide power to the additional process circuits.

A significant requirement is the 3 650-kW back-up power supply in the form of gen-sets to maintain the operation of the large air blowers used for the bio-oxidation reactors in the event of a power outage.

Power at the Gatsuurt mine area will be serviced by an existing 10-kV line from Tunkhel. This line will be upgraded to provide 500 kW of power for distribution to ancillary buildings at Gatsuurt.

Boroo Main Substation Modifications

The existing 110/33 kV Boroo substation will be modified and a new 110/33 kV substation added to accommodate the additional electrical power requirements. The changes to the primary power distribution system include:

- A new 110 kV utility power line, approximately 6 km long, from the tap-off point on the 110 kV transmission line between Zunnharaa and Bornuur, to the Boroo 110/33 kV substation.
- A new 11 -kV tie switch, TS1, installed on the 110-kV transmission line between Zunnharaa and Bornuur (CRETG request)
- A 110 kV main incoming galvanized steel terminating structure.
- A new 15 MVA, 110/33 kV, oil filled transformer complete with switching and protection equipment, neutral grounding resistor (NGR).
- A new 33 kV distribution line from the 110/33 kV Boroo substation to the BIOX® and related facilities unit switchyard.
- A new 33 kV BIOX® and related facilities unit switchyard.
- A new 2-MVA, 33-6 kV oil-filled transformer at 110-33 kV Boroo substation.
- Two additional tie switches, TS2 and TS3, for increasing the reliability and flexibility in the substation design.

Erchim Engineering Co., Ltd. (Erchim), a Mongolian firm that participated in the construction of facilities for Boroo, has provided a quotation for the design and construction of utility power and distribution lines and the main substation additions/modifications.

Boroo Power Distribution

Site power distribution from the bio-oxidation unit switchyard to the various major load centers will be from a 33 kV high resistance grounded system. In each major process area, local substations will step the voltage down to 6.6 kV, high resistance grounded. Power at 6.6 kV will be distributed to the larger motors (above 160 kW) and to 6.6 kV/400 V outdoor transformers. The transformers will supply motor control centres (MCCs) which will supply the 380 V motors, as well as lighting and heating loads. The 400 V systems will be resistance grounded. The grounding system was chosen in order to provide a high level of continuity of service while, at the same time, providing safety to personnel through the use of appropriate ground fault relaying.

There are two circuits from the bio-oxidation unit switchyard to each of the local substations and which provides a redundant power feed in each case to maintain the continuity of operation, in case of power distribution system faults.

Boroo Selection of System Voltages

System voltages are planned as follows:

- 6.6 kV, 3 phase, 50-Hz, resistance grounded neutral (25 amps) for site power distribution and motors larger than 160 kW.
- 400 V, 3 phase, 50-Hz, resistance grounded neutral (5 amps) for 380 V motors and low voltage distribution.
- 400/230 V, 3-phase, 50 Hz, solidly grounded for lighting, receptacles and other small power loads.
- 120 V, 1-phase, 50 Hz, solidly grounded for instrumentation and controls.
- 125 V DC supply from storage batteries/battery charger for main substation breaker(s) operation.
- 220 V UPS power supply where uninterruptible power is required.

Boroo Emergency Power Supply

During power outages, the BIOX® process requires air and some agitation to maintain the culture until the full process is restored. This is typically accomplished by operating two BIOX® blowers and cycling through the BIOX® reactor agitators individually on emergency power.

Two 1825 kW standby diesel power gensets will be installed next to the BIOX® utilities substation and connected to 6.6 kV bus to supply the BIOX® emergency electrical power requirements in the event of the utility supply outages.

The gensets are self-contained in factory assembled enclosure complete with all services. Changeover from the utility supply to the standby supply will be manually initiated rather than automatically on loss of utility supply, as there will be no requirement for immediate restoration of supply.

Gatsuurt Site Power Requirements

It has been estimated that the Gatsuurt site will have a total installed electrical connected load of approximately 600 kW. A 500 kVA transformer has been installed at Gatsuurt for this duty. The incoming power is sourced from the existing 10 kV distribution line from Tunkhel to the Gatsuurt exploration.

Gatsuurt Power Supply

A 3.5 km long extension, single circuit, 10 kV overhead distribution line from the Gatsuurt exploration camp to the Gatsuurt site has been built and commissioned in 2010.

Gatsuurt Site Electrical Loads

The estimated installed and running loads for the site is shown in Table 69.

Table 1.4 Site Electrical Loads

Load Centre	Installed kW	Running kW
Gatsuurt Maintenance Facilities	600	350
Electrical System Losses (assume 2.5% of demand)		10
Total	600	360

Gatsuurt Power Distribution

The power from the load center will be distributed at 400/230 V throughout the site.

System Voltage

System voltage is as follows:

- 400 V, 3-phase, 50 Hz, solidly grounded for 380 V motors and LV distribution.
- 400/230 V, 3 phase, 50 Hz, solidly grounded for lighting, receptacles and other small power loads.

Gatsuurt Emergency Power Supply

Emergency power will be needed in the event of a power outage. Stand-by power will be supplied by existing generator at the Gatsuurt exploration camp. Changeover from the utility supply to the standby supply will be manually initiated. If the outage is expected to be for an extended period, additional generators may be transferred from the Boroo mine which has its own fixed stand-by power system.

Water supply

Fresh water required at the Boroo process plant will be taken from the existing bore field located in Boroo river valley to the east of the mine and pumped to a water storage tank at the process plant site. The fresh water supply system is designed to supply an average flow of 300 m^3/h.

An existing potable water treatment plant will treat the fresh water prior to storage in the potable water storage tank.

Water consumption and distribution: Treated water will be distributed for laundry and bathroom. Also it will be connected to bathrooms and faucet in the workshop and locker rooms.

Structure to be connected is:

1. Workshop
2. Admin
3. First aid center
4. Gatehouse
5. Ger camp and kitchen, restroom

In accordance with the appendix of 153th order, "Rate of the public water consumption" by Minister of MNET, daily water consumption per person is 25 liters for drinking or resident use.

The workforce planned to be deployed at the Gatsuurt site totals 100 personnel and total water consumption will not exceed 9700 liters per day. Fresh water will be supplied from portable water tank with 75 m^3 capacity and fire water storage tank with 75 m^3 capacity will be regularly full.

A bacteriological analysis on treated water from water treatment facility will be conducted periodically. A wastewater treatment system will be installed in the Gatsuurt mine. The system will be capable of treating sewage for 100 personnel and there is no significant impact to the environment. Sewage from resident use will be collected and conveyed by gravity to a septic tank and will be routed through both mechanical and biological treatment systems. This treatment process will be capable of achieving the relevant Mongolian standard for wastewater and is best suited for use in undersized or temporal camp (Figure 1.3).

Sewage will be collected and chlorinated before disposal. Effluent from the sewage treatment plant will be discharged into a septic field. The capacity of the sewage system will be increased to accommodate the enlarged permanent camp and the addition of temporary facilities.

Wastewater treatment system will be charged with 0.8 kW electric connections automatically. Two of Installation techniques are to install underground for temporal use and to install aboveground for seasonal use.

Solid waste from the construction camp, construction activities and from the permanent facilities will be trucked to the landfill site.

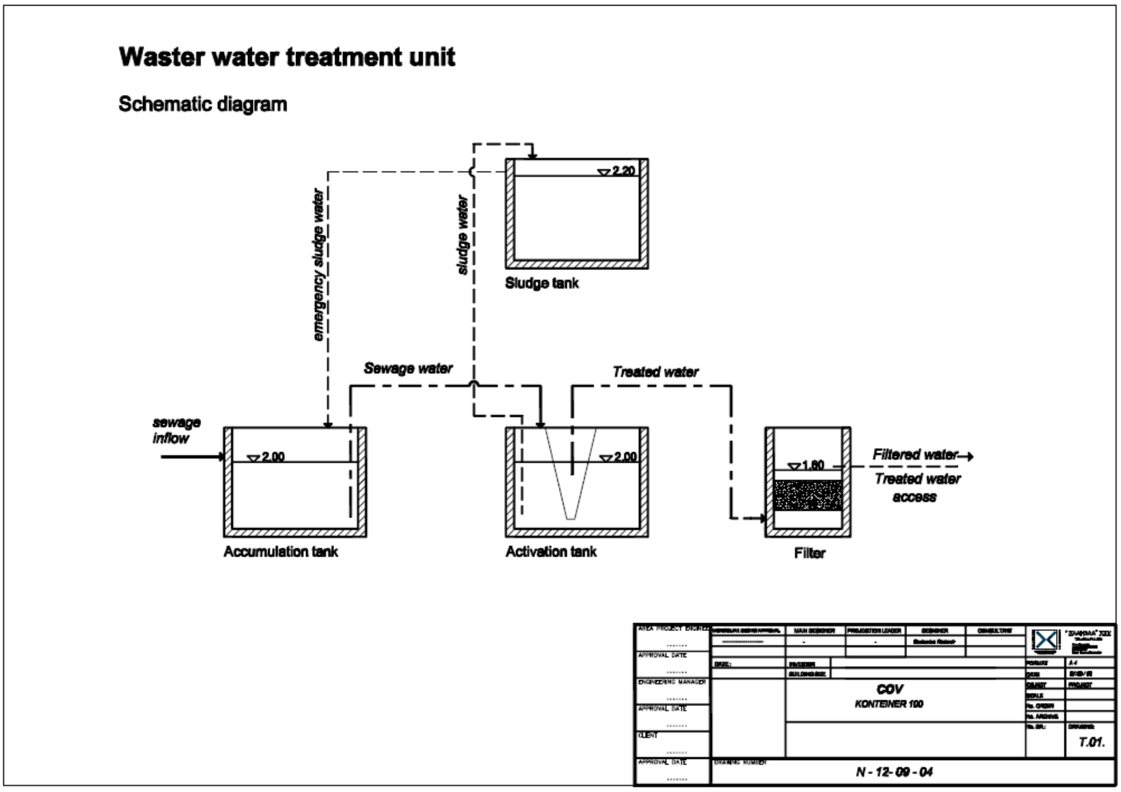


Figure 1.3 Waste water treatment unit

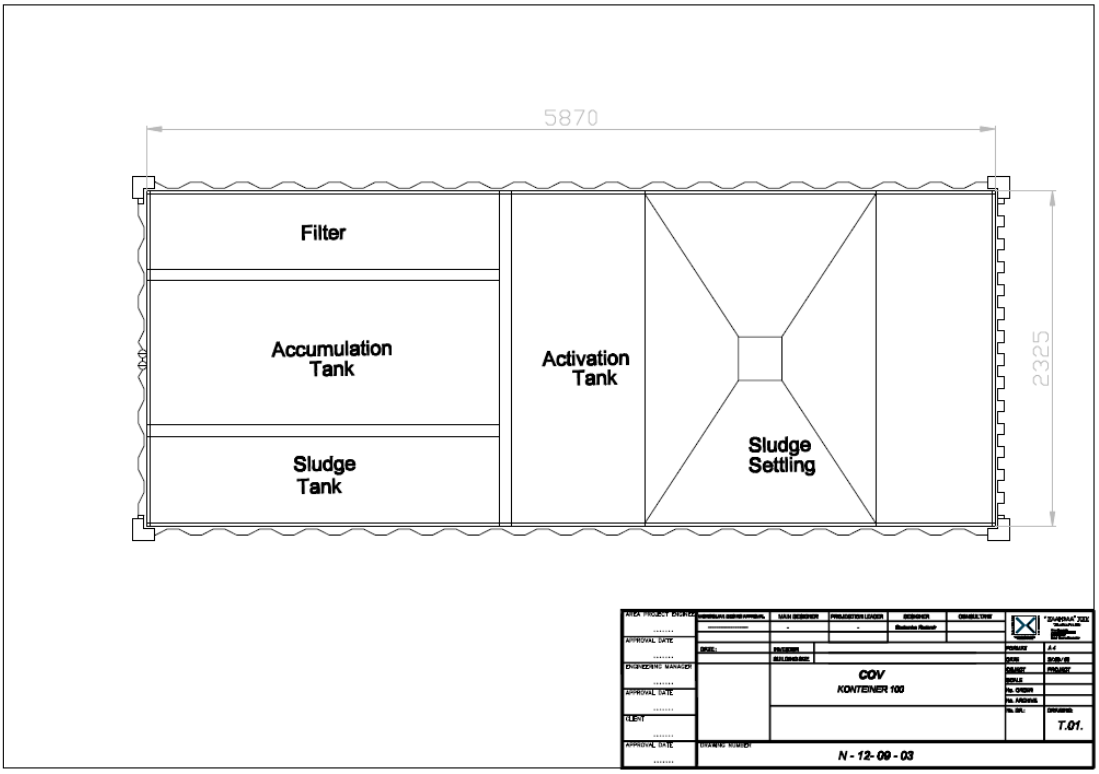


Figure 1.4 Waste water treatment unit establishment

Fuel storage:

At the Gatsuurt site, diesel and gasoline storage facilities will be provided at the mine services area. One diesel fuel storage tank and one gasoline storage tank will be installed above-ground. A mine maintenance/operations administration building and a security gatehouse facility will be built at the mine site.

Man camp: During the operating phase of the project, Gatsuurt operating personnel will be housed at Boroo and transported to and from Gatsuurt on a shift to shift basis.

A 400-person construction camp will be located to the east of the existing Boroo accommodation facilities. This camp will include 30-person management accommodation units built next to the Boroo facility, and 80 4-person gers, kitchen/dining facility and recreation facility.

The workforce planned to be deployed at the Gatsuurt would be on site only during work hours. Most of the workers will overnight (sleep) at the Boroo Camp. The exception to this could be security team members and other workers on a temporary basis.

Site workers during work hours are expected to totals between 70-100 personnel. For the workers that must overnight at Gatsuurt, the accommodations that are to be constructed include Gers, kitchen, shower and laundry. An extension of the existing potable water distribution, treatment storage system, power supply and service, first aid center, administration is planned. Also an extension of Boroo site camp is planned to accommodate personnel may be required. The workforce is planned to be transported between the neighboring communities and the mine site on a daily basis.

Security: Fencing will be limited to the shop area perimeter. An estimated 600 meters of fencing will be installed around the perimeter of the shop facilities. The fence will be a 1.8-meter high chain link fence.

A security gatehouse will be located in the facilities area. This building will serve as headquarters for the security operations as well as the check in location for entering the Gatsuurt Mine. A truck scale is also located adjacent to the security gatehouse.

Maintenance Facility

The GAC is a 48 m by 24 m pre-engineered, steel frame building with a concrete slab floor. The building incorporates three service bays. Each bay is 16 m by 12 m with an 8-m overhead door. Two bays will be used for heavy equipment service while the third will serve the highway ore haul truck fleet. No wash facilities exist for cleaning heavy equipment. A steam truck will be used to clean equipment outside before service. Equipment requiring major repairs will be driven or transported to Boroo by lowbed trailer for service.

Sea containers were used to provide maintenance offices, a tool crib, warehouse, lunchroom, and change rooms for both men and women. Office space also exists for mine operations and engineering. Photo 1.1 shows the GAC during construction with the sea containers at both ends of the building.

Photo 1.1 GAC Construction Progress Photograph

Photo 1.2 shows the completed GAC and gatehouse.

Photo 1.2 Overview of Completed GAC

Gatehouse

The security gatehouse is a prefabricated building composed of six sea container units arranged on a concrete slab and joined with a common roof (see Photo 1.2). The gatehouse provides offices for security, dispatch, first aid, safety and environment within the sea containers which were converted off-site prior to placement on the concrete foundation during the assembly of the building. Space left between the sea containers provides an interior corridor within the building and a parking garage for the ambulance. The gatehouse is located to control access in and out of the main gate and to provide supervision for the truck scale and fuel storage area.

Weigh Scales

Weigh scales were installed at Gatsuurt and at Boroo primarily to weigh ore haul truck loads for both haulage contractor payment and for metallurgical accounting. The weigh scale at Boroo will also be used to weigh limestone deliveries. The weigh scales were installed in 2010 as part of Phase 1.

Gatsuurt site facilities: The facilities at Gatsuurt will include:

- Open Pit Mine-Main zone
- Open Pit Mine-Central zone
- Sulphide ore stockpile
- NAG waste dump
- PAG waste dump
- Sedimentation/filtering/monitoring pond
- Surface water diversion system
- Flood protection dam
- Access/Haul roads

- Fuel station
- Administration
- Workshop and other facilities (please see figure 1.5)

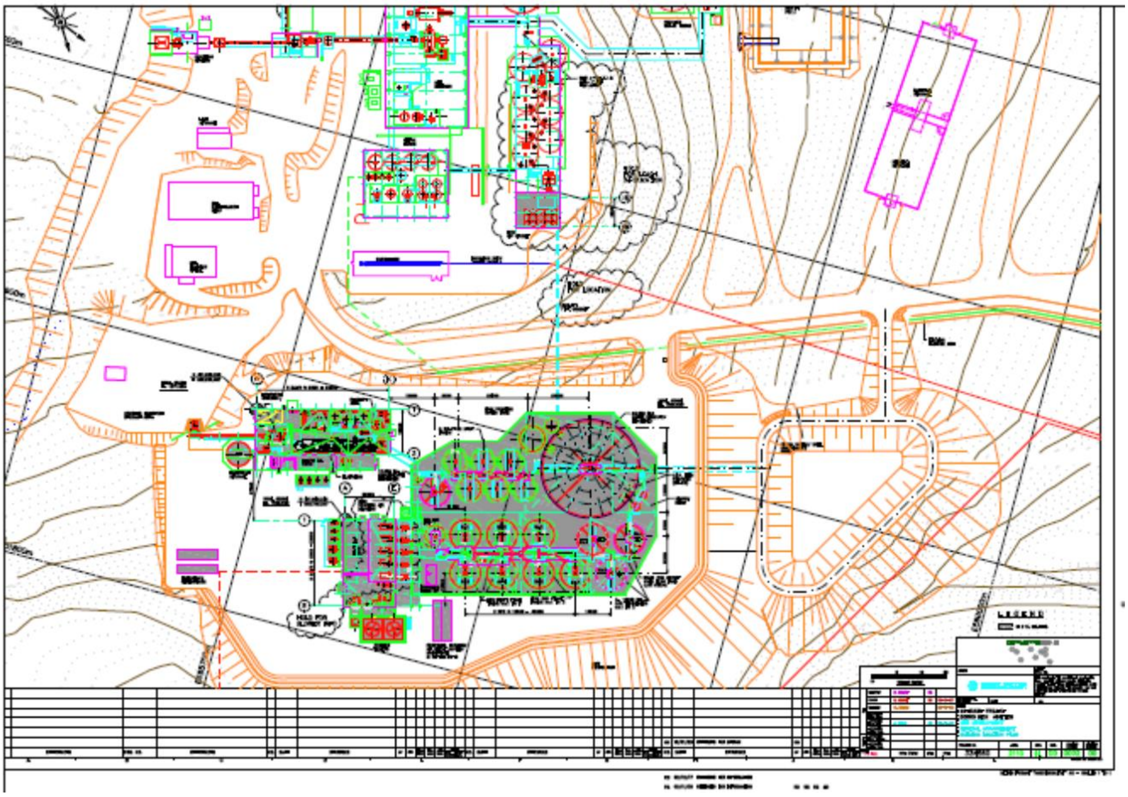


Figure 1.5 Gatsuurt site facilities

1.9 Other projects

Gatsuurt LLC had operated placer gold mine between 1999 and 2006, which is located in the project area of Centerra Gold Company. Alluvial gold mine area is located an area under 372A mining license.

Gatsuurt LLC possess placer deposit mining license 825A with 94 hectares, which is located in the northwestern area named Biluut and currently, they are implementing exploration survey.

In the southern area named Bulagiin am (Bulag mountainside), Puraam LLC possess placer gold mining license 801A with 133 hectares and operate placer mining.

In the Noyon Mountainside (north side), Luchero LLC possess placer gold mining license 8523A with 189 hectares and not performing any operation. Uguumur Taria LLC possess placer exploration license with 152 hectares in the northwestern site of the project area and not performing any operation.

1.10 Project schedule

All mining related to the Gatsuurt project is planned to be completed during a six to ten-year period following approval to mine. The mine schedule is shown in Table 1.5 above.

2 Project Technique and Technology

2.1 Project technology

2.1.1 Investigation history

The Gatsuurt deposit is located geographically in the western section of the Khentii mountain ranges. The north and east facing slopes are gently sloping, moderately forested and devoid of outcrops. (See Figure 3.1) The average elevation is approximately 1300 mASL with the rivers located at approximately 1000 mASL and the highest peak at less than 2500 mASL. Along the riverbed occurred dark ground soil above the sedimentary rocks.

Figure 2.1 Gatsuurt valley

The Gatsuurt Project situated in the North Khentii gold belt. The gold belt forms part of the northeast trending North Khentei tectonic belt of north central Mongolia. The Bayangol and the Yeroogol fault systems, respectively bound the tectonic belt to the northwest and southeast (see Figure 3.2). The North Khentei tectonic belt is composed of three major lithotectonic components.

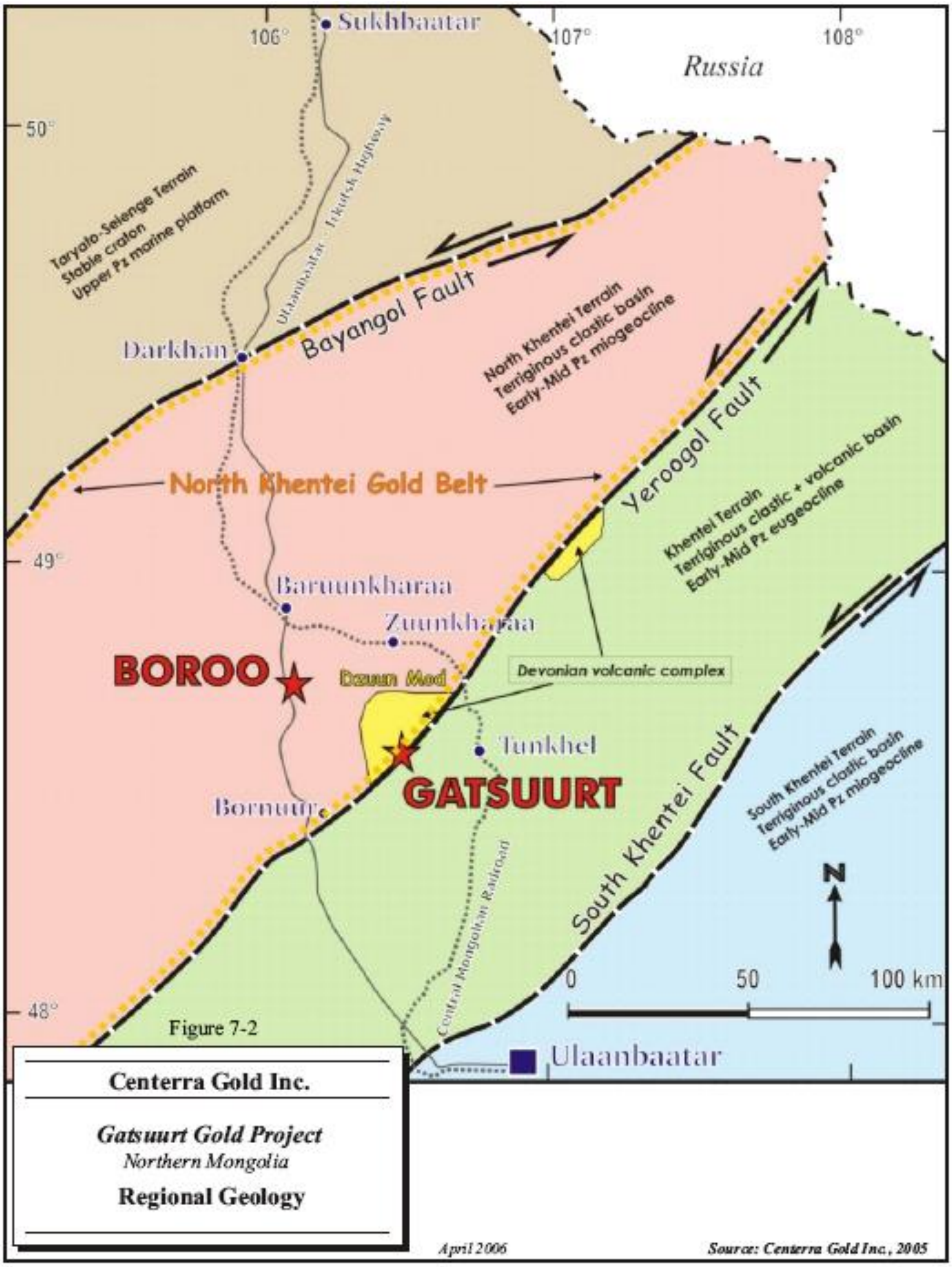


Figure 2.2 North Khentii tectonic belt

Figure 2.3 Gatsuurt valley destruction (May 2009)

There occur glaciation areas in the region. The alluvium is 10 m to 20 m thick, except where stripped by placer mining or buried under placer waste and tailings during Gatsuurt LLC placer mining operations. (See Figure 3.3) Gatsuurt LLC had mined between 1991 and 2006 and not reclaimed due to bedrocks under river valley alluvium reserves gold deposit.

Drainage from Gatsuurt follows the Gatsuurt River, the Sujigtei River, and the Kharaa River to eventually empty into Lake Baikal in Russia. The Gatsuurt deposit is located in a tectonic setting along the Sujigtei fault that forms part of the Yeroogol system. The Gatsuurt Project includes two separate mineralized zones designated as the Central Zone and Main Zone. These zones separated with Sujigtei fault, which passes diagonally from the southwest to the northeast. Mine project is completed under geological study of the area.

Exploration: Key exploration data contained within the project area include:

- diamond drilling,
- drill hole survey data,
- trenching,
- soil and stream geochemical data,
- geophysical survey data,
- Geological mapping.

Diamond drilling: During 1998 and Sep 2005, 249-diamond drill holes totaling 33,203 m were completed at the Central Zone. Drilling purpose is to estimate ore reserves and average block grade. Former drilling held by Cascadia LLC during 1998-2001.

Table 2.1 Diamond core and RC exploration drilling from 1998 through Dec 2005

Central zone			Main zone		Other[1]	
Year	Holes	Metres	Holes	Metres.	Holes	Metres.
1998	3	595	1	277	-	-
1999	3	342	5	749	-	-
2000	13	1,796	3	426	-	-
2001	28	2,738	-	-	1	79
2002	52	4,814	-	-	5	309
2003	12[2]	1,755	11[3]	435	3[4]	239
2004	110[5]	17,066	4	1,359	-	-
2005	28[6]	4,097	59[7]	10,254	5[7]	780
Total	249	33,203	83	13,500	14	1,407

Notes: 1 "Other" includes 49er Zone, Biluut Target and Narst Zone
2 Includes seven RC holes
3 All 11 holes are RC
4 Includes one RC hole
5 Includes 25 RC holes
6 Includes 24 RC holes
7 Includes three RC holes

Both Cascadia and Centerra standardized the methods for core logging and sampling drill core for drilling campaigns. Information collected during Cascadia operations was recorded on hard copy drill logs and included observations on lithology, alteration, structure, and mineralization. A review of the logs indicates that they are complete and of high quality. Handwritten logs were later converted to digital by word processing. For Centerra campaigns, core logging is directly in digital format using Core

View/Interdex software. Drill hole data are imported to Gemcom Software International Inc. (Gemcom) Version 5.5, with Gemcom and MapInfo used for graphics. Collars were surveyed by theodolite, EDM (electronic measuring device), and Satellite global positioning system (GPS) in 2001. Errors were discovered in the EDM results and all collars were resurveyed with differential GPS in 2002. Differential GPS has been used to survey all hole collars in subsequent drilling. Surveys are tied into the UTM WGS 84 grid.

Down hole surveying: The down hole surveying for the Cascadia and Centerra drilling through 2001 consisted of acid dip inclination tests at 50 m intervals. A Tropari instrument that reads inclination as well as azimuth by magnetic compass took Downhole measurements in 2002. The Tropari was replaced by Sperry Sun single shot surveys in 2003. A Reflex Instruments AB single shot digital device was in use for the 2004 program. Tests were recorded every 50 m down hole, with azimuth readings referenced to magnetic north. A four-degree adjustment was applied in collar surveying. The magnetic declination at the Central Zone is 4°W in 2004. 21% of the holes had no downhole surveys and there will be some uncertainty as to their position at depth. Some 1% of the holes had the same azimuth and dips downhole, which indicates that these holes have no deviation or were not surveyed.

Sampling: The Central Zone mineral resource and reserve estimate is supported by diamond drill hole core samples. Mineral reserve estimate is supported by diamond drill hole core and channel samples. Until 2001, sampling of mineralization was carried out at two-metre to three-metre intervals. Centerra revised core-sampling practice after 2001 to sampling at one-metre intervals in mineralization and two-metre intervals in unaltered host granites or waste. Core recovery, as well as RQD, is generally 90% to 100% within the Gatsuurt Mineralized zones. Localized, minor poor core recovery and low RQD occur in faulted intervals.

Sample preparation and analysis: The procedures for sample preparation and assaying are described in annual exploration reports for the Noyon Project (including Gatsuurt). Most of the drill core samples collected by Cascadia and Centerra were submitted to SGS Analabs (SGS Mongolia LLC) for assaying. Dunn Analytical assayed some Cascadia samples in early holes.

The samples are sorted and dried prior to sample preparation. Sample preparation begins with comminution in a Rhino/Terminator jaw crusher to a nominal 3 mm to 2 mm size. The crushed material is reduced in a Lab Tech Essa 201 8-bin rotary splitter to 750 g to 1,500 g and pulverized to 90% passing 75 µm in a Labtech LM1or LM2 bowl and ring pulverizer. Two splits of 300 g each are taken, with one allocated for assay and the other archived. SGS Analabs assaying employs fire assay digestion on one-assay ton aliquots and an atomic absorption finish on a 10 ml volume by a Varian Spectra 50A or 55B unit. Detection limit is 0.01 g/t, or 10 ppb.

The process at Alex Stewart preparation facility is similar to that at SGS Analabs. Samples are dried at 105º C and crushed in a 160 mm by 100 mm jaw crusher to 95% passing -2 mm. The sample is reduced by an 11 gate riffle to approximately 300 g before grinding in a Lab Tech Essa LM2 bowl and ring pulverizer to 95% passing -75 µm. The procedures for quality control have included the use of standard reference materials, duplicates (resampling of core), blanks submitted by Centerra, and checks on pulps at other laboratories.

Quartered core duplicates have been submitted for assay (one quarter core is retained in the core box for reference and archive). Core duplicates have been taken at 20 m to 40 m intervals down hole.

Approximately one in every 50 pulps has been re-assayed, and many of the samples have an assay from a second pulp. Results are usually listed in order along with original assays on the drill logs. The original assay is recorded in resource estimation database.

2.1.2 Geological formation and geotechnical condition

The North Khentii gold belt deposits and occurrences are typically mesothermal and may comprise individual quartz veins with coarse gold and low-sulphide content, as well as disseminated fine gold in sulphidized rocks. Permian rhyolite and Boroo Complex granodiorite, granites and diorites, and Kharaa Series metasedimentary rocks underlie the Gatsuurt area. These lithostructural units occur along, and are separated by, the Sujigtei subvertical fault. Volcanics (rhyolite) are found on the northwest side of the Sujigtei fault, whereas Boroo granite occurs on the southeast side.

Exploration to date indicates that the Gatsuurt deposit consists of disseminated and vein style gold mineralization in volcanic, granite and metasedimentary rocks in two geographically separate zones, Central and Main. The Central and Main zones are located adjacent to the Sujigtei fault.

2.1.3 Mining Structure and Design

The Gatsuurt Mine will consist of two open pits (Main Zone and Central Zone), water diversion dams and ditches, Non Acid Generating (NAG) waste rock disposal facilities (WRDFs), access roads, power supply (powerline and diesel generators), fresh and potable water supply and distribution, warehouse and shop, telecommunication structures, and transportation of goods and personnel. Gatsuurt Mine will utilize the existing BGM facilities approximately 54 km to the northwest to process the ore. A figure illustrating the site plan for the Gatsuurt facility is included a Figure 3.4.

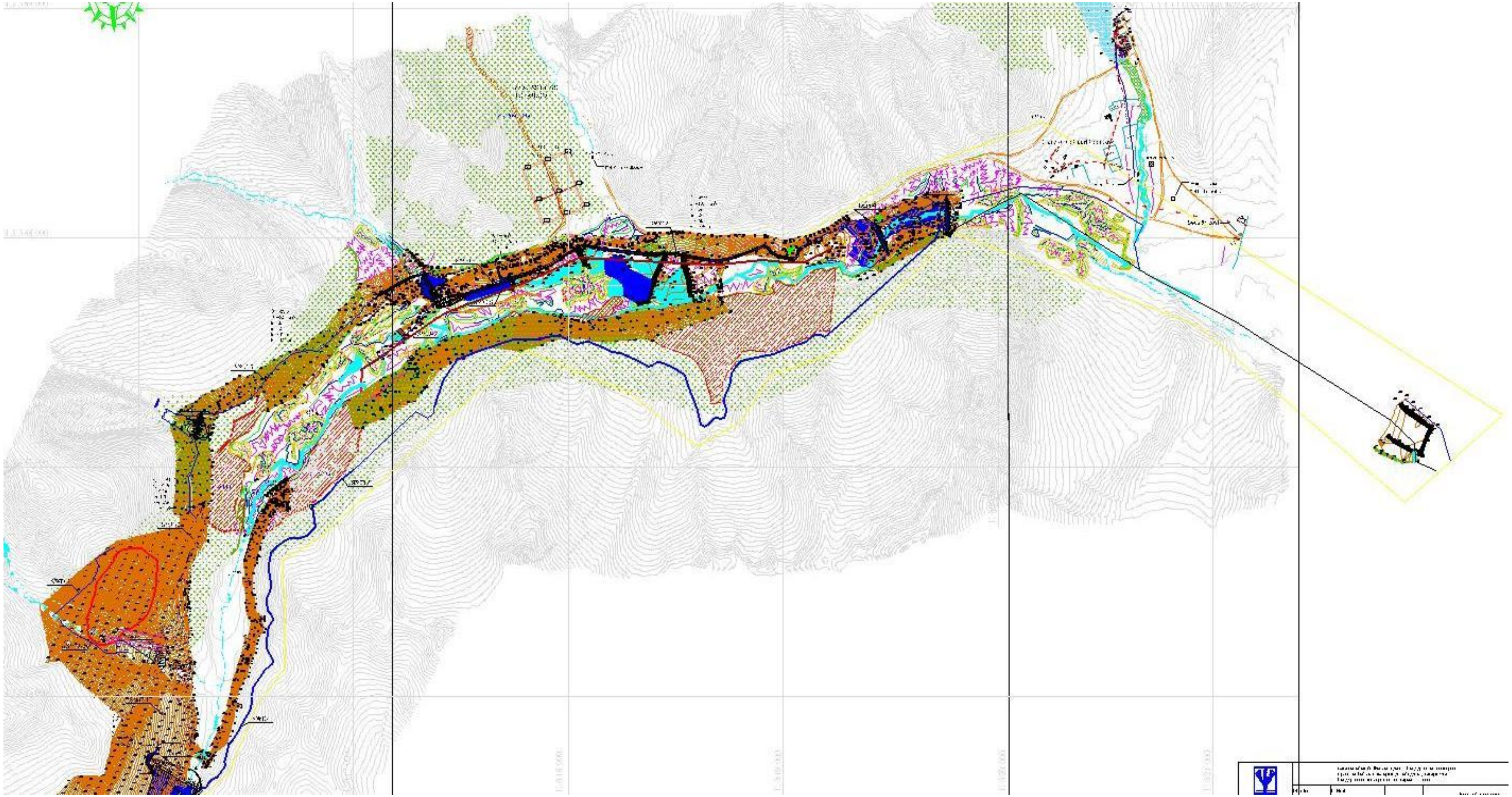


Figure 2.4 Gatsuurt Mine Plan

Much of the larger Central Zone Pit (CZP), the sulfide ore stockpile, and the WRDFs will be constructed on existing disturbance created by previous placer mining operations in the valley. The Main Zone Pit (MZP) will be constructed on slopes southwest of the CZP. A haul/access road will connect these features and continue to the north, up the Biluut River Valley and on to the Boroo Gold Mine (BGM). Table 3.2 presents a breakdown of estimated proposed disturbance by mine facility.

Table 2.2 Summary of Proposed Gatsuurt Mine Disturbance

Facility	Proposed Disturbance in Hectares
Central Zone Pit	38.2
Main Zone Pit	9.5
Ore Stockpile	19.4
Encapsulated Acid Generating/Potential Acid Generating WRDF	22.5
Non-Acid Generating/Potential Acid Generating WRDF	48
Waste Disposal Area	0.5
Storm water Pond and Monitoring Pond	6.8
Structures & Buildings (includes admin/shop facilities)	2.6
Drainage (includes diversion dams and diversion ditches)	5.8
Roads (excluding BGM haul/access road north from Gatsuurt project area)	8.1
Total	**161.4 ha**

Centerra proposes to divert surface water flow around the WRDF, sulfide ore stockpile, CZP and MZP during mining operations. The diversion dams will divert surface flow from both the Gatsuurt River and northern tributaries.

The WRDF will consist of non-acid-generating (NAG) material. The locations of the WRDF is shown on Figure 3.4.

The primary location where the Acid Generating (AG) and Potentially Acid Generating (PAG) waste rock is to be selectively placed is in the bottom of the mined-out Central Zone Pit. Placement in this location insures the eventual submersion of the waste rock by incoming groundwater and to a lesser degree the inputs from atmospheric precipitation as well as inputs from surface water sources. These water sources insure that the waste rock is encased in water, oxygen is cut off and that the initiation of the acid rock drainage reaction is prevented. This form of ARD mitigation has proven to be one of the most effective ARD mitigation methods available.

Placement will be made from the bottom of the CZP to the oxygen extinction depth that is located a distance below the level of the final pit water level. The suite of groundwater characteristics is unknown at this time as the series of pump tests and aquifer tests that are one means of quantifying these characteristics cannot be done as access into Gatsuurt for this kind of work is not permitted now, and has been restricted for some time previous to this date.

When this work can be done and the groundwater studied to a suitable degree, it will be possible to define the final pit water level, the rate of filling could be calculated. However, at this time, general assessments on groundwater character, using existing information, are all that is possible with any degree of accuracy. These general assessments indicate that the above plan for placement of waste rock within the CZP for eventual submersion by local waters is a viable program.

During operations, the waste rock that is produced will be sampled and tested using on-site testing equipment. Duplicate samples will be tested in offsite laboratories in order to verify the onsite testing results. Corrections would be made should offsite testing indicate that onsite results were inaccurate.

On site testing would be conducted on every 10,000 tons of waste rock. Testing equipment would include a sample crushing facility and a LECO sulfur analyzer. Waste rock would be classified as PAG or AG, and the rock placed for eventual movement into the CZP should testing that indicated that the sulfur content of the test sample was 0.3% or more.

Two ponds will be located at the project area; a storm water collection pond at the facilities site, and a sedimentation/monitoring pond downstream of the WRDFs and the mine facility. The combined sedimentation and monitoring ponds will be sized for maximum storage of a one in 20-year, 24-hour storm event

The storm water pond will collect runoff from the site facilities and will be tested for water quality before release into the sedimentation/monitoring pond. The sedimentation/monitoring pond will collect diverted and pumped water from the CZP, MZP and the WRDFs. The water that is collected in the monitoring pond will be tested, prior to release off the license area. Water that meets relevant water quality criteria will be discharged directly into the Gatsuurt River. A contingency for discharge of treated water that is unable to achieve criteria is to discharge further downstream into the Kharaa River using an approved mixing zone, although further assessment work is required to fully assess this contingency and it is expected that water treatment will be sufficient to achieve criteria at the Gatsuurt River discharge.

Water that enters the Gatsuurt mine area without contact with mine facilities, will be routed around the mine and discharged without treatment. There will be limited testing of this water as it will exit the mine with the same quality as it entered the mine, so treatment is not justified.

Water that impacts the waste rock disposal facilities will be tested prior to release. If the tested water does not meet relevant criteria, then management plans will be initiated to insure water quality criteria are achieved at the relevant compliance points.

Water treatment options that could be instituted include one or the full set of the following programs. Passive water treatment programs are the preferred options. Active treatment is a secondary option. Passive treatment methods are more sustainable and may continue to operate with little maintenance obligations post-closure. Active treatment options would require continued input of financial and manpower resources to maintain operations post closure.

Following is the list of both passive and active water treatment options: All water management options that are discussed in this document would require further study. However, the Company is confident that these methods of water management can be used at Gatsuurt following further study and review by Company and regulatory stakeholders.

<u>Passive Treatment:</u> Mixing Zones – Discharge non-compliant water into a cleaner receiving water and achieve criteria at the downstream margin of the mixing zone.

<u>Passive Treatment:</u> Sediment Ponds – Discharge impacted water into the sediment ponds to facilitate loss of entrained sediments.

<u>Passive Treatment:</u> Rapid Infiltration Basins – Discharge impacted water into shallow trenches or ponds that facilitate the downward migration of affected water into the groundwater (groundwater is re-charged this way so that the overall hydrologic system is maintained.

Passive Treatment: Land Application – Surface application of mine affected water encouraging plant and soil treatment of affected water. Applied water would eventually report to shallow water and deeper water aquifers.

Passive and Active: Treatment: Deep Injection of Contaminated Water into the Groundwater – Delivery of impacted non-attainment water into the deep groundwater system using large diameter deep injection well or wells. This recharges the regional aquifer.

Active Treatment: Chemical Water Treatment – Treatment of mine impacted water using chemicals to modify water chemistry, and various physical treatment reagents to modify physical characteristics.

Active Treatment: Mechanical Water Treatment – Treatment using large filter systems to remove undesirable elements to achieve criteria.

Active Treatment: Groundwater Extraction and Re-Injection – Groundwater extraction wells are used to remove water from the system so that the water does not affect mine operations and re-injection downgradient of the extraction area. Groundwater extraction wells are often used to extract groundwater from the mine pit area so that water does not impact the safety of the mine nor deliver excess water to the mine pit.

Combination of two or more of the above treatment methods would likely be implemented during operations in order to handle the volume of water that impacts the property and to manage this water in the most environmentally acceptable manner.

2.1.4 Open Pit Mining

The total mining reserve contained in the Central and Main Zone pits is 17.49 Mt of ore grading 3.09 g/t Au containing 1,739,861 oz. of gold. This reserve is associated with 89.46 Mt of waste providing an average overall strip ratio of 5.11:1. Details of the reserve by material type can be found below in in Table 3.3

Table 2.3 Gatsuurt Project Open Pit Mining Reserve

Ore	Units	Central Zone			Main Zone	Total
		Cut Back 1	Cut Back 2	North Cut Back		
Oxide	Quantity (kt)	3 902	43	0	0	3 945
	Grade (g/t Au)	2.90	3.08	-	-	2.90
	Contained Metal (oz. Au)	367,496	4,250	-	-	367,744
	Recovery (% Au)	73.1	49.5	-	-	72.8
	Recovered Metal (oz. Au)	265,759	2,103	-	-	267,823
Sulphide	Quantity (kt)	3 662	3 939	101	5 843	13 544
	Grade (g/t Au)	3.29	3.72	3.36	2.68	3.15
	Contained Metal (oz. Au)	387,623	470,798	10,954	502,959	1,372,116
	Recovery (% Au)	87.0	878.0	87.0	87.0	87.0
	Recovered Metal (oz. Au)	337,232	409,594	9,530	437,574	1,193,741
Total Ore	Quantity (kt)	7 564	3 982	101	5 843	17 489
	Grade (g/t Au)	3.09	3.71	3.36	2.68	3.09
	Contained Metal (oz. Au)	751,119	475,048	10,954	505,959	1,739,861

Ore	Units	Central Zone			Main Zone	Total
		Cut Back 1	Cut Back 2	North Cut Back		
	Recovery (% Au)	80.3	86.7	87.0	87.0	84.0
	Recovered Metal (oz. Au)	602,991	411,697	9,530	437,574	1,461,564
Waste	Quantity (kt)	31 112	37 584	1 886	18 885	89 455
Total	Quantity (kt)	38 676	41 566	1 987	24 728	106 944
Strip Ratio	W:O	4.11	9.44	18.67	3.23	5.11

The Gatsuurt reserve is to be mined at a nominal rate of 35 000 t/d to generate 1.75 Mt/y of ore for processing at the Boroo mill. Ore will be shipped from the Gatsuurt pit stockpile to the Boroo run of mine pad for processing at a rate of 5 000 t/d. Mining and ore haulage will operate 350 days per year on a 12-h continuous shift basis.

The principal mining equipment units are shown in Table 3.4

Table 2.4 Principal Mine Equipment Units

Item	Number	Unit
Drill	1	IR DM45 or equivalent
Loading	1	12 x 15m^3 RH120E
Mine Haulage	4	90-t , Cat 777

2.1.5 Pit Dewatering

During pit excavation and mining, water is anticipated to enter the CZP from both groundwater and surface water sources. Three water diversion dams will be constructed to contain and divert runoff that might enter the open pits. The water will be routed into diversion ditches that will transport the water downgradient where it would be delivered to the appropriate treatment system. The proposed water diversion system and open pits are illustrated in Figure 3.5.

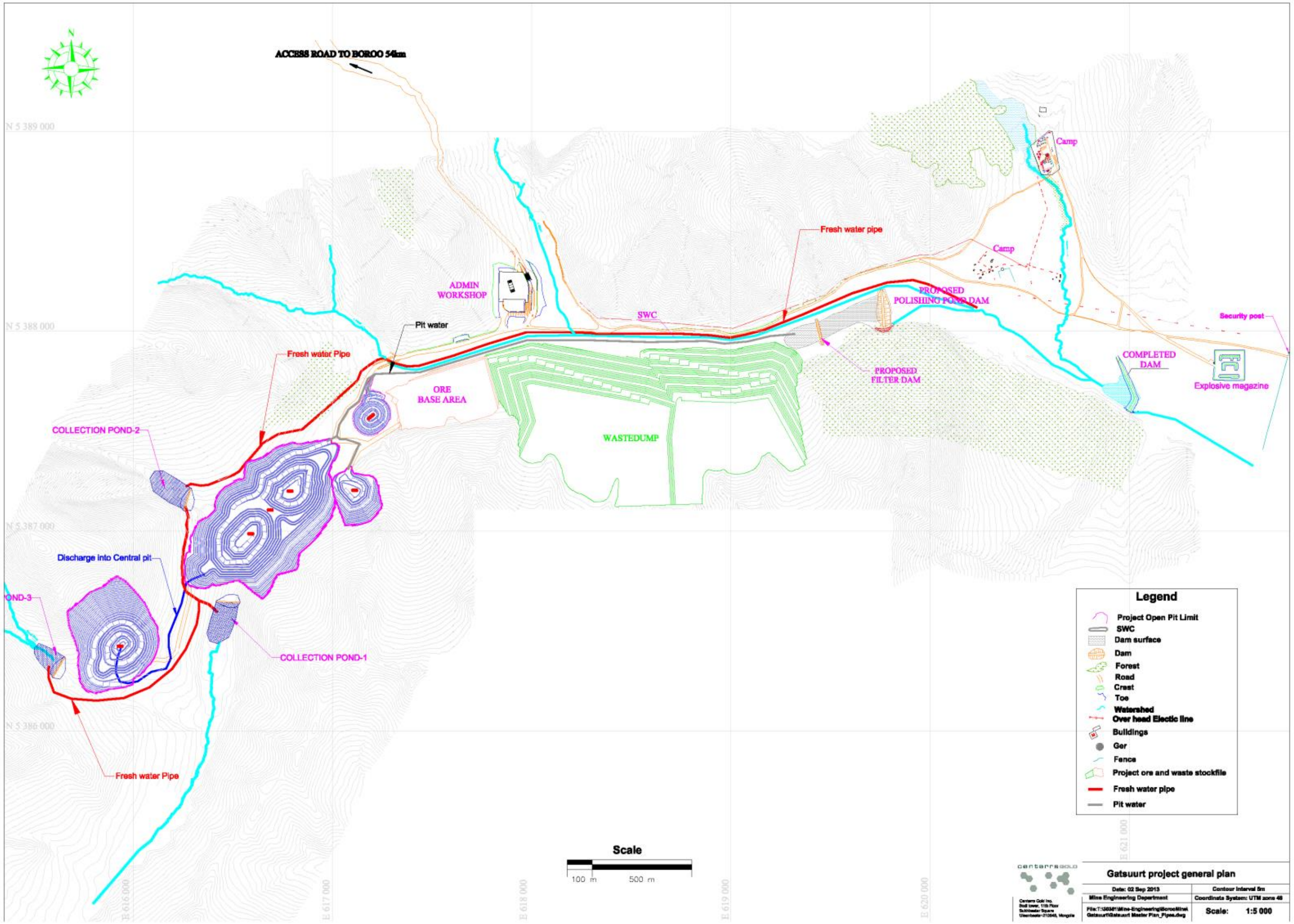


Figure 2.5 Gatsuurt project general plan

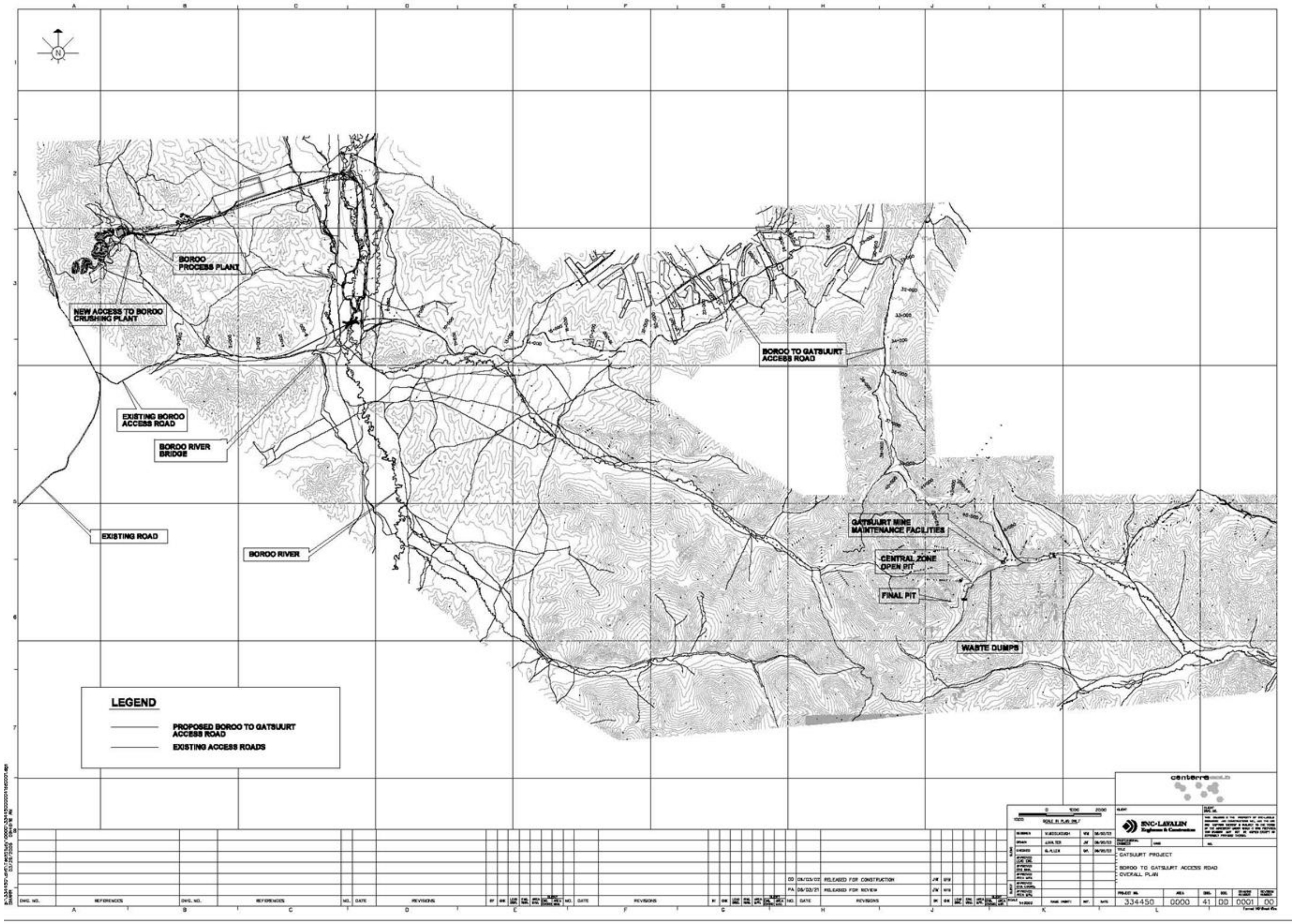


Figure 2.6 Gatsuurt Road

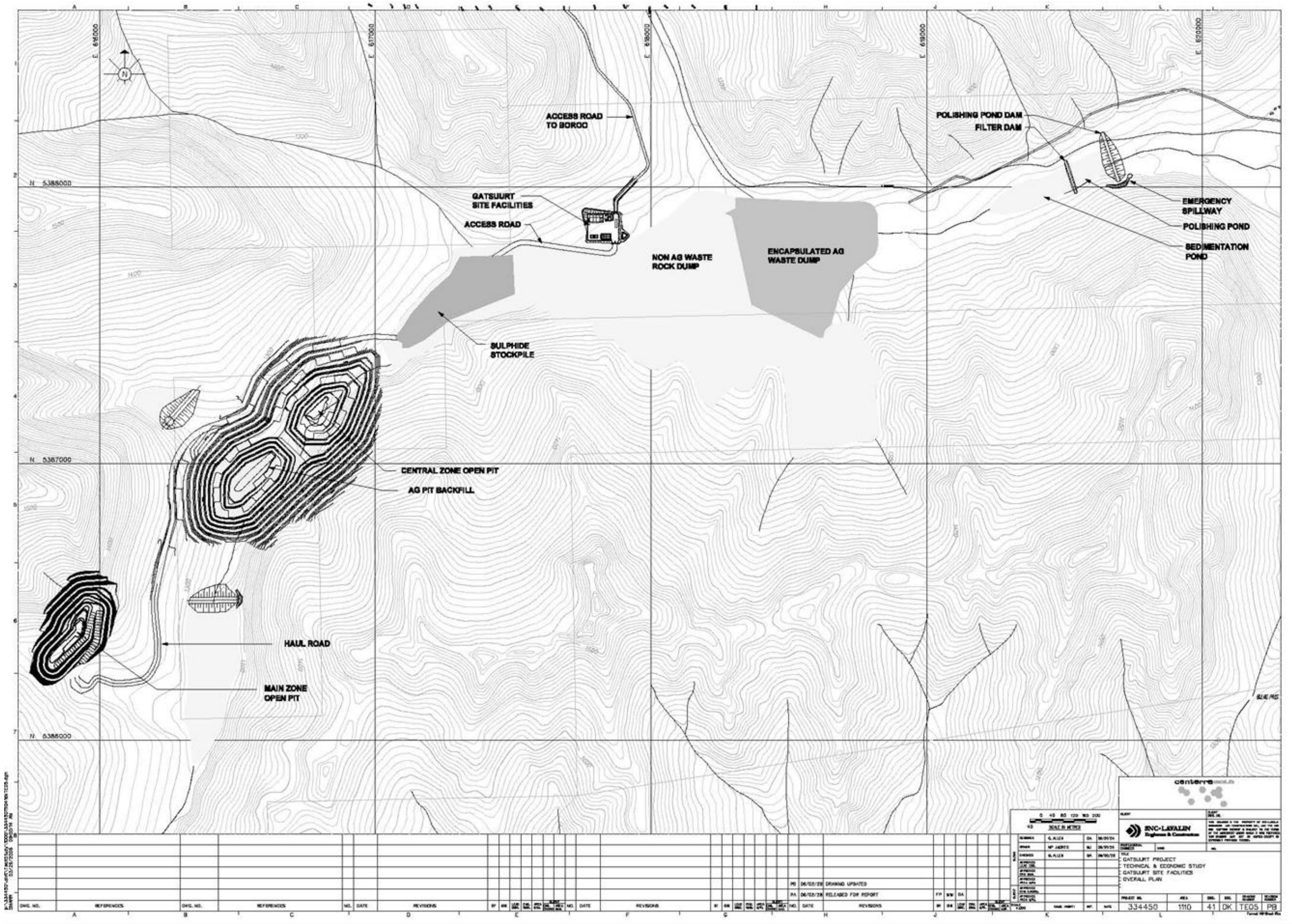


Figure 2.7 Location of Open Pits, WRDFs and Sulphide ore stockpile

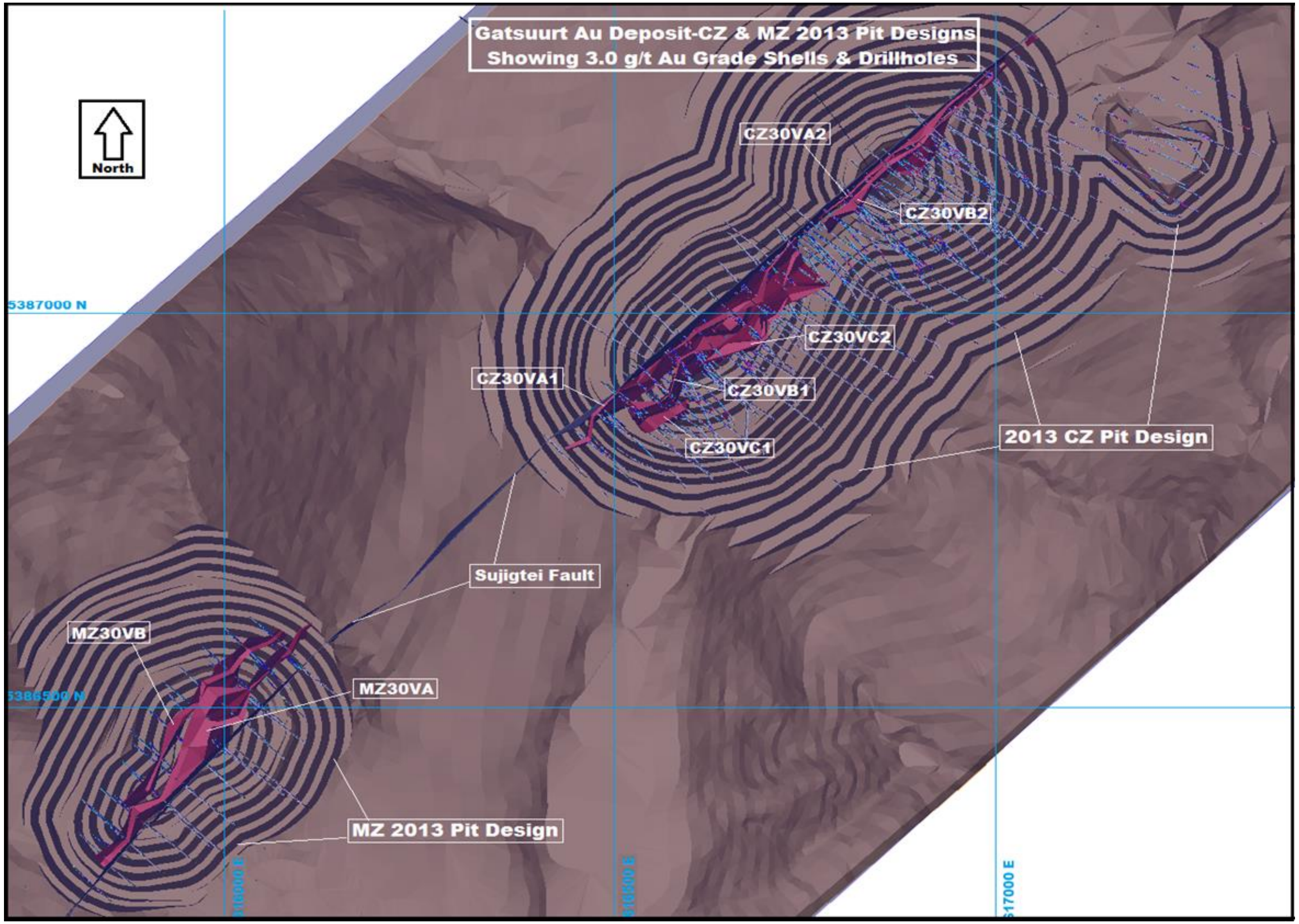
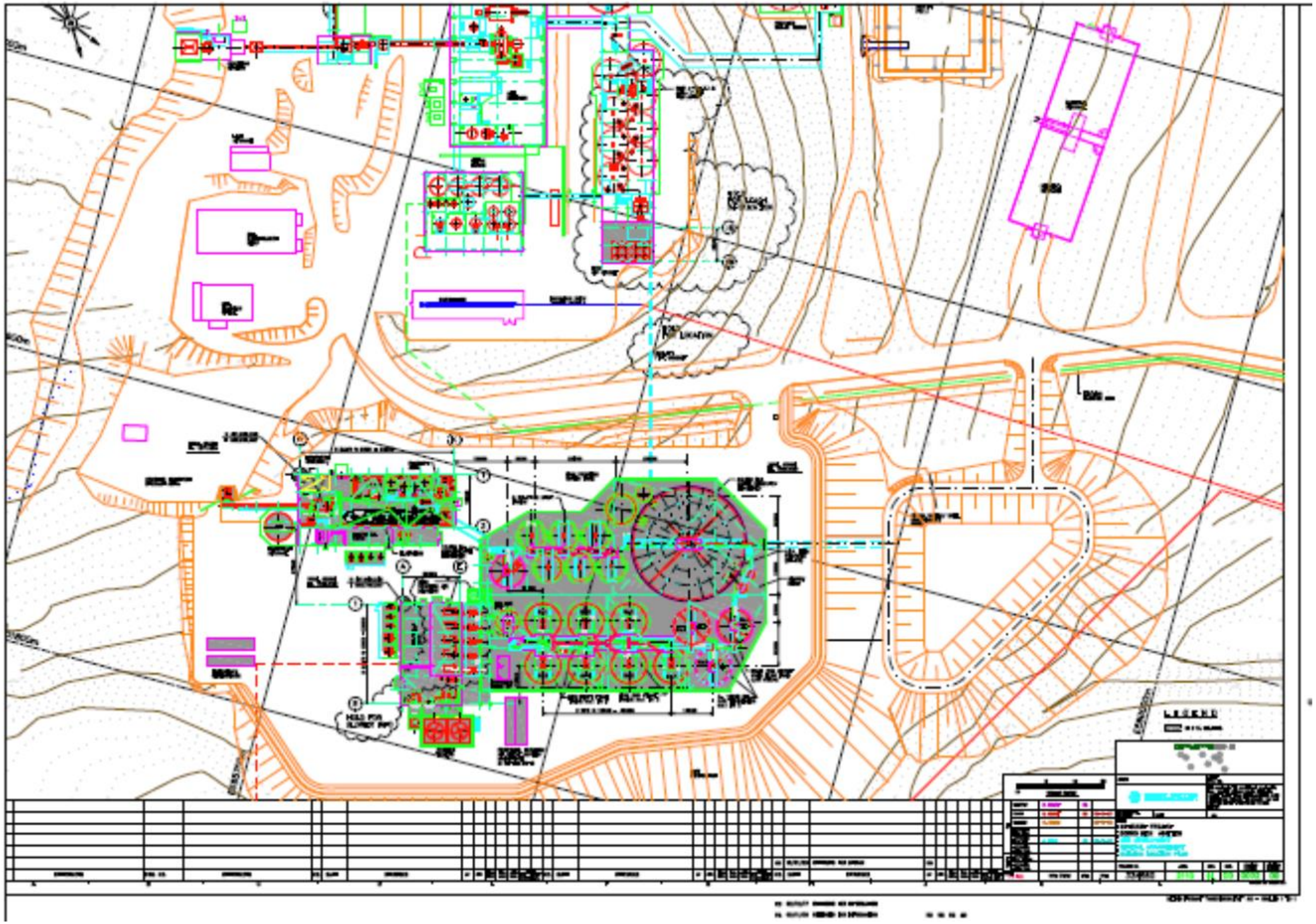


Figure 2.8 Central and Main Zone Pit Designs



A preliminary estimate of groundwater flow into the pits based on preliminary estimates only follows:

Table 2.5 Gatsuurt Pit Inflow Estimates

Year	Pit Depth (m)	Inflow 1 (k=0.1m/d) (kL/day)	Inflow 1 (k=0.1m/d) (L/s)	Inflow 2 (k=0.2m/d) (L/s)	Inflow 3 (k=0.3m/d) (L/s)
Central Zone pit					
1	39	4838	56	90	120
2	78	6905	80	131	176
3	117	8045	93	154	209
4	156	8483	98	164	223
5	195	8320	96	162	221
Main Zone pit					
0.25	37.5	5,834	68		
0.5	75	8,217	95		
0.75	112.5	9,534	110		
1	150	10,067	117		
North Pit					
0.25	16.25	1447	17		
0.5	32.5	2306	27		
0.75	48.75	2991	35		
1	65	3553	41		
North East pit					
0.25	23.75	2,516	29		
0.5	47.5	3,847	45		
0.75	71.25	4816	56		
1	95	5522	64		

Such flow will be collected by a network of drains and sumps, pumped out of the pit, directed into a diversion ditch, and diverted to the sedimentation/monitoring pond located below the WRDFs for testing followed by management using one of the numerous treatment methods prior to the relevant compliance point.

2.1.6 Process Facilities

All ore mined from the Gatsuurt open pits will be hauled to the BGM for processing. The details of the Biox processing facility for the sulfide ore and expanded tailings management facilities are fully addressed under a Detailed EIA that was approved in 2010.

2.1.7 Waste Rock Disposal Facilities

Acid Genetrating (AG) and Potentially Acid Generating (PAG) waste rock material will be disposed of in the bottom of the CZP on completion of mining. The Non Acid Generating (NAG) waste rock may be used for other purposes at the Gatsuurt Mine, including construction of diversion dams upstream of the open pits and as road base material for internal haul roads. The locations of the NAG Waste Rock Dump Facility (WRDF) and ore stockpiles are shown in Figure 3.5. The NAG waste placed in a waste rock facility will be covered with growth material and reclaimed at the completion of mining.

NAG Waste rock will be stored in a single dump located to the south of the Central Zone pit. . The dump will abut the south side of the valley, will have a final height of about 80 m and has been designed with an adequate factor of safety to ensure stability. The dump will be constructed at angle of repose but will be configured in 20 m lifts allowing re-sloping to 3:1 in order to permit re-vegetation as required.

All waste material from the Main Zone is considered acid generating and is planned to be disposed of in the mined out Central Zone Pit. This waste will be dumped in the pit bottom and subsequently become submerged as the pit floods. The mine design includes a contingency for disposal of AG/PAG material to the WRDF and applying an engineered cover to control acid generation should the capacity for disposal to the Central Zone Pit be exceeded.

2.1.8 Waste Rock Characterization

The potential to create acid drainage is related to the presence of sulfide minerals in waste rock excavated from the two pits. The creation of acid drainage occurs when the sulfide material is subject to oxidation, which requires aerobic conditions and sufficient quantities of water. This process is increased through the catalyzing action of certain types of bacteria.

The waste material has been classified into three types:

- Non-Acid Generating (NAG);
- Potentially Acid Generating (PAG); and
- Acid Generating (AG).

The Gatsuurt waste rock produces acidity (conversion of sulfides to sulfates with the resulting production of free hydrogen ion or acidity). However, the Gatsuurt rock also produces neutralizing potential (buffering capacity) that neutralizes the acidity that is produced so that the resulting waste rock interaction is the production of neutral water. This means that based on the humidity cell test data, the waste rock will not produce acid rock drainage. However, the fact that the waste rock and ore might produce excessive levels of arsenic and could create acidic conditions are possibilities that the Company recognizes and have taken measures to mitigate, so that the impacts of the mine are minimized to the extent practical and possible.

The so-called humidity cell test report includes not only the humidity cell testing but also XRD, XRF Whole Rock Analysis, ICP-OES/MS, MWMP, Sieve Analysis, Modified ABA and NAG tests for each of 16 rock samples that were submitted for testing. These 16 samples included both waste rock and ore samples. Test results verified the high concentration of Arsenic in most samples, as expected for an arseno-pyrite ore body. The tests also verified the possibility of acid generation in some samples.

The information that is provided in this report is a valuable management tool. The Company used this information to design waste rock storage facilities and water management programs that would address any issues that might develop with respect to elevated Arsenic or the possibility of acid generation.

2.1.9 Water Management

Mining is expected to encounter groundwater below the valley floor. Temporary sumps will be established on each bench. A submersible pump using generator power will pump water from the pit via a pipeline to the diversion ditch which will carry it to the sedimentation pond. Two diversion dams will be constructed south and northwest of the pit to prevent runoff from entering during spring thaw or thunderstorms (Figure 3.5).

The monitoring pond will contain the water that has spilled over from the sedimentation pond. This pond will be approximately 8 m depth. Water in the monitoring pond will be held behind the dam and released once applicable water quality standards have been met. The sedimentation monitoring pond will be sized to contain a one in 20-year, 24-hour storm event. To reduce seepage from the monitoring pond a low permeability soil layer will be used where necessary.

During mining, runoff and groundwater entering the pits will be pumped and discharged into a ditch, located to the south of the Diversion Channel (Figure 3.5). This run-off is diverted to the sedimentation/monitoring pond. Surface water runoff and seepage from the WRDFs and stockpiles will also be routed directly to the sedimentation/monitoring pond and monitored prior to discharge.

Diversion ditches will be constructed to prevent runoff from the surrounding watersheds from entering any of the mine facilities. These diversion ditches will transport water back to the Gatsuurt River below the sedimentation/monitoring dam as presented in Figure 3.6.

Surface water runoff from the mine truck shop and office area will be channeled and collected in a storm water pond adjacent to the facilities as presented in Figure 3.3. Water quality will be monitored and measures taken to ensure that water discharged into the environment meets applicable standards taking into account pre-existing levels of contamination.

2.1.9.1 Growth Media Stockpiles

Topsoil was not stockpiled as part of the previous placer mining operations with 146 ha, so the reclaimed areas will not be covered with topsoil. Material excavated during the previous placer mining operations may be mixed with current excavated material in an attempt to create a better growth medium (increase the volume of growth medium). Specifically, areas of fines and areas of coarse material may be identified and mixed to create a substrate more suitable for vegetation establishment during reclamation. Any suitable growth medium from the facilities area and MZP will be stockpiled prior to construction of facilities.

2.2 Open Pit Mining

2.2.1 Open Pit Exploitation

Two open pits (MZP and CZP) are planned for the Gatsuurt Mine. Figure 3.5 shows the locations of these pits. The mining process proposed for the Gatsuurt property is a standard truck haulage operation with a drill, blast, and load and haul cycle. Loading will be completed with front-end loaders and haulage with 50-tonne rigid body end dump trucks. A normal support fleet of bulldozers and graders will assist the mining operation. A backhoe will provide ore cleaning along the contacts of ore and waste. Ore material will be separated into oxide and sulfide ore, and hauled to its respective destination. The oxide ore will be hauled directly to the BGM facility.

2.2.2 Open Pit Parameters

The Central Zone ultimate pit centre of the elongated pit, along its longitudinal axis. (Figure 3.7-3.8).

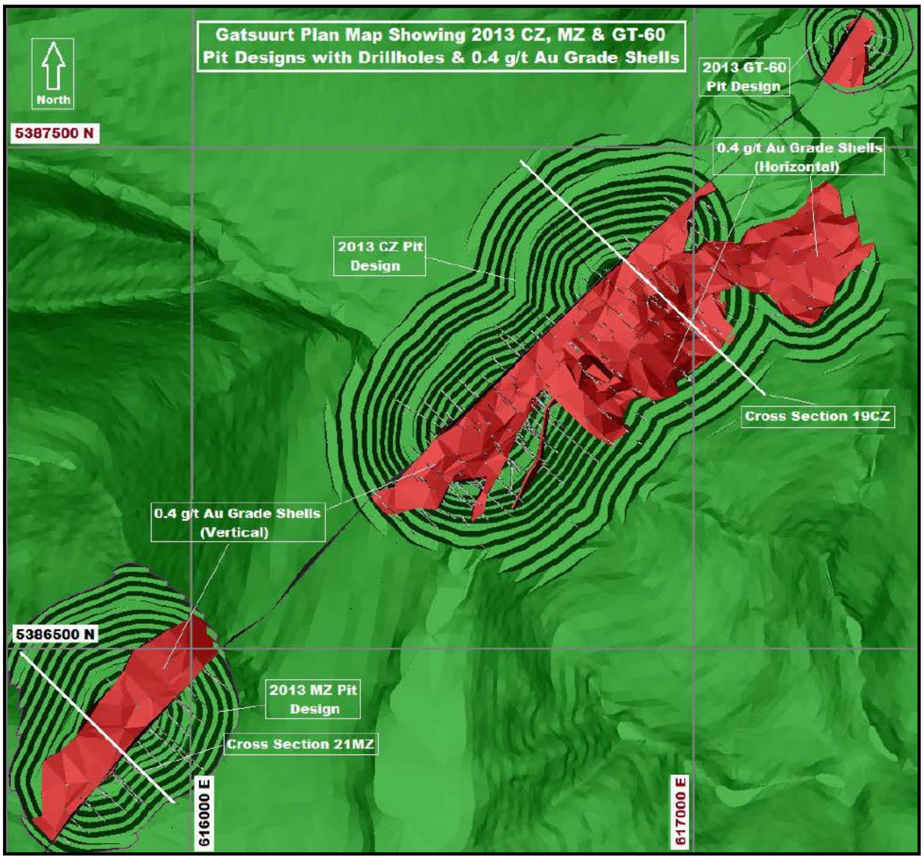


Figure 2.9 Plan View of 2013 CZ Pit Design and 0.4 g/t Au Grade Shells

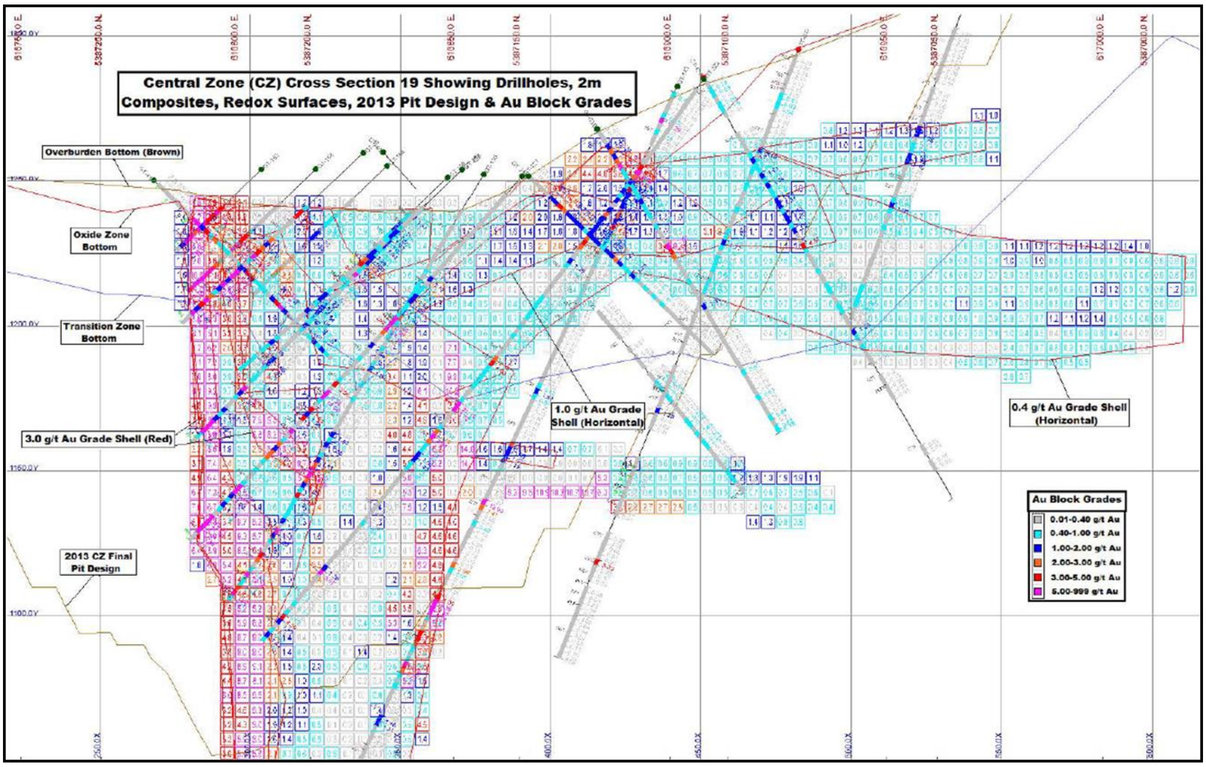


Figure 2.10 Central zone open pit longitudinal sections

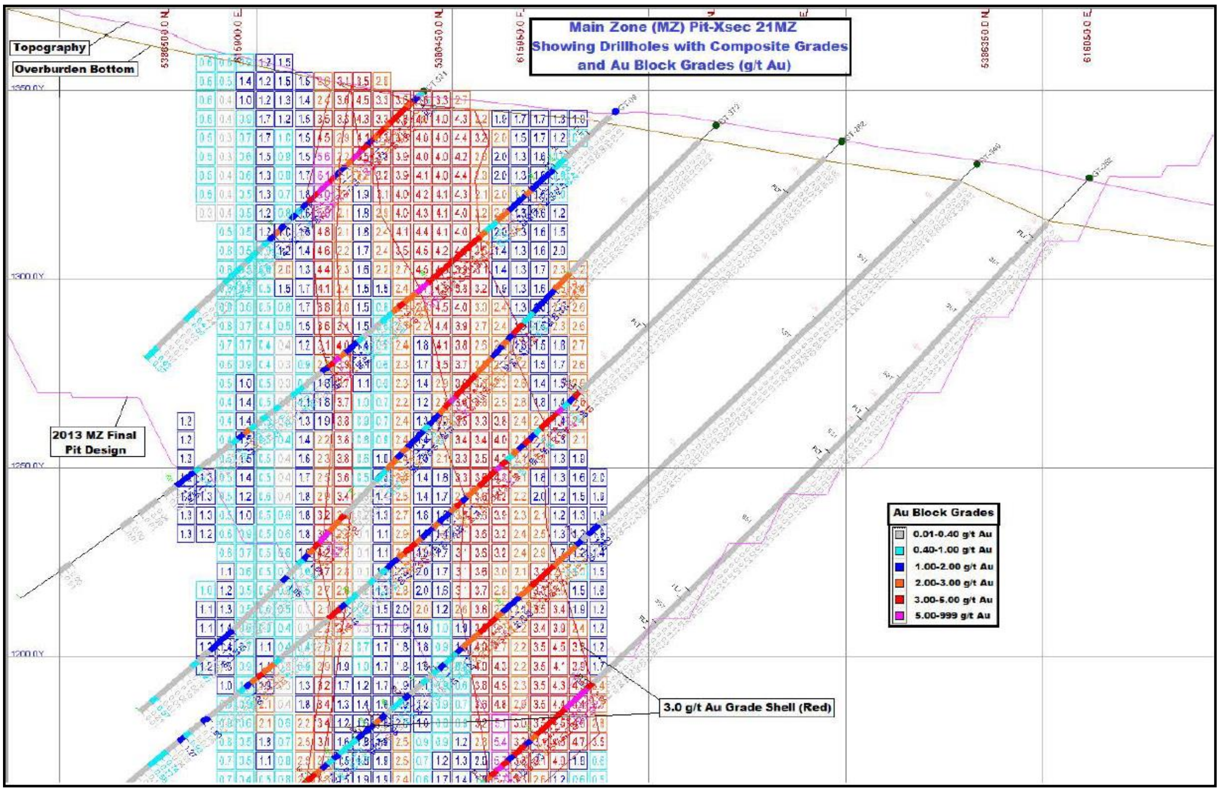


Figure 2.11 Central zone open pit cross section

Main zone open pit longitudinal section

Main zone open pit cross section

During and after operation, safety berms will be maintained around each of these pits. The production schedule for mining of both the CZP and MZP is presented in Table 1.3.

2.2.3 Mine Exploitation Parameters

Open pit design: Pit slope bench heights are designed to be spaced at 5-8 m intervals vertically, with face angles at 60-700 depending on material type. Safety berm widths will range from 8 m to 10 m. Haulage ramps are designed to be 22 m wide to facilitate single lane traffic for 90 t trucks or double lane traffic for 50t trucks. Ramp grades have been designed at 10%.

Mining procedure: Primary loading will be performed by two 7.6-cubic meter hydraulic excavators in backhoe configuration. The excavators will load a fleet of six 50-tonne rigid-frame haul trucks. A 6.9-cubic meter front-end loader CAT988 will provide back-up for the excavators. Massive rocks will be loosened with blasting or drilling prior excavate and load.

Drilling: Drilling will be performed by two blast hole drill rigs drilling 127 mm holes on a four-meter by four-meter pattern. Holes will be 5.5 meters deep allowing 0.5 meters for subgrade. Drilling equipment are Tamrock D45K and Ingersol-Rand DM45 with 200 kHz capacity.

Blasting: ANFO will be used for blasting and blasting will be conducted by a contractor once a week. Loading will be with locally available packaged emulsion due to expected wet conditions below the valley floor. Wherever possible, an ammonium nitrate/fuel oil mixture [ANFO] will be used. Initiation will be non-electric using materials of Russian or Chinese manufacture. The design powder factor is 0.43 kilograms per bank cubic meter. Also portable mixing machine with 10 t will be used. Blasting substance will be stored in the warehouse of Boroo site and transported as demand. No explosive warehouse will be constructed in the Gatsuurt Mine and transported substances will be stored in the temporal warehouse. Blasting operation will be guided by personnel of Centerra Gold Mongolia.

Internal haulage: will be performed by CAT773D through main road. Mined waste rocks will be dumped separately according to its properties. Dump trucks will be used to haul waste rocks for constructing road, water diversion dams and tailings facility. Average vehicular distance is 500 m and 1000 m for ore and soil respectively.

Ore haulage: Ore will be stockpiled near the CZP entrance for loading into highway trucks. Reloading will be performed by CAT5110 near Central Zone open pit.

A fleet of 26 40-tonne trucks will haul oxide and sulfide ore from the Gatsuurt Mine to the BGM mill for processing. Trailers of Mercedes Benz and Chinese joint venture will be used for external haulage. When ore mining reach to 5000 t per day, it will require 26 of dump truck.

2.2.4 Buildings and Infrastructure

Gatsuurt site facilities and infrastructure is illustrated in the section 1.9 briefly. Location of structures are shown in the Figure 3.13. MZP and CZP will be connected with roads.

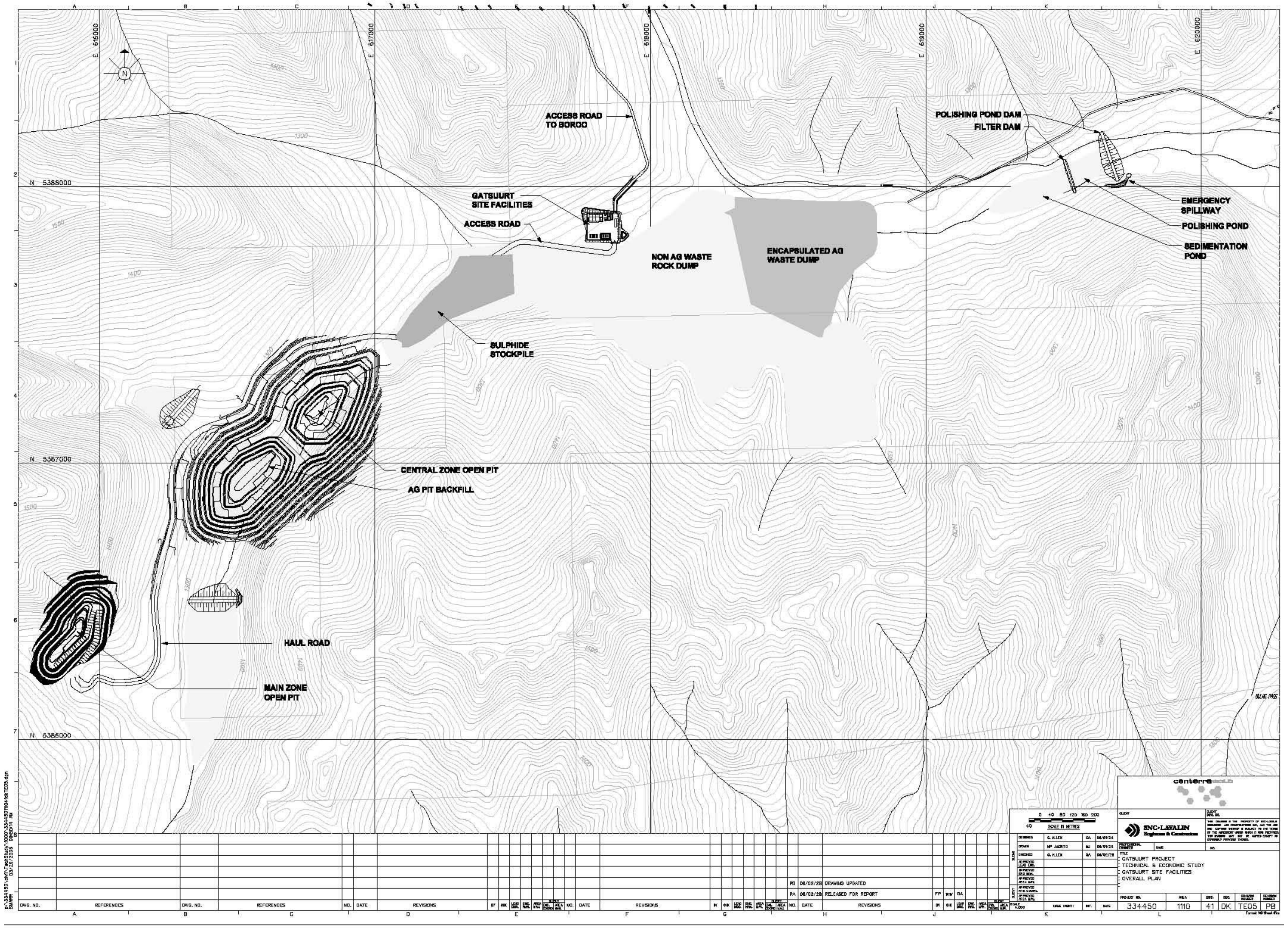
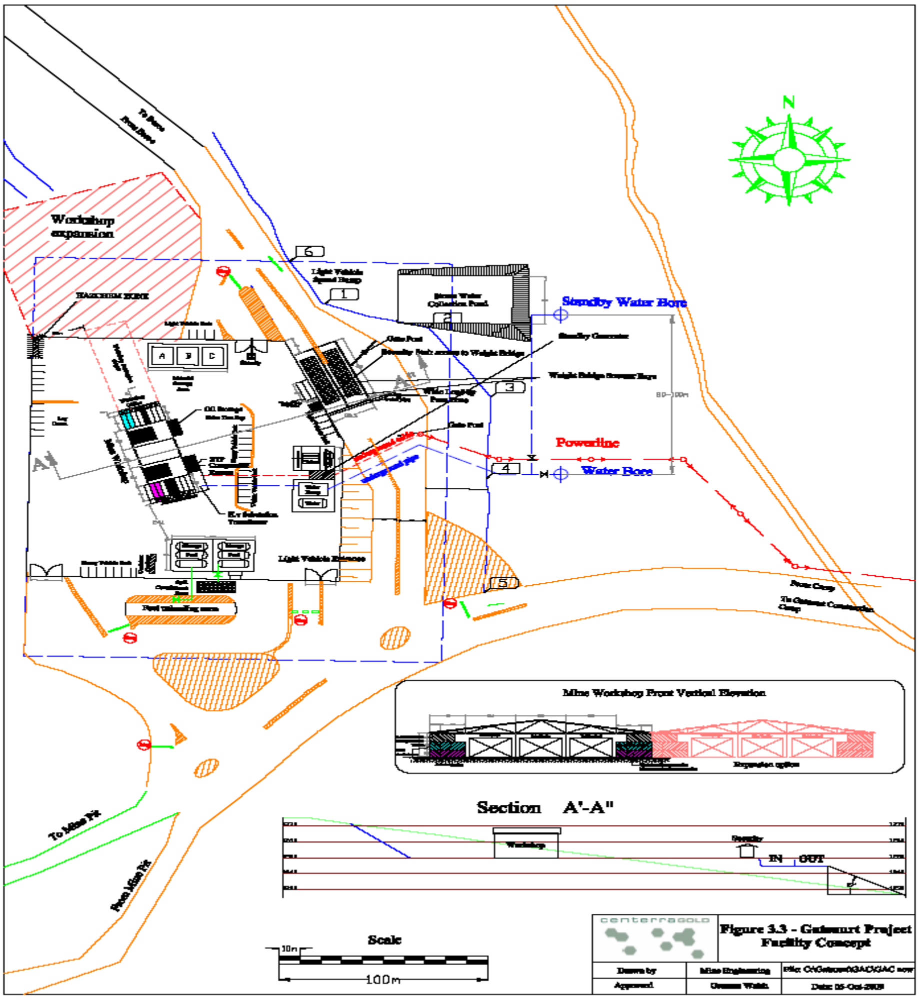
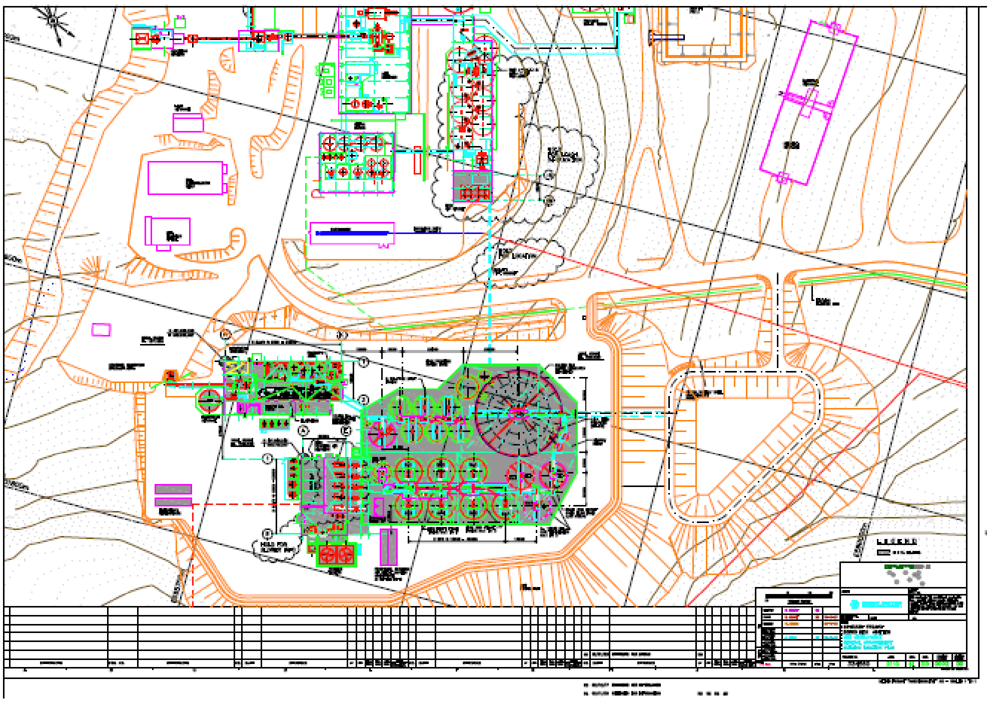


Figure 2.12 Location of structures


Workshop expansion
Standby Water Bore
Powerline
Water Bore
Light Vehicle Entrance
Fuel Unloading area
Mine Workshop Front Vertical Elevation
Section A'-A"
IN
OUT
Scale
100m
centerragold
Figure 3.3 - Gatsuurt Project Facility Concept



2.3 Raw and Auxiliary Material, Final Product

2.3.1 Resources

A few natural resources will be used for mine operation. During project operation, it is planned to mine 1.7 Mt of oxide ore grading 2.55 g/t Au and 7.2 Mt of primary and transition ore grading at 3.63 g/t Au and totally 844,000 oz. (26.3 t) of gold. Gold recovery for oxide ore treated in the existing Boroo process plant is projected to be 82.8%. Gold recovery for transition and sulfide ore is projected to be 85.6% in the Biox facility.

Totally, 51265 thousand tonnes of soils will be stripped and 60244 thousand tonnes of excavation will be performed. An average ratio of stripping is 5.7 percent. Mined ore will be concentrated and processed to produce bar gold. Groundwater will be used for domestic consumption. Up to 100 people will camped in the mine and daily water consumption is 100 x 25 l = 2500 liter for drinking and 40 x 180 l = 7200 liter for bath and totally consumes 9.7 cubic meter water per day. Yearly water consumption is 3530.8 cubic meter and water consumption for run of mine operation is 24715.6 cubic meter. Water supplies for villages in the Gatsuurt area are obtained directly from water wells. Average water flow of boreholes in Gatsuurt riverbed is 12-15 liter/sec and 1296 m3/day, which means water supply can be provided by one well. Mining operation will emerge dust that require to water dumps, trenches. It is based on Appendix 6 of 153 decrees by MNE in 1995 that induced temporal rates to water areas and field. Four-liter water will be deployed per square meter area, which will give moisture 1.5 m in depth. Approximately 14.4 ha of area (30 percent of mining area) will be watered 110 days throughout a year and totally 63360 cubic meter water will be used for watering haul roads, pit benches and access roads to minimize dust impacts annually. (4 l õ 144000 m2 õ 110 days = 63 360 000l = 63 360 m^3)

Water consumption of mining operation is 63360 m3 x 7 years = 443 520 cubic meter. Diverted and collected runoff and pit water will be used for watering. Total water consumption both domestic and technological is (24715.6 + 443520 =) 468035.6 m^3.

2.3.2 Blasting substance and fuel

Blasting substance and fuel will be used commonly during mining operation. Blasting substance will be stored in the warehouse of Boroo site and transported as demand. Wherever possible, an ammonium nitrate/fuel oil mixture [ANFO] will be used. The blast holes will be loaded with bulk ANFO with a designed powder factor of 0.7 kg/bcm.

Annually, there will be drilled total of 25000 holes for 220000 m length and 342.5 t and 2740.0 t of blasting substance will be used per year and during mining operation respectively. Total amount of fuel to be supplemented is 3966.9 t of diesel annually.

2.3.3 Radioactive Substance

No radioactive substances will be used during mine operation.

2.3.4 Final Product

It is planned to mine 1.7 Mt of oxide ore and 7.2 Mt of primary and transition ore and total outcome is 986,000 oz. (26.3 t) of bar gold.

2.4 Intermediate products and wastes

2.4.1 Intermediate product

No intermediate product to be produced through Gatsuurt gold mine operation.

2.4.2 Dust and gas emission

Dust: will be generated primarily from mine blasting, wind, material transportation on dirt road, topsoil loading and stockpiling. Especially in dry seasons, operations such as topsoil stripping, ore mining and loading, blasting and drilling, material transportation and hauling are future sources of dust although inconsistently.

Air pollutants from vehicle exhaust: will be generated from exhaust of mine machinery operations, ore hauling to Boroo site, other vehicular traffic and facilities (diesel motors, temporary and emergency stations). In the process of choosing mine machinery and equipment, consideration will be given to air pollutant emission standards and fuel consumption efficiency.

Noise: During both construction and operation phase at Gatsuurt mine, noise is expected to be generated as a result of blasting and mine machinery operations.

2.4.3 Solid waste

During mining operation, stripped overburden will stay dumped as a solid waste. Total amounts of waste rocks and overburden is referred in detail in the Section 3 (technological section). Solid waste that originates from the man-camp will be collected and disposed in a separate solid waste dump facility that is permitted for containment of solid waste according to Mongolian legislation. Throughout mine operation, 252 tonnes of solid waste will be generated in volumes estimated using the following calculations:

originate person generates an average of 1 kg of solid waste/day
100 people x 1 kg = 100 kg waste a day X 30 days = 3 tons per month

2.4.4 Liquid waste

Daily water consumption per person is estimated based on Appendix entitled "Domestic rates of water consumption" and consumption is estimated at roughly 25 liters for domestic and 180 liters for bath. A wastewater treatment system will be installed to treat this domestic waste water.

3 Labour health and safety

Ensuring occupational safety is Centerra Gold Company's Gatsuurt Project's highest priority. Centerra Gold will operate under the guidelines of the Mongolian Law on Occupational Safety and Hygiene, General Rule for Open-cast Mining Safety and other applicable laws and jurisdictions. At all times, Centerra Gold sets priority to ensure safe production to Gatsuurt management and employees, to follow international best practice of implementing a management system for Gatsuurt mine safety and hygiene, and to carry out all required tasks on occupational safety and hygiene within this framework. Centerra Gold is planning to set up a Safety and Health Department made up of Mongolian specialists with relevant work experience and to establish an Occupational Health and Safety Committee representative of company employees.

Safety Department will define occupational health and safety policy; develop long and short term goals for Gatsuurt management approval and monitor their continuous implementation. During Gatsuurt mine set-up, mining operations and decommissioning, Safety and Health department will develop following programs in support of the above-mentioned commitments:

1. Policy and Rules for Labour health and Safety of Gatsuurt mine
2. Management system for Labour health and Safety
3. Risk assessment of Gatsuurt mine
4. To approve and be guided Emergency plan based on pre-assigned potential risk assessment.
5. Develop required guidelines/instruction such as for new employees and organize training for labour health and safety
6. Develop safety rules for heavy and light trucks and maintain road traffic safety.
7. Rules of personal safety equipment
8. Safety rules for workshop and maintenance
9. Safety rules for contractors
10. Monitoring plan for labour safety and health.

3.1.1 Health and safety policy

Gatsuurt mine's Health and Safety Policy ties together with Centerra Gold Mongolia's Health and Safety Policy. It endeavors to prevent occupational health and safety hazards, comply fully with applicable jurisdictions to secure continuous improvement in health and safety performance. This policy is applicable to all operations of Gatsuurt surface mining activities, including hauling and transportation, maintenance, ore monitor and engineering works, administration, contractors, visitors and consultant servicing specialists. Gatsuurt mine management will review and approve its health and safety policy annually and before introducing new technology. Health and Safety department takes the responsibility to coordinate this work. Mine site, Ulaanbaatar city office employees and contractor employees will receive health and safety education and training on this policy. The policy will also be made known regularly during general and departmental safety meetings. All companies and employees performing contracting duties at any Gatsuurt mine licensed area are responsible for supporting and operating under Gatsuurt Health and Safety Policy.

3.1.2 Health and safety management system

Health and Safety Management System and its programs will be developed as a mechanism to coordinate health and safety matters during mine operations, mine decommissioning and start-up of related new projects. The management system will provide guidance to company management and health and safety department's professional staff in carrying out their responsible duties.

The Health and Safety Management System will cover all aspects of Gatsuurt mine workflow that is listed below:

- Surface mining
- Buildings on the surface and all construction and installation work areas
- Ore hauling
- Operating of heavy equipment at maintenance shop
- Mine administration and its subsidiary operations
- Geology ore monitoring, engineering activities etc.

Gatsuurt mine Health and Safety (HS) Department is responsible for developing the HSMS and its timely reviews when needed. The HSMS will be finalized and go into effect upon a signature by Centerra Gold Mongolia's company general director.

3.1.3 Gatsuurt mine hazard risk assessment

The objective of risk assessment is to assess hazards and risks associated with potential safety hazards, accidents and incidents, potential injuries, fire hazards, transportation and hauling accidents, serious property damages and losses, natural disasters and other hazards so that preventive actions are taken.

Hazard risk assessment method

Risk assessment will be performed in three steps. The first step is to cover all potential hazards associated mine site activities. All hazards at Gatsuurt new mining project operations will be identified and evaluated in the risk assessment, and necessary preventive measures will be identified. Gatsuurt mine director is accountable for carrying out a realistic hazard and risk assessment, identifying risk reduction and elimination actions with the support of Health and Safety Department, and to provide sufficient resources for risk prevention as reflected in Health and Safety Policy.

The second step in risk assessment is completed by a risk assessment group composed staff in charge of a special task or a new project. The team shall conduct an evaluation and calculation of potential risks according using the job hazard assessment sheet and risk assessment spreadsheet as a guideline. Thirdly, risks should be assessed by Gatsuurt mine employees as a daily work routine as it will the main tool to protect oneself from involving or creating any potential hazardous event. Based on risk assessment, health and safety job safety procedures will be developed and set as guideline.

Emergency response planning

Gatsuurt mine management believes that accidents and emergencies can be prevented and will therefore set controls and other necessary measures in all aspects of its operations. Gatsuurt mine management will be set in the following priority incurred losses:

- People
- Environment
- Materials

And take required actions to control its extension by developing a detailed, effective, implementation plan and ensure disaster preparedness.

Gatsuurt emergency response plan will be an independent document that will be reviewed by associated professional agencies and approved annually. HS Department will regularly roll out classroom and field training courses to responsible employees. In addition, the Emergency Response Team (ERT) made of volunteer employees as part of company's disaster preparedness planning is intended to be instituted. A certain of ERT members must be available for emergency response in each work shift. Site ERT will receive required training and conduct exercises every two weeks.

3.1.4 Gatsuurt mine health and safety induction and training

Occupational health and safety training will be delivered according to requirements set in Mongolia's labor law, law on occupational health and safety, other health and safety requirements, and company-enforced internal rules.

- New employee job safety induction will be two days or 14 hours long.
- HS Department will deliver HS training to Gatsuurt senior employees according to following schedule:

HS training is one of company's continuous improvement programs. A senior employee who will perform this task must deliver required general and refresher training according to a set schedule to company employees. Every visitor to mine site will be given a brief safety induction by safety officer and sign up under the induction instructions.

3.1.5 Mine heavy duty equipment and light vehicle safety rules

Transportation/vehicle: The number of light vehicles on site will be monitored and if needed their number can be limited. Before work start, employees and contractors who are intending to enter Gatsuurt mine site must provide their vehicle list and receive an approval.

Prior vehicle's entrance into the mine site, security department will do an inspection.

The affiliated Gatsuurt department will maintain registration documents and certificate copies of all passenger vehicles and haul trucks. All Gatsuurt site employees and contractors must make certain that equipment and machinery under their authority are used, installed and maintained according to pertinent rules and jurisdictions.

All mobile equipment and machinery used by site employees and contractors must have undergone a check by authoritative inspectors and assessed for their suitability of use. In other words, a written approval that the machinery, equipment or/and its part(s) fulfill requirements of being registered, approved, safe, and have passed permissible noise levels.

Speed limit: All employees and contractors must follow the speed limits set for mine site. Speed limits may be changed or vary and will be notified as required.

A crane with a load should not exceed the pedestrian's 5km/hr speed limit. All drivers must be aware and follow rules on speed limits, speed reduction signs, no entry signs, stop and yield signs and other road signs. Employee transporting buses or vehicles

Employees will be transported according to Gatsuurt mine approved rule. Permitted transportation includes:

- When taking a bus or a vehicle, passengers must wear seatbelts at all times.

3.1.6 Personal Protective Equipment (PPE)

Gatsuurt mine's HS department understands that Personal Protective Equipment (PPE) are perceived as the last resort for personal protection and injury prevention when hazard or accident occurs. Eradication of potential hazards and danger risks, their impacts, technological changes, improvement in engineering designs, and the enforcement operational rules are other important methods that will be employed.

A general rule on PPE use will be established for Gatsuurt mine.

3.1.7 Safety rules for maintenance related works

Gatsuurt mine will have a maintenance shop for required maintenance of heavy machinery and light vehicles. The shop will have following main and supplementary safety engineering controls.

Job safety procedures will be developed where needed upon a job task risk assessment for all aspects of maintenance shop operations.

3.1.8 Contractor company safety

Gatsuurt mine will address contractor's safety and hygiene equal to that of its own employees. To ensure safe contractor servicing, the company will develop and put in force safety standards and requirements that will be a part of the services contract with every contractor company. Gatsuurt health and safety policy will be applicable to contractors and company management will endeavor to provide a risk-free, safe working environment to its service providers.

3.1.9 Occupational health and safety monitoring program

Monitoring programs applicable to Gatsuurt mine operations, technology, work environment and natural environment will be developed by Gatsuurt HS department. Hygiene program will be directed towards protecting and preventing employees from work-related illnesses, and in accordance with applicable Mongolian and international approved norms and standards. The comprehensive hygiene program will have following components:

- Air quality monitoring in confined work spaces and environments
- Respiratory protection program
- Hearing conservation program
- Heat and cold protection program

For implementing the Hygiene monitoring program, workplace health impacts (noise, dust, and heavy metals) will be monitored using applicable tools that meet manufacturer specifications, test results will be determined at certified laboratories and for standard compliance issues, mitigation and improvement measures will be taken. The hygiene program will follow Mongolian standards, requirements from related specialized regulatory agencies, as well as internationally approved practices, such as the NIOSH standard.

Employees who have received adequate hygiene monitoring training courses will use these tools strictly following monitoring methods listed in Mongolian and NOSH standards.

4 Environmental baseline study

A review of Environmental baseline study:

Our team has been executed following research works between May and July of 2009, beyond the Environmental Baseline study of Gatsuurt Gold Mine.

Performed field studies are:

- Soil sampling (5 points) to analyze general contents and heavy metals – duplicated samples were analyzed by Ekho Khangal Laboratory of Mongolia and SVL laboratory of USA
- Surface water monitoring data indicates that concentrations of a number of analytes, including arsenic, have exceeded the drinking water standard. Elevated concentrations could be erroneous (i.e. due to errors in sample collection; analysis or data entry) or related with variability associated with seasonal recharge events (i.e. which may be the cause of the elevated arsenic concentrations on occasion) or from groundwater inflow to surface water (i.e. through springs) which may result in the elevated iron concentrations for example. Exceedences of 2012 Mongolian Drinking Water and National Water Standards are summarized in Table 80 and highlighted in Appendix C.
- Figure 23 to Figure 25 presents piper diagram graphical plots of all surface water and groundwater sample locations. The results support previous interpretations that samples are all bicarbonate and calcium dominated and characterized by total dissolved solids (TDS) less than 1000 mg/L.
- The results support the conceptual understanding that alluvial groundwater is in hydraulic continuity with the surface water. The available data does not enable assessment of the degree of hydraulic continuity of potential separate groundwater systems (within the basement underlying the alluvial system) as no bores have been installed to target the deeper groundwater system to date.

Monitoring Location ID	Monitoring Type	2005	2006	2009	2010	2011	2012
Gatsuurt Upst	Surface Water	+	+	+	+	+	+
Gatsuurt Dwst	Surface Water	+	+	+	+	+	+
Dam GU1	Surface Water	-	-	-	+	+	+
Narst Dwst GU2	Surface Water	-	-	-	+	+	+
Arst Upst	Surface Water	-	-	+	+	+	+
Biluut Dwst GU3	Surface Water	-	+	+	+	+	+
Dam GU4	Surface Water	-	-	-	+	+	+
Dam GU5	Surface Water	-	-	-	+	+	+
Dam GU6	Surface Water	-	-	-	+	+	+
Balj Upst	Surface Water	-	-	+	+	+	+
Balj Dwnst	Surface Water	-	-	+	+	+	+
Kharaa Upst	Surface Water	-	-	+	+	+	+
Near Camp	Surface Water	+	+	+	+	+	+
Gats Well GU7	Groundwater	-	-	+	+	-	+
Gatsuurt river middle	Surface Water	+	+	-	-	-	-
Gatsuurt pond #1	Surface Water	+	+	-	+	-	-
Gatsuurt pond #2	Surface Water	+	+	-	+	-	-

Monitoring Location ID	Monitoring Type	2005	2006	2009	2010	2011	2012
Gatsuurt pond #3	Surface Water	-	-	-	+	-	-
WD-BH-1	Groundwater	+	+	-	+	-	-
WD-BH-2	Groundwater	+	-	-	-	-	-
WDD-BH-1	Groundwater	+	+	-	-	-	-
TMF-BH-1A	Groundwater	+	-	-	+	-	-
GT340	Groundwater	+	-	-	-	-	-
GT342	Groundwater	+	-	-	-	-	-
GT344	Groundwater	+	-	-	-	-	-
GT352	Groundwater	+	-	-	-	-	-
GT366	Groundwater	+	+	-	-	-	-
BLANK SAMPLE	-	-	-	-	+	+	+
GT-346	Groundwater	-	-	-	-	-	+
GTT-366	Groundwater	-	-	-	-	-	+
Dam GU-6 out flow	Surface Water	-	-	-	-	-	+
1.0km dwst Kharaa- Balj conf	Surface Water	-	-	-	-	-	+
Kharaa- Balj Conf	Surface Water	-	-	-	-	-	+
0.5km dwst Gatsuurt-Balj conf	Surface Water	-	-	-	-	-	+
0.5km dwst Kharaa- Balj conf	Surface Water	-	-	-	-	-	+
Gatsuurt- Balj conf	Surface Water	-	-	-	-	-	+
TMF-A-BH2	Groundwater	-	-	-	-	+	-
(-)not measured			(+)measured				

Gatsuurt hydro geological studies – reports, studies and assessments

Item	Author	Source
Gatsuurt Gold Project – Technical and Economic Study, March 2006	SNC-LAVALIN Engineers & Constructors Inc	CGM
Gatsuurt Gold Project - Updated Feasibility Study, March 2006	CGM	CGM
Hydrogeological Investigation at Gatsuurt Mine and Tunkhel Village, Mandal Soum, Selenge Aimag	Soil Trade LLC.	CGM
Technical Report on the Gatsuurt Gold Project, Northern Mongolia, May 2006.	Roscoe Postle associates Inc	CGM
Detailed Environmental Impact Assessment Report, 2009 (DEIA)	Nature Friendly LLC	CGM
Design Project for Water Collector and Purifying Structure in the Gatsuurt Gold Placer Mining Area and Restoration Approaches for the Gatsuurt River, 2009	Hydrofontain	CGM
Hydrogeological conditions of the Gatsuurt hard-rock gold deposit and the estimate of groundwater inflow to the Gatsuurt Open Pits	Prof. M. Alei / Boroo Gold	CGM
Geotechnical Investigation for Gatsuurt Project, March 2006	Soil Trade LLC	CGM
Rainfall data for Zuun-Kharaa, 1970-2011	National Agency for Meteorology and Environment Monitoring	National Agency for Meteorology and Environment Monitoring
Geological drill logs, maps and cross sections	CGM	CGM
Surface and groundwater monitoring data	CGM	CGM

Flora and Fauna

Baseline vegetation surveys were conducted in July 2006. These surveys were designed to characterize vegetation types and to identify sensitive plant species potentially occurring or known to occur in the vicinity. A discussion of "special status" species (i.e., rare or endangered species) that may occur in the area is included. The area surveyed during the July 2006 visit includes the main survey area, located in and above the upper end of the existing placer disturbance, and an area along the access road that runs north of the Gatsuurt River to the main survey area.

Air quality

Air quality in the area of the proposed Gatsuurt sit area is generally good due to the lack of emission sources. Anthropogenic sources include open alluvial placer mining pits and eroded soils, informal roads that are generating dust primarily from wind impact. Calculating baseline dust levels at project area is important for determining mine operations impact on dust formation once operations commission. There is very low noise and vibration noted.

4.1 Climate condition

Temperature, precipitation amount, wind and humidity data were collected from two weather stations located near Gatsuurt project area. Baruunkharaa weather station is situated 20 km north from project area and Zuunkharaa weather station is 27 km southwest of project area. Weather data for encompasses period between 1975 and 2004 (See Figure 6.1).

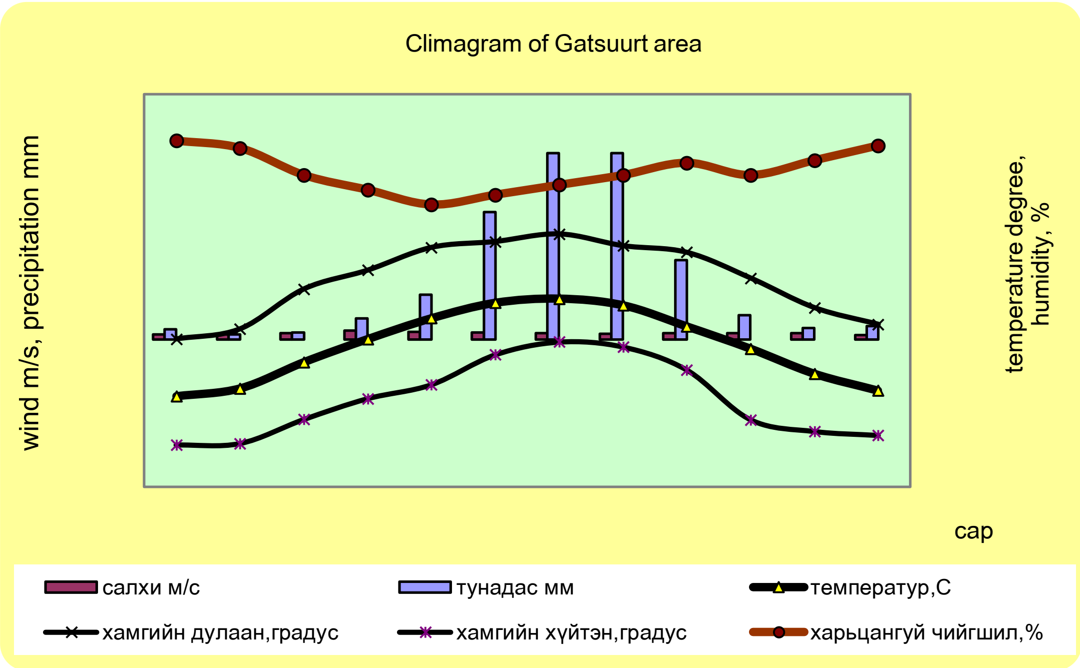


Figure 4.1 Gatsuurt area climagram

Meteorological parameters

Air Temperature: Yearly average temperature recorded at ZuunKharaa weather station is -1,9. January average temperature is -26,9^0. In July, summer season's warmest month is recorded at average temperature of +19^0. Winter is continuous for an average of 171 days and up to 250 days recorded maximum and 124 days recorded minimum. For any climate regime of a particular area, the decisive factors to consider are air, soil heat reserve, variation. During the coldest month, January, at riverbeds, the average temperature reaches -26.9^{0}C, whereas it is about -24.5^{0}C in other places. The coldest in project area reaches -48^{0}C, although cold variations occur in different regions. During the warmest month of July, average annual temperature is +19^{0}C and +16^{0}C at elevated places. Absolute maximum temperature is +37^{0}C.

Table 4.1 Air temperature of the area (C)-ZuunKharaa meteorological station

Month	I	II	III	IY	Y	YI	YII	YIII	IX	X	XI	XII	Average
Air temperature	-26,9	-23,7	-10,5	2,6	9,9	16,8	19,0	16,8	9,4	0,6	-13,2	-24,1	-1,9
Absolutely lowest t^0	-47	-45	-41	-23	-14	-7	-2	-3	-13	-25	-45	-48	-48
Absolutely highest t^0	-2	6	20	28	33	37	37	39	33	27	15	5	39

Cloudiness, solar radiation, sunshine: The solar radiation and sunshine in Gastuurt project area of Mandal soum is average to the region, although some features are noted. At Gatsuurt project area, there are total 100-112 clear sky days. At lower atmosphere, there are 240-260 days which makes it into a considerably cloudy region of Mongolia. That is, days with cloudiness level of 10 there are 72. There are 51 cloudy days at the lower atmosphere, suggesting that there is sufficient insulation and heat. The horizontal surface reflects about 4,410 mJ/m2 of solar radiation, and 2,515 mJ/m2 direct radiations in a year in the project area. Total solar radiation is 120 mJ/m2 in December, when the Earth is farther from the Sun, and 580-590 mJ/m2 in May and June. The solar radiation equation is negative from November to the middle of February, and positive from March to October. The annual average cloudiness at Gatsuurt project area is 4.6, 1.7 at lower atmosphere and it follows summer regime. Solar radiation has seasonal pattern and will inevitably affect Gatsuurt project area operations, particularly to those personnel working outdoors. Solar radiation balance has higher loss rate between October and February, which is explained by ground freezing starting from the surface. Solar net radiation between March and October shows positive value, which is explained by thawing ground.

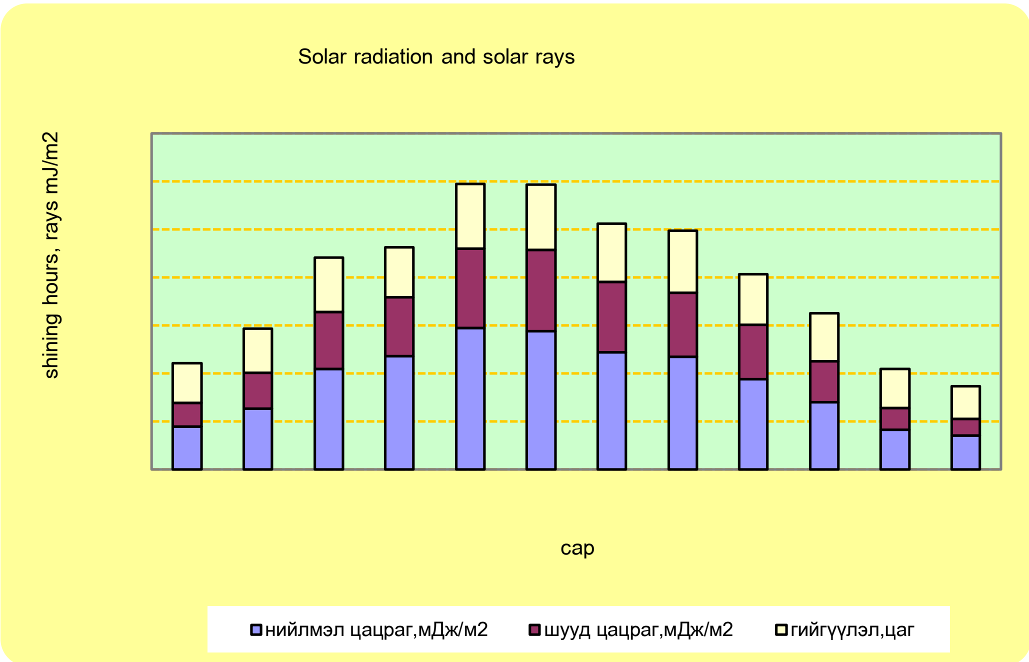


Figure 4.2 Solar radiation and solar rays

Sun shines approximately 2,540 hours in a year, 130-180 hours in wintertime, 5.5-6.5 hours in an average winter day and 240-270 hours in summer time, with 9.5-10.5 hours in an average summer day. Insulation during will depend on cloudiness and ranges between 53-60 % in the summer seasonal and at 61-67% in other seasons. Due to sun radiation effect, ground surface heats, becomes cold, creating a heat exchange regime in the air.

Soil temperature condition: During soil stripping, earthworks, and ore excavation the because the deeper areas of ground are affected, it is valuable to know information of temperature regimes, soil climate, freeze and thaw norms, as well as humidity. Soil surface average temperature is +20C, which means that the ore body is not significantly affected by freeze. The average soil temperature in July is +240C (absolute highest 64-680), and the coldest January is -250C (absolute lowest -490C). Overall, the soil temperature is 2-40C lower during cold seasons and is 5-90C higher during hot seasons. The absolute amplitude temperature at soil surface reaches 102 0C, but reduces as it reaches further down into the soil.

Freezing and thawing of soil: When the surface soil temperature reaches below zero, the soil starts freezing at a speed depending on its soil cover, soil thermal environment, liquid water content, mineralization and soil structure. Gatsuurt gold project area, the soil starts freezing from the surface in Fall, particularly October 10 to 20th (on average October 15th). The soil continues to freeze further down into the ground until enough energy is existent to instigate pore-water nucleation, which typically occurs until March-April of the next year. In the Spring seagoing, soil thawing process starts, notably form April 1 to June 15. For approximately 51-80 days (on average 65 days), the thawing process occurs from surface ground and further underground. That is to say that the ground in this area is frozen 195-220 days (with an average of 207). The depth of freezing will depend on soil and rock type, soil moisture and is clay, clayish 2.7 m, sands smaller in diameter 2,9 m, sands small in diameter 3.2 m, and can reached deeper into rocks at a depth of 3,8 m [2,3]. Depending on each year's weather, including heat and cold exchange, soil freezing-thawing periods can be variable every year.

Wind regime, patterns of windstorms: The microclimate and the wind regime will inevitably impact on mine operations. Prevailing winds between BGM and the Gatsuurt property are from the west, southwest, and north. Cyclone (clockwise) and anti-cyclone (counter-clockwise) winds influence the local wind regime. The anti-cyclone influence in winter results in winds from the north-northwest. Cyclone winds occur in the summer months and results in winds from the west-northwest. Topographic features, such as mountain ranges, hills, and plains, also have a localized effect on wind direction. The meteorological station at BGM has recorded an average wind speed of 2.8 m/sec with mid-range wind speed at 5 m/sec, and the highest wind speeds between 18 m/sec to 34 m/sec. Dust storms are likely to occur in springtime during periods of strong wind.

Prevailing winds at the Gatsuurt property are from the west, southwest, and north (see Table 4.3). Although the wind direction changes with different seasons, particularly in winter season when the wind blows from Boroo river valley Southwest. This is common of mountain valley winds. During daytime, wind blows from valley and during the night time, the wind blows from the mountains.

Table 4.2 Wind directions, windless frequency, average speed (Gatsuurt region)

January	North	North east	East	South east	South	South west	West	North west	
Frequency,%	13.9	17.9	12.4	10.6	12.5	8	15.4	9.2	54.9
Speed, m/s	1.7	1.6	1.1	1.1	0.9	1.2	1.2	1.7	

April									
Frequency,%	23.7	11.5	9.4	5.2	8.7	9.2	15.1	17.1	21.2
Speed, m/s	3.9	3.3	2.5	2.1	2.8	3.3	3.6	3.7	
July									
Frequency,%	18.2	15	11.1	9.1	8.6	7.4	17.1	13.6	26
Speed, m/s	3.1	2.9	2.7	2.7	2.4	2.6	2.9	3	
October									
Frequency,%	24.1	10.3	6.6	6.3	7.6	10.6	18.6	15.8	32.5
Speed, m/s	3.2	2.9	1.6	1.5	2.3	3.1	2.4	2.9	

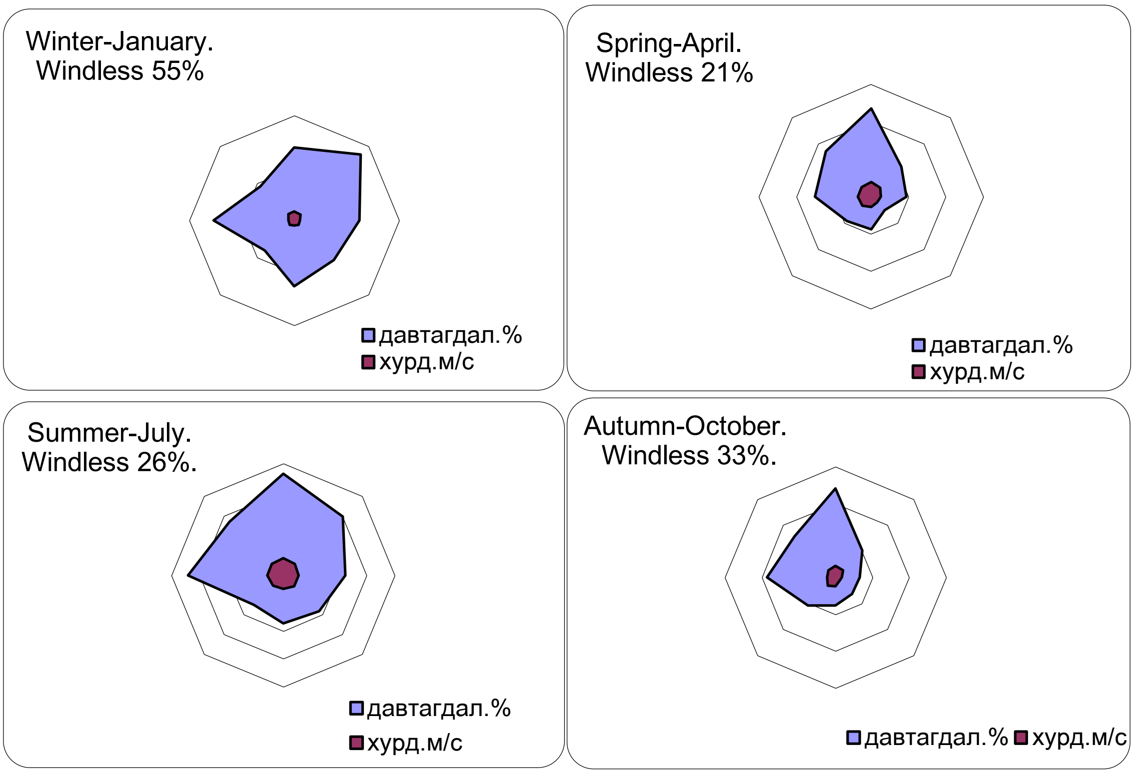


Figure 4.3 Wind direction, windless frequency and average speed

Wind speed: In general, wind speed increase in spring and autumn and decrease in the winter and summer. Wind speeds progressively increase during the day from morning to evening, with the lowest wind speeds occurring at night. In directions dominant in the area, average speed of wind is 1–3 m/s in winter, 3.2–7.0 m/s in spring, 1–5.5 m/s in summer and 1.6–4.5 m/s in autumn.

Table 4.3 Highest wind speed of the region (m/sec)

Month	I	II	III	IY	Y	YI	YII	YIII	IX	X	XI	XII	Average
Average	2,2	2,4	3,2	3,9	3,9	3,3	2,7	2,8	2,9	2,5	2,4	2,0	2,8

Annual wind speed, regardless of wind direction, is 2.6 m/s. However, the wind velocity increases in Spring months 3-4 m/s, winter wind speed is lower at an average of 1-2 m/s in December and February. Other month's average is 2-3.5 m/s, which makes the area relatively low wind area in the country. Wind regime is marked by two high wind seasons (Spring, Fall) and two low wind seasons (Summer and Winter). The highest wind speed recorded reaches 10-2-m/s, but can be up to 20-24 m/s in the Spring season.

Air humidity and precipitation: The distribution of local precipitation is also affected by microclimate conditions influenced by surface topography, elevation, and aspect. The precipitation amount increases with increase in elevation and from north to south. The average precipitation at the project area is 265-310 mm (See Table 6.5). Out of annual average precipitation, the 8 mm or 3,01 % occurs in the winter, 29 mm or 10.94% in Spring, 184 mm in 69.43%, and 44 mm or 16,6 % in the Fall. Out of this, 21,2 % occurs in cold season in the form of snow and the rest 78,8% occurs in warm season in the form of rain.

Table 4.4 Number of rainy and snowy days in project area

Month	I		II		III		IV		V		VI	
	snow	rain	snow	rain	snow	rain	snow	rain	snow	rain	snow	rain
Average	1	0	2	0	2	0	2	1	1	3	0	6
Month	VII		VIII		IX		X		XI		XII	
	snow	rain	snow	rain	snow	rain	snow	rain	snow	rain	snow	rain
Average	0	12	0	11	1	7	3	2	5	0	5	0

In terms of air humidity, the project area is considered to be in dry zone. The relative air humidity is 66%. Humidity is lower in Spring and Fall and higher in Winter and Summer.

Table 4.5 Air humidity

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Average	78	78	69	49	47	54	66	67	67	66	74	79	66

Table 4.6 Precipitation, mm

Month	1	2	3	4	5	6	7	8	9	10	11	12	
Precipitation, mm	2,3	2,3	3,1	10,3	19,0	59,3	84,4	80,3	30,7	10,2	2,7	3,1	307,7
Daily maximum precipitation, mm	3,0	4,0	8,0	19,0	21,0	68,7	44,0	39,0	29,0	18,0	5,0	4,0	

Snow cover, atmospheric phenomena: On average, there are 49 rainy days recorded annually at project area, 31 snow days, although these numbers can vary. 5-10% of annual precipitation is snow, although the average snow covers if thin. However, this regime is not followed in years where there has been much snowfall.

Seasonal variation: Gatsuurt gold processing mine conditions are largely influenced by a climate marked with 4 seasonal variations, including warm and cold period climate. On an average, 5-10 percent of total precipitation is snow and snowfall is approximately 5-15 sm. Snow density is 0.25-0.27 g/sm3. This specification may change when it is a heavy snowfall.

Table 4.7 Four season of Gatsuurt area

Description	winter	spring	summer	autumn
Starting	18.X	27.III	22.Y	30.YIII
Finishing	27.III	22.Y	30.YIII	18.X
Days	160	56	100	49

Table 4.7 and Figure 4.4 show climatic conditions in conjunction with gold exploration, gold processing operation and completion stages, as well as topsoil stripping, and work environment factors. The purpose of providing weather constraints is to ensure that they are addressed for effective phase-based planning of mine operations and machinery allocations. Continental climate in the project area is seen by nearly even distribution of spring-fall and winter-summer seasons. Annual seasonal period depends on the weather conditions for that particular year, but never vary above 3-6 days.

Winter. The winter period continues for 160 days, starting from October 18 to March 27 of the next year. Several characteristics of winter relatively stable weather conditions, lowest sun height (18-230), a stable snow cover falls relatively early, and temperature reaches extreme (-430). At the ending of a winter season, the strength of coldness gradually falls and the spring climate is approached.

Spring period starts from the end of winter and continues for 56 days (March 27th to May 22nd). Weather in spring is changeable, even though a gradual temperature increase is observed. The spring season at Gastsuurt project area will be marked by fierce winds, blowing air is filled with dust and sand, although dust distribution will depend on wind speed and wind direction. As the hours of daylight increase and the ground slowly warms, ice and snow thaw and runoff snowmelt is visible in the early days of spring season. The soils at edges and that darker in color gradually thaws, and despite sudden cooling at nights, by late spring, soil thawing slowly moves deeper into the ground.

Summer. Summer period are relatively warm, in some cases there are continuous rain falls. Summer seasons is most favorable for mine operations and can be most productive. In Central region, which includes Gatsuurt project area, the summer continues for 100 days (May 22 to August 30). The majority of rainfall (93% or 273 mm) occurs in this season. Rainfall is considerably heavier in the north. Rise in temperature, heavy rainfall, thunders, rainstorms and potential floods will inevitably influence the gold mining activities.

Autumn. Autumn continues from late summer and beginning of Winter August 30 to October 18. Distinct features of weather condition in the fall are increasing drops in temperature, cold nights occurring with the first frost, and precipitation changing from rainfall to snowfall. Ice and snow are created and soil melts. Daylights reduce and nights are longer, thus requiring that outdoors works are adjust to seasonal conditions. Work production overall decreases and seasonal works are stopped.

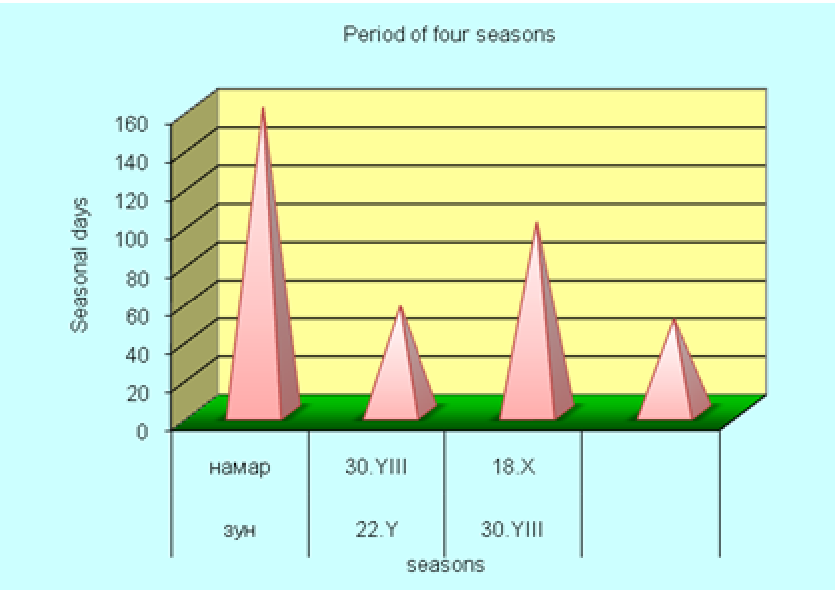


Figure 4.4 Period of four seasons

4.2 Gatsuurt Gold Project Geologic Setting

4.2.1 Regional geologic setting

The Gatsuurt deposits are located within the North Khentii tectonic belt in north central Mongolia. The tectonic belt is bounded on the northwest and southeast by the Bayangol and Yeroogol fault systems. The North Khentei belt is dominated by three lithotectonic components (Figure 4.1).

- The oldest rocks are Late Precambrian to Early Paleozoic flysch sequences which are intruded by later Early Paleozoic intrusive complexes. In the Gatsuurt area, the Sujigtei fault system separates two different geologic settings. To the northwest, the bedrock consists of Permian felsic volcanic rocks associated with the Dzuun Mod caldera. To the southeast, intermediate members of the Boroo Intrusive Complex intrude the Lower Paleozoic clastic metasedimentary rocks of the Kharaa Formation. Miogeosynclinal flysch includes the Precambrian Yeroo Series- green-schist grade metamorphic rocks northwest adjacent to the Yeroogol fault and the Lower Paleozoic Kharaa Series sandstones, shales, siltstones, conglomerates, phyllites, quartz-sericite and sericite-chlorite schists and some intermediate tuffs. Early Paleozoic Boroo Complex (450 Ma to520 Ma) biotite and biotite-hornblende granodiorite and granites have intruded the Yeroo and Kharaa Series east of the Bayangol fault zone. Renewed movement along Sujigtei fault at Gatsuurt dislocated the intrusive rocks. These are overlain by Middle to Upper Permian continental volcanic rocks and sedimentary rocks. The tectonic belt is bounded on the northwest and southeast by the Bayangol and Yeroogol fault systems.
- Mid to upper-Devonian continental volcanic and sedimentary rocks lie upon on the Yeroo, Kharaa and Boroo rocks and are spatially confined to the Yeroogol fault system. Volcanic rocks consist of sub-volcanic rhyolite porphyry, tuffaceous andesite lava and breccia. Sedimentary rocks consist of shale, sandstone and conglomerate.
- The youngest rock units are Jurassic to Cretaceous and Tertiary coal-bearing sedimentary rocks and conglomerates.

The Bayangol and Yeroogol fault system trend northeast southwest and are thought to be strike-slip fault zones with left-lateral displacement. The Lakefield Research Report writes that the regional extent, together with their associated volcanism and magmatism, indicates that they are deep-seated features. Higher order structures oriented approximately 020°, 130° intersect the Yeroogol fault, and these intersections are considered favorable for gold. The Gatsuurt Project is located in such a tectonic setting along the Sujigtei fault that form part of the Yeroogol system. The North Khentii gold belt has a long history of alluvial placer mining and includes bedrock gold deposits. Placer districts, gold, and arsenic abnormalities in stream sediments align roughly parallel to the Bayangol and Yeroogol fault system. The Gatsuurt placer that overlies the Central Zone occurs in the latter system. Bedrock gold deposits within the trend include the Boroo Mine, Gatsuurt and Bumbat.

4.2.2 Geological description

Exploration to date indicates that the Gatsuurt deposit consists of disseminated and vein style gold mineralization in volcanics, granite and metasedimentary rocks in two geographically separate zones, the Central and Main. The Central and Main zones are located adjacent to the Sujigtei fault. The Central Zone lies on the southeast hanging wall side of the structure whereas the Main Zone is on the northwest side approximately 400 m to the southwest. The combined length of the two zones is approximately 1.5 km and their combined width is at least 300 m. The North Khentii gold belt deposits and occurrences are typically mesothermal and may comprise individual quartz veins with coarse gold and low-sulphide content as well as disseminated fine gold in sulphidized rocks. Permian rhyolite and Boroo Complex granodiorite, granites and diorites and Kharaa Series metasedimentary rocks underlie the Gatsuurt area. These lithostructural units occur along, and are separated by, the Sujigtei sub vertical fault. Volcanics (rhyolite) are found on the northwest side of the Sujigtei fault whereas Boroo granite occurs on the southeast side. The granite contains fault bounded "xenoliths" of Kharaa Series metasedimentary rocks and hosts volumetrically minor diorite dikes and xenoliths of other Boroo Complex rocks.

4.2.3 Ore composition and formation

In terms of gold mineralization, Gatsuurt ore is divided into 2 types of mineralization zones. Marked by geological and location characteristics, ore bodies are divided into Central Zone and Main Zone.

Central Zone: A continuous 1,400 m long mineralized structure marked by alteration and gold values of 1 g/t or more is indicated in the drill core from the Central Zone. Gold is associated with three styles of mineralization

- disseminated and fracture controlled stockwork sulphide veinlets
- pervasive silicified zones with very fine grained sulphides and occasional visible gold
- discrete white quartz veins with variable sulphide content and occasional

The sulphides typically comprise two to six percent by volume and consist of equal amounts of pyrite and arsenopyrite. Petrog Some "lattice bound" gold within arsenopyrite is also suspected; especially in the Main Zone. Geographic studies have identified micron-size gold grains as discrete particles within pyrite.

Gold grades, intensity of the alteration and sulphidation are typically dramatically less in rhyolite porphyry, Kharaa meta-sandstones, magnetic granite and diorite xenoliths or fault slices. However, narrow structures that crosscut Kharaa meta-sandstones may carry high grade, visible gold, pyrite, and arsenopyrite in generally small amounts but up to 16%. These latter quartz veins and veinlets vary from 1 cm up to 2 m wide and mainly fill fractures and breccia. Gold distribution in the Central Zone is more variable over short distances and exhibits a much broader range than in the Main Zone where the host geological environment is considerably more homogeneous and has a relatively uniform distribution of gold. Late fine-grained silica alteration and fine-grained quartz veins carry coarse-grained free gold in the Central Zone but are scarce in the Main Zone. As much as 20% of the gold in the Central Zone may occur as native metal. Gangue minerals are quartz, carbonate, sericite and rarely feldspar, muscovite and fluorite. Gold values in the principal quartz-sericitic and sulphidation alteration zone correlate well with arsenic content, where late silica veins/veinlets are not present.

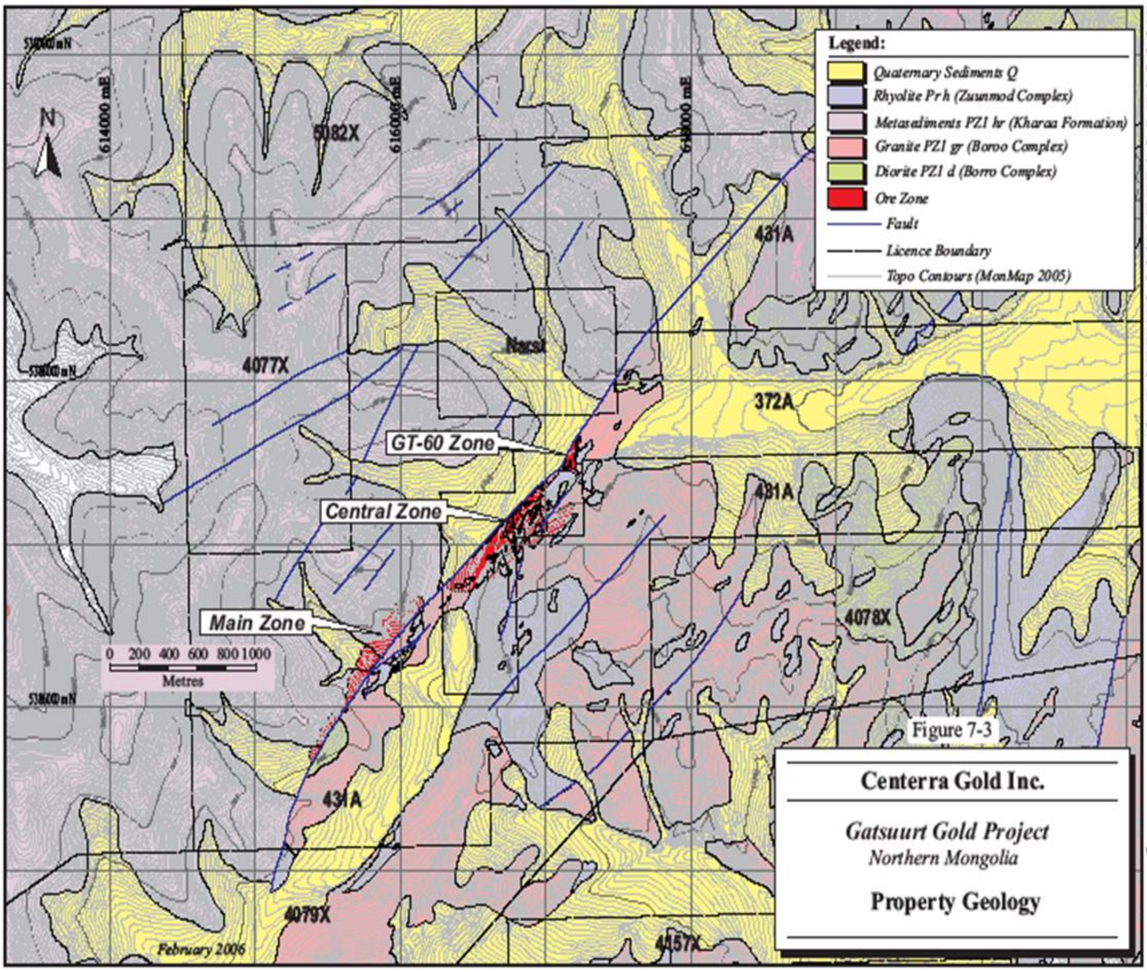


Figure 4.5 Geological setting of Gatsuurt gold mine

4.3 Hydrology, groundwater quality

Project area is located in the Selenge river basin of North hydrogeological region (as described by Doctor N.Jadambaa).

14-Selenge river basin of North hydrogeological region.

North hydrogeological region: According to hydrogeological map of Mongolia with scale 1:1000000 and 1:500000, groundwater formations are determined in the following deposits:

a) Alluvial deposits within river valley
b) Granite formations of various ages
c) Sedimentary rocks as grindstone, sandstone and zanuujun
d) Various volatile rocks [1]

Figure 4.6 Hydrogeological regions of Mongolia

1. Collector features of aquifers: Collector features of rocks (fissure, porosity) determine water containing circumstances. Collectors occurred in the Gatsuurt mine, are fissure and porosity. Loose deposits, lithological contents and fragmental rock contents from Modern and Upper Quaternary ages were found spread commonly and properties and thickness are much different. These are originated from alluvial, alluvial-prolluvial mixed deposits. Alluvial deposit spread in the limited area of along river basin and have hydraulic conductivity with surface water. Prolluvial deposit spread in the mountainside and hollow valleys intermountains. The deposits are settled alternatively with poorly or moderately rounded gravel, sandy and clayey particles with various thickness, which are differ between 10-20 meters. [3] According to hydrogeological survey, the deposits contained much aquiferous. [2] Alluvial-prolluvial fissure deposit mainly spread in the mountainous surface, plat field and hollow valleys intermountains. The deposits are settled alternatively with well or moderately rounded gravel, clayey mills, sand or sandrock with various thickness, which including thin layers, mishel and cleavage. At Gatsuurt mine site, bedrock gold deposits are found in fault collectors. At ground surface area, weatherized fractured rocks are predominating and their dissemination is disorderly and not uniform. Altered fractured rocks are disseminated following natural topography. Zone with intrusive rocks reaches a depth of 60-100 meters. Groundwater is present in these fractures. Water depths are not uniform across project area, showing high correlation with rock fracture dissemination. Water table reaches about 70 m at gold deposit area. Due to tectonic movements, contact between rocks was loosened at some zones resulting in the creation of tectonic bedrock aquifer collectors. Compared to weatherized fractured rock zone, tectonic fractures are located deeper into the bottom and have higher water saturation was recorded. Water saturated tectonic fault zone contains water from bedrock aquifers.

Groundwater types: In the Gatsuurt mine, it is classified two different types with respect to its collector feature, water filtration characteristic, distribution formation, flow direction, surface leakage and nourishment.

a. Groundwater in quaternary (overburden) system.
b. Groundwater in bedrock system.

Groundwater from alluvial and prolluvial fissure encountered between 0.5-15m depth underground with water of bedrock.

- Water is found at depth of 0.5-15m at this region's permeable alluvial and prolluvial deposit trenches and holes. This is near surface soil water. Water containing rock collector's attributes vary and that is why water containing layers are not uniform. The surficial geology consists of modern and Quaternary-age rocks. Boreholes where water was detected in these structures showed water discharge of 1.2 to 6.0l/s for water table drawdown of 2.5-5.5m. [3]
- Aquifer, porous rock pattern zone water is widely distributed at Gatsuurt study area, thereby creating an independent hydrogeological formation. Aquifer water is detected at depth between 8.5-9.0 m and its distribution depth is defined by zone thickness and the depth of tectonic fracture. In terms of hydraulic properties, with low pressure gradient, it creates a hydrogeologically water-containing zone. Water layer thickness at magma-aged faults is 23.5-35.0 m. At this layer, water discharge rate at the drilled borehole was 0.56-2.44 l/sec. Water is clear (mineralization of 0.7 g/l), low contents of hydrocarbonate-sulfate-sodium were found; water is rather soft (3.5 mg-eqiuv/l), alkaline (pH=7.6). [2]

Figure 4.7 Hydrogeological map of the project area

Underground water movement: One can say that because Gatsuurt mine project permeated water has open/free surface, it fairly correctly follows the ground surface formations. Therefore, water flow follows mountain valley and slopes and flows in the direction of river valley. At present, it is not possible to develop a map showing groundwater movement and its surface cross section because there was no in-depth study of groundwater conducted at the project area. Water seepage coefficient is not the same throughout these permeable rocks, which also means that water seepage rate will be varying across the project area. The relatively high borehole water discharge rate indicates high infiltration rate at studied boreholes.

Subsurface water composition regime: Gatsuurt project subsurface water is charged by precipitation and follows fissure flows of hydrogeological faults from upper source and feeding downwards. Water is detected at fairly shallow depths. This can be explained by generally open surface and freshness of water. In addition, the surrounding higher hills and mountains create the subsurface water flow channel zone and assist in recharging the water with precipitation, thus also transporting it. The plentiful subsurface water reserves are directly related to precipitation at project area. The subsurface water flow coefficient at this area is 0.15. The previous hydrogeological study at the project area did not calculate water reserves and availability.

Surface and groundwater connectivity: The subsurface water at Gatsuurt gold deposit zone has direct hydraulic connectivity with Gatsuurt River, which is fed by Narst River, Biluut River and Nergui river. A direct hydraulic connectivity is created because soil water level is higher. Two culverts are also conveying channel water from Noyon Mountain downwards.

Hydrogeological structure: Hydrogeologically Gatsuurt ore deposit zone can be structurally divided into following:

- Hydrogeological massive
- Hydrogeological basin
- Water containing fractured rocks

Gatsuurt ore reserve territory's hydrogeological massive has naturally intrusive granite stone structure, and its water saturation capacity is expressed by the abovementioned rock's alteration zone, tectonic fault cross section. Water is primarily captured in rock pore spaces. Water drainage direction is facing downward towards river valley, thus further feeding down-gradient flow paths. There are no large hydrogeological basins at Gatsuurt project area. However, there is Gatsuurt River and Biluut River channels flowing down gradient of the fault cut near project territory fringe. These water streams may be filling valley's porous rock layers and feeding the ground water. This hydrogeological structure can be explained by such feature as high water permeability observed in rock fissures and pores. At some of drilled boreholes water flow rate reached 12-15 l/s. Therefore, it is important to have knowledge of Gatsuurt site hydrogeological structure and its properties for future water supply purposes. The largest zone of water containing fractured rocks is near Noyon Mountain fault zone. It has been historically recorded that water permeability is high near this fault zone. This is evident from 0.4-0.8 l/s flow rate of two springs running from Noyon Mountain foothill. Fault zone created during tectonic contact's last phase influenced on hydro morphology at project area and impacted on subsurface water movement's features.

Groundwater regime: There has been large variability in subsurface water regime, showing high dependence on climatic factors. Water table usually fluctuates as high precipitation, flooding years with dry and arid years' alternate. Water table is also impacted on water permeability of the previous year. The highest drawdown in subsurface water level was observed in the months of February and March and highest water tables were recorded in July and August months of summer. There is typically a rather slow drawdown in subsurface water level, particularly at low permeability rock zones. These water table fluctuations were noted in groundwater wells of Seleneg province water farm (old name) that were drilled near Gatsuurt mine. There have been no detailed studies carried out on Gatsuurt project site and surrounding land's hydrogeological conditions and subsurface water regime. Only soil quality study and that soil water was detected were mentioned in "Soil Trade" LLC 2005 Study Report, which includes a section on geotechnical assessment work.

Table 4.8 Hydrogeological description of earlier wells around Gatsuurt area (1978-1992)

	No	Well type	Hydrogeological description							
			Depth, m	Flow, l/s	Aquifer	Thick of Aquifer, m	Static level, m	Dynamic level, m	Level change, m	Mineralization, mg/l
Gatsuurt area	931	Drilling	25.5	3.7	12-18	6.0	4.8	6.0	1.2	0.2
	8039	Drilling	46.0	1.5	18-36 39-46	7-8	18.0	20.0	2.0	-
	9882	Drilling	40.0	6.0	5-19 21-25 30-33	3-14	6.0	21.0	10.0	-
	7961	Drilling	31.0	1.4	5-8 22-31	3-9	5.0	7.5	2.5	-
	7980	Drilling	45.0	1.4	14-31	7.0	14.0	19.6	5.6	-

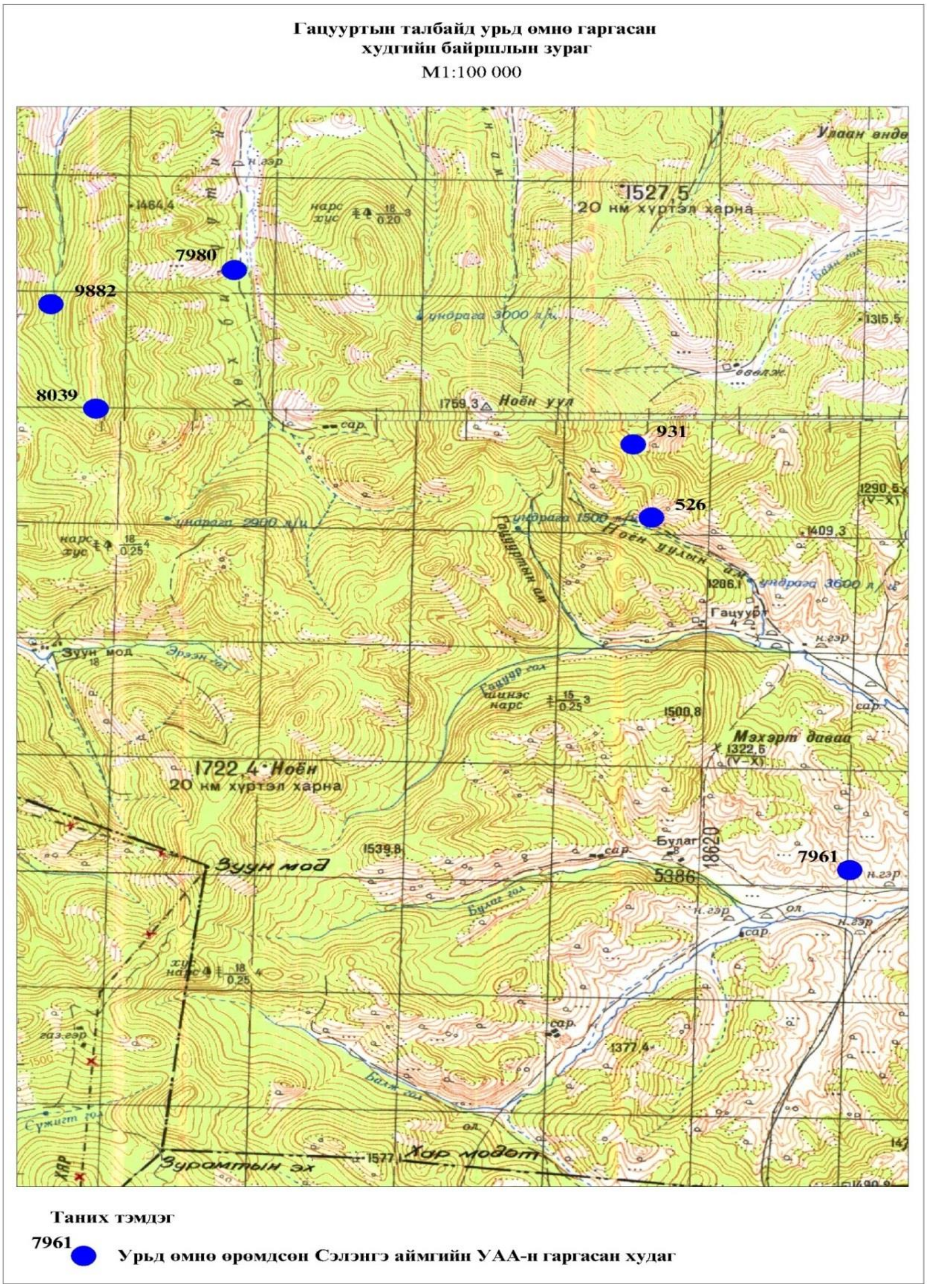


Figure 4.8 Locations of earlier wells in the Gatsuurt area

It is observed that groundwater level is absolutely different and groundwater regime is also different according to their groundwater nourishment and formation. During the drilling, groundwater encountered at 0.3-5.48 depth in the Gatsuurt River upstream and it shows higher groundwater nourishment. [4] A field investigation program was undertaken by Soil Trade LLC between June and October 2005, as a component of a site-wide geotechnical assessment field program. As result [4] of engineering-geological and monitoring borehole section (cutting) in the proposed boreholes BH-1.2 and

3 locations for water diversion dam, groundwater encountered at 0.3-5.4m depth ground. In accordance with geology-lithologically, below 12.5 m depth refer to fissure rocks of granite. This is the reason that groundwater be formed close to ground surface in the seasonal freezing zone.

Table 4.9 Water level measure

Borehole No	Coordination		Absolute height, m	Borehole depth, m	Groundwater level, m	Measurement date
	N	E				
TMF-BH-1A	5388086,52	619946,21	1173,02	14	0,72	09/08/2005
TMF-BH-2A	5388175,61	619670,27	1190,55	22	14,33	09/08/2005
TMF-BH-3A	5388046,33	619667,20	1177,19	14	0,3	09/08/2005
TMF/A/-BH-1	5388076,43	618172,13	1218,38	32	4,5	09/08/2005
TMF/A/-BH-2	5388342,53	618118,26	1227,05	23	5,48	09/08/2005
PS-BH-1	5388015,87	617845,55	1244,22	18	Усилрээгүй	09/08/2005
PS-BH-2	5388068,85	617986,03	1237,46	22,0	-	09/08/2005
PS-BH-3	5387948,34	617690,12	1252,13	16,0	-	09/08/2005
WD-BH-1	5387782,95	618113,36	1217,23	21,0	5,18	09/08/2005
WD-BH-2	5387681,32	617652,43	1234,52	23,0	15,05	09/08/2005
WD-BH-3	5386508,42	616410,34	1266,72	20,5	2,81	09/08/2005
WW-1	5387960,42	621087,95	1157,83	60	28,02	09/08/2005

2. Groundwater (soil water): Groundwater spread shallow in river bed or embankment and its level is not more than 2-5 meters because of infiltration that depends on rock elevation and properties. Groundwater factors are nourished with rainwater and surface water down runoff. Groundwater widely spread in the Gatsuurt river valley.

Precipitation intensity depend on infiltrating rainfall amount, groundwater level and rock composition in the aerobic zone. Groundwater level (H) and precipitation (P) have direct interdependence. Depending on climatic conditions, the groundwater levels may vary significantly depending on drought or heavy rainfall conditions. The unconfined shallow groundwater flow system in the river valleys is closely associated with the surface water flow system within the river valleys.

A field investigation program was undertaken by Soil Trade LLC between June and October 2005, as a component of a site-wide geotechnical assessment field program. As result [4] of engineering-geological and monitoring borehole section (cutting) in the proposed boreholes BH-1.2 and 3 locations for water diversion dam, boreholes TME for waste dump and boreholes TMF-TP for soil contamination, taken samples for water and soil analysis. Groundwater encountered at 0.7 meters for TMF-TP-13, at 0.4 meters for TMF-TP-9 and no groundwater occurred in the boreholes TMF-TP-2, 6 and 12. (Figure 4.10)

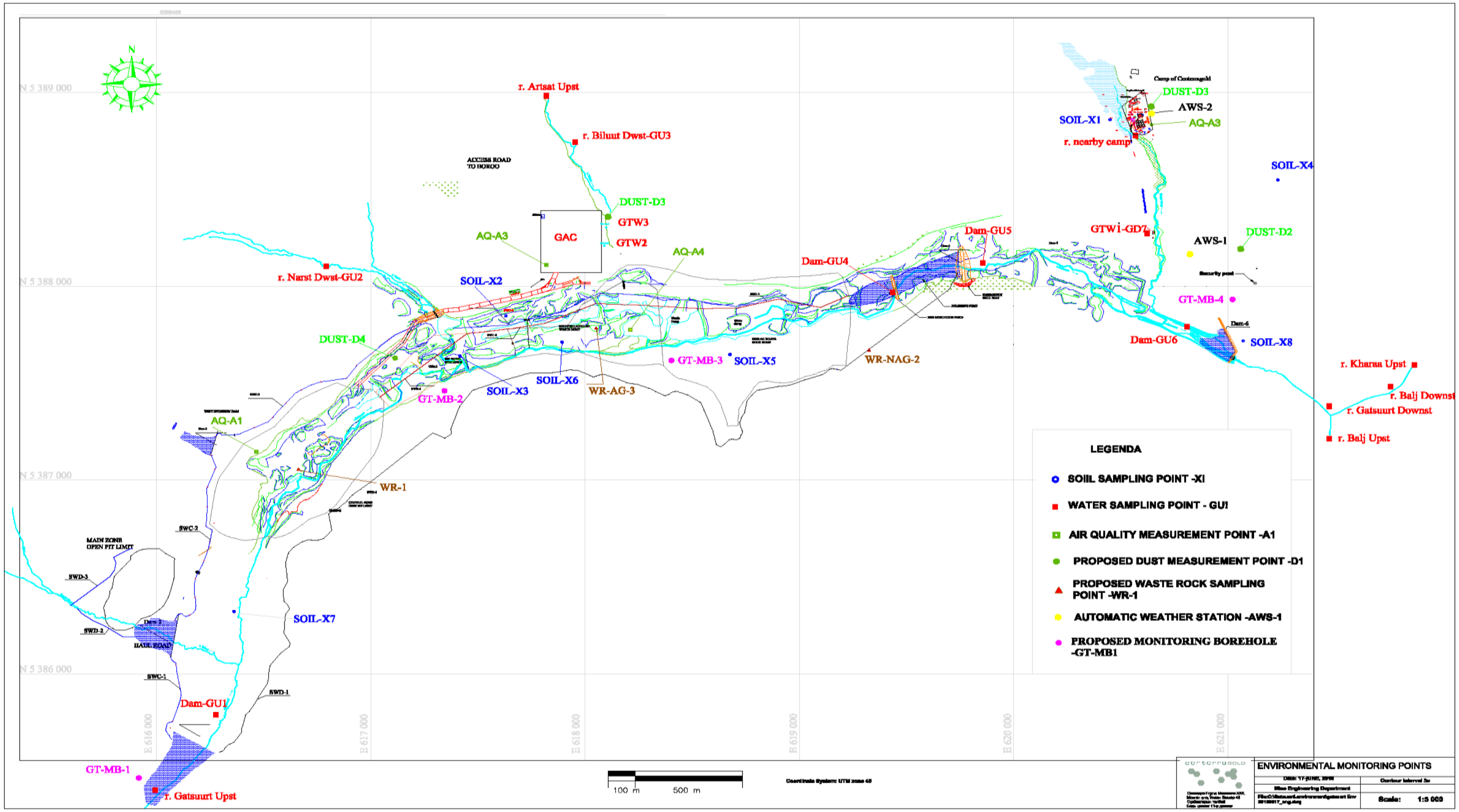


Figure 4.9 Environmental monitoring points

Figure 4.10 Gatsuurt Sample Points Outside the License Boundary

Soil water at boreholes near Gatsuurt water diversion dam was observed at 0.3-3.2 meters. Due to high water feed from surrounding hills, ground bedrock water seeped through pores of intermediary rock layers and closer up to ground surface, thus existing in the form of soil water. On the other hand, the riparian, hydrophytic vegetation in the area indicates that forest vegetation can impact on raise in soil water level.

It is possible to calculate open pit water anticipatory by using above information. A result shows that groundwater was found to occur from starting 1172 m elevation. From this elevation aquifer rocks will be found and thickness of aquifer is about 70 meters. An aquifer layer is approximately 500 meters long, 150 meters wide. Assessment of the in situ permeability was determined by a methodology as "Big well".

$$Q = 1.36k \frac{(2H - S)S}{\lg \frac{R_o}{r_o}}$$

There: k -coefficient of permeability, average value 1,3 m/day

H -thickness of aquifer , $H_{average}$=70 m

S -draw-down, depth 70 m

R_o - maximum radius of influence $R_o = R + r_o$

r_o -radius of test well, $r_o = \sqrt{\frac{f}{\pi}} = \sqrt{\frac{500*150}{3.14}} = 154.5$ m

$R = 2S\sqrt{kH} = 2*70\sqrt{1.3*70} = 1335.5$ м, $R_o = 1335.5 + 154.5 = 1490$ м

$$Q = 1.36*1.3 \frac{(2*70 - 70)70}{\lg \frac{1490}{154.5}} = 8840 \text{ m}^3\text{/day.}$$

As a result of the test, it is requiring to pump out about 8840 cubic meter water daily and 8840 m3 x 365 days = 3 226 600 m3 annually. It is anticipated that mining at 1172 m elevation will commence from the fourth year of the project. Then pit dewatering will commence from the third year of the project. Pumped out water from open pit will be flow through the treatment facility to pond.

Groundwater quality: In the Gatsuurt area significantly spread groundwater (soil water) without pressure. The samples were analyzed and results were reported by Soil Trade LLC. The water quality is described as "fresh, soft water of second type of sodium- calcium and mixed grade. Three of the sample results (2005) are shown in the following table.

Table 4.10 Result of chemical analysis

Ione	Boreholes TMF/A/-BH-1			TMF-BH-1			WD-BH-1		
	mg/l	mg-eq/l	mg-eq-%/l	mg/l	mg-eq/l	mg-eq-%/l	mg/l	mg-eq/l	mg-eq-%/l
$Na^+ K^+$	8.1	0.35	12.96	4.4	0.19	6.35	23.9	1.04	16.80
Ca^{2+}	36	1.8	66.67	30.0	1.50	50.17	54.0	2.70	43.62
Mg^{2+}	6.7	0.55	20.37	15.9	1.30	43.48	29.2	2.45	39.58
NH_4^+	-	-	-	-	-	-	-	-	-

Fe^{++}	-	-	-	-	-	-	-	-	-
Fe^{+++}	-	-	-	-	-	-	-	-	-
Total anion	50.8	2.7	100	50.3	2.99	100	107.8	6.19	100
Cl^-	5.3	0.15	5.56	14.2	0.40	13.38	5.3	0.15	2.42
SO_4^{--}	13.0	0.25	9.26	6.0	0.12	4.01	15.0	0.31	5.02
NO_2^-	-	-	-	-	-	-	-	-	-
NO_3^-	-	-	-	1.5	0.02	0.67	1.8	0.03	0.48
CO_3^-	-	-	-	-	-	-	-	-	-
HCO_3^-	140.3	2.30	85.18	149.4	2.45	81.94	347.7	5.70	92.08
Total cation	157.6	2.7	100	171.1	2.99	100.0	369.8	6.19	100
Cation+anion	208.4	5.4	200	221.4	5.98	200	477.6	12.38	200
pH	7.2			7.10			7.3		
Total hardness		2.35			2.80			5.15	
Balanced hardness		0.5			0.35			-	
Unbalanced hardness		2.30			2.45			5.15	
Mineralization	208.4			221.4			477.6		

A laboratory analysis provides drinking water quality standard of Mongolia and can be used for resident use. In 2005, Soil Trade LLC not conducted laboratory analysis for heavy metals. In 2009, a laboratory analysis for heavy metal had analyzed by Central Geological Laboratory of Mongolia and the result is illustrated in the Table 4.11.

Table 4.11 Laboratory analysis for heavy metals

Borehole No	Chemical elements, mg/l							
	Fe	Al	Cd	As	Mn	Zn	Pb	Hg
WDD-BH-1	1.59	1.82	<0.005	<0.01	0.02	<0.01	<0.05	<0.005
GT-344	0.07	0.067	<0.005	<0.01	<0.01	<0.01	<0.05	<0.005
TMF(A)-BH-2	0.14	0.13	<0.005	<0.01	0.02	<0.01	<0.05	<0.005

A result in the above table shows that chemical elements don`t exceed permissible level of the standards. A result of laboratory analysis by Ekho Khangal LLC of Mongolia is presented in the next table. An analysis is from well located near security post of Gatsuurt mine.

Table 4.12 Result of Laboratory analysis of water sample near security post

#	Methods of analyses	Indicators	Result (mg/l)
1	MNS3900-2005	Total hardness	3.10 mg-eq/l
2	MNS3900-2005	Temperature	19
3	MNS3900-2005	Taste	0
4	MNS3900-2005	Odor	0
5	MNS3652.6-84	Na	8.5
6	MNS3652.6-84	K	1.3
7	MNS2572-99	Ca	44.00
8	MNS4341-99	mg	10.1
9	MNS4424-96	Cl	35.46
10	MNS1097-70	Hydrocarbonate	219.6
11	MNS1097-70	Carbonate	Not detected
12	MNS1097-70	Alkaline	3.6 mg-eq/l
13	HS-3300 Water Analyzer	Al	0.02

As a comparison of former and last laboratory analysis, groundwater quality in Gatsuurt region not changed and the result of laboratory analysis will be considered as major circumstance prior mining operation. Currently, drilled boreholes for the purpose of engineering and geotechnical investigation destroyed and will not be used for monitoring or investigation furthermore.

4.4 Surface water, quality and regime

The Gatsuurt project is located within the Gatsuurt River valley and formed well surface watershed. The Gatsuurt River has three tributaries Narst, Biluut and Nergui rivers which are form main surface watershed. There are two springs flow from eastern hillside of Noyon Mountain and it is upstream of Gatsuurt River. It flows 12.5 km towards and drains into Balj river. River upstream cover larger area of swampy and course with curved.

All rivers and freshwater lakes freeze in the winter, and smaller streams commonly freeze to the bottom. Surface water in the project area is rare, with small streams flowing only in response to rain storm events. In some areas, artesian wells are situated close to the ground surface.

An investigation of surface water hydrology was performed by Hydrofontane LLC from August to October in 2009.

Item	Author	Source
Gatsuurt Gold Project – Technical and Economic Study, March 2006	SNC-LAVALIN Engineers & Constructors Inc	CGM
Gatsuurt Gold Project - Updated Feasibility Study, March 2006	CGM	CGM
Hydrogeological Investigation at Gatsuurt Mine and Tunkhel Village, Mandal Soum, Selenge Aimag	Soil Trade LLC.	CGM
Technical Report on the Gatsuurt Gold Project, Northern Mongolia, May 2006.	Roscoe Postle associates Inc	CGM
Detailed Environmental Impact Assessment Report, 2009 (DEIA)	Nature Friendly LLC	CGM
Design Project for Water Collector and Purifying Structure in the Gatsuurt Gold Placer Mining Area and Restoration Approaches for the Gatsuurt River, 2009	Hydrofontain	CGM
Hydrogeological conditions of the Gatsuurt hard-rock gold deposit and the estimate of groundwater inflow to the Gatsuurt Open Pits	Prof. M. Alei / Boroo Gold	CGM
Geotechnical Investigation for Gatsuurt Project, March 2006	Soil Trade LLC	CGM
Rainfall data for Zuun-Kharaa, 1970-2011	National Agency for Meteorology and Environment Monitoring	National Agency for Meteorology and Environment Monitoring
Geological drill logs, maps and cross sections	CGM	CGM
Surface and groundwater monitoring data	CGM	CGM

Table 4.13 Summary of Gatsuurt Water Monitoring

Monitoring Location ID	Monitoring Type	2005	2006	2009	2010	2011	2012
Gatsuurt Upst	Surface Water	+	+	+	+	+	+
Gatsuurt Dwst	Surface Water	+	+	+	+	+	+
Dam GU1	Surface Water	-	-	-	+	+	+
Narst Dwst GU2	Surface Water	-	-	-	+	+	+
Arst Upst	Surface Water	-	-	+	+	+	+
Biluut Dwst GU3	Surface Water	-	+	+	+	+	+

Monitoring Location ID	Monitoring Type	2005	2006	2009	2010	2011	2012
Dam GU4	Surface Water	-	-	-	+	+	+
Dam GU5	Surface Water	-	-	-	+	+	+
Dam GU6	Surface Water	-	-	-	+	+	+
Balj Upst	Surface Water	-	-	+	+	+	+
Balj Dwnst	Surface Water	-	-	+	+	+	+
Kharaa Upst	Surface Water	-	-	+	+	+	+
Near Camp	Surface Water	+	+	+	+	+	+
Gats Well GU7	Groundwater	-	-	+	+	-	+
Gatsuurt river middle	Surface Water	+	+	-	-	-	-
Gatsuurt pond #1	Surface Water	+	+	-	+	-	-
Gatsuurt pond #2	Surface Water	+	+	-	+	-	-
Gatsuurt pond #3	Surface Water	-	-	-	+	-	-
WD-BH-1	Groundwater	+	+	-	+	-	-
WD-BH-2	Groundwater	+	-	-	-	-	-
WDD-BH-1	Groundwater	+	+	-	-	-	-
TMF-BH-1A	Groundwater	+	-	-	+	-	-
GT340	Groundwater	+	-	-	-	-	-
GT342	Groundwater	+	-	-	-	-	-
GT344	Groundwater	+	-	-	-	-	-
GT352	Groundwater	+	-	-	-	-	-
GT366	Groundwater	+	+	-	-	-	-
BLANK SAMPLE	-	-	-	-	+	+	+
GT-346	Groundwater	-	-	-	-	-	+
GTT-366	Groundwater	-	-	-	-	-	+
Dam GU-6 out flow	Surface Water	-	-	-	-	-	+
1.0km dwst Kharaa- Balj conf	Surface Water	-	-	-	-	-	+
Kharaa- Balj Conf	Surface Water	-	-	-	-	-	+
0.5km dwst Gatsuurt-Balj conf	Surface Water	-	-	-	-	-	+
0.5km dwst Kharaa- Balj conf	Surface Water	-	-	-	-	-	+
Gatsuurt- Balj conf	Surface Water	-	-	-	-	-	+
TMF-A-BH2	Groundwater	-	-	-	-	+	-
(-)not measured			(+)measured				

River bank stability is generally good. Despite that small flood plain, there have been few flooding events and only in few instances, the river water channel has bifurcated. River water streambed is 6-8 m wide, bank height is 0,6-1,5 m, with fine-grained gravel deposits in the river bottom. The river's water is primary fed by melting snow and runoff water in the warmer seasons, which adds a significant volume to the existing water. The selected cross sectional area of the river had wetted route throughout the warm seasons. But in the winter, starting from upstream the river, ice buildup is created and the water freezes to the bottom, thus stopping the river flow. In September of 2009, water discharge rate was measured at selected river's cross section (using the floatation method). Water stream flow was at the same level or did not show any changes. Measurements showed an approximate velocity v=0.018 m/sec. Gatsuurt River water catchment area is 3192.3 ha. The river basin's hydrographic features (water catchment area capacity, channel length, average gradient steepness, meandering) are illustrated in the M1:100000 scale map.

Table 4.14 Multiyear average runoff of Gatsuurt River

Crossbar	Water catchment area /km^2/	Multiyear average				Flow with various provision, /m^3/sec/		
		Runoff /m^3/sec/	Modulus /l/sec km^2/	Variance coefficient				
				Cv	Cs	50%	75%	95%
Rated	-	*0.125*	*1.20*	*1.0*	*1.0 Cv*	*0.125*	*0.095*	*0.065*

River runoff divided into 5 different classifications:

1. In the middle of November. River will be covered with ice sheet and river flow will be changed. It continues until the end of April in spring.
2. In the spring, there occurs melting snows/ice and observed spring flood approximately for a month.
3. After spring flood, it starts the spring-summer runoff scarcity period and it continues during 20-30 days in the river upstream and middle. Also it continues 45 days for the river downstream.
4. In the summer, it rains until in the middle of September and occur summer run off period.
5. When summer period is over, average rainfall decreases and runoff will be declined. It continues until to cover ice sheet.

Table 4.15 Runoff distribution of Gatsuurt river for each crossbar within a year

Month	Average		Lower		Lowest	
	%	Q_{50} /m^3/sec/	%	Q_{75} /m^3/sec/	%	Q_{95}/m^3/sec/
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	5.5	0.0825	5.5	0.0627	5.5	0.0429
5	15.0	0.225	15.0	0.171	15.0	0.117
6	15.0	0.225	15.0	0.171	15.0	0.117
7	15.0	0.225	15.0	0.171	15.0	0.117
8	15.0	0.225	15.0	0.171	15.0	0.117
9	15.0	0.225	15.0	0.171	15.0	0.117
10	15.0	0.225	15.0	0.171	15.0	0.117
11	4.5	0.0675	4.5	0.0512	4.5	0.0351
12	0.0	0.0	0.0	0.0	0.0	0.0
Year	*100.0*	*0.125*	*100.0*	*0.095*	*100.0*	*0.065*

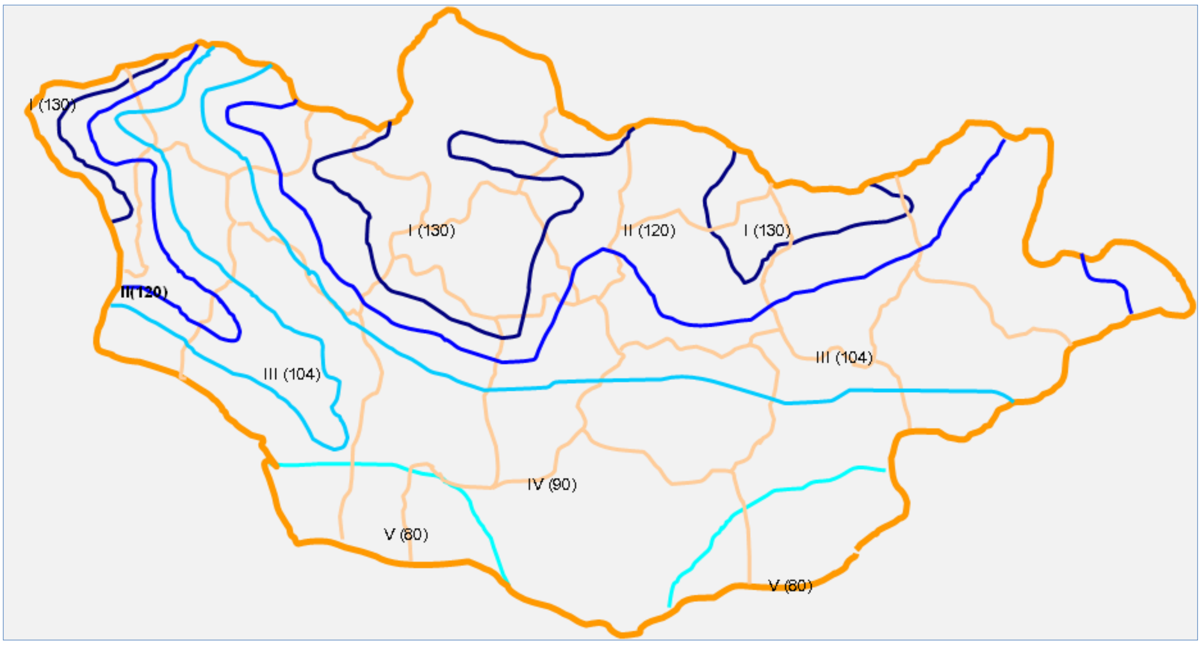


Figure 4.11 Subdivision of daily maximum precipitation with 1 % provision

Surface water and flood estimated factors are illustrated in the Table 6.16.

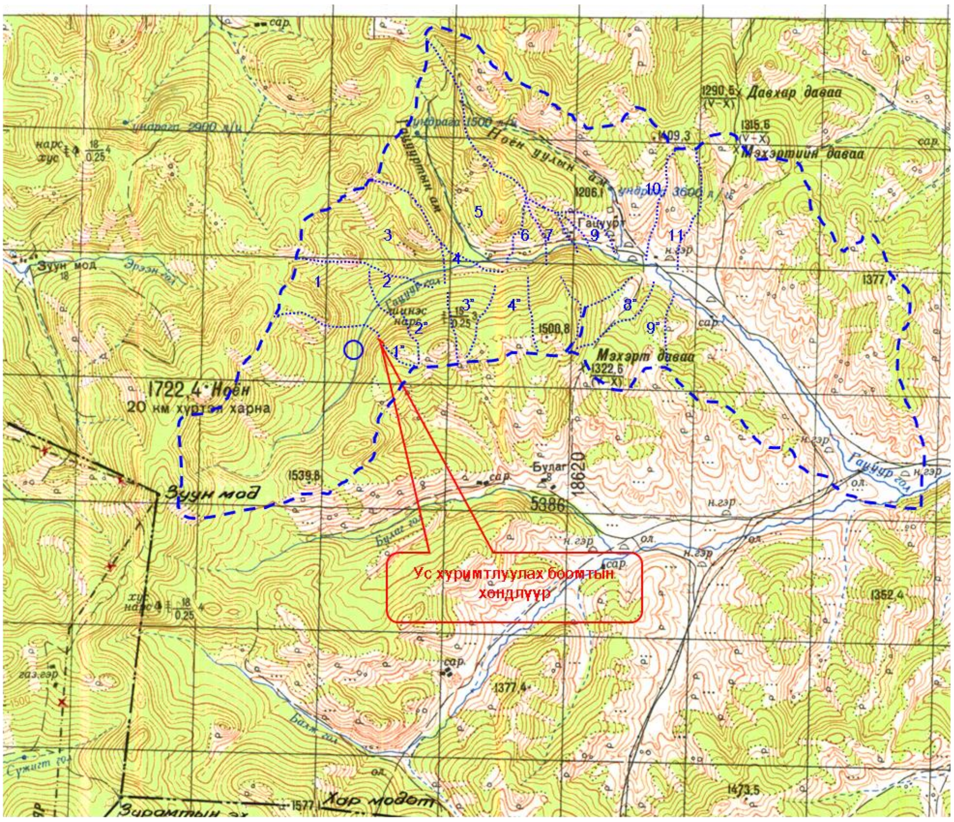


Figure 4.12 Water catchment area of Gatsuurt mine

Table 4.16 An estimation of surface water factors

	F (km²)	L_r (km)	J_r (‰)	l_{x6} (km)	J_{x6} (‰)	·	·$H_{1\%}$ (mm)	Φ_{x6}	t_{x6} (minute)	Φ_r	$q_{1\%}$ (L/sec.km²)	$Q_{1\%}$ (m³/sec)	$Q_{5\%}$ (m³/sec)	$Q_{10\%}$ (m³/sec)
1	***1.850***	1.700	212.00	1.09	42.98	0.43	51.25	12.00	200.00	8.46	0.0550	***1.04***	***0.92***	***0.75***
2	***0.685***	0.950	277.00	0.72	38.92	0.58	69.07	8.62	100.00	5.15	0.1000	***0.95***	***0.83***	***0.68***
3	***2.176***	2.210	164.00	0.98	40.90	0.48	57.89	10.87	200.00	11.14	0.0850	***2.14***	***1.88***	***1.54***
4	***0.328***	0.750	314.00	0.44	28.90	0.66	79.38	6.75	60.00	4.53	0.1400	***0.73***	***0.64***	***0.52***
5	***4.612***	3.820	184.00	1.21	41.90	0.50	60.31	11.72	200.00	15.21	0.0510	***2.84***	***2.50***	***2.04***
6	***0.567***	1.120	236.00	0.51	30.40	0.50	60.28	8.23	100.00	6.94	0.0960	***0.66***	***0.58***	***0.47***
7	***0.411***	1.220	217.00	0.34	39.26	0.47	56.54	6.50	60.00	8.56	0.1100	***0.51***	***0.45***	***0.37***
8	***0.162***	0.620	00.00	0.26	8.77	0.64	77.31	4.91	50.00	4.56	0.1440	***0.36***	***0.32***	***0.26***
9	***0.284***	1.100	182.00	0.26	40.80	0.41	48.77	6.07	60.00	9.31	0.1600	***0.44***	***0.39***	***0.32***
10	***6.374***	4.840	148.00	1.32	42.90	0.40	48.11	13.63	200.00	20.21	0.0760	***4.66***	***4.10***	***3.36***
11	***1.044***	2.010	165.00	0.52	41.50	0.35	42.42	9.19	120.00	13.14	0.1800	***1.59***	***1.40***	***1.15***
1"	***0.321***	0.800	312.00	0.40	41.60	0.66	78.97	5.92	60.00	4.87	0.1380	***0.70***	***0.62***	***0.50***
2"	***1.011***	1.200	242.00	0.84	36.90	0.50	59.99	10.14	150.00	6.39	0.0860	***1.04***	***0.92***	***0.75***
3"	***0.645***	1.200	250.00	0.54	37.35	0.53	63.15	7.87	100.00	6.98	0.0875	***0.71***	***0.63***	***0.51***
4"	***1.041***	1.400	214.00	0.74	41.08	0.45	53.62	9.81	120.00	7.93	0.0720	***0.80***	***0.71***	***0.58***
5"	***0.092***	1.210	258.00	0.08	41.00	0.57	67.96	2.79	20.00	11.13	0.1820	***0.23***	***0.20***	***0.16***
6"	***0.446***	0.620	240.00	0.72	39.99	0.51	61.74	9.05	80.00	4.03	0.1640	***0.90***	***0.79***	***0.65***
7"	***0.283***	0.730	371.00	0.39	40.30	0.77	92.58	5.41	50.00	4.16	0.1400	***0.73***	***0.65***	***0.53***
8"	***0.724***	1.620	218.00	0.45	41.00	0.46	55.54	7.47	80.00	9.89	0.1200	***0.97***	***0.85***	***0.69***
9"	***1.521***	1.940	189.00	0.78	26.40	0.39	46.84	12.03	200.00	10.76	0.0750	***1.07***	***0.94***	***0.77***
10"	***8.346***	5.460	152.00	1.53	26.40	0.40	48.02	16.59	200.00	21.14	0.0720	***5.77***	***5.08***	***4.15***

Figure 4.13 Project area layouts

Laboratory analysis have been analyzed with Central geological laboratory (CGL) of Mongolia, Laboratory of Ekho Khangal LLC and SVL laboratory of USA for chemical, physical and heavy metals investigation. Sampling points of surface water are:

Monitoring Location ID	Monitoring Type	2005	2006	2009	2010	2011	2012
Gatsuurt Upst	Surface Water	+	+	+	+	+	+
Gatsuurt Dwst	Surface Water	+	+	+	+	+	+
Dam GU1	Surface Water	-	-	-	+	+	+
Narst Dwst GU2	Surface Water	-	-	-	+	+	+
Arst Upst	Surface Water	-	-	+	+	+	+
Biluut Dwst GU3	Surface Water	-	+	+	+	+	+
Dam GU4	Surface Water	-	-	-	+	+	+
Dam GU5	Surface Water	-	-	-	+	+	+
Dam GU6	Surface Water	-	-	-	+	+	+
Balj Upst	Surface Water	-	-	+	+	+	+
Balj Dwnst	Surface Water	-	-	+	+	+	+
Kharaa Upst	Surface Water	-	-	+	+	+	+
Near Camp	Surface Water	+	+	+	+	+	+
Gats Well GU7	Groundwater	-	-	+	+	-	+
Gatsuurt river middle	Surface Water	+	+	-	-	-	-
Gatsuurt pond #1	Surface Water	+	+	-	+	-	-
Gatsuurt pond #2	Surface Water	+	+	-	+	-	-

Monitoring Location ID	Monitoring Type	2005	2006	2009	2010	2011	2012
Gatsuurt pond #3	Surface Water	-	-	-	+	-	-
WD-BH-1	Groundwater	+	+	-	+	-	-
WD-BH-2	Groundwater	+	-	-	-	-	-
WDD-BH-1	Groundwater	+	+	-	-	-	-
TMF-BH-1A	Groundwater	+	-	-	+	-	-
GT340	Groundwater	+	-	-	-	-	-
GT342	Groundwater	+	-	-	-	-	-
GT344	Groundwater	+	-	-	-	-	-
GT352	Groundwater	+	-	-	-	-	-
GT366	Groundwater	+	+	-	-	-	-
BLANK SAMPLE	-	-	-	-	+	+	+
GT-346	Groundwater	-	-	-	-	-	+
GTT-366	Groundwater	-	-	-	-	-	+
Dam GU-6 out flow	Surface Water	-	-	-	-	-	+
1.0km dwst Kharaa- Balj conf	Surface Water	-	-	-	-	-	+
Kharaa- Balj Conf	Surface Water	-	-	-	-	-	+
0.5km dwst Gatsuurt-Balj conf	Surface Water	-	-	-	-	-	+
0.5km dwst Kharaa- Balj conf	Surface Water	-	-	-	-	-	+
Gatsuurt- Balj conf	Surface Water	-	-	-	-	-	+
TMF-A-BH2	Groundwater	-	-	-	-	+	-
(-)not measured			(+)measured				

Results of Water Quality Analyses

Gatsuurt River upstream

4.5 Surface and groundwater

4.5.1 Hydrology and Surface water quality

The Gatsuurt project is located within the Gatsuurt River valley in the Noyon Mountain Range of the Kharaa River watershed. The Gatsuurt River, a second-order tributary, flows through the mine site area into the Balj River, which empties into the Kharaa River. The Kharaa River drains into Orkhon River, flowing 291 km towards the northwest, where it eventually drains into Lake Baikal in Russia. The total drainage area of the Gatsuurt valley upstream of the project site is approximately 2 218 ha.

All rivers and freshwater lakes freeze in the winter, and smaller streams commonly freeze to the bottom. Surface water in the project area is rare, with small streams flowing only in response to rain storm events.

In some areas, artesian wells are situated close to the ground surface. During wet spring periods, water may flow in marsh bottoms and some ephemeral streams may result in response to saturated conditions.

For the Boroo River, an annual average runoff ratio of 0.074 was reported along with an average monthly flow distribution for the Boroo River. This information, together with the annual average precipitation data from Baruunkharaa meteorological station (1975 to 2004), yields the monthly flow distribution for the Gatsuurt River shown in Table 6.17.

Table 4.17 Monthly Site Runoff Distribution – Gatsuurt River at Project Site

Month	% of Annual Flow[1] Average Monthly	Site Runoff (m^3)
January	0.4	1 800
February	0.3	1 300
March	0.4	1 800
April	5.0	22 300
May	15.1	67 300
June	13.0	57 900
July	17.4	77 600
August	20.9	93 200
September	14.0	62 400
October	8.9	39 700
November	3.1	13 800
December	1.4	6 200
Annual	99.9	445 300

[1]Based on Boroo River streamflow as a percentage of annual flow.

Gatsuurt river water catchment area is 3192.3 ha. The river basin's hydrographic features (water catchment area capacity, channel length, average gradient steepness, meandering) are illustrated in the M1:100000 scale map.

Surface Water Quality

Site-specific surface water quality information for the Gatsuurt site is required in order to identify potential issues related to mine facility design and operations, and to characterize baseline conditions against which potential future changes to the local streams and rivers, as a result of the mine development, can be compared.

Surface water quality samples in the vicinity of the project site have been collected since June, 2005.

Because of prior place mining operation, Gatsuurt river flow changed and ceased in the middle. A river flow interrupted and emerged several ponds in the middle. A Narst and Biluut river drains into Gatsuurt River downstream. Gatsuurt River expose ground surface in the lower part of the mine area and drains into Balj River from eastern part.

Prior to the Centerra Gold operations purchasing the current mining licenses alluvial mining operations have been undertaken in the area of the Gatsuurt River in the territory of Mandal soum, Selenge aimag. These previous alluvial operations have caused minor changes in the surface and hydrological properties of the surrounding area. The Gatsuurt River stream morphology has also been previously altered by the past alluvial operations in the area due to the installation of roads, earthen dams, alluvial stockpiles, and surface water retention ponds. The Gatsuurt River exhibits low flow characteristics as it passes through the mine-site and collects surface waters from the local watersheds.

Exploration and estimation of the reserves contained in the Gatsuurt alluvial gold deposit had been performed during 1990-1992; an area of approximately 146 ha has been affected by previous alluvial mining operations during 1992-2000. Baseline surface water surveys indicate that water flowing through the existing ponds from past alluvial operations contains arsenic which is naturally occurring.

Surface water quality in the Gatsuurt valley is lower mineralized, fresh and soft. Water content of Gatsuurt River upstream contains lower heavy metals. Some study results show metal contents Fe, Al with small amount.

In the middle of the Gatsuurt River flow is ceased and drain underground, there are several small ponds and swampy location derived caused by prior placer mining operation. Laboratory analysis for the first and Central zone ponds result that water quality of both are fresh (mineralization <400 mg/l) and soft-softer (hardness 3.0-3.10 mg-eq/l). The content of base ions increased a little Al 0.02-0.03 mg/l etc.

According to the CGL laboratory analysis, an arsenic content is higher than the permissible level (2-9 times more than standard) for the most part of the ponds. Although the samples had absolutely higher Fe and Al ions content.

But it will be classified into the category "polluted" according to Surface water quality standard because Fe content is more than 0.5 mg/l.

Hydrogeology and Groundwater quality

Regional Hydrogeology: The primary aquifers in the region comprise upper unconsolidated alluvial and colluvial sediment, and bedrock strata. Groundwater within the overburden system occurs within the permeable alluvial and colluvial deposits found along the base of the hills, intermontane valleys, Gatsuurt riverbanks and its flood plain terraces. The deposits consist of sandy, clayey and gravely soils of recent and upper Quaternary ages. The aquifer is recharged from runoff and infiltration through the permeable soils. Reflecting climatic conditions, the groundwater levels may vary significantly depending on drought or heavy rainfall. The unconfined shallow groundwater flow system in the river valleys is interconnected with the surface water flow system within valleys with flows typically close to surface and following topography.

The deeper groundwater flow system occurs within bedrock, with groundwater occurrence typically restricted to fracturing and weathered zones. Recharge is thought to occur through infiltration from overlying alluvial systems or directly from rainfall and snowmelt where bedrock outcrops outside the valleys. There is some evidence of confined aquifer units in places with springs reportedly occurring along the base of the hills at some locations.

The geological profile at Gatsuurt is separated into four main zones including:

- Overburden, comprising coarse gravels, sands and clays of Quaternary age extending from surface on the valley fringes up to 27m towards the central parts of the alluvial channel;
- Oxidized rock comprising highly weathered and broken granite and rhyolite extending to depths up to 45m bgl;
- Transition zone, consisting of fractured and weathered granite and rhyolite becoming less weathered with depth;
- Unoxidised rock comprising fractured granite and rhyolite.

Reports indicate that the Quaternary alluvial overburden, which occurs along the main Gatsuurt river channel and to a lesser extent in smaller feeder channels, is a significant water bearing unit with water levels typically less than 1m bgl. Results of alluvium composition analysis completed during the geotechnical programme indicate that whilst the gradation of the alluvial deposits varies, they are composed predominantly of gravel and sand. The alluvial aquifer unit is unconfined and reported to be highly variable depending on seasonal recharge events. It is likely that a high level of interconnection exists between surface water flows and the groundwater flow within the alluvial system.

Groundwater in the underlying granite and rhyolite occurs mainly within the weathered and broken rock within the oxidised zone and in the fracture zones of the deeper unweathered rock with the aperture and density of fracturing (and subsequent water bearing capacity) typically decreasing with depth. Groundwater within the fractured bedrock is generally unconfined, however artesian conditions were reportedly experienced in one drill hole at the central pit indicating the existence of a confined aquifer unit. Further work would be required to confirm the extent of any confined aquifer system.

Recharge of the shallow alluvial system occurs mainly via direct infiltration of surface water flows and directly via rainfall away from the main flow lines (i.e. on the valley fringes and flood terraces).

The level of connectivity between the groundwater and surface water systems suggests that whilst aquifer units may receive direct recharge from surface water flows, the reverse is also likely with groundwater providing base flow to surface water systems during periods of low rainfall.

Groundwater Quality Monitoring Data Summary

Groundwater quality monitoring has been undertaken since 2005 and is ongoing at 6 groundwater monitoring locations including geotechnical holes and over 20 surface water monitoring locations. Groundwater quality results show the water to be within Mongolian Drinking Water Standards for most analytes tested; however, for geotechnical hole water analysis of Arsenic and nitrate limits were exceeded the Drinking water standard in sometimes.

Surface water monitoring data indicates that concentrations of a number of analytes, including arsenic, have exceeded the drinking water standard. These water quality results for surface and groundwater suggest that the two water sources are on close communication with each other and that both reflect the chemical character of the arseno-pyrite ore body that hosts this good deposit. The exceedances that have been noted are generally within one order of magnitude of the criteria and would therefore not be difficult in relative terms to treat and bring into compliance. Mixing with a suitably large clean water source would likely effect the required treatment.

Review of Gatsuurt Surface Water Quality

	Fe	Al	Cd	As	Mn	Zn	Pb	Hg
Content	0.02	<0.025	<0.005	<0.01	<0.01	<0.01	<0.05	<0.005
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	0.0001

As a shown in the Table 4.16, content of Pb and Hg is not certain, it shows higher than the permissible level. Detection limit of the device is Pb<0.05, Hg<0.005. There were taken 5 different sampling on May 05, May 23, July 17, August 21 and September 13 in 2009 and analyzed 40 different specifications by SVL laboratory. Selected specifications are presented in the Table 4.17. The result of the SVL laboratory analysis shows the approximate values of water mineralization and hardness compared with the laboratory result by Ekho Khangal. Water acid-base balance is pH 7.29-7.82 and low alkalinity.

Table 4.18 Gatsuurt river upstream, Heavy metal contents by SVL, (mg/l)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June - 09	<0.060	0.104	<0.002	<0.003	<0.004	<0.010	<0.0075	0.0033	<0.01	<0.006	<0.010
13 Aug -09	<0.060	<0.080	<0.002	0.0165	<0.004	<0.010	<0.0075	0.0047	<0.01	<0.006	<0.010
10 Sep -09	0.143	0.237	<0.002	<0.003	<0.004	<0.010	<0.0075	0.0043	<0.01	<0.006	<0.010
28 Sep -09	<0.060	0.109	<0.002	<0.003	<0.004	<0.010	<0.0075	0.0059	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

In the shown Table 4.17, arsenic content of the sample on August 13 (sampling date is on July 17) is defined more than permissible level. Some study results show metal contents Fe, Al, Ba with small amount.

Middle of the Gatsuurt River, Pond 1-3

In the middle of the Gatsuurt River flow is ceased and drain underground, there are several small ponds and swampy location derived caused by prior placer mining operation. Laboratory analysis for the first and Central zone ponds result that water quality of both are fresh (mineralization <400 mg/l) and soft-softer (hardness 3.0-3.10 mg-eq/l). The content of base ions increased a little Al 0.02-0.03 mg/l etc.

Central geological laboratory analyzed 8 specifications of heavy metals and the result is illustrated in the following table.

Table 4.19 Middle of the Gatsuurt river, Heavy metal contents by CGL, (mg/l)

Ponds	Fe	Al	Cd	As	Mn	Zn	Pb	Hg
Pond 1	0.03	<0.025	<0.005	0.12	<0.01	<0.01	<0.05	<0.005
Pond 2	<0.02	<0.025	<0.005	0.07	0.01	<0.01	<0.05	<0.005
Pond 3	0.06	0.051	<0.005	0.01	0.02	<0.01	<0.05	<0.005
Pond 4	0.07	<0.025	<0.005	0.01	0.03	<0.01	<0.05	<0.005
Pond last	0.17	<0.025	<0.005	0.05	0.02	<0.01	<0.05	<0.005
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	0.0001

An arsenic content is higher than the permissible level (5-12 times more than standard) for the most part of the ponds. Water acid-base balance is pH 7.7-9.66 (See Table 4.21) that indicates the context with low alkalinity and alkalinity. The acid-base context fluctuates with high range.

Table 4.20 Pond water pH

Ponds	11 June -09	13 Aug -09	10 Sep -09	28 Sep -09
Pond 1	7.81	7.94	8.04	7.84
Pond 2	7.83	9.22	8.01	7.89
Pond 3	7.88	9.79	7.70	9.66
MNS 4586:98	6.5-8.5			

Table 4.21 Middle of the Gatsuurt River, Pond 1, Heavy metal contents by SVL, (mg/l)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June - 09	0.235	0.246	<0.002	0.0230	0.0664	<0.010	<0.0075	0.0115	<0.01	0.0213	<0.010

13 Aug -09	0.549	0.455	<0.002	0.0119	0.0334	<0.010	<0.0075	0.0126	<0.01	<0.006	<0.010
10 Sep -09	0.082	0.126	<0.002	0.0657	0.0056	<0.010	<0.0075	0.0056	<0.01	<0.006	<0.010
28 Sep -09	<0.060	0.129	<0.002	0.0400	0.0198	0.0135	<0.0075	0.0092	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

Table 4.22 Middle of the Gatsuurt River, Pond 2, Heavy metal contents by SVL, (mg/l)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June -09	0.175	0.150	<0.002	0.0109	0.0357	<0.010	<0.0075	0.0075	<0.01	<0.006	<0.010
13 Aug -09	0.226	0.229	<0.002	0.0545	0.0441	<0.010	<0.0075	0.0037	<0.01	<0.006	<0.010
10 Sep -09	<0.060	0.082	<0.002	0.0091	<0.004	<0.010	<0.0075	0.0054	<0.01	<0.006	<0.010
28 Sep -09	0.184	0.170	<0.002	0.0092	0.0230	<0.010	<0.0075	0.0077	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

Table 4.23 Middle of the Gatsuurt River, Pond 3, Heavy metal contents by SVL, (mg/l)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June -09	0.984	0.890	<0.002	0.0268	0.202	<0.010	<0.0075	0.0158	<0.01	<0.006	<0.010
13 Aug -09	0.292	0.349	<0.002	0.0403	0.0302	<0.010	<0.0075	0.0059	<0.01	<0.006	<0.010
10 Sep -09	1.57	1.68	<0.002	0.0913	0.104	<0.010	<0.0075	0.0091	<0.01	<0.006	<0.010
28 Sep -09	1.05	1.29	<0.002	0.0403	0.0586	0.0122	<0.0075	0.0134	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

According to the laboratory analysis, almost all samples had higher arsenic content than the permissible level (2-9 times higher). Although the samples had absolutely higher Fe and Al ions content, there is not identified the permissible level in the MNS 4586:98 standard. But it will be classified into the category “polluted” according to Surface water quality standard because Fe content is more than 0.5 mg/l. Last laboratory analysis showed higher Zn content.

Gatsuurt River downstream

Narst and Biluut rivers drain into the Gatsuurt River and river flow surface at downstream by infiltration pond water. A laboratory result of Gatsuurt river downstream by Ekho Khangal laboratory shows that water quality is fresh (mineralization <300 mg/l), soft (hardness 2.10 mg-eq/l and slightly increased mineralization and hardness but it is lower than the ponds.

Table 4.24 Gatsuurt River Downstream, Heavy metal contents by CGL, (mg/l)

	Fe	Al	Cd	As	Mn	Zn	Pb	Hg

Content	0.08	0.101	<0.005	0.02	<0.01	<0.01	<0.05	<0.005
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	0.0001

An arsenic content in the Gatsuurt River downstream is 2 times more than the standard norm by CGL analysis. An acid-base context is pH 8.07-5.87 and increased beside the upstream by SVL analysis.

Table 4.25 Gatsuurt River Downstream, Heavy metal contents by SVL, (mg/l)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June -09	1.62	1.35	<0.002		0.0501	<0.010	<0.0075	0.0149	<0.01	<0.006	<0.010
13 Aug -09	0.874	0.767	<0.002	0.0315	0.0287	<0.010	<0.0075	0.0126	<0.01	<0.006	0.016
10 Sep -09	0.326	0.346	<0.002	0.0264	0.0103	<0.010	<0.0075	0.0079	<0.01	<0.006	<0.010
28 Sep -09	0.071	0.111	<0.002	0.0258	0.0088	<0.010	<0.0075	0.0072	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

An arsenic content in the Gatsuurt River downstream is 3 times more than the standard norm by SVL analysis

Narst River

Narst River drains down part of the impacted river flow by prior placer mining operation eastwardly. SVL laboratory result shows that water quality of Narst River is very fresh and soft with pH 7.33-8.00. Sampling for Narst River is divided two: Narst river water sample not impacted by mining operation (samples for previous months) and sample from Narst river pond impacted by Gatsuurt river flow (samples for latest months).

Table 4.26 Narst river, Heavy metals contents by SVL, (mg/L)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June -09	5.36	6.13	<0.002	0.0141	0.282	0.0166	<0.0075	0.0326	<0.01	0.0070	<0.010
13 Aug -09	1.28	1.62	<0.002	0.0080	0.0356	<0.010	<0.0075	0.0114	<0.01	0.235	0.016
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

A laboratory result shows that Narst River main flow have higher content of some heavy metals.

Table 4.27 Narst river pond, Heavy metals contents by SVL, (mg/L)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
10 Sep -09	1.11	1.44	<0.002	0.0060	0.0382	<0.010	<0.0075	0.0099	<0.01	<0.006	<0.010
28 Sep -09	0.533	0.668	<0.002	0.0040	<0.008	0.0102	<0.0075	0.0080	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

Higher content of Fe and Al is detected in the Narst river pond.

Biluut River

Biluut River sourced from the mountainside in the southern part of the Narst mountainside and drains into Gatsuurt River. Ekho Khangal laboratory result shows that water quality of Biluut River is very fresh (mineralization <200 mg/L) and very soft (hardness 0.9 mg-eq/L).

Table 4.28 Biluut River, Heavy metals contents by CGL, (mg/L)

	Fe	Al	Cd	As	Mn	Zn	Pb	Hg
Content	0.36	0.51	<0.005	<0.01	0.01	<0.01	<0.05	<0.005
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	0.0001

An acid-base context, analyzed by SVL is pH 8.07-8.57 and increased than the river upstream.

Table 4.29 Biluut River, Heavy metals contents by SVL, (mg/L)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June -09	<0.060	0.459	<0.002	<0.003	<0.004	<0.010	<0.0075	0.0097	<0.01	<0.006	<0.010
13 Aug -09	0.322	0.094	<0.002	<0.003	<0.004	<0.010	<0.0075	0.0091	<0.01	<0.006	<0.010
10 Sep -09	1.43	1.75	<0.002	<0.003	0.0155	<0.010	<0.0075	0.0171	<0.01	<0.006	<0.010
28 Sep -09	0.732	0.878	<0.002	<0.003	0.0082	0.0155	<0.0075	0.0121	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

A laboratory result shows that Biluut River not polluted or impacted by heavy and hazardous elements relatively. But latest result had contained heavy metals such as Fe and Al.

Small River near camp

An exploratory camp is located in the lower part of the Biluut mountainside (near Gatsuurt river downstream) and a small river flows besides the camp. Water quality is presented as fresh and soft in the laboratory result by the Ekho Khangal laboratory.

Table 4.30 Small river near camp, Heavy metals contents by CGL, (mg/L)

	Fe	Al	Cd	As	Mn	Zn	Pb	Hg
Content	0.07	<0.025	<0.005	<0.01	<0.01	<0.01	<0.05	<0.005
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	0.0001

An acid-base context is pH 7.78-8.01 in the result analyzed by SVL.

Table 4.31 Small river near camp, Heavy metals contents by SVL, (mg/L)

Date	Fe	Al	Cd	As	Mn	Zn	Pb	Ba	TCN	Cr	Cu
11 June -09	0.093	0.161	<0.002	<0.003	<0.004	<0.010	<0.0075	0.0094	<0.01	<0.006	<0.010
13 Aug -09	0.629	0.699	<0.002	<0.003	0.0122	<0.010	<0.0075	0.0126	<0.01	<0.006	<0.010

10 Sep -09	0.235	0.297	<0.002	<0.003	0.0051	<0.010	<0.0075	0.0087	<0.01	<0.006	<0.010
28 Sep -09	<0.060	0.094	<0.002	<0.003	<0.004	0.0132	<0.0075	0.0095	<0.01	<0.006	<0.010
MNS 4586:98			0.005	0.01	0.1	0.01	0.01	-	-	0.05	0.01

A laboratory result shows that small river near camp not polluted or impacted by heavy and hazardous elements. But the result had contained heavy metals such as Fe and Al.

An arsenic content of the surface water is illustrated in the following figure.

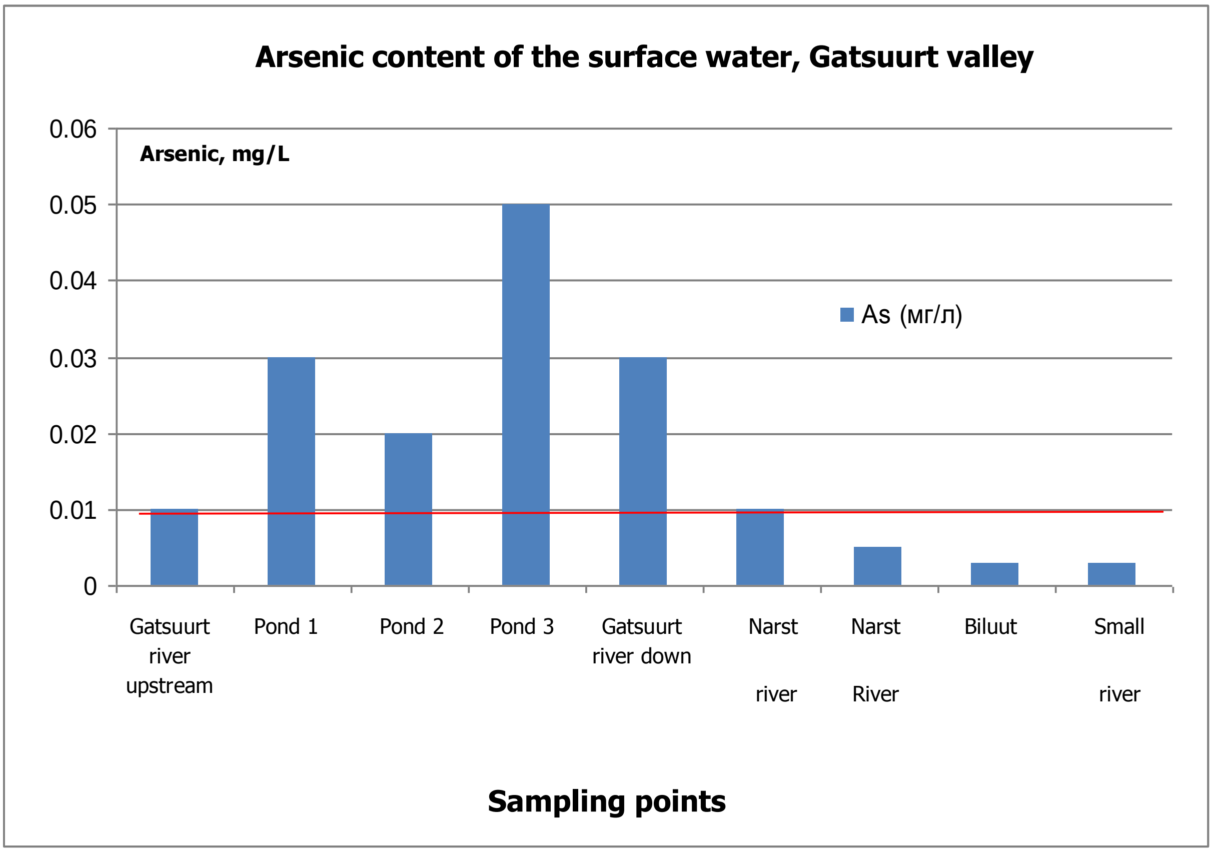


Figure 4.14 Arsenic content of the surface water, Gatsuurt valley, (red line is standard level (As 0.01 mg/L))

Surface water quality in the Gatsuurt valley is lower mineralized, fresh and soft. Water content of Gatsuurt River upstream contains lower heavy metals.

4.6 Soil condition, erosion and contamination

4.6.1 Soil profile, soil classification and fertility

The project area, it falls into forest steppe eco region and in terms of soil classification, soils at Gatsuurt project area belong to the dry steppe chestnut soils of the Orkhon-Selenge region. The highest point is Noyon Uul at 1,722 m ASL, and the lowest point is Gatsuurt River at 1,200 m ASL. Geomorphologically, relative short mountains and hills of Khangai, Khentii region, dominate the area.

Many of the soil profiles at Gatsuurt are no longer representative of the region due to land disturbance from historic mining activities. The soils in the Gatsuurt area belong to the dry steppe chestnut soils of the Orkhon-Selenge region. The soils consist of mainly dark chestnut and mountain chernozem soils of alluvium and colluviums origin. At the project area, five types of soils may be classified. (Figure 4.16-4.17)

Black Earth Mountain Soil

The black earth mountain soils are generally formed on the diluvia and eluvia sediments that are on the forest boundaries on the southern skirt of a mountain, typically 1300m ASL. A representative record of soil profile and analysis of black earth mountain soil was taken from the Gatsuurt valley on a mountain slope (approximately 36^{o}).

Table 4.32 Black Earth Mountain Soil

0-3 cm Reinforced with vegetation
3-13cm Dark brownish and black colored; wet and scare; plant roots reinforced; light clayey and weak lump composition; the light clayey is slowly transferring to the color of the next stratum.
13-41cm Light brown colored; wet and scare; plant roots; light clayey stones; weak lump composition; slow transfer to the next stratum.
41-60 cm Light yellowish colored, no specific structure

Thickness of humus stratum of the black earth mountain soil is approximately 10 cm and the humus content in its upper layer 4.39%. Its pH is 7.14 or almost neutral. Sum of the absorbed basis contained in 10 kg of soil is 29.8 mg, with most of it being calcium cat ion. Results suggest the black earth mountain soils have good soil structure and characteristics. The soil contained 4.8 mg of movable phosphorus and 21.0 mg of exchangeable kali. This soil also displayed 20% of light clayness in mechanical or fiber composition, suggesting the soil has good water resistance quality and medium ventilation quality.

Dark Brown Mountain Soil

This type of soil is formed on delluvial gravels existing under the mountain forest and mountain black earth soil at elevations of 1100-1200m ASL. The surface of the soil is stony. At this elevation, vegetation is considered good with herbaceous and scattered shrubs, ranging in height from 15-20 cm. This type of soil is typical of pastureland within the valley.

Table 4.33 Dark Brown Mountain Soil

0-10 cm Black brown colored, loose and wet, with plant roots, its mechanical structure has light clayey and weak lump, it transfers gradually to the next stratum with its color.
10-28 cm Light brown and brownish colored; wet and compact plant roots; Mechanical structure has weak lump stones; sandstones transfer into the next stratum with its color.
28-79 cm Reddish and orange colored; significantly not much amount of plant roots; with composition of compact lump; boils weakly in the influence of hydrochloric acid and transfers into the next stratum with its color.
79-116 cm Reddish colored, no compact plant roots, large weak lump, composition consisting of mechanical sandstone.

General soil properties of the black brown mountain soil from samples recorded include: 7.62% of humus, 40 % total nitrogen and pH 6.99-7.00. The total exchangeable kali is 22.0 mg and phosphorus 3.60 mg. The physical clay content (powdered earth) in mechanical or fiber composition is 26.4-27.9%. Thickness of humus layer is 18-28 cm and light clayey absorbed is 12.0-16.0 mg-equ. The data suggests that the dark brown mountain soil, which is used as a pastureland, has the potential to be used for agricultural crop production, subject to receiving adequate precipitation.

Dark soil of Mountain Forest

This soil is formed on eluvia-diluvia gravel within forest areas at elevations of 1,300-1,500m ASL. Soil profile is representative of that found in a connecting ravine to the main Gatsuurt valley. Soil surface layer is stony and vegetation cover is about 50-60 percent coverage.

Table 4.34 Dark soil of Mountain Forest

0-21 cm	Black brown colored, well formed, with plant roots, mechanical structure has wet round granules, it transfers gradually to the next stratum with its color.
21-45 cm	Light yellow colored; wet and compact tree roots in depth; Mechanical structure has weak lump stones; it transfers into the next stratum less and less

Thickness of humus layer is 18-21 cm and samples recorded include: 8.6% of humus, 51 % total nitrogen and pH 5.80. The total exchangeable kali is 38.0 mg-eq/100 g and phosphorus 2.60 mg-eq/100 g. The absorbed basis of this soil is good (39.0mg-equ.). However, this tends to decrease gradually from upper to lower layers. Fiber composition of soil is light clayey, 27.0%.

Figure 4.15 Gatsuurt river valley (south-eastern look)

Mountain Meadow Steppe-like soil

Mountain Meadow Steppe-like soils are distributed on the diluvia sediments, narrow ravines facing toward and northward of the Gatsuurt valley mountains, at the land surface. Soil surface layer is less stony and vegetation cover is well.

Table 4.35 Mountain Meadow Steppe-like soil

0-28 cm	Black and blackish colored, wet, rich in plant roots, weak lump composition, light clay, transfers into the next stratum with its color.

28-51 cm	Light brown colored, wet, poor in plant roots, large lump composition, medium clay, at 38 cm depth, boils in 10% hydrochloric acid and transfers gradually into the next stratum.
51-82 cm	Reddish and light colored, wet, no plant roots, light clayey stones, weak lump composition, no transfer into the next stratum has occurred.

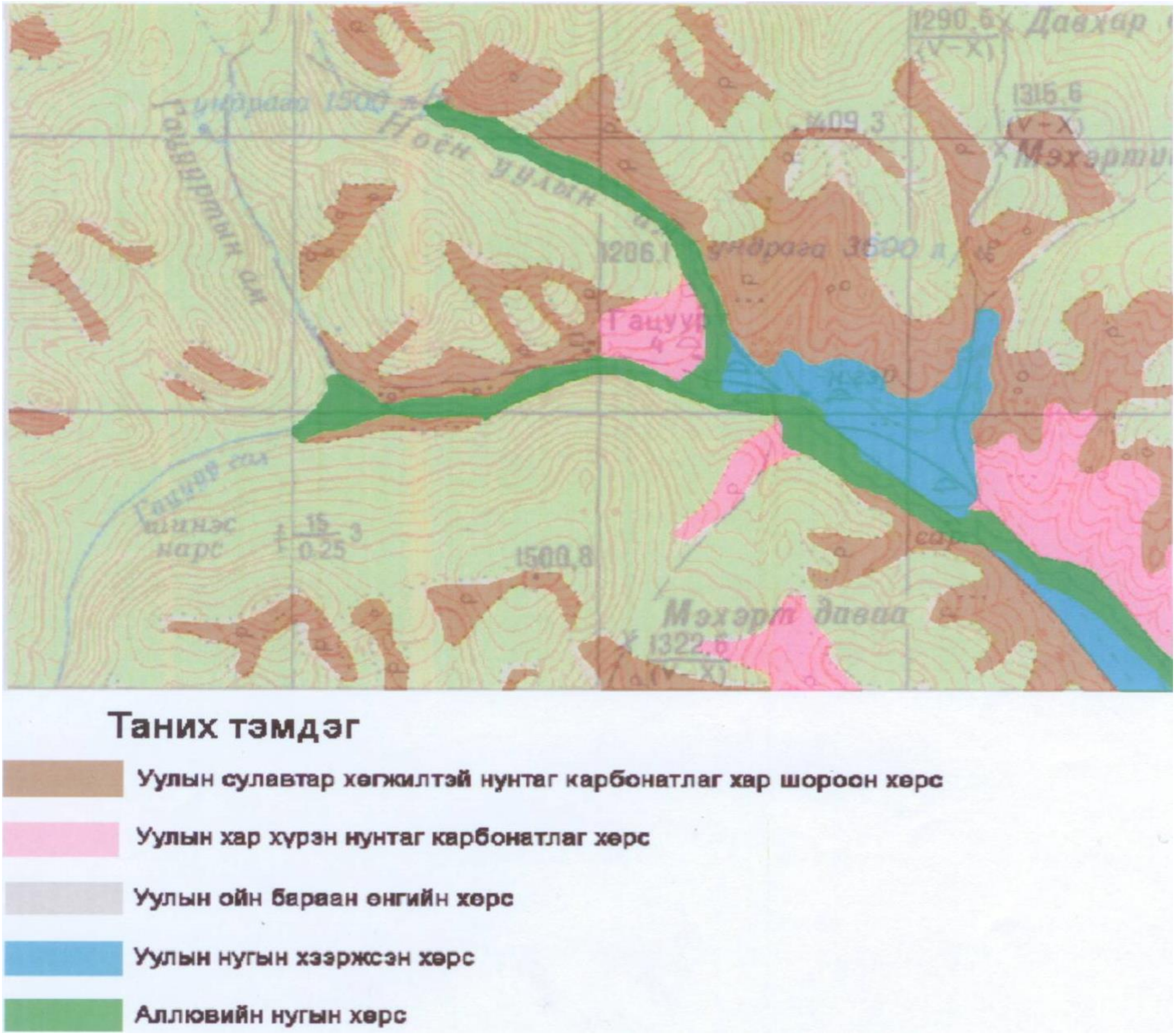


Figure 4.16 Soil distribution before mining operation

The thickness of its humus layer is typically 0-27 cm in depth. Humus content is 6.71% with total nitrogen of 0.33% and pH of 6.4-7.5. Data indicate that a 100 gr soil sample contains 36.0 mg exchangeable kali and 1.98 mg phosphorus. Fiber composition of small particles with diameter of <0.01 accounted for approximately 23.0 % soil content. Chemical and physical soil properties of this soil type suggest is may have sufficient fertility to be used as pastureland for livestock.

Alluvial meadow soil

Alluvial meadow soils are common on the alluvial sediments in narrow ravines between the mountains along the Gatsuurt River valley. The surface of the soil is typical on what is found in the flood plain where slopes are relatively flat (approximately 5 degrees). Typical plant species found on alluvial meadow soils include *Carex duriscula, C.enervis, Potentilla* and small salt marsh grasses. (Table 4.35)

Table 4.36 Alluvial meadow soil

0-43 cm Blackish and dark grey in a dry form color, wet, top, layer is reinforced with plant roots in large lump structure and transfers gradually into the next stratum with its color.	
43-60 cm	Blackish colored, wet, no plant roots, large lump structure, medium clay, and transfers gradually into the next stratum.
60-81 cm	Light brown colored, wet, compact, medium clay and no clear transfer.

Thickness of humus in this soil varies depending on relief. Recorded pH for this soil type is 7.8 and 44 % total nitrogen or almost neutral, with no evidence of the salt marsh vegetation supported on these soils. Thickness of humus layer is 7.45 percent and decrease gradually in depth. The total exchangeable kali is 9.0 mg-eq/100 g and phosphorus 4.9 mg-eq/100 g. The absorbed basis of this soil is good (46.0mg-equ.). However, this tends to decrease gradually from upper to lower layers. Fiber composition of soil is light clayey, 35.3%.

Table 4.37 A. Agro-chemical composition of the soil in the Gatsuurt area*

Soil code	Sampling depth, cm	%			pH	Absorbed basis of 100 g soil (mg-eq)			Content of 100 g soil (mg)		Fiber composition		
		Humus	Total nitrogen	Carbonate		Ca	Mg	Ca + Mg	P_2O_5	K_2O	<0.001	>0.01	<0.01
Black Earth Mountain Soil													
A	3-13	4.34	0.21	-	7.2	22.4	11.2	3.6	2.97	31.2	13.1	75.4	24.6
BC	20-30	0.71	0.03	4.32	7.4	19.0	8.1	27.1	-	-	16.1	74.3	26.7
Dark soil of Mountain Forest													
A	0-10	8.6	0.81	-	5.8	28.0	11.0	39.0	2.6	38.0	12.1	73.0	29.0
BC	20-30	4.14	0.22	-	6.0	26.0	12.0	38.0	3.61	41.0	10.1	74.0	26.0
C	40-50	-	-	-	6.3	14.0	7.0	21.0	-	-	-	-	-
Mountain Meadow Steppe-like soil													
A	0-10	6.71	0.33	-	6.4	16.0	8.0	24.0	1.98	36.0	8.1	77.0	23
	10-27	5.60	0.27	-	6.8	14.2	12.0	28.2	2.60	39.7	10	71	29
B	30-40	2.01	0.1	3.31	7.4	18.0	10	28.0	-	-	-	-	-
C	60-70	-	-	4.71	7.5	-	-	-	-	-	-	-	-
Dark Brown Mountain Soil													
A	0-10	4.21	0.21	-	6.7	19.1	13.0	32.1	2.81	28.0	10.1	79.5	24.1
B_1	20-30	1.8	0.10	-	7.1	15.1	8.0	23.1	2.60	31.0	8.1	76.1	23.6
B_2	40-60	-	-	1.81	6.9	18.0	10	28.0	-	-	9.1	82.0	18.0
A	0.20	3.88	0.19	-	6.8	17.1	9.0	26.1	2.71	28.7	13.0	72.1	27.9
Alluvial meadow soil													
A	0-10	7.14	0.44	-	7.1	21.0	12.0	43.0	3.01	44.0	13.0	61.0	39.0
	10-20	6.20	0.38	-	6.9	18.0	13.0	31.0	6.01	45.0	14.0	60.0	40.0
	25-30	5.21	0.25	-	6.8	20.0	14.0	34.0	1.98	46.0	-	-	-
AB	35-40	4.60	0.20	-	7.4	-	-	-	-	-	-	-	-
B	60-70	-	-	-	7.6	-	-	-	-	-	-	-	-

*-Study result of soil and vegetation by Gazar Eco LLC in 2004

Table 4.38 B. Agro-chemical composition of the soil in the Gatsuurt area*

Sampling depth, cm	Indicators, %			pH	Active	Absorbed cation	Chemical composition of soluble salts
	Humus	Carbonate	Total		mg/100g soil	mg-eq/ 100 g soil	mg-eq/ 100 g soil

			Nitrogen, NO_2	Phosphorus, P_2O_5	Kali, K_2O		Nitrogen, NO_2	Phosphorus, P_2O_5	Kali, K_2O	Magnesium Mg^{2+}	CO^{2-}	HCO_3	Cl	SO_4	Ca^{2+}	Mg^{2+}	K^+	Na^+
West mountainside, the bottom of the birch and pine forest, Black Earth Mountain Soil																		
0-30	3,45	3,0	0,2	0,23	1,56	4,72	3,2	3,9	34,4	6,0	-	0,20	0,30	0,11	0,30	0,16	0,5	0,10
River upstream, Dark soil of Mountain Forest of the pine forest, H-1364 m, N 48 37 150, E 106 34 2504																		
0-30	3,38	2,40	0,12	0,18	2,52	7,51	2,9	3,0	27,0	4,5	-	0,28	0,30	0,12	0,35	0,15	0,04	0,15
Dump soil from the disturbed area by prior placer mining operation																		
-	0,86	2,51	0,08	0,28	3,48	8,00	2,7	2,2	28,1	5,0	-	0,20	0,21	0,12	0,30	0,10	0,01	0,12
East mountainside of the river, the bottom of the birch and pine forest, Black Earth Mountain Soil																		
0,30	3,04	2,30	0,10	0,24	1,70	7,45	3,8	3,2	28,0	9,0	-	0,30	0,32	0,10	0,40	0,20	0,01	0,11
Alluvial meadow soil																		
0-30	4,21	2,50	0,11	0,22	2,28	7,91	3,1	4,0	33,8	7,0	-	0,24	0,20	0,10	0,30	0,10	0,03	0,11

*-Laboratory result analyzed by Ekho Khangal laboratory

An agro-chemical composition of the soil in the Gatsuurt area is presented in the table 6.36A and B. Gazar Eco LLC have sampled the soil by the genetic stratum and Ekho Khangal LLC have sampled the soil by mixed stratum. The result of the both study is indicated approximate values.

The soil in the area is very fertile, rich in nutrients and organic matter. Also potassium and phosphorus are sufficiently mobile in the soil to be used by the vegetation root system. No toxic salts were detected in the soil and it can be concluded that the soil in project area is very suitable for agricultural use, including for farmlands, pastureland and hay grass preparation. Table 4.40 shows humus content at 0-10 cm depth in sampled representative soils.

Table 4.39 Humus reserve contained at 0-10 cm depth soil

#	Soil type	Humus content, %	Humus reserve, t/ha
1	Black Earth Mountain Soil	4.34	112.8
2	Dark soil of Mountain Forest	7.62	198.1
3	Dark Brown Mountain Soil	8.60	223.6
4	Mountain Meadow Steppe-like soil	6.71	174.4
5	Alluvial meadow soil	7.45	193.7
	Total	34.6	902.6

As seen in the table from the five soil profiles representative of the project area, at 0-10cm depth, humus content is 34.2 % or 902.6 tone/ha. This means that the soil in the project area is very rich in nutrients and organic matter. This type of soil dominates at undisturbed Gatsuurt gold project area, as seen in Table 4.41.

Table 4.40 Soil distribution in the Gatsuurt area, %

#	Soil types	Area,ha	Percentage, %
1	Black Earth Mountain Soil	771	34.5
2	Dark soil of Mountain Forest	196,8	8.8
3	Dark Brown Mountain Soil	979.4	43.8
4	Mountain Meadow Steppe-like soil	127,4	5.7
5	Alluvial meadow soil	161,4	7.2
	Total	2236.0	100.0

4.6.2 Existing Soil Deterioration (Erosion and pollution)

Chemical pollution: Gatsuurt river valley has impacted and disturbed by prior placer mining operation and it is counted quite large ecological damage because of no reclamation.

Duplicated soil samples for disturbed and no disturbed areas were taken from Gatsuurt mine area and analyzed in the CGL in Mongolia and SVL laboratory of USA. A laboratory analysis by SVL included broader range of specification and concluded based on the SVL results.

Gatsuurt River upstream

Soils samples were taken from the Gatsuurt river upstream and Central zone.

Table 4.41 Gatsuurt River upstream, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
19 June -09	0.94	6550	49.9	30.0	32700	15.2	9750	37.5	134	64.6	<0.033	27.9	<0.50
05 Oct-09	<0.2	6300	34.8	21.4	28200	15.7	5330	17.4	110	49.6	0.047	81.2	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

The result of the soil analysis shows higher Fe content and arsenic level is 7-20 times more than the permissible level. An acid-base balance of the soil is pH 6.10-6.50.

Table 4.42 Central zone, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
19 June -09	0.63	3140	31.2	19.5	24500	19.1	5060	27.3	82.4	52.1	<0.033	32.8	<0.50
05 Oct-09 non disturb	<0.2	4190	28.5	13.0	23800	13.8	5060	20.8	81.6	55.6	0.423	6.0	<0.50
05 Oct-09 disturbed	<0.2	1560	8.63	15.8	14300	12.7	745	80.2	<50	59.1	0.060	233	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

As shown in the Table 4.43, soil content of this region contains higher Fe and As (As is 32.8-233 mg/kg). Soil sample from disturbed area had lower soluble mineral salts comparing with non-disturbed area but it had higher arsenic content with 44 times more. An acid-base balance of the soil is low with pH 6.10-6.50

Middle of the Gatsuurt River

In table, presented laboratory results, in the below table, are soil analysis of pond 3, proposed areas for sulphide ore stockpile and waste rock dump.

Table 4.43 Pond 3-1, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
19 June -09	1.60	7110	47.4	45.0	44200	28.6	8130	43.0	110	104	0.080	423	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

Table 4.44 Pond 3-2, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
19 June -09	0.25	2440	9.11	13.5	18500	10.5	1440	12.1	<50	45.5	<0.033	123	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

Table 4.45 Main zone, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
19 June -09	1.0	5140	36.1	19.3	30200	18.7	6030	28.6	81.5	93.9	<0.033	464	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

Table 4.46 Sulphide ore stockpile area, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
05 Oct-09 non disturb	<0.2	4770	33.8	21.9	31400	14.4	6600	33.7	105	61.2	0052	7.0	<0.50
05 Oct-09 disturbed	<0.2	2900	13.2	12.9	16700	10.8	2230	8.83	57.7	44.9	<0.033	87.5	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

Table 4.47 Waste rock dump area, soil contents by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
05 Oct-09 non disturb	<0.2	38200	38.7	32.2	29200	10.6	10500	25.9	158	62.6	<0.033	8.5	<0.50
05 Oct-09 disturbed	<0.2	6480	18.6	19.8	21200	4.65	4560	9.30	95.6	41.2	<0.033	61.1	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

In the middle of the Gatsuurt River, an acid-base balance of the soil is ranged from pH 5.27 to pH 7.88 and from low acid to low alkaline. All samples result higher Fe content besides large arsenic content (15-116 times more than standard level). Comparing disturbed and non-disturbed soil samples, mineral salt is decreased but arsenic level is increased 8-44 times respectively.

Biluur River upstream

Table 4.48 Biluut river upstream, soil content by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
05 Oct-09	<0.2	5750	30.2	23.8	28300	18.0	5240	24.9	95.2	87.3	0.073	9.6	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

Soil sampled from Biluut river valley had high Fe content as same as Gatsuurt river valley and also arsenic is detected apparently (As 9.6 mg/kg). Soil is low acidic with pH 5.51

Soil of Gatsuurt camp area

Table 4.49 Soil sampled from east side of the Gatsuurt camp, soil content by SVL, (mg/kg)

Date	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Ni	Na	Zn	Hg	As	TCN
05 Oct-09	<0.2	11500	23.7	20.4	18800	8.93	5430	16.1	85.9	60.8	0.045	5.0	<0.50
MNS 5850:2008	1.50	-	100	80.0	-	70.0	-	100	-	150	1.0	4.0	-

Soil sampled from Gatsuurt camp area had high Fe content as same as Biluut river valley and also arsenic is detected apparently (As 5.0 mg/kg). Soil is low acidic with pH 6.43.

An arsenic content in the soil of Gatsuurt river valley is illustrated in the following figure.

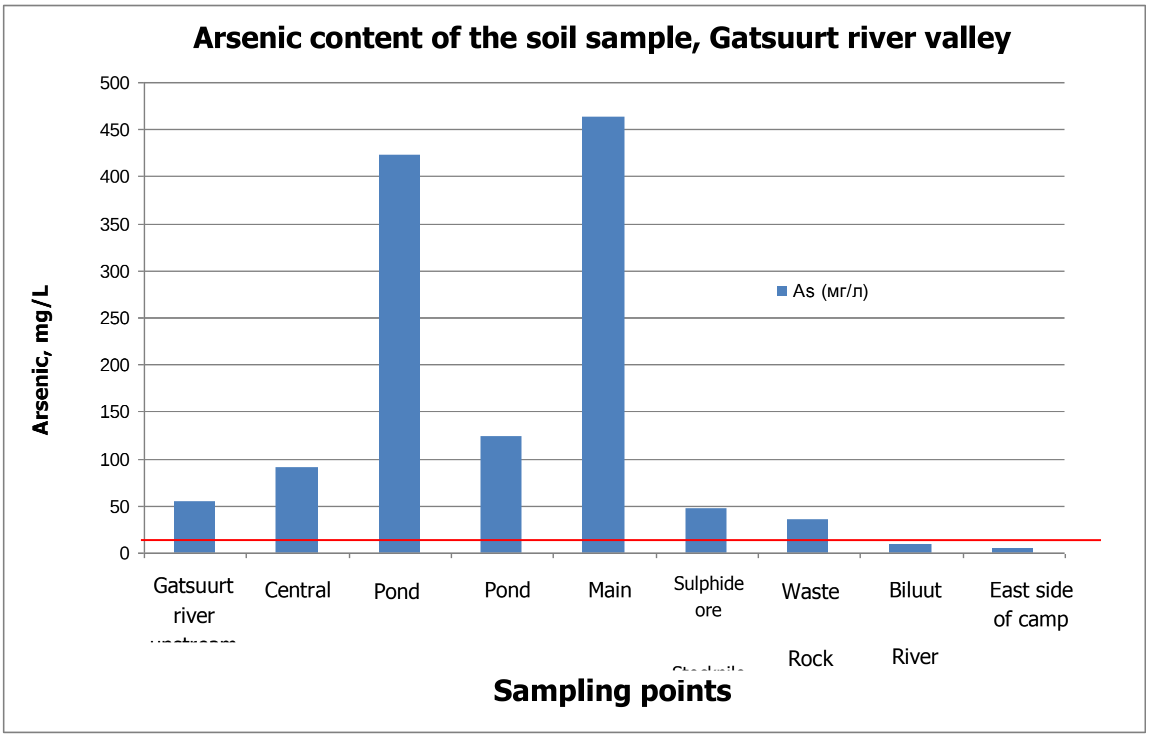


Figure 4.17 Arsenic content of the soil, Gatsuurt river valley, (red line is standard level (As 4.0 mg/L))

Soil erosion and quality deterioration: Soil erosion is defined as a "removal of topsoil faster than the soil forming processes can replace it, due to natural, animal, and human activity. The dominant forces driving soil erosion due to impacts of wind, water, human activity, including use of technical machinery. Soil erosion by wind erosion is created when fine particles are suspended by the wind and then transported great distances. Water is another significant agent of soil erosion and can cause a significant amount of soil loss each year.

1. Soil erosion by wind: Many of the soil profiles in the project area are no longer representative of the region due to land disturbances from historic mining activities by Gatsuurt Company. It is visible to the naked eye that the fine particles of the nutrient-rich topsoil were carried by winds down into the Gatsuurt valley. It can be concluded that the 146 ha area impacted by placer mining activity was significantly impacted by wind erosion.
2. Soil erosion by water: The Gatsuurt River, a second-order tributary, flows through the project licensed site area. However, due to irresponsible placer mining operations, particularly digging and excavation work at river beds and dumping of overburden material at river beds, has resulted in changes to Gatsuurt river course. Specifically, the river currently flows under the dam and has created several medium-size lakes. Because of changes to river course, new flow patterns, streams and runoff water channels (following waste material stockpile landforms). Therefore, it is difficult to do a detailed estimate of soil impacted by water erosion. We estimated that the soil eroded by water is approximately half or 50% of the total 146 ha land disturbed by placer mining.
3. Due impact of placer mining activities, some soil erosion and disturbance is observed at project area, particularly to dark brown mountain soil, dark soil of mountain forest and dry steppe chestnut soil. As of May 2009, overburden stockpile, excavated pits cover an estimated 146 ha and employee camp area is about 0.5 ha.

4.7 Vegetation

In terms of vegetation, according to N. Ulziihutag (1984) "Survey of Mongolian Vegetation Provinces", the Gatsuurt gold project falls into the Khentii mountain taiga region. However, some parts of the research area fall within the Baga Khentii Mountain range, which lies west of Mongolia's Daurian mountain forest steppe belt. In other words, because the project area borders both with Khentiin mountain taiga and with Daurian mountain forest steppe zones, it has several special vegetation and fauna features.

Project area's vegetation is diverse, ranging from tress such as pine, birch, larch, and oak tree to shrub such as *Rosa canina*, and plants such as siberian currant, and wild rose- all of which are native to mountain taiga and steppe forest regions.

As to surface, small mountains, hillocks, knolls are changing in turn. As to vegetation, in general there are feather-grass-sedge-meadows along the valley, feather-grass-couch-steppe, feather-grass-couch-steppe of the front side and valley of mountains and hillocks, herbs- fescue-steppe. (Figure 4.18).

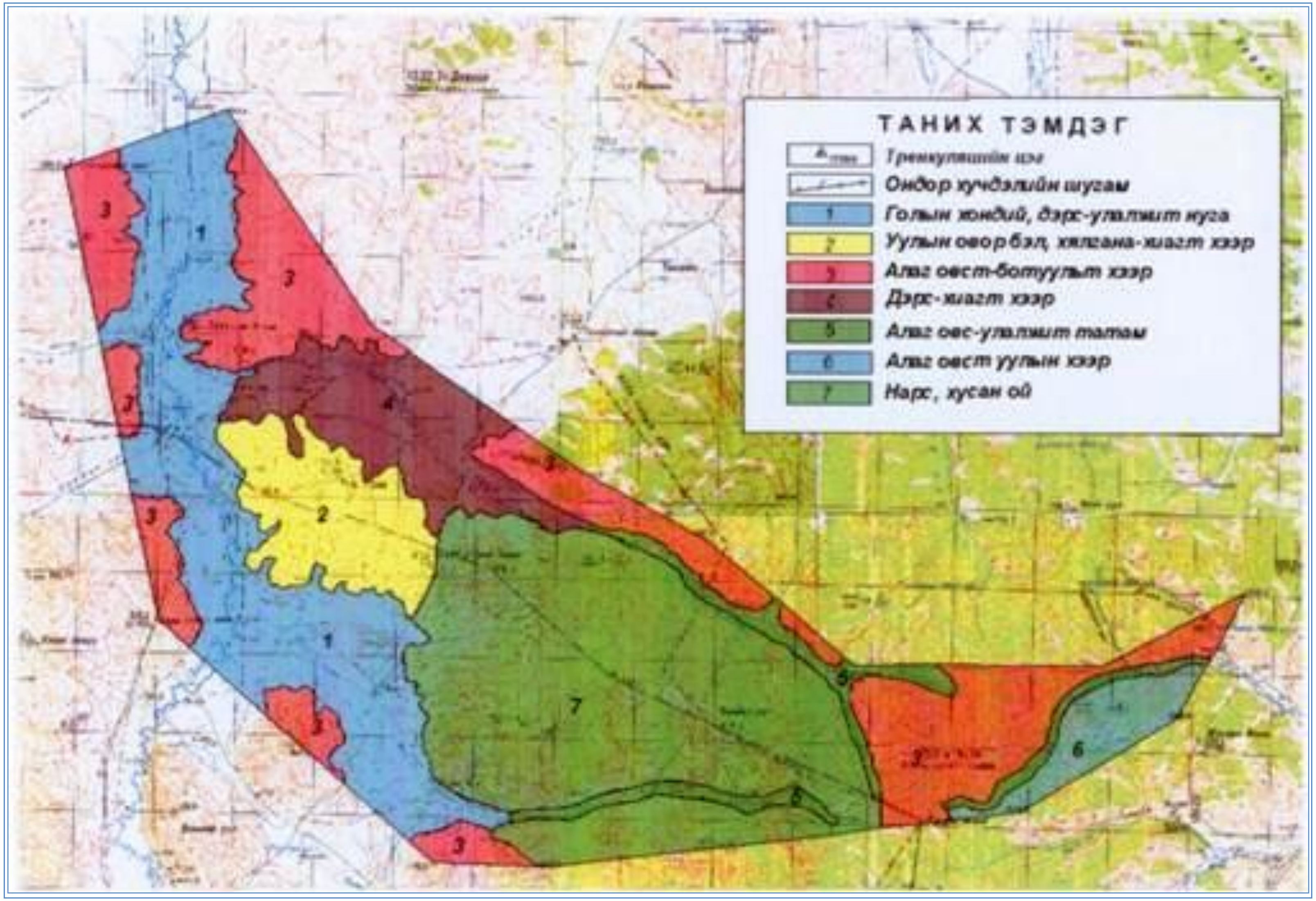


Figure 4.18 Pastureland vegetation (developed by Gazar Eco LLC, in 2006)

However, the region's western and eastern parts behind mountains, the larch forest ecosystem occurs and birch-pine, birch-larch, birch-pine-larch mixed forest, pine forest Shrubs and woody plants were also observed.

Forest with different grass and larch occur to the west and east of the territory along the north side of the mountain an also mixed forest, like birch-pine, birch-larch, birch-pine-larch, birch forest, shrub grove occurs. Mostly broad-leaved and mixed forest, in some places bright larch forest occurs in this region and mountain, steppe vegetation is prevailing. Here mountain steppe vegetation occurs in different versions. Livestock-khazargana, livestock-khazargana-herbs, feather-grass-potentilla acaulis-steppe are included into dominating steppe types and *Leymus chinensus*, livestock-leynus chinensus-livestock grass steppes are prevailing in the east side of the territory. Also meadow steppes, water meadow rich with grassy plant occur frequently. Steppe stony valley occurs in crumbs stony and gravelly places. Herbs, steppe with small broad-leaved caragana are prevailing in places with sandy soil.

Birch-pine, birch-larch mixed forest, shrub grove occurs in mountains of the Gatsuurt gold deposit region, which is the territory for extraction. Forest side is rich with shrub plant, like horny rose /sweetbrier/, willow spiraea. Shrub plant as spiraea, cotoneaster mostly grow in mountain steppe zone.

Plant-association of steppe stony valley with saltmarsh and tussock grass grow in places with rock, stone and crumbs stony and gravelly soil and elements, plants of mountain, forest, steppe zone widely grow along mountain hollows. Here meadow steppe, water meadow rich with grass occur frequently.

Vegetation cover is primarily composed of: *Rhododendron dahuricum* 10.8 %, *Spiraea salicuifolia S.tlexuosa* -5%, *Rosa acicu*laris-3.5%, *Carex tanceolata*-7.0%, *Fragaria orientalis*- 6.5%, *Iris ruthenica*-5.0%, *Lathirus humilis*- 5%, *Calamagrostis obtusata -C.Krylovii. C.epigeios*-5.0%, *Festuca ovina*-2.0%, *Vicia*-3.0%, *Bromus pumpelliana*-2.0%, *Sanguisorba ofsicinalis* -1.8 %.

Based on 2006-2007 study by Gazar Eco Co Ltd at Selenge aimag Gatsuurt gold project area in addition to Nature Friendly's study, a total of 4 kingdoms, 48 orders, 178 families and 389 species of vegetation have been observed. Hydrophytic vegetation community takes up a large portion of vegetation cover at Khentii and Mongol Dahurian belts. At Gatsuurt project area, hydrophytic vegetation take up nearly 40%. The grass and grass-like plants are suitable for pasturelands and agricultural use. For instance, from the above-mentioned 389 species, 303 plant species fall into the category of and are suitable for pastureland and agricultural purposes. At project area 8 endangered and 5 rare species of plants such as *Juniperus Sabina., Lilium dahuricum, L. martagon, Cypripedium macranthium, Rhododendron dahuricum, Gentiana macropylla,* and *Sambucus manshurica*. Rare species include *Juniperus pseudosabina, Paeonia anomala, Stelleria dichotoma, Chelidonium majius, Valeriana officinalis, Paragmatus comminus* were observed. None of the endangered and rare species are observed in the area, which will be impacted by mining operation. (See Appendix 3. List of plants)

On June 15, 2009, the average crop yield was calculated. The crop yield amount was estimated relatively higher than the average because project area is fenced around not to graze livestock and pasture vegetation had been maturated in the same time. (Figure 4.18).

4.8 Forest

4.8.1 Forest investigation

An engineering and technical staff consisting of 5 persons conducted field study at the 59.2 ha forests grown in the newly explored deposit under the mining license of this company in the Gatsuurt mine, Mandal soum, Selenge aimag from May 24-25, 2009, and July 16-18, 2009 and completed reporting, mapping, calculations and ecological and economic assessment (See Appendix A).

Figure 4.19 Part of the forest reserves map on forest structure in 1992

Forest evaluation parameters were determined by measurements with special equipment for forest evaluation such as for forest height, density and diameter, forest reserves were determined by forest count by the method to count by stripes in total of 7086.1 meters in 4 areas which are Area #1 (Main Zone), i.e. 904.4 m, Area #2, divided into 2 sections, Central Zone A, i.e. 1628.4 m and Central Zone B, i.e. 1776.8 m, Area #3 (Non ag waste rock dump), i.e. 1776.5 , and Area #4, i.e. 1000 m on the road to be newly built, lengthwise, and wood volume was determined with each type of trees by identifying "sum of areas of cross section of the trees". Data processing and mapping was done using software such as AutoCad 7.0 and ArcView 3.3. (Figure 6.20).

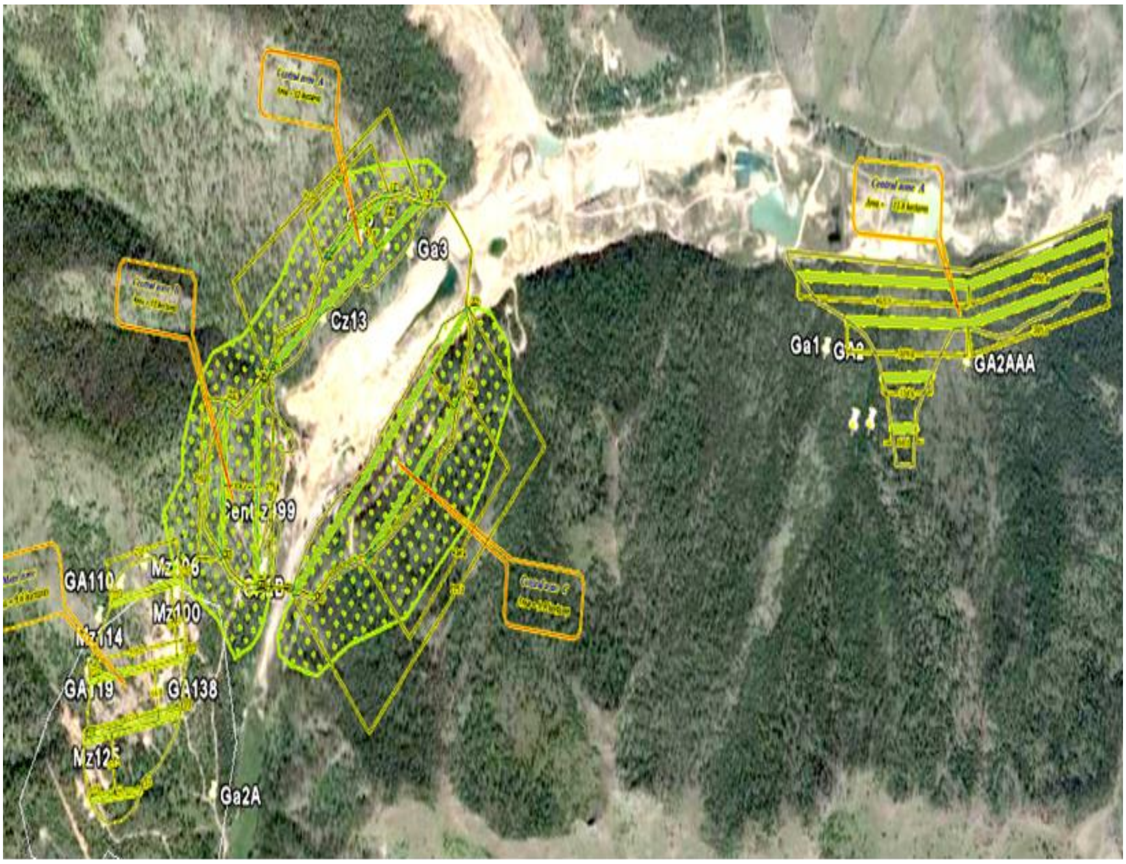


Figure 4.20 Satellite data used in field study of forests, summary of study and forests counting

Forest vegetation types:

- Taiga-like forest
- Pine forest with grass with iris (*Pinus sylvestris*)
- Siberian larch forest with Ritid moss (*Larix sibirica*)
- Birch forest with segmented grass (*Betula plathyphylla*)
- Grass – Siberian young larch forest with sedge (*Larix sibirica*)
- Loose Siberian larch forest with sedge (Larix sibirica, *Betula plathyphylla*)

Besides above coniferous forests there are following supplementary forests and shrubs.

- Spiraea
- Dasiphora fruticosa
- Rhododendron
- Salix
- Rosa

4.8.2 Forest reserve and fund

Approximately 59.2 ha of forested area in the licensed area under mining licenses held by "Centerra Gold Mongolia" LLC, is related to the green zone of Zuunkharaa town registered in the variation #18 of section #2004, variations #5 and 6 of section #2553, variations #1, 3, 4 and 5 of section #2554, and variation #1 of section 2555 of Mandal soum, Selenge aimag, according to the maps and materials of forest structure made in 1996.

Figure 4.21 General overview of forested area under mining license

Licensed area under mining license is a forest with mainly pines and larches with birches. During the previous mining operations at the alluvial deposit, main soil was stripped creating a large stockpile which blocked the river flow and small lakes and ponds have been created in some areas. As a result, shrubs in the river valley were completely destroyed and some trees in the edge of the forest have been disturbed by previous mining operations.

4.8.3 Areas and reserves of forests fund disturbed by mine operations

Area #1 (Main zone):

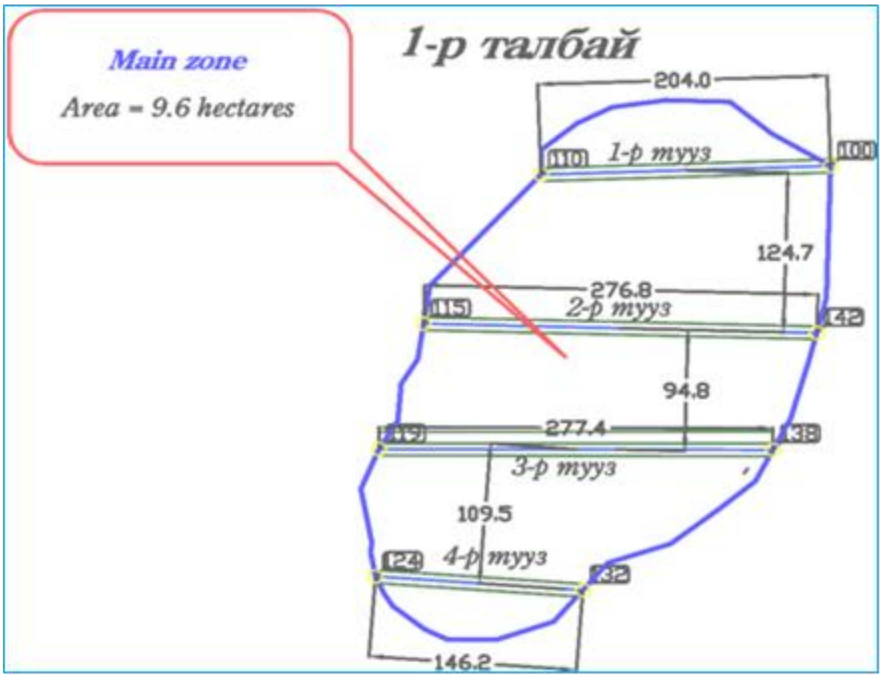


Figure 4.22 Sketch of evaluation of forests in the Main Zone

Area #1 is 9.6 ha in total Average evaluation parameters of the trees and reserves of above forested area have been determined with the method to count on a 10 m stripe of 904.4 m lengthwise, i.e. 0.904 ha area.

Figure 4.23 Current overview of Area #1 (Main Zone)

Natural reserves of forest fund and average evaluation parameters of trees in mine operation area #1 (Main Zone) are as follows (Table 6.51):

Table 4.50 Forest evaluation parameters of Area #1 (Main zone)

Parameters	Birch	Pine
Average diameter – d_m, cm	12.04	18.3
Average height – h_m, cm	11.3	19.5
Reserve – M, m^3	78.3	95.2

Area #2 (Central zone):

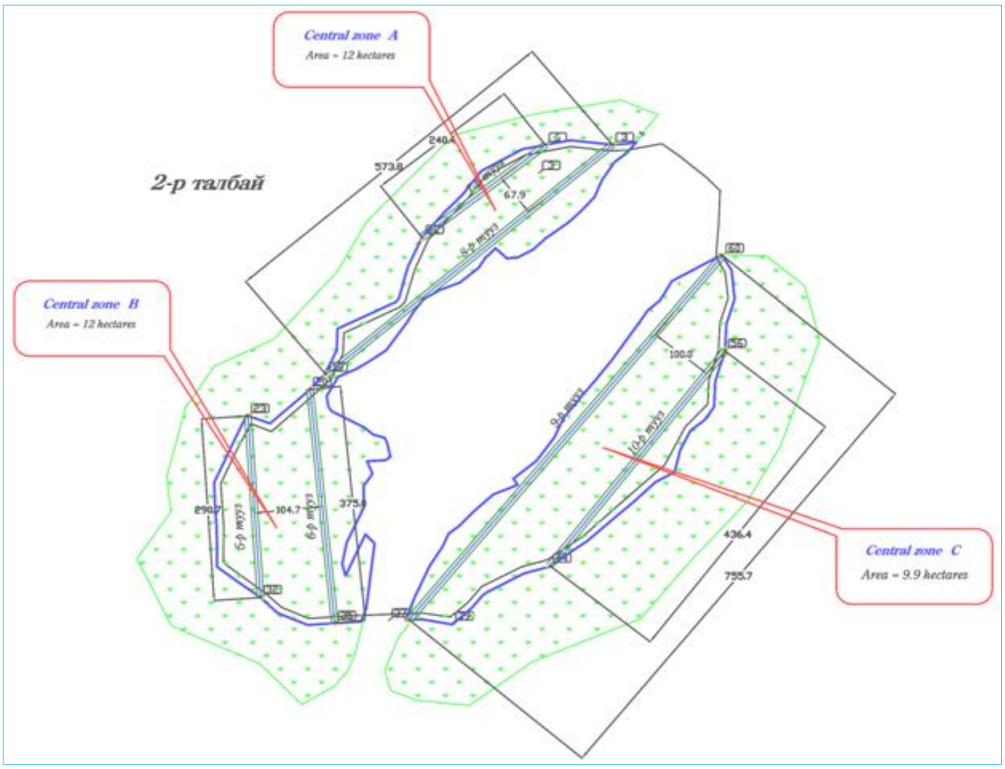


Figure 4.24 Sketch of evaluation of forests in the Central Zone

Area #2 is 21.9 ha and was divided into 3 sections and average evaluation parameters of the trees and reserves of above forested area have been determined with the method to count on a 10 m stripe in 814.2 m (Central zone A), 584.7 m (Central zone B) and 1776.8 m (Central Zone B), total of 3175.4 meters lengthwise, i.e. 3.18 ha area. Natural reserves of forest fund and average evaluation parameters of trees in mine operation are #2 (Central Zone) are as follows (Table 4.52):

Table 4.51 Forest evaluation parameters of Area #2. (Central zone)

Parameters	*Birch*	*Pine*	*Larch*
Average diameter – d_m, cm	*17.0*	*18.5*	*32.6*
Average height – h_m, cm	*14.5*	*23.6*	*20.3*
Reserve – M, m^3	*680.0*	*685.0*	*354.0*

Area #3 or Section A. (Non AG waste rock dump):

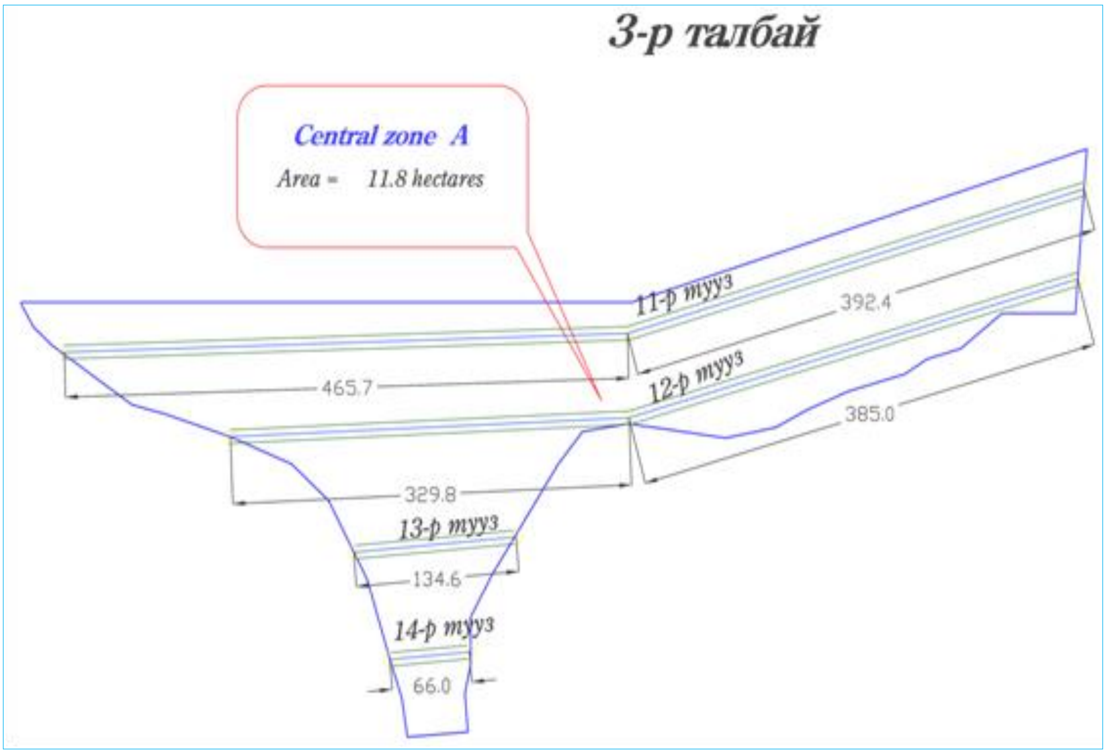


Figure 4.25 Sketch of evaluation of forests (NAG waste rock dump)

Figure 4.26 Forest in mine operations area of Section A (NAG waste rock dump)

Area #3 is 25.5 ha in total. Average evaluation parameters of the trees and reserves of above forested area have been determined with the method to count on a 10 m stripe of 1776.5 meters, total of 3175.4 meters lengthwise, i.e. 3.18 ha area in the Non ag waste rock dump area or Area #3. Parameters of forest reserve and forest evaluation in the mine operation area #3 or NAG waste rock dump are as follows.

Table 4.52 Forest evaluation parameters of area #3 or Section A. (NAG waste rock dump)

Parameters	*Pine*	*Larch*	*Birch*
Average diameter – d_m, cm	12.3	8.5	17
Average height – h_m, cm	7.8	6.3	14.01
Reserve – M, m^3	153	132	387

Area #4 or new road:

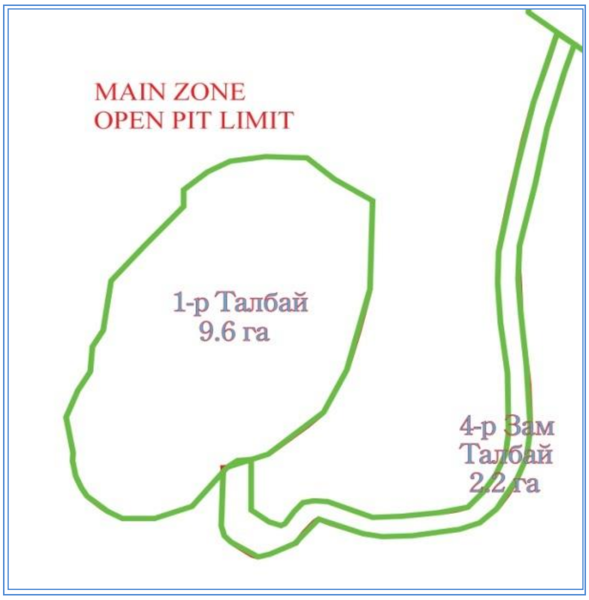


Figure 4.27 Sketch of tree count in the area of road connecting Central and Main zones

Area #4 or the area to build a new road connecting Central and Main zone is 2.2 ha in total, and tree count was conducted establishing 13 points of sampling in the length of 1000 m with regular radius of 10 m.

Table 4.53 Forest evaluation parameters of Area #4 or road trees

Parameters	*Pine*	Larch	*Birch*
Average age – A, years	135	120	50
Total number of trees – N. pieces	261	169	1446
Total area of cross section of trees – G, m2	10.6	7.7	9.0
Average diameter – dm,cm	20.7	20.8	9.7
Average height – hm, cm	19.5	20.7	9.7
Reserve – M, m3	83	64	35

4.9 Fauna

In 2006, Centerra Gold Inc developed the Technical and Economic Study of Gatsuurt Gold Project open pit mining. As part of this Study, baseline environmental conditions study was carried and fauna distribution study findings were included in the report. These include 50 special of mammals (bear, deer, roe deer), 253 bird species, out of which 61 are native and 16 are itinerary birds.

In terms of fishes, following fishes are recorded: ruff, lenok, taimen, Siberian sturgeon, pike, and perch. Although a detailed study of fish species at Gatsuurt River and nearby streams was not carried out.

The project area does not fall into special protected land and there are no animal species that fall into the Red Book of Mongolia. Gatsuurt Rivers runs over the future mine operations area and the river is part of the Sujigt, Kharaa River chains. Khentii northwestern fauna study was carried out by German

Gettingam University and National University of Mongolia's Biology faculty in 2000. According to this study, there are 9 species of small mammals, 146 species of birds, and just from macroinvertebrates, 154 species of butterflies were found.

Between 1969 and 1975, Mongolian Russian wildlife research expedition was at Orkhon Selenge pastureland and while passing by Zuunkharaa and Bayangol soums, pastureland insects and micro vertebrates found were Homoptera, Orthoptera, Plecoptera, Coleoptera, and Lepidoptera. Distribution was recorded. Around 90 species were recorded and published in "Насекомые Монголии" (Insects of Mongolia) book sections 1, 5 and 8. In July –August, 2001, an insect research group at Biological Institute of the Academy of Sciences carried out a study of local fauna and particularly the long horn beetle (Cerambycidae) and as a result discovered 10 new species, which suggest that the area is rich in wildlife and insects.

Due to mining operations, following animals are most vulnerable to be scared away and are likely to disappear from their original habitat: Corsac Fox (*Vulpes corsac*), Red Fox (*Vulpes vulpes*), Grey wolf (*Canis lupus*), Eurasian Lynx (*Lynx lynx*). The Siberian marmot (*Marmota sibirica*) is regionally considered to be endangered. However, their population distribution is wide and data is insufficient to do impact evaluation.

In addition, there are fishes of small rivers and lakes that are regionally considered be near threatened. They include: Ike (*Leuciscus idus*), the regionally disappearing Salmonidae (*Brachymystax lenok*) and Taimen (*Hucho taimen*). No assessment was made on the species of Least Concern status regionally. For reptiles and amphibians, 5 species of animals have been registered at project area, but due to widespread distribution and deficient data, no evaluation has been made.

Fieldwork at the project area showed six families and 19 species of insects, birds, which include Ruddy Shel duck (*Tadorna ferruginea*), Chough (*Pyrrhocorax pyrrhocorax*), Carrion crow (*Corvus corane*), Tree sparrow (*Passer montanus*), Common cuckoo (*Cuculus canorus*), and the Eurasian Magpie (*Pica pica*).

One of the primary parasites that destroy the forest resource are Gypsy Moth (*Ocneria dispar*). There was a large fire at Gatsuurt forest edge in 2008, which later caused large migration of the secondary pest insects into the area.

Many streams flow from the pond side at the project area thus creating a favorable environment for mosquitoes and squash bugs, snails and small invertebrates, and molluscs to breed.

Locals have mentioned that at the mixed forest, forest-flies, one of numerous blood-sucking flies, are bred, requiring that actions are taken to prevent from them. Our studies suggest that the area is relatively limited in the number of fauna species, due to which field work was carried out for a short period of time and also based on field observations. Therefore, information on fauna (mammals, birds, reptiles and amphibians) was collected using available sources such as the Mongolian Biodiversity Database and the IUCN Red List.

5 Potential and Core Negative impacts of the Project and Mitigation

5.1 Potential negative impacts

Centerra Gold Mongolia Company retained Nature Friendly Co Ltd to carry out a detailed study and assessment of potential and adverse impacts on the environment resulting from its mine operations, ore processing and closure reclamation activity at Gatsuurt gold mine. Upon project site visit and field work in May, June and July of 2009, Nature Friendly experts familiarized themselves with environmental baseline conditions, including ore and waste material stockpiles, site facilities, extent of existing environmental pollution and environmental monitoring program carried out.

Mongolian Environmental Impact Assessment Law, guidelines developed by the Ministry of Nature and Environment, Checklist method and EIA matrix developed by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and the Battelle Environmental Evaluation System were utilized in the process of reviewing previous sections of the Report, which cover mining operations, ore milling and processing, Tailings Management Facility, heap leach cyanide leaching project operations, mine decommissioning and closure as seen in sections: mining technology (Section 3), secondary products and waste management (Section 4), environmental baseline conditions (Section 6), employment and social aspects (Section 5) of the report.

5.1.1 Potential adverse impacts of the project- their scale, severity and impact duration

In order to correctly identify potential environmental impacts of any mining operations, a checklist that addresses principal environmental characteristics is developed prior project commissioning, which assesses project impact type, scale, severity and duration on such aspects as local and regional environment and ecology, socio-economic and demographic features, as well human health. These considerations have been clearly marked in guidelines developed by the World Bank and UNESCAP.

Table 5.1 Potential Environmental Impacts of Open Pit Mining Operations and Decommissioning-Impact Type, Scale, Severity and Duration

Environmental Indicators	Direct Impact	Indirect Impact	Self-reversible	Duration- short	Duration-long	Reversible	Non-reversible	Severity- high	Severity -medium	Severity negligible
1.Changes to the Natural Ecosystem										
Changes to groundwater flow	x				x		x			x
Changes to surface water flow										
Changes to vegetation cover	x				x		x		x	
Soil erosion	x				x		x		x	
Changes to local geology	x				x		x	x		
Impact on wildlife habitats		x			x		x			x
Changes to the microclimate		x			x		x		x	
2.Environmental Resources & Use										
Underground resources	x				x		x		x	
Pastureland	x				x		x		x	
Minerals and raw material resources	x				x		x	x		
Fossil fuel resources	x				x		x			x
3.Changes to Environmental Quality										
Deterioration of groundwater quality	x				x		x			x
Deterioration of surface water quality										
Air pollution	x				x		x			x

Environmental Indicators	Direct Impact	Indirect Impact	Self-reversible	Duration- short	Duration-long	Reversible	Non-reversible	Severity- high	Severity -medium	Severity negligible
Soil pollution	x				x		x			x
Hazardous and toxic materials spilled into waterways and thus affecting wildlife, livestock and humans										
Impact of noise and vibration	x				x	x			x	
4.Nature's visuals physical changes, impact on archaeological and historic resources, paleontological findings										
Changes to visual aesthetics of nature	x				x		x		x	
Impact on landscape and its features	x				x		x	x		
Impact on specially protected lands										
Impact on places of historic and cultural value										
Impact on archaeological and paleontological findings in project area										
5. Socio-economic aspects										
Changes to private ownership and tax income	x				x		x	x		
Contribution to the Gross Domestic Product	x				x		x	x		
Poverty reduction	x				x		x			x
Increase employment opportunities	x				x		x		x	
Increase in seasonal employment and income	x				x		x			x
Impact on public health	x				x		x			x
6.Mine closure and reclamation impacts										
Impact on soil and landform during mine closure-decommissioning of roads and movement of machinery and heavy equipment	x				x		x			x
Change to chemical composition of water due to Acid Mine Drainage , increase in water acidity	x			x		x				x
Wedge and pit wall failure	x			x		x				x
Windstorm, fire, earthquake, thunderbolt		x		x		x				x
Total	25	4	-	5	24	4	24	5	11	13

29 impacts were identified to result from mining operations at the project area. Based upon assessment of impact type, duration, severity on the natural environment and the socio-economic conditions following conclusion can be made: out of 25 direct impacts, 4 on socio-economic impact are beneficial impacts, and the remaining are adverse.

Direct impacts: 25 impacts are anticipated to have direct impact, including: heavy machinery movement resulting in noise, emission of toxic gases to the air, impact on odour, impact on wildlife species and shrinking of their habitats, impact on soil quality due to disturbances within mining land are and in its surroundings, including the roads, creation of waste rock dumps are anticipated to generate dust, cause soil pollution and changes to microclimate. Other anticipated emergencies and natural disasters (earthquake, windstorm, and fire) are considered as indirect impacts.

Specifically, soil stripping, blasting, ore loading and hauling, rock stockpiling activities will directly impact on changes to the local geology, landform and landscape, causing soil erosion and quality deterioration. Forest area and pastureland will not be suitable for use. There will be an impact on the underground resources such as ground water quality and flow change. Other impacts include resource use and depletion, increase in dust and noise due to mining machinery operations, aesthetic impact on landscape and its features. In addition, potential adverse impact is anticipated due to spill of sewage and fuels thereby impacting on soil and groundwater quality. The abovementioned impacts will also influence on public health of local community and employees. Positive anticipated impacts include generation of employment opportunities, increase in fiscal income, contribution to gross domestic product and tax payment benefits.

Indirect impact: Indirect impacts include heavy machinery movement resulting in noise, emission of toxic gases to the air, impact on odor, impact on wildlife species and shrinking of their habitats, impact on soil quality due to disturbances within mining land and its surroundings, including the roads, creation of waste rock dumps are anticipated to generate dust, cause soil pollution and changes to microclimate. Other anticipated emergency situations and natural disasters (earthquake, windstorm, and fire) are considered as indirect impacts.

Impact duration: The predominant majority –24 of the anticipated impacts is expected to be long time in duration, and five will have short-term impact. The ore body is expected to be mined in 7 years, which means that changes to the nature and ecosystem, natural resource use, changes to the environmental quality, anticipate impacts to the national, regional and local economies are expected to have long-term impacts. Other impact such as accidental release of sewage due to failure in sewage pipeline can cause odour and hygiene issues, although these impacts are expected to be short in duration.

Impact reversibility: Potential impacts have been classified as negative and beneficial, as well as reversible and irreversible. Irreversible impacts include: throughout mining operations anticipated changes to geology, use of ore reserves, soil quality in project area, flora and vegetation cover, surface and groundwater quality and flow, wildlife habitat, air quality changes due to generated dust, gases released from vehicle exhausts. These environmental aspects will adversely impact on the aesthetics of landscape and its features and fall into irreversible category.

Impacts such as noise due to operations of mine machinery and equipment, blasting, sewage water and fuel material spills causing pollution of soil and water, as well as impacts resulting from improper domestic waste handling and immediate disposal, impacts from environmental incidents and natural disasters are anticipated to have reversible impacts on mine operations, environmental quality for human and livestock settlement, as well public health.

Impact severity: As seen in the table above, out of all impacts 17.2% are expected to have high severity impact. 37.9% medium severity and 44.9% are anticipated to be low in impact severity.

- Since an open pit mine will be created at Central area, cutting through Gatsuurt River at 100 meters deep, impacts high in severity are expected to geology where mining will take place, and changes to project area landform and landscape due to creation of an open pit.
- However strong positive economic impact on Selenge aimag Mandal soum is expected with increased local fiscal income, private ownership and company's tax payments.
- Impacts anticipated to be medium in severity include: soil erosion and quality deterioration, changes to the vegetation cover structure that will generate medium-term visual impact on aesthetics of project's local landscape as open pits are created. Also, medium term impact on groundwater quality from site discharges is expected. The other 13 impacts are expected to be low in severity.

5.1.2 Potential impacts depending on project location and decisions made during project implementation

In order to assess environmental impact of Gatsuurt gold mining project depending on project location and technology/equipment selection and well as environmental concerns during project implementation were assessed and "occurrence likelihood" (by the potential impact) list was developed according to impact consequence. "Negative", "neutral", "positive" impacts were checked for each category, whichever applied. Results of impact identification and likelihood of occurrence assessment are seen in Table 5.2.

Table 5.2 Potential environmental impacts from Gatsuurt gold mining project environmental impacts based project location and technology choices during planning and operations–environmental impact likelihood of occurrence checklist

Environmental concerns	No impact	Consequence		
		Negative	Neutral	Positive
1 Potential environmental concerns related to project location				
Disturbance and changes to river flow				
Issues relating to local community and livestock re-settlement	x			
Forest removal			x	
Destruction of historic, cultural and archaeological, paleontological finding sites	x			
Changes to water supply and groundwater regime			x	
Changes to water regime of springs and stream, causing water dry up and disappearance				x
2.Potential environmental concerns related to project selection and planning				
The acceptance of project operations and mining quality by local community, suitability of raw material production methods, hauling and environmental pollution engineering controls				x
Planning quality for preventing industrial hazards, job-related illnesses, and state of employee awareness to prevent blasting, hazardous gas and fire related accidents.				x
Whether controls are in place on potential dust generated from ore excavation, blasting, and hauling			x	
Whether quality controls were set on production technology				x
Whether there are potential air, water and soil pollution, waste disposal and noise related issues due to project operation technology/equipment selected			x	
Whether special attention given to generation of toxic gases, dust and exhausts			x	
Whether project includes section on noise reduction during mine operations		x		
3.Potential environmental concerns from building and facility construction work, mining safety				
Whether water resource was polluted during construction	x			
Whether soil erosion/deterioration occurred during and after buildings construction			x	
Whether conditions for industrial accident, hazardous environment, epidemic spread are in place			x	
4. Potential environmental concerns during project implementation				
Whether adequate project planning, budget forecast and sufficient funding available during project implementation and quality control				x
Whether sufficient funding and adequate planning done on prevention of job-related illnesses and work safety			x	
Whether the plan covers reduction and prevention of soil erosion, quality deterioration (soil covering, revegetation, watering)		x		
Engineering and procedural controls on wastewater line failure that can pollute soil and water thereby affective soil and water regimes			x	
Whether the project plan aims to reduce negative impact on land use, minimize earthworks and preventing disturbance of surrounding lands.				x
Effective monitoring (whether project covers monitoring schedule and budget for effective monitoring)			x	
Whether other minerals other than gold were studied to be economical for production				x

Environmental concerns	No impact	Consequence		
		Negative	Neutral	Positive
Whether engineering and finance related concerns were reviewed for project implementation				x
5.Project assessment criteria (qualitative assessment aspects)				
During project implementation, did not assess possibilities for other alternative use		x		
Whether technology and equipment selection, and alternatives were most economical and technologically suitable				x

Impacts from project location: Open pits will be located in the area, where have changed river flow and disturbed by former placer gold mining.

It is also important to consider that sulfide-containing ores will be revealed on to surface in the process of mining, which can lead to acid rock drainage environmental issues.

Due to Mongolian "Gatsuurt" Co Ltd company's alluvial operations at the riverbed without any later reclamation work, the Gatsuurt river flow was completely destroyed and water disappears in some areas. Totally, 146 ha area disturbed by mining operation and some small ponds are derived due to mining disturbance. By environmental study, it is ascertained that derivative ponds have high arsenic content.

Therefore, it would appropriate to repair Gatsuurt river flow, return the natural surroundings to an accepted level and establish a dedicated water collection pond (dam) to collect and treat potentially ARD affected water. The mining project can be implemented within the framework of repairing existing environmental destructions. It is required to implement specific project to be taken for collecting and diverting natural surface water (Gatsuurt River and its tributaries) not flow to open pit and impacted by mining operation. Consequently, determine measures to treat impacted natural water, to sediment/neutralize until natural permissible level

In addition, creation of overburden material stockpiles and use of haul roads will inevitably generate dust, thus requiring regular application of dust reduction agents. Improper handling of waste can also pollute the soil which can further impact on groundwater quality because the river basin is charged by precipitation, thus requiring that petroleum products and other wastes should not be disposed in the surrounding area.

Environmental issues from mining project decisions and planning: It has been foreseen that there will be adverse environmental impacts from Gatsuurt open pit mining operations, particularly from soil stripping, ore excavation after blasting, extraction of pit deposits, ore loading and hauling within and outside of project area. Nevertheless, impact severity from these operations is expected to be less than from potential acid rock drainage uncertainty due to high sulphide content in deposit's ores. Measures for stockpiling and storage of acid generating rocks have been clearly covered in the section 8 of the report, it mentions that acid generating waste rock will be disposed of below the water level in the Central Zone Pit to prevent ARD and also provides a detailed schedule for pollution control and environmental monitoring.

The Feasibility study does not provide sufficient information on planned dust reduction measures, including technology controls on blasting, ore mining and hauling. Also, there is presented coverage of issues such as air pollution, solid waste material (such as overburden materials), dust, air emissions, noise and control to be put in place in the section 8.

Therefore, the annual Mine Plan after commencement of mining must include detailed information on measures the company will take to prevent, control and reduce pollution, improve workplace hygiene and sanitation in each step of its mining operations.

Environmental issues from construction and processing safety: During construction phase, environmental impacts are anticipated from following operations:

- Preparatory work for tree cutting, wood preparation and earthworks
- Establishment of site road
- Site water diversion system and channels, potable and sewage lines
- Site vegetation clearing, topsoil stripping
- Establishment of water diversion towards the down gradient water collection monitoring pond
- Sediment monitoring pond construction work: compaction of pond base, dam and top
- Clearing of area for soil stockpiling, establishment of water diversion channels around Central and Main zone topsoil stockpiles

Machinery maintenance shop, administrative area, employee camp construction work will not significantly impact on surface or ground water resource. However, once these facilities are established, human and vehicular movement will inevitably promote tree and vegetation cover clearing in the surroundings.

Although there are sections covering employee safety in the mining plan, no information is available of preventive measures to be taken on hazardous working conditions and infectious illness outbreak.

Environmental concerns during project implementation: It is worth noting that the Mine Plan realistically and extensively covers sections on mine operations quality and budget planning. Although there are sections on safe work production and workplace safety, it is recommended that the mine plan includes more information on employee work-related illness prevention and continual improvement plans for employee health and safety, and accident prevention in its annual mine plans.

Although the project did not consider mining of other minerals from the deposit, the technology selection has been considered from various alternatives and is economically and technologically suitable.

5.1.3 Potential environmental impacts in the operations phase

It is important to identify in detail potential environmental impacts resulting from each aspect of mining operations to identify which steps the process can have significant impacts and thus require mitigation. The commonly used procedural impact matrix is widely used by impact assessment experts. One of these methods is used via the Leopold matrix, which is a qualitative environmental impact assessment method, used to identify the potential environmental impact of a project on the environment. The system consists in a matrix with columns representing the various activities of the project, and rows representing the various environmental factors to be considered. The intersections are filled in to indicate the magnitude (from -10 to +10) and the importance (from 1 to 10) of the impact of each activity on each environmental factor.

The matrix has been used here with some minor modifications. It includes all primary environmental factors (air, soil, water, flora, fauna etc.) that will be affected by the project.

Potential environmental impacts from open pit mining operations: The Table 5.3 was developed based on Leopold Matrix and covers environmental factors and potential impacts from Gatsuurt open pit gold mining operations. It is seen from the table that different operations components of open pit gold mining can have different environmental impact magnitudes.

Table 5.3 Potential environmental impacts from open pit mining operations

Activity / Impacted environmental component	Preparatory earthworks, soil stripping	Drilling of mountain core	Blasting, rock removal	Excavation, loading, loading	Hauling of soil, overburden, ores	Creation of deep open pits	Creation of stockpiles	Creation of dam, ditches, water diversion channels	Infrastructure establishment	Total
Soil	6/6	1/1	-	1/1	1/1	-	5/5	2/2	1/1	**18/18**
Air	2/3	2/2	3/3	2/2	1/1	1/1	2/2	1/1	-	**14/15**
Water	2/2	1/1	1/1	-	-	2/2	8/8	4/4	1/1	**19/19**
Flora (Forest)	5/5	-	-	-	2/2	-	4/4	1/1	1/1	**13/13**
Fauna	2/3	1/1	3/3	1/1	1/1	-	1/1	1/1	1/1	**11/12**
Geological structure	3/3	2/2	7/7	-	-	6/6	-	1/1	1/1	**20/20**
Pastureland	3/3	-	1/1	-	1/1	1/1	3/3	1/1	1/1	**11/11**
Visual aesthetics of nature	4/5	-	2/2	-	1/1	3/3	3/3	1/1	-	**14/15**
Public health	2/2	1/1	1/1	2/2	2/2	1/1	1/1		-	**10/10**
Score	**29/32**	**8/8**	**18/18**	**6/6**	**11/12**	**14/14**	**22/22**	**9/9**	**6/6**	**123/ 127**

Therefore, it is concluded that the operations that will have the largest magnitude on environment and its components soil stripping, blasting, drilling and creation of an open pit and waste material stockpiles. The environmental factors primarily impacted are: local geology (20), water (19/19), soil (18/18), visual aesthetics of nature (14/15) and air (14/15). Therefore, the section below on environmental significant impacts provides a detailed assessment on each of these components (section 5.2).

This detailed environmental impact assessment was developed to assist in developing the environmental protection plan and to eliminate or mitigate potentially adverse environmental impacts.

5.2 Core Negative Impact Assessment

5.2.1 Landform change, soil erosion, quality deterioration

The core negative impact resulting from Gatsuurt gold mine operations by Centerra Gold Mongolia LLC is landform change and land cover deterioration. Open pit mining will result in 47.7 ha land or 60,224 million tones and 22.3 million m^3 soil cover destruction, and creation of 80-200 m deep open pits. A total of 8,959 thousand tons of ore will be mined from Gatsuurt project. About 89.9 ha of land will be covered by overburden material. Using following equation, land to be affected for production of 1 tons of ore was calculated.

$$K = \frac{S_1 + S_2}{Q} = \frac{477000 + 899000}{8959000} \approx 0.154 \ m^2 / tonne$$

S_1 – Mining area, m^2

S_2 – Stockpile area, m^2

Q – Total amount of ore to be mined, tonne

To mine one ton of ore, 0,154-m^2 healthy land (pastureland), 59.2 ha of forest land will be destroyed. Totally, area of 12.6 ha, including construction of 3.1 ha, mine internal roads of 8.1 ha, storm water diversion and sedimentation pond and water collection/diversion facility, will be destroyed and eroded. In addition, there is 146 ha destroyed area by prior placer mining of Gatsuurt company. (Not rehabilitated).

Destroyed areas of 161.4 ha will be effected by mining operation of Centerra Gold Mongolian in Gatsuurt site. The amount of highly disturbed area is 125 ha, which includes open pits, waste rock dump, storm water diversion and sedimentation pond. Other areas of 36.4 ha will be disturbed moderately.

This requires concentrating on progressive reclamation, mitigation of soil erosion and not driving off roads. Besides soil erosion or condense, might hold fertility lose caused by solid and liquid wastes or fuel/chemical spilling and leakage. In addition, fauna will be impacted by deforestation and instability of vegetation biomass or biodiversity might be derived. Gatsuurt mine area already has been hit by prior placer mining. Following activities will have an effect on soil surface disturbance.

- Topsoil stripping in the Central and Main zone and topsoil stockpiling
- Sedimentation/filter ponds are planned to be constructed on the disturbed area by prior placer mining. Progressive reclamation will be implemented throughout mining operation.
- Sulphide ore stockpile and waste rocks dump will be placed over the disturbed area, no soil coverage will be impacted by the dumping and stockpiling. Prior to place dump and stockpile, disturbed area will be re-contoured for preparation.
- A quantity of lump soil from prior placer mining will be used for surface water diversion facility. After topsoil stripped from the ground, dams and pond will be constructed.

Soil coverage will be impacted where construct site structure and buildings such as: structure basement, fuel storage and workshop. All possible topsoil will be stripped from the areas and stockpiled separately.

5.2.2 Change of geological formation

According to potential impacts, geological formation of Gatsuurt village will be impacted certainly. Mining operation will affect the structure, physical-mechanical properties and formation of many years' accumulated mineral and rock. Geological formation in depth (200m) will be changed entirely and manmade or dumped area is 47.7 ha. The area of 12.6 ha, where build site infrastructure and hydro technical facility of Gatsuurt river course reclamation or sedimentation structure, will be stressed under mechanical impact. It is extremely impacted by prior placer mining and core negative impacts are changed surface water runoff, ceased Gatsuurt river flow, changed geological formation and landscape.

There are no negative impacts on surface and groundwater reserves from Gatsuurt site structure and facilities.

5.2.3 Impact on water quality

The potential for impacts to surface water quality during the construction phase will primarily result from the introduction to surface water bodies of contaminants, such as:

- Sediments
- Fuels
- Ammonia and nitrates (from blasting)
- ARD
- Nitrate contamination (from sanitary sewage drain field)

Other impacts are related to changes in surface drainage patterns. This includes the physical construction of the river diversion pond/dam upstream of the open pits where the water will not be affected by mining activities. From this pond, flow from the headwaters of the Gatsuurt River will be routed around the pit and waste rock dump by pumping and ditches to a point down gradient of the SMP. These changes to the surface drainage will affect the Gatsuurt River.

Impacts from off-site sediment discharge will be significantly reduced once the project site drainage management system is in place and the SMP is constructed. The drainage system at Gatsuurt will involve collection ditches to direct runoff from and around each of the mine components (i.e., open pit, waste rock dump and plant site) to the SMP. It requires to develop a project "Project to collect surface water and sedimentation" and implement urgently when approved by professional agents.

Interim mitigation measures to be taken include the use of downstream sediment control measures (i.e., silt curtains or other flow control devices in Gatsuurt River) during the construction phase. Provided that there is proper site management of erosion and sedimentation, which follows accepted construction practices, plus monitoring and maintenance of control measures, the project should not cause any significant direct or indirect impacts to surface water quality.

Surface water quality impacts as a result of spills during the construction phase, are expected to be small-scale and of short duration. In general, spills may be associated with refueling operations at the on-site fuel depot or in-field refueling.

Potential impacts on groundwater and its quality can be caused by mining operation.

- Dewatering open pit, might lead groundwater level reduction.

- ARD from any AG/PAG waste rock dump that may need to be constructed
- Leakage or spilling from fuel storage and fuel station
- It is possible to occur metal leaching such as arsenopyrite, pyrite or acid rock drainage from disturbed ground by placer mining operation.

There will be little impact from fuel accidental releases into the ground water. Fuel storage container will be engineered with additional controls. During mine operations, company's pollution control system and spill prevention plans will be put in effect.

5.2.4 Air pollution and dust estimation

Air quality in the Gatsuurt area is generally good but following air pollution sources were identified to impact air quality during mine construction and operation stages at selected project area. The main source polluting air quality is dust from the dumps soils and disturbed areas by prior placer mining.

- Dust generated due to open pit mining activities (pit, dumps, roads)
- Air pollutants from vehicle exhaust (mining heavy machinery movement, vehicular traffic)
- Noise from blasting and traffic of heavy machinery

Dust will be generated primarily from mine blasting, wind, material transportation on dirt road, topsoil loading and stockpiling. Following calculation shows a comparison volume (V0) with pollens and pollution and amount of explosives (A).

$$V_0 = 44000 \times A^{1.08} = 44000 \times 68.5^{1.08} = 4226671.48 m^3$$
$$A - Amount of \exp losives, tonnes$$

Next equation that shows rising height H0 of dusty cloud, coefficient "B" related to depth of blasting hole and amount of explosives. Depth is 15 m:

$$H_0 = B \times (164 + 0.258 \times A) = 1 \times (164 + 0.258 \times 68.5) = 181.673 m^3$$

Total content of pollutant in dusty cloud that sprayed out is indicated ・ - % and in our case, rational quantity is ・=60% to subside down during blasting.

$$\Pi_0 = R \times q \times A\left(1 - \frac{\eta}{100}\right);$$
$$q - distinctive\_percent\_of\_pollu\tan t\_per\_1\_tonne\_blasting\_agent, \ (m/m)$$

Total amount of pollutant in dusty cloud, which sprayed out, simply calculated with following equation. To q-(distinctive percent of pollutant per ton of blasting agent, m/m) define need to calculate consumptions ratio (Δ).

$$\Delta = \frac{1000\,A}{V_{гм}}$$

$$There: \qquad V_{гм} - \ volumeofmassiverocks, \ m^3 \_inourcase:$$

$$V_{гм} = 86880\,m^3 \qquad and$$

$$\Delta = \Delta = \frac{1000 \times 68.5}{86880} = 0.79\ kg/m^3 \quad .$$

q- is 0.088 for Gatsuurt mine explosive and volume of dust and dust-like substance is estimated as a following:

$$П_{0-dustsubstan\,ve} = R \times q \times A\left(1 - \frac{\eta}{100}\right) = 0.16 \cdot 0.088 \cdot 86500\left(1 - \frac{85\%}{100}\right) = 182.688\ kg$$

CO2 :

$$П_{0-CO} = 0.5 \times П_{0-Тоосонцор} = 91.344\,kg$$

Total amount of pollutant is estimated monthly and annually and shown in the table.

Table 5.4 Amount of pollutant, annually

Description	Monthly	Yearly
$П_{0\text{-dust}}$	730.752 kg	8759.0 kg
$П_{0\text{-CO}}$	365.38 kg	4384.5 kg

5.2.5 Potential impacts to vegetation

Gatsuurt mine operations will inevitably adversely impact on soil cover and vegetation. Blasting and vehicular movement of heavy machinery will generate dust that can settle to areas 500 m apart. The depletion of fine-grained minerals is critical for vegetation growth.

The areas containing the CZP, WRDF's, sulfide ore stockpile and sedimentation / filtering ponds have been previously disturbed by past alluvial mining activities. Vegetation is sparse in these areas and will be minimally impacted by additional mining operations.

5.2.6 Potential impact to forestry

As part of the proposed mining operations the areas of the main zone pit and maintenance facilities will have to be logged prior to topsoil removal. The outer areas of the CZP and some upper haul/access roads will also be logged to prepare for mine operations. The footprint areas of the dams and surface water diversion structures will also be cleared prior to construction. In addition, the floodplain areas behind the dams will be impacted by the water retention affecting the local forestry.

5.2.7 Potential impacts from ARD

Information regarding waste rock/tailings geochemistry and management alternatives for the Gatsuurt mine project are included.

Geochemical Processes: Natural weathering of rock is a part of the geochemical cycling of elements, and waste rock and tailings from many types of mining participate in this process. The chemistry of the weathering of waste rock and tailings begins through simple dissolution reactions and is often limited by the low solubility of many mineral phases. However, waste rock and tailings produced by the milling of sulfide minerals present additional management challenges due to the possibility of oxidation of reduced sulfur (sulfide) to more oxidized forms, such as sulfate. This dissolution and oxidation process can occur when sulfide waste rock and tailings are exposed to atmospheric oxygen and water.

Sulfide oxidation may cause the release of metals in waste rock and tailings containing sulfide. In the presence of water and atmospheric oxygen, the oxidation reaction removes sulfide from solution, and so enhances dissolution reactions of sulfide minerals. In addition, oxidation of sulfide minerals can produce acidity, through both oxidation of sulfide and formation of metal oxy-hydroxides. If the acidity from these reactions is not neutralized, solution pH will decrease, often leading to additional dissolution of mineral solid phases. Interrupting or preventing this cycle requires waste rock and tailings management based on an understanding of the chemistry of sulfide oxidation.

The importance of proper management of sulfide waste rock and tailings and the possibility of ARD from the tailings of sulfide ores has long been recognized, and much progress has been made in describing the chemistry of sulfide mineral oxidation and ARD formation (e.g., Temple and Delchamps, 1953; Singer and Stumm, 1970; Nordstrom, 1982; Nicholson et al., 1988; Blowes and Jambor, 1990; Elberling and Damgaard, 2001; Herbert and Schippers, 2008). It is now known that oxidation of sulfide minerals is a biogeochemical process that is affected by many variables, including the composition of ore. Because of its abundance, pyrite (FeS2) is often used as a model when describing sulfide mineral oxidation

In an open system with mass flow (i.e., water and oxygen moving through tailings), products of one reaction may become reactants of another reaction, and mass may leave the system. Under these more realistic assumptions, oxidation of sulfide minerals is viewed as an ongoing process, the rate of which is controlled by chemical kinetics. Management of oxidation is then based on directing chemical reactions towards steady-state conditions where oxidation is minimized. In practice, minimizing oxidation requires limiting the availability of water or oxygen, as one or both of these reactants are essential components of the reactions shown above.

Limiting exposure of sulfide waste rock and tailings to water is referred to as dry storage. The feasibility of this approach may depend on the environmental characteristics of the disposal site. Waste rock and tailings must be placed at an elevation that will always remain above the water table and must be shielded from atmospheric moisture.

Subaqueous Storage: Oxidation of sulfide tailings may also be reduced by limiting exposure to atmospheric oxygen. On-going research, including extensive field studies, has shown that the best way to reduce oxygen exposure is through the use of a water cover (e.g., Moses and Herman, 1989; Robertson, 1991; Morin, 1993; Pedersen et al., 1993; Fraser and Robertson, 1994; Peacey et al., 2002).

Water covers over tailings may take many forms depending on implementation, but in all cases this management practice is referred to as subaqueous disposal. A recent literature review of water covers is provided by Peinerud (2003). Also, the Mine Environment Neutral Drainage (MEND) program of Natural Resources Canada (NRCan) directed research on subaqueous disposal of sulfide tailings between 1988 and 2000 and has published many reports and reviews describing this work. An extensive listing of research and papers is found on the MEND web site (http://mend2000.nrcan.gc.ca). Research such as that conducted by the MEND Program has demonstrated that water covers are the preferred method for sulfide tailings disposal, if a suitable water repository is available.

The effectiveness of water covers as an oxygen barrier is a direct consequence of the low solubility and diffusivity of oxygen in water relative to air. Even when water is fully saturated with dissolved oxygen, the concentration of oxygen in water is about 25,000 times less than that in air, on a mass basis under typical ambient conditions. As Equation 6 shows, a closed pyrite-sulfate system at equilibrium moves toward pyrite as oxygen concentration decreases, and so, decreasing available oxygen will reduce the oxidation of pyrite. While equilibrium will not be obtained in an open system such as a subaqueous tailings disposal facility, the effectiveness of water covers is, to a first approximation, well explained by the large decrease in oxygen concentrations between air and water.

Subaqueous sulfide tailings disposal facilities are open to atmospheric oxygen and contain large quantities of reduced sulfur; thus, these systems are not at equilibrium. Given the low solubility of oxygen in water, the extent of sulfide oxidation will depend on the availability of oxygen. Dissolved oxygen in water at the water-tailings interface will be consumed as the chemistry represented by Equations 1, 2 and 4 proceeds, and a concentration gradient will, therefore, always be present over the depth of a water cover. Atmospheric oxygen will be drawn along this gradient towards the submerged tailings.

The minimum rate at which oxygen advances along the concentration gradient is set by the diffusivity of oxygen in water. Oxygen diffusivity in water is about 10,000 times lower than in air, so, as with solubility, water forms a very effective barrier preventing sulfide tailings oxidation, relative to tailings exposed to the atmosphere.

Molecular diffusivity sets the minimum rate at which oxygen may be replenished in water. The actual rate at which oxygen is replenished in water near the water-tailings interface in a subaqueous disposal facility (and, therefore, the rate at which tailings oxidize) will depend on a number of factors, such as the water depth, and the amount of turbulence in both the water and the atmosphere (often set by the wind speed). Each of these variables has been examined in field and laboratory settings, and many of these studies are presented in the MEND references. An important conclusion of this work is that, in many settings, as little as one to two meters of water depth will provide a very effective cover over sulfide tailings, even given the effects of wind-induced turbulence and the possibility of tailings resuspension. Elberling and Damgaard (2001) have also shown that the rate of oxygen consumption (and so, the rate of tailings oxidation) is not constant, but decreases with increasing age of submerged tailings. This is attributed to the formation of a thin veneer (millimeter-scale) of oxidized tailings at the water-tailings interface. Considered as a whole, the results of the field and laboratory investigations show that water covers of only a few metres depth can reduce sulfide tailings oxidation rates by several orders of magnitude relative to tailings exposed to the atmosphere.

As the depth of a water cover increases, other physical and chemical processes may begin to operate in a subaqueous disposal facility. These processes can further reduce not only the extent of sulfide oxidation, but also the transport of dissolved metals that may be released by oxidation of tailings. Two important processes are the formation of an anoxic hypolimnion and the cycling of reduced and oxidized iron.

This tailings management approach, however, must also be weighed against other mining waste management needs for mines and mills where development rock storage may also be required.

Gatsuurt Site Specific ARD Analysis: A site specific analysis has been completed on the available information provided by Centerra regarding static (acid base accounting (ABA)) and kinetic (humidity cell) testing of composite rock samples. Previous studies reviewed included the SGS report dated October 30, 2006 (static and kinetic test results) SNC-Lavalin (2006), JBR (2007) along with samples submitted by Centerra for ABA analysis in May and July of 2009.

Background: The ore body in the main zone is contained within rhyolite, and the ore body in the central zone is contained within granite. Bedrock is weathered near the surface and transitions to un-oxidized rock at a mean depth of roughly 60 m. Ore is classified as oxide and refractory, and contains varying amounts of sulfide.

SGS (2006) conducted ARD analysis consisting of ABA and humidity cells on 16 composite samples representing dominant rock types, and waste or ore classification. The SGS samples are identified as:

1. Granite oxide waste
2. Granite oxide low-grade
3. Granite sulfide waste
4. Granite sulfide low-grade
5. Diorite oxide waste
6. Diorite sulfide waste
7. Rhyolite oxide waste – central
8. Rhyolite oxide waste – main
9. Rhyolite oxide low-grade – main
10. Rhyolite sulfide waste – central
11. Rhyolite sulfide waste – main
12. Rhyolite sulfide low-grade – main
13. Kharra sandstone oxide waste
14. Kharra sandstone oxide low-grade
15. Kharra sandstone sulfide waste
16. Kharra sandstone sulfide low-grade

Additional ABA testing was done in July, 2009 on samples (the 2009 samples) identified as waste rock (two sample: central zone rhyolite; granite near Biluut river basin) and main zone rhyolite (four depths each at bore holes GT-371, GT-374, GT-386, and GT-391). These samples appear to be discrete samples from specific depths in single bore holes.

Sulfide Content: As described above, ARD is a result of oxidation of sulfide. Thus, sulfide content will determine the acid potential (AP) of a rock sample. A sulfide content greater than 0.3%, while very low given the possible range of sulfide in rock (greater than 50%), is often used to divide rock samples into those that are suspect with respect to ARD and those that are less worthy of close examination.

- All rock samples included in the above-referenced data have low levels of sulfide, although sulfide content varies among rock types.
  - In the SGS data set, 15 of the 16 composite samples had sulfide content of 0.29% or less, with many of the samples having sulfide content below the detection limit of 0.01%.

- Of the SGS samples, only Granite sulfide waste (3, above) had sulfide above 0.3%, with 0.59% sulfide.
- These results are only partly corroborated by the 2009 data.
- The two samples labeled "waste rock" each had non-detectable levels of sulfide.
- The "Main Zone Rhyolite" samples had greater sulfide than previously reported for Gatsuurt rock.

- Of 16 samples, 11 had more than 0.3% sulfide.
- The five-number summary (minimum, lower quartile, median, upper quartile, maximum) of sulfide in these samples is 0.01, 0.03, 0.81, 1.18, and 1.65.
- Although a statistical analysis of the SGS data was not performed, the 2009 samples appear to represent a different population than the earlier SGS samples.
- The new data, while still showing relatively low sulfide content, suggest that the Acid Potential (AP) in Gatsuurt rocks is greater than previously indicated.

Neutralization Potential: Acid generated though sulfide oxidation may be neutralized by carbonates and other acid-consuming minerals in rock releasing acid or in nearby rock. While carbonates represent a rapidly available form of neutralizing potential (NP), minerals containing aluminosilicates may also contribute NP, though generally at a slower rate. The presence of both of these mineral classes can provide both immediate and long-term neutralizing capacity. Various tests may be employed to determine NP as a part of an ABA analysis. Both the SGS testing and that done in 2009 used the Modified Sobek test to determine neutralization potential. This test is considered conservative, in that it will determine neutralization potential due to carbonates and some aluminosilicates, though not NP that may be provided by other silicates.

While NP is directly reported as an ABA parameter, the ratio of NP to AP provides a direct assessment of the ARD potential of a rock sample. Current classification criteria list rock potential for ARD as likely; possible; low; and none for NP/AP ratios of <1; 1-2; 2-4; and >4, respectively. Earlier classification criteria of likely; possible; and none (<1; 1-3; and >3) are also sometimes used.

- Rock samples in both data sets have variable levels of NP.
- SGS samples were analyzed for carbonate carbon, and this parameter was "highly" variable among those samples. However, the presence of NP in excess of that provided by available carbonate suggested that other sources of NP were present in SGS samples.
- In the SGS data set, 15 of the 16 composite samples had NP/AP ratios greater than 4, and so would be classified as having no potential for ARD.
- Of the SGS samples, and as with the sulfide content, only Granite sulfide waste (3, above) had NP/AP below 4, with NP/AP of 2.6. This is the only sample in this group that would be classified as having a "low" ARD potential (using the older classification criteria, this sample would be a "possible" ARD sample).
- Using the current classification criteria, no sample in the SGS group is classified as having possible or likely ARD potential.
- The five-number summary (minimum, lower quartile, median, upper quartile, maximum) of NP/AP ratios in SGS samples is 2.6, 14.4, 20.7, 144, 433.
- As with sulfide content, the 2009 rock samples produce somewhat different results from those generated by the SGS composite samples.
- The two "waste rock samples" had NP/AP greater than 4 and are not likely to generate ARD, although these samples do not have the very high NP/AP ratios seen in the SGS samples.
- Of 16 "Main Zone Rhyolite" samples, 11 had NP/AP less than 4.

- ・One sample has "low" potential for ARD.
- Three samples have "possible" potential for ARD.

- Seven samples are “likely” to generate ARD.
- The five-number summary (minimum, lower quartile, median, upper quartile, maximum) of NP/AP in the 2009 samples is 0.1, 0.7, 1.5, 17.4, and 397.
- The two data set give very different assessments with respect to ARD from rocks associated with the Gatsuurt mine project.

Humidity Cells: The SGS samples were analyzed using humidity cells to follow the evolution of sample geochemistry over time. Run times for the cells (20 weeks) were adequate to establish baseline conditions. This test run time is considered the standard for humidity cell test work.

Important conclusions from these tests include:

- Granite sulfide waste was the only sample to generate ARD during humidity cell testing. This result is consistent with static test (ABA) results.
- Several samples leached carbonate at rates exceeding that necessary to neutralize oxidized sulfide. This result suggests that simple dissolution may deplete carbonate neutralizing potential in these samples, such that this source of neutralization may be gone before all sulfide in these samples is oxidized. These samples may then generate ARD after long time periods.
- Several of the cells leached unacceptable levels of arsenic, despite the lack of ARD generation. This suggests that dissolution reactions may be sufficient to mobilize arsenic without initial acid generation.

Gatsuurt Site Specific ARD Results:

Gatsuurt Humidity Cell Test Results

A selection of 16 waste rock samples were collected from the proposed pit excavation areas and sent to SGS Labs in Canada and tested for a wide variety of the most thorough, state-of-the-art analytical ARD predictive tests that are available in the world today. Following is an explanation of the test procedures and the results of this test work on the Gatsuurt samples.

It is important to note that the Humidity Cell tests were only one of eight so-called Kinetic Acid Rock Potential Characterization tests and analyses conducted on 16 rock samples from the Gatsuurt site. (The other seven were: XRD Analysis, XRF Whole Rock Analyses, ICP-OES/MS, Meteoric Water Mobility Test, Particle Size Distribution by Sieve Analysis, Modified ABA testing, and the NAG test.) In addition to this kinetic test work, Boroo conducted a number of static waste rock tests, which would continue throughout the mine life.

The purpose of these ongoing static tests is to assess the potential for Acid Rock Drainage (ARD) and to assist in the design of strategies to reduce or mitigate it. The humidity cell tests indicated that, as expected, both acid-producing as well as buffering minerals are present in the 16 samples. (In fact, this acid-alkaline balance is present in all rock in various degrees.) The test work also confirmed that potential ARD would be an issue requiring systematic management to limit acid production and ensure rehabilitation as needed.

ARD is a naturally-occurring phenomenon. Thus, the objective of an ARD control program is not to eliminate it completely, but to limit it and slow it to a rate similar to natural ARD. A second issue for ARD mitigation is the volume of waste rock to be managed. International standards normally call for the management of only high potential ARD rock, rock containing only equal portions of neutralizing and acid generating constituents. Centerra, however, has voluntarily committed to manage both high and medium potential rock; medium rock generally contains twice as much neutralizing constituents as those that could generate acid. The proposed Gatsuurt plans are conservative and meet or exceed international practices and reflect Centerra's commitment to responsible environmental management.

Using recognized cutoff values to assess high, medium and low potential ARD rock, Centerra has identified the volumes, tonnages, rock types and locations at the Gatsuurt site where each type of rock is expected to be encountered. With this data in hand, Centerra plans to manage and mitigate the possible generation of ARD through the use of a waste rock storage facility (WRF) and associated facilities that are carefully engineered to ensure that potentially acid generating waste rock is isolated from air and water to the maximum extent possible. This isolation eliminates the primary factors that enhance ARD, and slows the ARD process to a more natural rate.

5.2.8 Other impacts

Seismic activity may be generated by blasting operations, vehicular traffic, and heavy equipment movement during the construction phase. The vehicular traffic and heavy equipment movement will be as expected for an industrial facility. Blasting is planned during the development of the mine and during ore extraction process. Blasting is expected approximately 1 time during operational days. Each blast will have a duration of approximately 3 seconds. The mine levels vary from 0 m below the surface to almost 200 m below the surface. Air vibration should be dampened to imperceptible levels at the surface. Furthermore, the area surrounding the mine is sparsely populated, as such, air vibration issues will not be a concern for this mine. Due to the sparse population in the area seismic impacts to public or private structures will not occur. No local flora or fauna have been identified to be potentially affected by the weak seismic events caused by blasting for a period of several seconds each day. As discussed, surface vibration will be attenuated due to the elastic nature of the soils.

5.3 Mitigation measures

Its main goal is actualizing measures to mitigate, minimize and eliminate potential impacts on natural condition through the mining, processing and hauling operations. The following provides mitigation measures the will be taken to minimize potential impacts.

5.3.1 Mitigation measures to minimize topography, soil and drainage impact, technical /biological reclamation

Mitigation of Topographic and Drainage Impacts:

The reclamation plan will mitigate the short-term operations phase impact to topography. As a result of the construction of the surface water diversion and subsequent reclamation, the topography and drainage at the site will be improved from the existing impacted condition due to the past alluvial mining operations. The past alluvial operations have impacted the local topography and drainage and the operations / reclamation plan proposed for the Gatsuurt project will restore surface water drainage to conditions that existed prior to site operations. All surface structures will be removed and the site will be seeded with a mixture of natural vegetation. The only remaining facilities will be the open pits and waste rock disposal facilities once reclamation is completed. The surface water will be allowed to flow through the open pits and the surface water diversion will remain in the area of the WRDF's to route the water around. Topographic and related drainage impacts are anticipated to be minimal throughout the project life based on the sites already impaired condition.

Mitigation of soil disturbance and erosion:

Mining area structures have limited soil disturbance. Progressive technical and biological reclamation shall provide following requirements.

Following standards must be used as guidelines:

- MNS 5916:2008 Requirements for fertile soil removing and its temporary storage during the earth excavation (approved in 2008).
- MNS 5917:2008 Reclamation of land destroyed due to mining activities. General technical requirements
- MNS 5915: 2008 Environment. Classification of land destroyed due to mining activities
- MNS 5850:2000 Soil Quality Evaluation

During previous placer mining activities, 146 ha land was disturbed and the removed topsoil was not recovered for future use. Therefore, a topsoil stock registry must be made and a plan should be developed to consider the reclamation topsoil depth (15-20 cm thickness).

At selected points, soil sampling should be carried out to monitor whether there is soil pollution, and to identify changes to heavy metal composition in the soil at reclaimed and non-reclaimed areas near the pits.

Technical requirements that should be prepared before progressive reclamation are listed below:

- Organize preliminary control for soil disturbance and erosion prior mining operation start
- Annual reclamation cost should be estimated and scheduled in mining plan
- Organize measures to prevent pit wall and dump bench collapse or sliding, define and map cracked or deformed parts
- To determine the danger zones, where might happen collapse or sliding, locate caution boards
- To develop reclamation plan, providing future public health and safety, the after use of the site is beneficial and sustainable for long term, reclaimed as well as surrounding environment.
- To select the area with lowest fertility or eroded with natural factor for dumping and stockpiling.

Biological reclamation:

Biological reclamation is measure that taken to minimize impacts caused by loose earth blown away and air pollution. Reclamation will be completed in order to return the areas to productive land utilization as pastureland, agriculture and other specification and bring close to former natural prospect. The most important requirement for biological reclamation is providing reclamation potential of natural its own.

- Biological reclamation should follow by MNS 4918:2000. Technical requirement, Revegetation of disturbed area.
- In the beginning, it is better to use organic fertilizers to support growth and increase soil fertility and convenient to dung, peat or mineral fertilizer in our country practice. A dose of organic, potassic, nitrogenous and phosphoric fertilizer is 20-30, 40-60, 60-80 and 40-60 kg per a hectare respectively.

Soil erosion and sediment control during project construction operations and reclamation will accomplish the following environmental protection and mitigation goals for the project:

- Prevent sediment erosion into nearby wetlands and streams.
- Maintain topsoil removed during project construction for later use in reclamation activities.

5.3.2 Mitigation measures of air pollution

Minimize dust:

Working of mining equipment include open alluvial placer mining pits and eroded soils, informal roads, drilling and blasting that are generating dust primarily from wind impact. It needs to implement mitigation measures when wind speed is 12-18 m/sec in spring and autumn, which are season of extreme draught. Mitigation measures are:

- Water truck deployment to reduce dust on haul roads
- Water will be utilized when required to reduce the amount of dust and particulates from haul and disposal operations
- Air quality monitoring will be performed throughout mine operations
- Where required, dust filters and personal protective equipment will be provided.
- In the process of choosing mine machinery and equipment, consideration will be given to air pollutant emission standards and fuel consumption efficiency.

Measures to be taken throughout processing are:

Excavating:

- Add water during dry and windy conditions
- Bulldozer or grade the road to straighten and remove loose soils, rocks
- Reduce the number of roads
- Construct dumps under the approved design and standard
- Complete reclamation of waste dumps and disturbed areas.

Dust impact on air quality have extremely different seasonal effect and depend on the wind speed, humidity and air dryness. There will be a requirement to water haul roads and open areas during dry and windy conditions. A watering rate is 150 m^3/ha, which give moist about 1.5 m in depth. Approximately, 8.1 ha of internal haul roads (80 000 m2) will be watered daily. If it requires to water for 30 days, water consumption is 150 m3/ha x 8 ha x 30 days = 36.0 thous.m3 and daily consumption is 1200 m3. Watering should be done 30 minutes earlier to start work when it is windy.

Minimize gas emission:

Air pollutants from vehicle exhaust will be generated from exhaust of mine machinery operations, ore hauling to Boroo site, other vehicular traffic and facilities (diesel motors, temporary and emergency stations). In the process of choosing mine machinery and equipment, consideration will be given to air pollutant emission standards and fuel consumption efficiency.

Noise:

During both construction and operation phases at Gatsuurt mine, noise is expected to be generated as a result of blasting and mine machinery operations. Sources of noise include:

- Blasting, ore loading, and crushing
- Hauling and transporting to the site

There are no human or livestock settlements in the vicinity of the project area. The closest settlement is Tunkhvel village, which is located 14 km. Therefore, it is concluded there will be no noise impact to the general public. Noise levels at the project site and its impact to site personnel will be assessed. Based on results of this assessment, measures to be taken will be planned.

5.3.3 Mitigation of Impacts to Forestry

The reclamation plan will mitigate the short-term operations phase impact to forestry. Reclamation activities in the area will include replacement of topsoil and re-vegetation of native trees. Forestry related impacts are anticipated to be minimal throughout the project life based on the sites already impaired condition due to previous alluvial mining operations.

5.3.4 Mitigation of Impacts to Vegetation

Mitigation of impacts to vegetation includes:

- Disturbing areas only large enough to conduct mining operations.
- Stockpiling of topsoil prior to mining activities.
- Subsequent to reclamation of operational areas a re-vegetation program will be established.
- Reclamation of the Gatsuurt River Valley project area will enhance current vegetation. Due to the past alluvial mining operations the vegetation in the river valley area has been decimated. Updated operational practices and surface water control features as part of the Gatsuurt project will increase the vegetated areas in the project vicinity.

5.3.5 Measures to protect wildlife

Following measures to be taken to shorten impact duration and minimize impacts on wildlife during mine operation.

- Distribute brochure/poster/attention note about not hunting wildlife in the vicinity of the project area.
- Plan early progressive reclamation that will enable wildlife migration or transition through revegetated areas.

5.3.6 Mitigation of ARD impacts

ARD mitigation plan

Definitions & Assumptions:

- The Acid Rock Drainage Reaction (ARD) is a chemical reaction that must have all three of the following: Sulfides + Water + Oxygen. The absence of any one of these three materials would eliminate the production of ARD. ARD mitigation programs involve implementation of measures to eliminate or slow the availability of one or more of these substances (Sulfides, water and/or Oxygen)

- If the ARD reaction is initiated, byproducts from the reaction create acidic water that is detrimental to most desirable aquatic animal and plant life. Refer to section 5.2.7
- Potentially Acid Generating waste rock comprises less than 4% of the total waste rock that would be produced at the Gatsuurt mine. This PAG material is scattered throughout the waste rock material and it is not restricted to one or two rock types that would be easy to identify. Therefore, the ability to identify PAG material by rock type ("by sight"), is not possible (the chemistry of the rock is the determinant of acid generating capacity, and the chemistry does not manifest itself in the appearance of the rock).
- ARD classifications of rock include Potentially Acid Generating (PAG), Non Acid Generating Rock (Non-PAG) and Acid Generating Rock (AG).
- The PAG cutoff level has been established as 0.3% Sulfide content percentage or more. All waste rock at this level or higher would be classified as potentially acid generating.
- Waste rock samples will be collected during the Gatsuurt mine operations and ARD test work conducted on the samples in order to facilitate waste rock management aimed at the mitigation of any measurable risk of ARD generation.

AG/PAG Waste Rock Management Option Discussion:

The primary and proposed mitigation measure is the placement of the waste rock in a position which ensures its eventual submersion in water. Thus, ARD waste rock from the Main Zone Pit will be placed in the bottom of the Central Zone Pit (CZP) prior to the filling of the CZP with water from storage dams upstream. This method of disposal creates an anoxic environment for the waste rock, which effectively stops ARD.

The humidity cell reports, along with the other tests listed previously, have identified the waste rock with potential to produce ARD. As noted above, Centerra has committed to managing that rock to a high standard beyond and has adopted a conservative approach to managing water at Gatsuurt. Specifically, it will classify even waste rock identified a marginal ARD risk as risk material and will manage it accordingly.

- Residual Ammonia and Nitrates

The use of ANFO as an explosive, introduces the potential for residual levels of ammonia and nitrates into the pit water and waste dump runoff. Excess levels of nitrates can lead to degradation of water quality. This release of nitrates occurs over a relatively short period of time, so does not represent a long term management problem.

Water from pit dewatering activities is not expected to be generated in large volumes. All excess water from the open pit and waste dump runoff will be directed to the sedimentation pond where water quality will be analyzed to assess impacts from mining disturbance including nitrates, ammonia, sulphates et cetera. Water quality that is considered to be consistent with background water quality will be released from the sedimentation pond into the Gatsuurt River.

As a failsafe measure, all contaminants from the use of explosives will be ultimately be directed to the sedimentation pond, which will act as a containment facility that will prevent release to the environment.

Seepage and surface runoff waters that are captured in this facility will be collected and analyzed for a suite of elements to assess mining impacts. Nitrates, ammonia, total dissolved solids, sulphates and selenium will be the primary parameters that would be monitored in order to assess impacts from upstream mining development.

Overall potential impacts to the environment from ammonia and/or nitrates, is considered to be very low.

- Sewage Effluent

Wastewater treatment system will be installed in the Gatsuurt mine. The system will be capable of treating sewage and there is no impact on environment. Sewage from resident use will be collected and conveyed by gravity to a septic tank and will be passing through by both mechanical and biological treatment. A system obtained the standard requirement of wastewater treatment of Mongolia and it is suitable to use for undersized or temporal camp.

Untreated sanitary sewage effluent will not be discharged to the environment. Overall, the potential for significant impacts to the environment from sanitary sewage, is considered to be very low.

5.3.7 Groundwater

Potential impacts on groundwater and its quality can be caused by mining operation.

- Dewatering open pit, might lead groundwater level reduction.
- Leakage or spilling from fuel storage and fuel station

There will be little impact from fuel accidental releases into the ground water. Fuel storage container will be engineered with additional controls. During mine operations, company's pollution control system and spill prevention plans will be put in effect.

Pursuant to the environmental observation and assessment program, ground water quality will be monitored from site groundwater monitoring wells. If impacts are found, water will be pumped and diverted into the sedimentation/infiltration water pond. Surface mining recultivation work will be completed so as not to affect the ground water quality.

5.3.8 Water management options

Arsenic occurs as a natural component of the Gatsuurt water system (both groundwater and surface water). Therefore, treatment to remove Arsenic would represent a modification of the natural background water quality of the Gatsuurt system.

The fact that Arsenic is a naturally occurring element would, in most western jurisdictions, would provide legal justification for modification of a standard criterion. In the case of an ore body with concentrations of Arseno Pyrite where Arsenic concentrations in the water exceed standard criteria such as Gatsuurt, the modification of the Arsenic criteria would result in raising the Arsenic criterion to the naturally occurring background level. This new level would be the compliance limit for that site.

Though this is an accepted practice in most western mine locations, Mongolian regulations may not accept this as a regulatory allowance when Gatsuurt is in operation. Therefore, the following discussion is presented in order to discuss what water treatment options may be used in the event that the background water quality cannot be used to modify the standing criteria. Boroo Gold will work with the Mongolian regulatory programs in an attempt to modify the water quality program so that background water quality is recognized as the discharge criteria for that system.

The goals of the Gatsuurt water treatment program will focus on the minimization of water to be treated or managed, use of known technology, minimization of waste production from any treatment that is undertaken and simplification of all management processes to the extent possible. All water management/discharge approaches that are available, feasible and which insure that regulatory requirements can be met, would likely be implemented at Gatsuurt during mining operations.

Both surface and groundwater will be produced during the mine production phase. Both have similar water quality issues, in particular exceedances of iron, aluminum and arsenic occasionally to frequently.

Most of the water management programs that are available could only be implemented during frost free times, roughly 6 months out of each year at Gatsuurt. During winter months, most of the water production is stopped and any water management program is difficult or impossible to operate.

Surface and groundwater can be further classified as impacted or unaffected by mine operations. Un-impacted water is surface or groundwater that does not come in contact with mine operations. It is anticipated that Mongolian regulators would accept the proposal that any water that is routed around the mine property without contacting mining operations could be discharged off the mine property without treatment and would not be subject to inspection from the regulatory community. Groundwater that is pumped out of the mine area without impacting the mining activities would also be classified as un-impacted water.

Impacted water is surface or groundwater that comes in contact with mining activities including: water that enters the mine pit, water that contacts waste rock facilities, roadways, mine staging areas etc. This mine impacted water would be subject to collection and assessment from the regulatory community and would be subject to the water criteria that apply to that particular water.

Impacted water that did not meet the relevant water quality criteria could be discharged without mechanical treatment (untreated) or with mechanical treatment (treated). Treatment approaches for untreated water would include discharges to the groundwater, to surface water, into holding structures or onto the land surface.

Discharges by any of these means would be done under the condition that compliance with a regulatory standard would need to be met at some point downgradient of the point of discharge. Therefore, these forms of discharge assume that contaminated water is discharged, and at some point between the discharge point and the compliance point, the discharged water is treated by natural or passive means and becomes compliant with the relevant standard.

Discharges of untreated mine water onto the land surface or land application is most effective during the driest parts of the year (2 or 3 months at Gatsuurt). This is typically done with sprinklers to increase the amount of water that is released. In this case the treatment is effected by the soil that the water must travel through before reaching soil water and possibly to the groundwater.

Discharges of untreated water to shallow pits (Rapid Infiltration Basins or RIBs) is one of the most effective passive treatment approaches to discharge large volumes of water (commonly used at mines in Nevada). RIB's facilitate the discharge of untreated water to the shallow groundwater. The shallow water that is mixed with the discharged water eventually seep downward to the deeper groundwater where further mixing of waters occurs. Groundwater monitoring wells are placed around the perimeter of the RIB's. Wells are monitored frequently in order to monitor any impacts that may be occurring to the groundwater.

Discharge using RIBs is one of the preferred methods for the discharge of untreated water in the USA and other western jurisdictions. Impacts to the groundwater are typically not detectable.

Impacted waster that is treated by mechanical means (water treatment plant) may be partially treated or completely treated to meet the relevant standard. Mechanical treatment methods include numerous methods, of various scale and sizes, using chemicals or filtering treatment methods. The most effective mechanical treatment method that is possible for the application at Gatsuurt would be assessed using Bench Scale testing (lab testing of various treatment methods). Selection of the most effective test approaches using bench scale testing, is often followed with pilot scale testing (small scale plant), to provide a practical assessment of the treatment approach that is under review.

It is expected that some form and scale of a mechanical water treatment system will be implemented at Gatsuurt at some point during the life of the project. The primary treatment parameter of concern that exists in the Gatsuurt water is Arsenic (other parameters may exceed Mongolian criteria occasionally as well as Arsenic, though Arsenic is the parameter of greatest concern).

The Boroo Gold mine has used a mechanical water treatment process since mine startup in 2004. Additions of Ferric Sulfate in the INCO SO2 detoxification circuit at Boroo have proven to be an effective means of reducing Arsenic concentrations in discharged mine slurry. Since this system has been used for about 10 years, Boroo is very familiar with every facet of the operation and maintenance of the system. Therefore, the Ferric Sulfate Arsenic treatment program will likely be one of the programs that is reviewed for use at Gatsuurt to treat Arsenic, though other options will be reviewed as well.

All of the water treatment options that are discussed are effective at reducing Arsenic, and all are effective at reducing the other parameters that occasionally exceed standing criteria in the Gatsuurt system.

Water that is discharged on the surface to a surface water facility would be allowed a length of stream or river referred to as a "mixing zone". A mixing zone is a section of receiving water that has a mixture of impacted water and receiving water that does not meet relevant standards. At a prescribed point that is downstream of the discharge point, the mixture of impacted and receiving water would meet water quality standards. This is the practical application of a mixing zone. Programs that recognize mixing zones are found in most western jurisdictions.

All of these water management options will likely be utilized at some point during the life of the Gatsuurt project. Boroo will work with the regulatory groups in order to make each of these part of the Mongolian regulatory system if they are not part of the regulatory program to date.

Surface water diversion system options

Water that enters the mine property from offsite areas or meteoric water that contacts the mine property are to be routed around the main mine working area in channels that are sized to contain a major runoff event. Pipework may be installed in some parts of the diversion system if it is decided that routing water in this manner provides benefits that justify these measures. One justification for piping water would be to segregate water to prevent mixing of the two waters. Decisions on whether to pipe water or to use open channel flow structures alone would be made during operations.

5.3.9 Soils

It is estimated that an area of approximately 146 hectares within the Gatsuurt valley no longer has a native soil structure due to past mining activities. A cohesive soil structure, root systems and aerial vegetative cover are the primary factors that bind and protect soils. Past placer mining has drastically disturbed or destroyed these elements thereby exposing soils to excessive erosion. Consequently, there is transport of a significant volume of sediment-laden runoff during storm events to downstream areas of the Gatsuurt valley. Mining area structures have limited soil disturbance.

- Potential impacts to soils during the construction and operational phases include:
- Erosion and compaction.
- Sedimentation.
- Contamination from improper handling and/or disposal of waste materials.
- In order to prevent further loss or destruction of soils due to the development of the Gatsuurt project, the following measures will be taken:
- The boundary limits of stripping and/or grubbing must be shown on all drawings "Issued for Construction".
- The use of vehicles off the mine site or access roads will be minimized.
- Dozers or heavy equipment will be prohibited from running across or through undisturbed soils not designated for removal.
- The length of time that grubbed areas are left exposed to the natural elements will be minimized to prevent unnecessary erosion.
- Efforts will be made to ensure that grubbed materials will not be pushed into areas that are to remain undisturbed.
- Organize preliminary control for soil disturbance and erosion prior mining operation start
- Annual reclamation cost should be estimated and scheduled in mining plan
- Prevent sediment erosion into nearby wetlands and streams.
- Maintain topsoil removed during project construction for later use in reclamation activities
- In order to protect soils from soil contamination:
- Fuel storage areas will be designated and contracted with berms in control spills.
- A Spill Contingency Plan will be developed to prevent and mitigate the contamination of soils due to petroleum or chemical spills.
- All hazardous wastes will be disposed at other designated facility.

5.3.10 Vegetation and Wildlife

Potential effects to vegetation and wildlife during operations include:

- Potential risks to wildlife safety as a result of contact with human activities.
- Changes to wildlife behaviour due to noise and other site activities.
- Deposition of dust on vegetation.
- Mitigation of impacts to vegetation includes:
- Disturbing areas only large enough to conduct mining operations.
- Stockpiling of topsoil prior to mining activities.
- Subsequent to reclamation of operational areas a re-vegetation program will be established.
- Reclamation of the Gatsuurt River Valley project area will enhance current vegetation. Due to the past alluvial mining operations the vegetation in the river valley area has been decimated.

Updated operational practices and surface water control features as part of the Gatsuurt project will increase the vegetated areas in the project vicinity.

Mitigation of Impacts to Forestry

Licensed area under mining license is a forest with mainly pines and larches with birches. Trees of additional 70 ha areas need to be removed as per the new mining plan.

The reclamation plan will mitigate the short-term operations phase impact to forestry. Reclamation activities in the area will include replacement of topsoil and re-vegetation of native trees. Forestry related impacts are anticipated to be minimal throughout the project life based on the sites already impaired condition due to previous alluvial mining operations.

Measures to protect wildlife

Following measures to be taken to shorten impact duration and minimize impacts on wildlife during mine operation.

- Distribute brochure/poster/attention note about not hunting wildlife in the vicinity of the project area.
- Plan early progressive reclamation that will enable wildlife migration or transition through revegetated areas.

6 Possible Hazards and Accidents

Listed below are potential environmental risk and adverse impacts that can have significant consequences:

- Impacts to ground and surface water quality from site discharges, including potential for acid rock drainage (ARD) and leaching of metals (e.g., arsenic) under non-acidic conditions.
- Long-term storage and management of waste products (e.g., tailings, waste rock and other hazardous and non-hazardous wastes).
- Stability of dams, berms, stockpiles and waste rock dump, potentially causing risk to public safety and environment.
- Changes to local hydrological regime.
- Air pollution (including dust)
- Noise, vibration (including due to blasting and vehicle, machinery movement)
- Fuel handling and storage
- Chemicals (blasting) handling and storage

Measures to prevent industrial accident and labour safety:

General requirements of labour safety;

- Provide general safety requirements for the processing phases, mechanics and equipment
- Electrical equipment and instruments should be assembled in accordance with design, provide safety requirements for the electric consumption, “MNS 5151:2002, Electrical safety”
- Identify quality requirements and usage interim for work clothes according to UST0012.4.015.89 standard

- Train and practice employees to provide safety against fire, maintain internal regulation and save fire equipment regular situation, "MNS 4244:94, Safety against fire and general requirement"
- To conduct three-phase inspection for labour safety,

1. Shift team
2. Departments or units of organization
3. Entire organization

- Prohibit using new substances and materials for processing equipment not produced under instruction or not verified under clear conditions of labour safety and health.
- Follow the guideline "General rules for blasting safety" when handle blasting operation.

Measures to prevent;

- Eliminate the condition such as offended the rules of industrial safety or originated insecure circumstances for human life or health.
- Develop and organize systematical training program to advance the understanding of labour safety
- Hire employees who pass medical examination and employees should be get involved in medical examination annually.
- Budget annual costs for labour safety and expend as reflected in cooperation contracts or purposed plan.
- Inform industrial accidents as ruled procedures, record and inspect the reasons, treat urgent emergency aid when accident occur.
- Compensate or rebate in accordance with fixed procedures for employees who work under irregular work conditions
- Prevent to be occur any accidents for the components, accessories of equipment caused by power-cut or electric current change (electric current or gas), electrical equipment assembled with the additional equipment not power on automatically

Training for labour safety;

Centerra Gold Mongolia planned to organize following training and workshops to provide labour safety.

1. Operators training of long distance heavy truck, which will be used for ore haulage between Gatsuurt and Boroo site.
2. Operators and labour safety training of excavator, loading truck, grader, bulldozer and drilling/blasting equipment
3. Operators training of mine auxiliary equipment
4. Training for new employees and other Labour safety and health related training under legal regulation.

6.1 Risk assessment of chemical (explosive) substance

According to Mongolian law, entitled "About dangerous and hazardous chemical substances" (effect on 2006), risk assessment of chemical dangerous and hazardous substances should be included in DEIA reports of entities, who use chemicals for the production. Our risk assessment prepared under this law and legislation. Exact procedure for chemical/explosive risk assessment has not been confirmed yet. To develop risk assessment of chemical/explosive in this report, applied the procedure, entitled "Guidance to detect limits of chemical accidents and evaluate results" confirmed by State citizen security department (former title) in 2001 and international guidelines for evaluation methods.

Although none of dangerous or hazardous chemicals used in Gatsuurt mine, two types of an explosive consisting of dry and emulsion will be used for mining. Both of which ammonium nitrate or ANFO, contain a widely used explosive mixture of ammonium nitrate with fuel oil. Explosive residues ammonia (NH4+) and nitrate (NO3-) can occur from use of ANFO. If left beyond the control, the pollutants can impact on the environmental through escaping via surface water, if available in high content, improper handling of ANFO can result in groundwater percolation, cause water contamination and destroy the natural ecosystem. In the Table 6.13, potential risk or dangers and preventing issue are referred.

Table 6.1 Potential risk of explosives

#	Types	Evidence	Preventive	First aid/quench
1	Fire	No danger if not concurrence fire situation. Fired items, quicken substance combustion. Emerge poisonous gas when explode	Prohibit to come closer	Use water or fire extinguisher
2	explosion	Explode or fire in the closed or high temperature	-	Evacuation from dangerous places, rescue, sprinkle water
3	Burn	-	Prevent from fire soot	-
4	Inhalation	Cough, headache and stomach disorder	Take measures to protect respiratory organs	Breathe fresh air or artificial breathing and see doctor
5	Itch	Turning red	Use personal safety equipment (mitt etc.)	See doctor
6	Eye	Turning red and ache	Wear glasses	Rinse with fresh water
7	Stomach	Pain in the stomach, lips, nails turn blue dizzy, weaken	Prohibit to drink, eat, and smoke	See doctor or go to ambulance

During the first phase of pit establishment, low-incentive ANFO blend must be used. Preventive measures and engineering controls should be established at ANFO storage area. In addition, monitoring of surface/puddle water at storage must be carried for detecting traces of ammonia and nitrate to ensure that regulatory standards are met.

During operation period of the Gastuurt mine, the potential adverse impact of ammonia and nitrate discharged into the waterways can be significant as it will affect water quality of Gatsuurt River. The current mine design is developed to ensure that no large amount of standing water is existent at project area. Pit water and runoff water will be diverted to the downstream sedimentation pond. The pond is also utilized to monitor nitrate, ammonia, sulphate in the water to assess mining impact on water quality. Water will be released to Gatsuurt River once it meets discharge quality.

Two water monitoring points for percolating water will be established at the edge of waste rock dumps (acid generating and non-acid generating dumps separated). This will aide in establishing correct understanding of the quality of water released from the waste rock dumps prior to impacting on the natural environment.

Chemical reaction will occur between the blasting material, mine rocks and groundwater. In the process of mining sulfide ores, the boreholes charged with the ammonia nitrate blasting agent may create dust explosion hazard as sulfide (pyrite) reacts with ammonia nitrate. as seen in the following formula:

$$2\,NH_4NO_3 + H_2SO_4 = (NH_4)_2SO_4 + 2HNO_3 - 15.96\ \text{kJ/mol}$$

$$2FeS_2 + 8HNO_3 = Fe_2(SO_4)_3 + 8NO + 4HNO_3 + S + 143\ \text{kJ/mol}$$

$$10NH_4NO_3 + 2FeS_2 + 4\,H_2SO_4 = Fe_2(SO_4)_3 + 5(NH_4)_2SO_4 + 10NO + 4H_2O + 1617\ \text{kJ/mol}$$

In ores with high sulfur content, the free sulfide is often at concentration levels of 0.01 to 1 g/l, creating a favorable environment for the abovementioned chemical reaction. In addition, due to following reaction, an explosion incident may occur:

$8NH_4NO_3 + 3FeS_2 + 2O_2 = 3FeSO_4 + 3(NH_4)_2SO_4 + 5N_2 + 4H_2O + 4006$ kJ/mol

$2FeSO_4 \longrightarrow Fe_2O_3 + 2SO_2 + 0.5\ O_2$; $(NH_4)_2SO_4 \longrightarrow N_2 + 4H_2O + S$

Measures to prevent from after blast explosion:

- to reduce or cool explosive flash, such as misting, hanging lime bags, etc.
- blasting within 12 hours of borehole charge.

6.2 Pit slope stability assessment

In accordance with MNS 5315:2008, Environment. Classification of land destroyed due to mining activities, depth of the open pits will be over 100 meters related to ground surface after the reclamation and slope angle is over 450 (60-700), which are included in the classification "Terraced of much depth". Therefore, the most regard issue is to provide long term stability for the open pit benches and waste rock dump. Golder Associates company implemented field investigation for the purpose of defining slope sliding and failures, develop future plan and preventing actions.

Main open pit: The pit design derived from the pit wall stability analyses with a bench of 8 m wide and 20 m high was evaluated for pit benches of current pit design with the steepest dipping angle of 68° for the un-oxidized rock unit The properties of the materials used in the analysis are summarized in Table 6.2.

Table 6.2 Summary of Material Properties Used in Stability Analysis

Stratigraphic unit	Depth	Weight	Mohr-Coulomb (Overall slope)*		Mohr-Coulomb (benches)**	
	m	кН/м³	c′, (кPa)	φ′, (degrees)	c′, (кKa)	φ′, (degrees)
Overburden	0-5	22.0	5	35	5	35
Oxidized rock	5-25	23.5	200	25	120(110)	15
Transition rock	25-65	24.5	250	30	200	25
Un-oxidized rock	From 65	25.5	300	35	300(200)	35(28)

Notes:
1. The parameters in brackets are those of granite if different from those of rhyolite
2. * Rating without consideration of the orientation of discontinuities
3. ** Rating with consideration of the orientation of discontinuities.

Based on the analyses, the preliminary pit slope design was presented in terms of face angle, overall angle, bench height and bench width as illustrated in Table 6.3.

Table 6.3 Summary of Pit Slope Design

Stratigraphic unit	Face angle (⁰)	Bench width (м)	Bench height (м)	Overall/inter-ramp angle (⁰)
Overburden	50	3	5	35
Oxidized rock	55	8	20	42
Transition rock	62	8	20	47
Un-oxidized rock	66-71	8-10	20	50

Central open pit: The pit design derived from the pit wall stability analyses with a bench of 8 m wide and 20 m high was evaluated for pit benches.

Table 6.4 Summary of Material Properties Used in Stability Analysis (Central zone)

Stratigraphic unit	Depth	Weight	Mohr-Coulomb (Overall slope)*		Mohr-Coulomb (benches)**	
	m	кH/m³	c′, (кPa)	φ′, (degrees)	m	кH/m³
Overburden	0-10	16.5	5	35	5	35
Oxidized rock	10-30	23.5	150	20	100	20
Transition rock	30-60	24.5	250	30	200	25
Un-oxidized rock	From 60	25.5	350	40	250	35

Notes:

* Rating without consideration for the orientation of discontinuities

** Rating with consideration for the orientation of discontinuities.

Based on the analyses, the preliminary pit slope design was presented in terms of face angle, overall angle, bench height and bench width as illustrated in Table 6.5.

Table 6.5 Summary of Pit Slope Design

Stratigraphic unit	Face angle (^{0})	Bench width (м)	Bench height (м)	Overall/inter-ramp angle (^{0})
Overburden	50	3	5	35
Oxidized rock	55	8	20	42
Transition rock	62	8	20	47
Un-oxidized rock	66-71	8-10	20	50

Notes: 1. Pit slope stability analysis is based on currently available exploration data for granite.

2. The analysed pit depth is 150 m.

6.3 Potential accident

Providing labour safety is a priority goal of the Gatsuurt mine administration. The personnel of Gatsuurt mine put the mind to provide processing safety condition and work under regulatory laws of Labour safety, Health, Open pit mining guidelines and other related rules and procedures. To develop and implement Safety and Health management system which can be internationally allowed. It plans to organize The committee of Safety and Health management, members of which will be selected high qualified and experienced professionals, delegating Department of Labour Safety and Health and workforce of the company.

Related article of the "Safety rules for open pit mining" approved by Ministry of Trade and Industry in 2003, is still effective and will be followed. Mining operation will be performed under the articles and requirements of the related procedures especially for excavating, drilling, blasting, dumping, mechanization of mining, haulage, electrical equipment, pit dewatering, pumping and health requirements, especially against dust, hazards, workplace, water supply, radiation safety.
Also there will be a plan for accident elimination. Especial operation such as "blasting" will be performed under the established rules and procedures.

Gatsuurt administration will implement all potential preventive measures against potential accidents and they hope that any accidents will be prevented to happen.
If it encounters any accidents, elimination and preventive measures will be taken to not worsen further as following order.

- Human

- Environment
- Property

Approved and experienced plan for the preventive measures will be developed and provided stand-by emergency.

Emergency plan, developed by Gatsuurt, is a separate document for implementation and will be verified and approved by authorized professional organization annually. Department of Labour Safety and Health will organize the training and workshops for the responsible personnel regularly.

A rescue team is a part of the Emergency plan and will work under continuous availability. One shift will have at least 5 members and number of members are 10 persons. A rescue team will be trained and practiced once biweekly.

6.4 Natural disaster and unexpected accident

There might occur unexpected accidents that can`t be predicted such as storm, earthquake, lightning and thunder. According to project implementation, there are much damages or failures of environmental pollution if these unexpected accidents occur.

Fire: Project area is located in the forest-steppe region that is called zone of fire dangerous. Weak regards for equipment and structures, can be source of human induced fire danger. However, fire dangers caused with lightning or thunders can be tide over less damage or environmental pollution.

Earthquake: Project area is located the seismic area with 6th grade. Purposed structures will be constructed with steel footing and soft walls, which is out of seismic dangers. Should consider any unexpected accidents because if there have an earthquake, open pits can collapse and damage human life or machineries. SNC Lavalin carried out the field investigation for the site geotechnical assessment of open pit slope stability and waste rocks dump slope stability in 2005. If there occur any accidents of deforming electric lines, gapping in the structures walls and damaging water pipelines, take urgent measures to rescue human lives. Employees have to been learned and practiced to get out the scene of the accident.

Flood and storm: in some cases, it is more dangerous than earthquake to damage human lives and environmental formation for the long term, especially for the soil and vegetation cover. Gatsuurt area is located in the bottomland of mountainous regions, which have probability hit by flood dangers. It rains 35-75 mm in someday during June through August. Rain of 85 mm representing 1:50 years and 100 mm representing 1:100 years will happen in the project area and then open pits are at a higher risk of flooding.

Measures taken to be preventing from above unexpected accidents, are:

- Should be evaluated and drawn a conclusion of earthquake-proof at mine facility and underground network by specialized entities.
- All workers need to undertake emergency response drills.
- Specific instructions or advices should be prefabricated and approved by the administration, that how to be reorganized if natural disaster happened and how to work
- Prepare fire extinguishers' (mechanical or automatically) all the time and no allowed to use water reverses or industrial fire extinguishers near the explosives.
- Constantly implement preventive measures to protect from security dam slotting caused by flooding in the warm seasons (especially summer rainy days)
- Construct surface water diversion facilities: security dam/barrier, drainage and ditches around open pit, social structure and waste rock dumps to prevent from flooding.

7 Reclamation Plan

BGC/CGM's primary objectives for post-mining reclamation of disturbances are to:

- Ensure public safety;
- Reduce or eliminate potential environmental impacts such as ARD or mining related groundwater impacts;
- Return the site to a condition which will support land uses similar to those which existed prior to the onset of mining activities. These land uses include livestock forage production, wildlife habitat, and mineral exploration and development;
- Control infiltration, erosion, sedimentation, and related degradation of existing drainages in an effort to minimize off-site impacts; and
- Employ reclamation practices using proven methods which do not require ongoing maintenance.

With these objectives in mind, reclamation activities are designed to:

- Stabilize the disturbed areas to a safe condition; and
- Protect both disturbed and undisturbed areas from unnecessary and undue degradation.

7.1.1 Reclamation Goals and Methods to Prevent Site Degradation

Reclamation is designed to achieve post-mining land uses similar to those prior to mining, as well as potential industrial uses. The pre-mining land uses included domestic livestock grazing, wildlife habitat, mineral exploration, and mineral development. Centerra Gold Mongolia practices concurrent reclamation to the extent feasible and/or reclamation immediately after a facility's operational life has ended. When feasible and appropriate to the type disturbance, disturbed areas will be re-contoured or shaped to blend with surrounding topography. This enhances re-vegetation success and reduces erosion and sedimentation from disturbed areas. Re-vegetation will be accomplished utilizing a local seed mixture native to the specific area.

The WRDF includes NAG Rock only. As such, the WRDF and sulfide ore stockpile facility will be designed to prevent infiltration of surface water and pore water. This will be done to prevent any future generation of ARD that may impact the local groundwater quality. The local surface water and groundwater quality will also be protected by the surface water diversion system that will be implemented during mining activities. Mine impacted water will be contained and treated prior to discharge into the Gatsuurt River. The non-impacted water collected by the surface water diversion system will be routed around the mine facility and discharged directly into the Gatsuurt River.

Previous alluvial mining operations at the site have disturbed and degraded the environmental conditions at the existing site. As part of the proposed Gatsuurt mine operations a large portion of the previous alluvial mining operations will be properly reclaimed and restored. The reclamation of previous alluvial mining activities will improve the local groundwater and soil conditions in the area.

7.2 Reclamation and Closure Plan

BGC/CGM's primary objectives for post-mining reclamation of disturbances are to:

- Ensure public safety;
- Reduce or eliminate potential environmental impacts such as ARD or mining related groundwater impacts;
- Return the site to a condition which will support land uses similar to those which existed prior to the onset of mining activities.
- Control infiltration, erosion, sedimentation, and related degradation of existing drainages in an effort to minimize off-site impacts; and
- Employ reclamation practices using proven methods and standards which do not require ongoing maintenance.

With these objectives in mind, reclamation activities are designed to:

- Stabilize the disturbed areas to a safe condition; and
- Protect both disturbed and undisturbed areas from unnecessary and undue degradation.

7.2.1 Reclamation Goals and Methods to Prevent Site Degradation

Reclamation is designed to achieve post-mining land uses similar to those prior to mining, as well as potential industrial uses. The pre-mining land uses included domestic livestock grazing, wildlife habitat, mineral exploration, and mineral development. Centerra Gold Mongolia practices concurrent reclamation to the extent feasible and/or reclamation immediately after a facility's operational life has ended. When feasible and appropriate to the type disturbance, disturbed areas will be re-contoured or shaped to blend with surrounding topography. This enhances re-vegetation success and reduces erosion and sedimentation from disturbed areas. Re-vegetation will be accomplished utilizing a local seed mixture native to the specific area.

The local surface water and groundwater quality will also be protected by the surface water diversion system that will be implemented during mining activities. The proposed surface water collection system will also allow Centerra Gold Mongolia to reclaim and treat the existing ponded water in the area of the previous alluvial mining operations. The treatment strategies employed will bring the existing surface water quality back to its natural background levels prior to discharge into the Gatsuurt River. The non-impacted water collected by the surface water diversion system will be routed around the mine facility and discharged directly into the Gatsuurt River.

Previous alluvial mining operations at the site have disturbed and degraded the environmental conditions at the existing site. As part of the proposed Gatsuurt mine operations a large portion of the previous alluvial mining operations will be properly reclaimed and restored. The reclamation of previous alluvial mining activities will improve the local groundwater and soil conditions in the area.

Growth Media Stockpiles

Topsoil was not stockpiled as part of the previous placer mining operations, so the reclaimed areas will not be covered with topsoil. Material excavated during the previous placer mining operations may be mixed with current excavated material in an attempt to create a better growth medium (increase the volume of growth medium). Specifically, areas of fines and areas of coarse material may be identified and mixed to create a substrate more suitable for vegetation establishment during reclamation. Any suitable growth medium from the facilities area and MZP will be stockpiled prior to construction of facilities.

7.3 Reclamation Schedule

Table 9.1 presents a proposed schedule for reclamation activities. It is BGC/CGMs intent to conduct reclamation after active operations to the extent feasible; however, the reclamation schedule is based on the anticipated schedule for conducting reclamation activities once operations are completed. As scheduled, reclamation continues for 3 years with vegetation and water quality monitoring to be conducted for 5 years after revegetation. The reclamation plan is presented in Figure 7.1.

7.3.1 Slope Stability Technical Criteria

Technical criteria used to determine final reclamation slope configurations are based on an evaluation of geotechnical stability, erosional stability, and suitability for re-vegetation purposes. Given these criteria, the final reclamation configurations were designed for the pits and waste rock dumps. These analyses were included in the 2006 Gatsuurt Feasibility Study Report (SNC-Lavalin, 2006a and 2006b), and are incorporated herein by reference.

These studies indicate that the current operational and reclamation designs of facilities at the Gatsuurt Mine will be stable under static and pseudo-static conditions.

7.3.2 Measures Used to Minimize Loading of Sediment to Surface Waters

Erosion control and sediment control during and after reclamation may be accomplished by the following measures, or other appropriate BMPs:

- Re-vegetation of disturbed sites;
- Construction of diversion ditches, both permanent and temporary when needed, to divert run-off away from reclaimed sites;
- Installation of riprap in erosion-prone areas of ditches and channels.
- A sedimentation pond will be utilized downstream of the mine site to settle out any sediment prior to water treatment and release into the Gatsuurt River.

7.3.3 Surface Facilities Not Subject to Reclamation

Surface facilities that may not be reclaimed include surface water controls, portions of some roads, and buildings or structures that may have commercial or industrial uses following mining activities. Surface water control structures such as channels and retention ponds may be left un-reclaimed to provide for control of storm water in the post reclamation period.

Table 7.1 Reclamation Schedule Gatsuurt Mine

	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8			
	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
Open Pits and Safety Berms																																
Earthwork				X																												
Revegetation																																
Waste Rock Disposal Facilities																																
Earthwork					X	X	X	X																								
Revegetation						X	X			X	X	X																				
Storage and Equipment																																
Earthwork						X	X	X	X																							
Revegetation							X				X	X																				
Ponds																																
Earthwork									X	X																						
Revegetation												X																				
Structures and Buildings																																
Demolition					X	X	X	X	X																							
Earthwork							X	X		X	X																					
Revegetation											X	X																				
Drainage Controls																																
Earthwork									X	X																						
Revegetation												X																				
Roads																																
Earthwork										X	X																					
Revegetation												X																				
Monitoring																																
Revegetation Monitoring													X	X	X	X	X	X	X	X	X	X	X	X								
Water Quality Monitoring													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

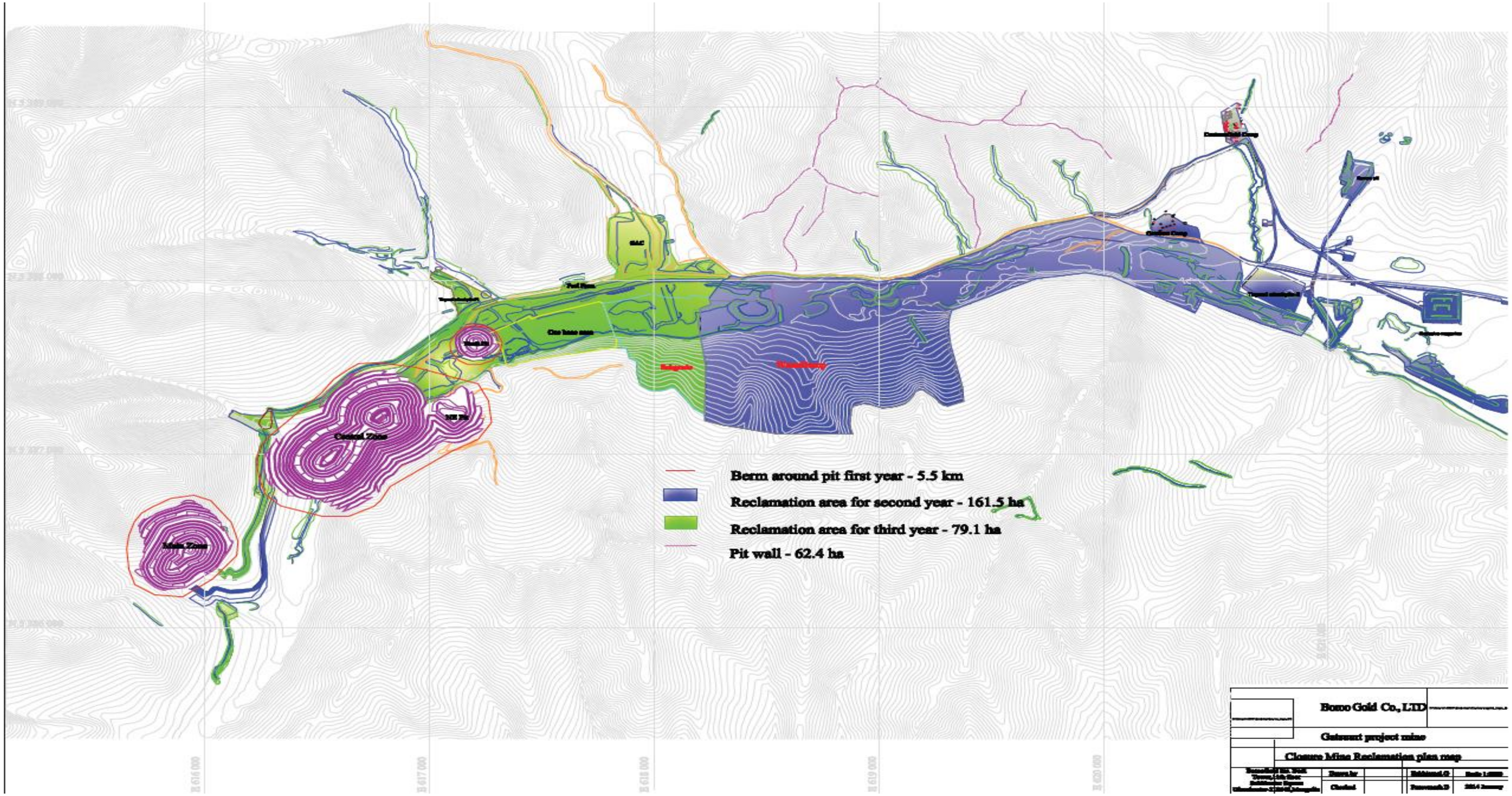


Figure 7.1 Reclamation plan

7.3.4 Surface Water Diversion Structure Reclamation

The Gatsuurt River flows through the proposed Gatsuurt Mine. The surface water will be diverted during operations to prevent run-on which may contaminate the surface waters. If required, the surface water diversion system will be left at the end of closure stage.

It must be understood that the present Gatsuurt River course was drastically disturbed by previous alluvial mining operations and does not follow a natural course. Nor is the water confined completely within the surface water course that is present. Surface water from the Gatsuurt River flows out of the surface course and moves out and under the alluvium that covers the valley floor.

Therefore, any stream channel construction that is undertaken would be superior to what exists as the Gatsuurt River course at present. The constructed course is designed to be stable, non-erosive, constructed to contain the water flows and would deliver the contained water to a stable and appropriate discharge point.

In this case, it then follows that it is not appropriate to set the reclamation goal for the Gatsuurt River as reconstruction of the existing river channel. The most appropriate design goal, and the goal that is proposed with this plan would be to construct a river channel that is engineered to be more stable than the existing course and to function as a natural river course.

7.3.5 Measures to be Taken during Extended Periods of Non-Operation

BGC/CGM does not anticipate that there will be extended periods of non-operation at the Gatsuurt Mine. If an extended period of non-operation is anticipated in the future, BGC/CGM will provide the regulatory agency with specific measures that would be conducted to maintain the site in a stable and safe configuration. Although the specifics of such activities will depend on the phase of operations and disturbance at the time such a period began, it is likely that most activities would consist of monitoring and maintaining surface water control structures and fences, and providing security or other methods to preclude public access.

7.4 Reclamation Methods

This section summarizes estimated disturbance amounts and proposed methods of closure and reclamation for each disturbance category. Reclamation tasks associated with these categories primarily include re-contouring, demolition, and seeding activities.

Where available in sufficient quantity and located on accessible slopes, topsoil in the disturbed areas will be salvaged and stockpiled. These growth medium stockpiles along with other available alluvial materials will be used to cover the disturbance areas prior to seeding. Each of the topsoil piles will have signs emplaced on the pile indicating topsoil or subsoil so that there is a permanent marker indicating the type of material.

Table 7.2 lists these reclamation categories and estimated disturbance amounts for each category. The locations of disturbance for reclamation activities are presented in Figure 7.1. Descriptions of the methods proposed to complete reclamation for each of these categories are provided below.

Table 7.2 Estimated Disturbance Categories and Sizes

Disturbance Category	Disturbance Amount (ha)
Topsoil stockpile #1	2.8 hectares
Topsoil stockpile #2	4.0 hectares
Old alluvial pit area (non-reclaimed land)	146.0 hectares
GAC, Fuel farm	10.0 hectares
Central zone (new disturbed)	25.4 hectares
Main zone (new disturbed)	15.1 hectares
Pit road	2.0 hectares
Diversion dam, channel, ditches	9.5 hectares
Waste dump and subgrade (new disturbed)	73.4 hectares
CGM and Gatsuurt camp	4.4 hectares
Dam-6, Camp's road, Borrow pit	7.6 hectares
Explosive magazine	2.8 hectares
Total	303.0 hectares

Roads: The roads will be constructed as repeated travel over relatively flat areas. These roads will have a total disturbance width of about 20 meters. The first stage of reclamation of the highly compacted road courses, a dozer (D9R or equivalent) would rip the running surface of roads. Any growth medium present will be incorporated into the fill slopes of these roads. Re-contouring of these roads will re-incorporate the growth medium in the near surface materials. The re-contoured surface will then be seeded by suitable seeds for re-vegetation.

Open Pits / Trenches: Proposed methods of open pit reclamation include erecting safety berms along the pit perimeter to restrict access. An excavator scraping material from immediately adjacent areas will construct the berms. A fence will be built around pits area as a warning of the presence of a fall hazard (the mine highwall) and to discourage foot travel near the highwall. Warning signs will also be placed near the highwall to provide further safety security.,

Process Ponds: This category includes the unlined storm water pond and the sedimentation/monitoring pond. Reclamation tasks associated with the storm water pond includes backfilling the pond and seeding the pond area.

Reclamation tasks associated with the sedimentation/monitoring pond include breaching the filter dam and the monitoring pond embankment to reestablish the natural drainage and seeding the pond area. The reclamation of the filter dam and monitoring pond will not be completed until the surface water quality in the area meets natural background.

Waste Rock dumps/ Ore Stockpile Facility:

The waste rock dump will be re-contoured to have slopes less than 22-25 degrees according to MNS 5917-2008 standards, them 10 cm of subsoil will be applied and suitable seeds will be planted.

For ore stockpile area, no major re-contouring of the benches will be required.

Structures and Buildings: Reclamation methods for structure and building areas include demolition of buildings and structures to the level of foundations, breaking concrete foundations, ripping surfaces to break up compacted ground, re-contouring the ground surface to be consistent with adjacent topography, burying building foundations with one meter of fill, and seeding the area. Small concrete foundations and pads may be broken and ripped with D9R dozers. However, thicker foundations will be more efficiently broken with a hydraulic excavator and hydraulic hammer. After the foundations are broken, they will be buried to a depth of one meter to provide adequate rooting depth for vegetation. Fill and/or waste rock material will be loaded and hauled to provide material for burial prior to reseeding.

If a cement foundation is to be buried beneath a cover of fill material, the foundation may be left in place and not broken.

Drainage: Facilities in this category include surface water diversion ditches designed to prevent run on to the pits, WRDFs, and other facilities. It is anticipated that the diversion ditches to route water around the WRDF's will be left in place as part of the post mining surface water control system. The sedimentation and monitoring pond dam will remain in place until natural background quality are met and water treatment is no longer required.

Open Pit Closure and Reclamation

Option: During excavation of the mine pits, NAG waste rock from the pits will be hauled to waste rock facilities for permanent storage.

The CZP will be filled with AG and PAG waste rock. Information collected to date indicate that all the AG and PAG rock that is produced during this mining program will be held in the CZP below the final water level. Any excess AG/PAG would be stored in a waste rock facility located next to the AG waste rock facility. This facility would be constructed with an engineered waste rock cover that would be designed to limit air and water invasion.

Access ramps to the pits will be blocked. Safety berms will be built around the circumference of the open pits to provide a warning to visitors of danger, and to discourage overland access into the pits.

natural groundwater seepage allowed to enter the pit until the seepage ceases: The pits will fill with groundwater naturally until the pre-mine groundwater level is achieved. If the sulfide bearing rock that is exposed in the mine highwall (considered PAG material) is covered with groundwater, then acid rock drainage would be minimized or completely stopped. Groundwater would continue to seep through the pit walls at a rate that will insure replacement of any water that is lost due to evaporation or other atmospheric losses (this replacement effect is a known phenomenon that occurs naturally).

Water Cover – this refers to the ARD remediation method whereby PAG material is submerged beneath a relatively deep layer of water in order to limit the amount of oxygen that reaches the PAG rock. Without Oxygen the ARD reaction will not occur. Therefore, a water cover is recognized as a preferred method for a permanent ARD remediation method that is often used for permanent disposal of PAG materials.

A trapezoid shaped security dam will be constructed around the open pits with 3 m height. When Gatsuurt mine closes, 62.4 ha of area will be surrounded with security dam to prevent human or animal access to the open pits. Total length of the dam is 5.5 km and the volume of material used is 116,111.1 tonnes.

Boroo Facilities closure and reclamation:

The ore from Gatsuurt will be processed in the Boroo Mill and BIOX facility. Therefore, closure of the Boroo tailings facility, roads, camp, Mill and BIOX will be postponed.

Boroo TMF east cell closure and reclamation: Planned in Year 4 and 5.

Boroo TMF main cell closure and reclamation: Planned in Year 5&6. Reclamation timing may change depends on BIOX CIP excess amount of water in the pond.

Boroo TMF west cell closure reclamation: Planned to conduct reclamation between Year 6&7. Reclamation timing may change depends on the operations at the BIOX CIP facilities.

As final slope of the tailings surface will be 1%, it has low probability of erosion so there will be no drainage features required for water control.

The layer to cover the tailings must have minimal erosion risk, little risk of capillary transmission of salts from the tails to the surface, in the soil and provide a suitable substrate for plant growth. It is proposed that the following materials be constructed on the surface of the tailings facility. Moving from the surface of the tailings upward, the following layers of material are proposed:

- waste rock layer on the tailings – 0.4 m
- Overburden fill layer -0.6 m
- Topsoil over the overburden layer – 0.15 m

Other TMF reclamation sites:

Storm water channels in the Western and Eastern hills: The channels on the western hill and eastern hill were built according to designs approved by official inspection organizations of Mongolia. These channels are stable and support a stand of perennials indicating that these channels are stable and will provide long term stability for the channelized water and protection for the tailings reclamation. These channels will remain as part of the final reclamation. Two additional storm water channels will be constructed on the edges of the Upper and Lower ponds to manage storm water that enters these areas.

Reclamation of dams surrounding Upper and Lower ponds: Upper pond dam is northern dam and dams surrounding Lower pond include south western, eastern and annex dams. The side slope of the dam slope will be constructed with a maximum slope of 3h:1v, dirt will be stacked and re-contoured, and 0.15 m top soil layer will be added on the surface, followed by reseeding. Technical and biological reclamation will be conducted with the following sequence on the northern southern eastern and annex dams.

- Excess dirt will be removed and stacked on slope and re-contoured by bulldozer.
- Top soil layer will be applied on slope and top with thickness of 0.15 m
- The area will be ploughed and perennial seeds will be planted for vegetation.

Reclamation of western slope of Upper pond: Western slope of the Upper pond is approximately 70 m wide and 1200 m long with an average inclination of 1:5. Its area is approximately 8.4 ha, and 7 ha area of the borrow pit of dirt to be used in reclamation has clayey soil where clay liner material was taken in the past, thus 15 cm thick top soil should be applied and ploughed and perennial seeds planted as reclamation.

Tailings facility pipelines: High density polyethylene pipes are installed from the processing plant until tailings dam will be thoroughly rinsed, dismantled, removed from the mine site and disposed at the garbage dump. Rinsing of the tailings line will be done according to procedures outlined by the International Cyanide Management Institute and in accordance with relevant Mongolian regulations.

Water pumping pipes of tailings facility: Water pipes installed from the storage pond at the tailings dam to the processing plant will be removed at the time of tailings facility closure. Pipes will be rinsed, dismantled, removed from the mine site and the land will be rehabilitated. Rinsing of the tailings line will be done according to procedures outlined by the International Cyanide Management Institute and in accordance with relevant Mongolian regulations.

Boroo mine camp and infrastructure: These facilities will be dismantled when they are no longer required. All salvageable material will then be removed from the site. Any remaining concrete pads will be broken up. Services including water, power, gas and sewage will be disconnected and removed or buried and covered with local soils. The areas will be re-contoured and revegetated.

Mill, BIOX and camp demolition and closure: Planned in Year 6-7

- Clean up;
- Remove hazardous materials;
- Decontamination of remaining materials;
- Removal of all equipment and machinery, to extent possible;
- Remove buried pipelines and services;
- Disassemble structures for re-use elsewhere or demolish;
- Remove most foundations. Re-grade and then cover all areas with topsoil prior to seeding;
- Demolition rubble will be buried in open pit or below toes of any active waste rock dumps

Borrow pits reclamation: Planned in Year 7&8, The area will be re-contoured according to MNS 5917-2008 standards, topsoil will be applied for revegetation.

Boroo TMF, BIOX and Mill - Post closure monitoring work will be conducted during Year 8-10.

Table 7.3 Mine Closure and Reclamation Cost Estimation

Expenditure type UOM		Period										TOTAL
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Rehabilitation	USD	$ 112,986	$ 3,258,449	$ 2,102,118	$ 3,411,758	$ 7,912,122	$ 539,980	$ 836,065				$ 18,173,477
Post Closure Monitoring	USD				$232,000	$232,000	$232,000	$232,000	$424,000	$192,000	$192,000	$1,736,000

Water treatment			$440,248	$440,248	$440,248	$440,248	$440,248	$440,248				$2,641,487
Off set program		$468,152	$468,152									$936,304
Mine closure management and other closure related costs	USD				$984,093	$1,000,239	$1,017,193	$1,034,994	$1,537,029	$1,449,288	$1,469,895	$8,492,731
Total	USD	$581,138	$4,166,849	$2,542,366	$5,068,099	$9,584,609	$2,229,421	$2,543,307	$1,961,029	$1,641,288	$1,991,895	$31,980,000
	MNT											

USD-MNT exchange rate was estimated at MNT 1,550 in the closure cost estimate.

Slope Stability Technical Criteria

Technical criteria used to determine final reclamation slope configurations are based on an evaluation of geotechnical stability, erosional stability, and suitability for re-vegetation purposes. Given these criteria, the final reclamation configurations were designed for the pits and WRDFs. These analyses were included in the 2006 Gatsuurt Feasibility Study Report (SNC-Lavalin, 2006a and 2006b), and are incorporated herein by reference.

These studies indicate that the current operational and reclamation designs of facilities at the Gatsuurt Mine will be stable under static and pseudo-static conditions. The studies supported a configuration of the WRDFs wherein the final slopes will be 2. 5H:1V (Horizontal: Vertical).

7.4.1 Measures Used to Minimize Loading of Sediment to Surface Waters

Erosion control and sediment control during and after reclamation may be accomplished by the following measures, or other appropriate BMPs:

- Re-vegetation of disturbed sites;
- Construction of diversion ditches, both permanent and temporary when needed, to divert run-off away from reclaimed sites;
- Installation of silt fences and/or straw bale dams in areas requiring sediment control; and
- Installation of riprap in erosion-prone areas of ditches and channels.
- A sedimentation pond will be utilized downstream of the mine site to settle out any sediment prior to release into the Gatsuurt River.

7.4.2 Surface Facilities Not Subject to Reclamation

Surface facilities that may not be reclaimed include surface water controls, portions of some roads, and buildings or structures that may have commercial or industrial uses following mining activities.

Surface water diversion structures that route water around the proposed WRDF's will be left in place to prevent ARD. Surface water control structures such as channels and retention ponds may be left un-reclaimed to provide for control of storm water in the post reclamation period.

Mine pits will remain open at the conclusion of mining. This means that the pits will not be backfilled with mine waste rock at closure. In-place rock in the pit highwalls will continue to breakdown over time following closure, creating slopes of loose rock with a lower angle slope than existed with the mine pit during operations (typically at the angle of repose for that rock material; typically, 1.5h:1v).

Pits are to be left open for several reasons: (1) because backfilling would make mining uneconomical i.e. mining would not take place if backfilling were required as this activity would make mining uneconomical, (2) an open pit facilitates access to the ore zone for future mining ventures should the price of the ore increase to economical levels (3) leaving pits open and allowing water to fill the void is the ideal environmental program for mitigation of acid rock drainage (ARD).

Though the pits will not receive mine backfill rock, the pits are expected to fill partially or completely with water. Pit water will come from a combination of surface water, groundwater and meteoric water. Water that collects in each pit will cover rock that could generate acid rock drainage if left exposed. The cover of water decreases the concentration of oxygen that is able to contact the submerged rock. Without oxygen, the ARD reaction is eliminated thereby stopping the ARD process. Because incursion of water into the pits is by passive means, this form of ARD mitigation is far less costly than other ARD mitigation measures, making the water cover the most cost effective solution to ARD mitigation and the measure proposed in this plan.

8 CONCLUSION

This report comprehensively identifies and assesses potential impacts, their severity and the scope of Gastuurt surface gold mining operations on environment, ecosystem components, regional socio-economy, and on sociology of mine workforce. Project implementation is expected to adversely impact on land surface, cause soil erosion and soil quality deterioration, impact on surface water, forest vegetation, air quality and vegetation cover. These adverse impacts expected from the project. It is expected that surface gold mining will impact on 161.4 ha. this area consists of several different land use categories including: existing pastureland that will be used for mining, establishment of acid and non-acid generating rock waste rock dumps, Gatsuurt river and storm water collection facilities, sedimentation pond and a monitoring pond. From the total disturbance, about 125 ha will have topsoil removed, and vegetative cover removed. An additional 47.7 ha land will be covered by two open pits (volume of 22.31 million m3 and depth 80-200 m).

The ore body at Gatsuurt is found in an Arseno-Pyrite formation (AP Formation). AP Formations by definition contain elevated concentrations of both Arsenic and Pyrite. Therefore, these elements appear in soils, ground and surface waters under natural conditions. As a result of this natural contribution of Arsenic and Pyrite the soils and water at Gatsuurt show elevated concentrations of these elements, often times exceeding Mongolian criteria. Historic mining at Gatsuurt have resulted in the release of more Arsenic and Pyrite further adding to the elevated concentrations of each of these elements. Because the water and soils exhibit these characteristics, Boroo Gold requests that the water that is discharged from the mine project area be legally recognized as acceptable water quality for discharge, rather than demanding compliance with the standard water quality criteria that are not reflective of the natural water quality.

Environmental impact of Gatsuurt project will be limited since during project implementation, as opposed to other gold mines, no toxic chemicals will be employed. Also there will be no Tails facility set up at project area. Predominant adverse impacts can be mitigated with a well-researched and step-by-step environmental rehabilitation program. The report has identified that project's startup will have negative impacts on natural resources consumption such as gold reserve extraction, impacts of forest cover reduction, pastureland vegetation, air and water quality. Recommendations on mitigation and impact elimination measures have been provided in the report, that include environmental rehabilitation measures as important part of sustainable land use, surface water pollution and depletion prevention measures. Additionally, environmental rehabilitation planning, disaster planning, risk assessment, nature resource ecological and economic assessment were included. During "Centerra Gold Mongolia Co., Ltd" operations, environmental protection plan, environmental monitoring program have been reflected in the report.

Centerra Gold Mongolia will revegetate and reforest eroded lands. Water quality criteria that are established for the Gatsuurt project by the Mongolian government will be achieved at the compliance point(s) that are defined by the Mongolian government. Numerous ways of managing mine water have been discussed in this document including: direct bypass of water entering the property to receiving waters downgradient; shallow injection of mine-impacted water (Rapid Infiltration Basins or RIB's); deep injection of mine waste water; land application; extraction of groundwater with dewatering wells and re-injection into the site groundwater system or discharge to receiving waters; active water treatment and discharge; passive water treatment and discharge. Each management approach would be managed carefully by site staff to insure that the established water quality criteria are achieved.

From economic and social aspects, mining operations are expected to have predominantly positive impacts. The most positive economic solution for Gatsuurt gold production is to use the infrastructure that currently exists at Boroo to process Gatsuurt ore and accommodate the Gatsuurt work force. The Boroo facility that is conveniently located near the Gatsuurt mine.

A new ancillary ore processing facility, a Biological-oxidization facility, will be constructed near The Biox facility Gatsuurt gold that cannot be produced using traditional facility because its ore has 92 percent sulfide, can be produced.

The existing facility has become an important contributor to Mongolia's economy since 2004. Processing of Gatsuurt ores will further enhance the positive effect on national and regional economy and promote the growth of Selenge province's Mandal and Byangol soums. It will also continue providing hundreds of work opportunities for Mongolians and associated contracting and servicing entities.

APPENDIX 1 Environmental Baseline Survey Results

LIST OF ACRONYMS & ABBREVIATIONS

AMSL	Above Mean Sea Level
BCI	Biotic Condition Index
cm	centimeter(s)
Corps	U.S. Army Corps of Engineers
DBH	Diameter at breast height
EIA	Environmental Impact Assessment
GPS	Global Positioning System
Ha	hectare(s)
JBR	JBR Environmental Consultants, Inc.
km	kilometer(s)
m	meter(s)
MNE	Ministry of Nature and Environment
OHWM	Ordinary High Water Mark
UNFAO	United Nations Forestry and Agriculture Organization
USACE	U.S. Army Corps of Engineers
USDI	U.S. Department of the Interior
USFWS U.S.	Fish and Wildlife Service
UTM	Universal Transmercator
WGS 84	World Geodetic Survey, 84 Datum
WWF	World Wildlife Fund

GATSUURT MINE PROJECT, GATSUURT VALLEY

MANDAL SOUM, SELENGE AIMAG

BASELINE SURVEY REPORT

EXECUTIVE SUMMARY

Centerra Gold Inc./Boroo Gold Company, Ltd. is proposing to conduct gold mining operations in the Gatsuurt River Valley in the Mandal soum of Selenge aimag. In order to comply with the Mongolian Department of the Ministry of Nature and the Environment (MNE), an Environmental Impact Assessment (EIA) is being prepared to evaluate the effects of the proposed project on natural resources in the survey area. This document describes the baseline water, soils, vegetation, wildlife, and special status species resources found in the survey area. Information included in this document was gathered in part during baseline surveys conducted in the area in July, 2006.

1.0 INTRODUCTION AND BACKGROUND

1.1 PURPOSE

Centerra Gold Inc./Boroo Gold Company, Ltd. (Centerra/Boroo) is conducting mineral exploration activities in the Gatsuurt River Valley in the Mandal soum of Selenge aimag. The exploration area includes historic placer mining operations that have disturbed much of the Gatsuurt River valley bottom. Unimproved roads, older buildings, and placer mining equipment (dredges, tracked vehicles, etc.) also exist in the survey area. More recent disturbance has occurred as a result of mineral exploration activities conducted by Centerra/Boroo.

The recent mineral exploration activities have identified two areas that Centerra/Boroo proposes to mine using open pit mining techniques. The proposed mine project would consist of two open pits, waste rock dumps, an ore stockpile, access and haul roads, as well as an upgraded power supply, fresh/potable water supply, a landfill, a mine operations building, warehouse and shop, telecommunications facilities, and sewage treatment and handling facilities.

Ore mined at the Gatsuurt Mine would be processed at the existing Boroo Mine, a permitted facility located approximately 35 kilometers (km) west of the Gatsuurt Mine project area. The haul road that would be used to transport ore from the Gatsuurt Mine to the Boroo Mine has been analyzed in a separate environmental document (JBR, 2006).

1.2 SURVEY AREA

The Gatsuurt survey area is located on and adjacent to the Gatsuurt River in the Mandal soum of Selenge aimag, approximately 90 km north of Ulaanbaatar, the capital city of Mongolia (Figure 1). Elevation in the survey area ranges from approximately 1,200 meters above mean sea level (AMSL) on the Gatsuurt River near the eastern edge of the Gatsuurt property, to approximately 1,500 meters AMSL on the hill slopes south of the river.

Habitats in the Gatsuurt River survey area experienced significant disturbance form previous placer mining operations. These previous operations have greatly altered the Gatsuurt River valley bottom. High flows have down-cut the river channel, and have resulted in the creation of multiple incised channels below the area of placer disturbance. The area has also been impacted by logging operations and by wildland fires.

The survey area for the project was divided into an intensively surveyed main survey area and a less intensively surveyed eastern survey area. The main survey area includes the proposed pit locations and adjacent areas on and near the upper reaches of the Gatsuurt River. The less intensively surveyed eastern survey area includes the access road into the main survey area and the central and eastern portions of the existing placer disturbance. The surveyed access road runs along the lower slopes of the hills north of the Gatsuurt River (Figure 2).

1.3 PROPOSED PROJECT DESCRIPTION

The Gatsuurt Mine Project would involve the construction of two open pits, an ore stockpile, waste rock dumps, roads, and mine facilities. Much of the Central Zone Pit, ore stockpiles, and waste rock dumps would be constructed within existing disturbance created by the previous placer mining operations. The Main Zone Pit would be constructed on slopes southwest of the Central Zone Pit. An access/haul road would connect these features and continue to the north, up the Biluut River Valley and on to the Boroo Mine. The proposed disturbance is shown on Figure 3. Table 1 presents a breakdown of proposed disturbance by mine facility.

Table 1 Summary of Gatsuurt Mine Disturbance, by Component

Facility	Proposed Disturbance (Hectares)
Central Zone Pit	37.09
Main Zone Pit	8.41
Stockpile	11.96
Encapsulated Acid Generating/Potential Acid Generating Dump	17.91
None- Acid Generating/Potential Acid Generating Dump	51.73
Roads (excluding Boroo Haul Road north from Gatsuurt Project Area)[1]	7.96
Total	135.06

[1] Analyzed in a separate environmental document

At the close of mining, Centerra/Boroo has committed to reclaiming the Gatsuurt River channel as a sinuous, stable drainage. Since the previous operator did not stockpile topsoil, the existing placer disturbance would be regraded and seeded, but would not be covered with topsoil.

Upon the completion of mining, or concurrent with mining, Centerra/Boroo proposes to reclaim the existing placer disturbance. Successful reclamation would serve to stabilize the Gatsuurt River and improve water quality. Several herbaceous plant species observed during the July 2006 baseline biological surveys were naturally revegetating disturbed soils present on old placer tailings and road cuts.

2.0 SOILS

This section provides a description of soil resources in the survey area. Baseline surveys of the area were conducted in July 2006. These surveys included an examination of soil profiles at several locations within the main survey area.

2.1 Methods

Soils in the survey area were characterized by examining road cuts and trenches. Fresh soil profiles were exposed with a shovel and the soil profiles were described and photographed (Appendix A). Soil profile photographs were reviewed by Dr. Ochirbat Batkhishig, Head of the Soil Science Laboratory at the Institute of Geography, Mongolian Academy of Sciences. Soils within the existing placer disturbance were not characterized, since these areas are highly disturbed. Locations of soil profiles are shown in Figures 4A through 4C and a list of the approximate recoverable topsoil available within the survey area is listed in Table 2.

2.2 SOIL SURVEY RESULTS

Based on the soil profile photographs, four principal soil types were identified in the survey area. These soils occur primarily on the slopes above the Gatsuurt River and its tributaries. The most common soil type identified in the area was the mountain dermo-taiga. This soil type was found on slopes in forested areas, and was the principal soil found in the area of the proposed Main Zone Pit. The soil tends to be shallow (20-32 cm), though it may be underlain by a stony subsoil of substantial depth (Appendix A).

The mountain forest dark-colored soil was found at three locations. Soil depths varied considerable (8-60 cm) depending on landscape position. In general, soils on ridges tended to be quite shallow, while soils on concave slopes were deeper. A stony loam or stony loamy-clay occurred as the subsoil in most locations (Appendix A).

A Chernozem (edge of forest soil) was found southeast of the Main Zone area, and on the south-facing slope above the access road. In the area of the access road, this soil was relatively deep on the lower portion of the slope but was shallower on the higher, steeper portion of the slope. A deep loess horizon was found on the lower portion of the slope (Appendix A).

One area of mountain taiga, ferromorphic soil was found on the north-facing slope south of the Gatsuurt River. This soil was similar to the mountain dermo-taiga, but included a red, iron-influenced subsoil (Appendix A).

2.3 RECOVERABLE TOPSOIL

Construction of the Central Zone Pit will disturb a total of 37.09 hectares. The central portion of this pit would be constructed within the existing placer disturbance. The southeastern 10.7 hectares of the pit would be excavated into the less disturbed birch-larch habitat southeast of the Gatsuurt River. Of this area, approximately 1.3 hectares southeast of the Gatsuurt River has been disturbed by the construction of exploration roads, leaving approximately 8.6 ha of less disturbed soils in this area. Soils on this slope (Appendix A, Figure 4B Soil Sample Locations 452 and 455) were identified as mountain dermo-taiga. The two soil profiles exposed on this slope had soils that were 22 to 30 cm deep and underlain by a rock layer. A deeper subsoil was found below this rocky layer. Near ridges, however, the rock layer was closer to the surface, and the upper soil (topsoil) layer was only a few centimeters thick. Over the 8.6 hectares of undisturbed slope south of the Gatsuurt River, approximately 21,500 cubic meters of topsoil may be available for recovery, based on an average topsoil depth of 25 cm and an average exploration road disturbance width of 4 meters.

The western and northern portions of the Central Zone Pit would disturb another 9.9 hectares of birch-larch community. Approximately 0.55 hectare of this area has been disturbed by exploration roads. Areas of exposed soil were not found in the northern and western portions of the proposed Central Zone Pit. These areas are located on the lower portions of the slope, where soils of shallow to moderate depth (30 to 60 cm) may be expected. Based on an undisturbed area of 9.35 hectares (i.e., the 9.9-hectare area of proposed disturbance minus the 0.55 hectare of existing road disturbance) and an average topsoil depth of 40 cm, approximately 37,400 cubic meters of topsoil may be available for recovery.

Construction of the Main Zone pit would impact approximately 8.31 hectares. Approximately 0.9 hectares of this area has been disturbed by the construction of exploration roads and trenches.

Approximately 7.4 hectares of new disturbance would occur on the slopes west of the Gatsuurt River as a result of construction of the Main Zone Pit. Soils in the area of the proposed Main Zone Pit were identified as Chernozem (edge of forest), mountain forest dark, and mountain dermo-taiga soils. The depth of the upper (topsoil) layer found at the four cuts examined varied from 8 to 70 cm, but tended to be fairly shallow (30 cm or less). Deeper soils were found in the lower elevation, less steep slopes. On ridges, the top soil layer was often only a few cm thick. This upper layer was underlain by a stony subsoil, often of considerable depth. Based on the four soils pits established in the area, and an examination of soils depths over the general area (very shallow on ridges, deeper on convex slopes), recoverable topsoil in the area of the Main Zone Pit averages approximately 20 to 30 cm in depth. Over the 7.4 hectares of undisturbed area in the Main Zone, approximately 14,800 to 22,200 cubic meters of topsoil may be available for recovery.

Other proposed disturbance that would affect soils in the survey area includes the creation of a haul/access road. Impacts that may result from the construction of a majority of this road have been analyzed in a separate document. Approximately 7.3 hectares of this road would be constructed in areas of undisturbed soils and outside of the area previously analyzed. Based on an average topsoil depth of 30 cm for soils lower on slopes in the area, 21,900 cubic meters of topsoil may be recoverable in the area of the haul/access road.

Table 2 Estimated Recoverable Topsoil

Location	Hectares	Soil Depth (CM)	Approximate Recoverable Topsoil Available (Cubic Meters)
Undisturbed Slope South of the Gatsuurt River	8.6	25	21,500
Central Zone Pit	9.35	40	37,400
Main Zone Pit	7.4	20 to 30	14,800 to 22,200
Haul/Access Road	7.3	30	21,900
Total			

3.0 VEGETATION

Baseline surveys were conducted in July 2006. These surveys were designed to characterize vegetation types and to identify sensitive plant species potentially occurring or known to occur in the vicinity. A discussion of "special status" species (i.e., rare or endangered species) that may occur in the area is included in Section 5 of this document. The area surveyed during the July 2006 visit includes the main survey area, located in and above the upper end of the existing placer disturbance, and an area along the access road that runs north of the Gatsuurt River to the main survey area (Figure 2). Appendix B presents a list of plant species recorded in the survey area.

3.1 METHODS

Background research was conducted prior to field surveys. Vegetation types were initially identified based on review of the vegetation report compiled by Gazar Eco Consultants (2005), a Flora magazine article describing Mongolian vegetation in the western Khentei Mountains (Dulamsuren et al., 2005), and a flora of Mongolia (Grubov, 2001). The information presented was used to plan and direct field survey efforts to ensure that all vegetation types in the survey area were included in the analysis.

Additionally, quantitative methods for sampling vegetation communities were researched (USDI, 1996). Consultation with Boroo Gold (McIntosh, 2006) determined which methods would be employed to document vegetation communities present within the survey area.

The area was field surveyed in July 2006. Reference area transects were established at seven locations to document five distinct vegetation community types that comprise the dominant vegetation types in most of the survey area (Figures 4 and 5). General site information was recorded for each transect including date of survey, the examiner's name, transect identification number, transect location, plot size, aspect, slope, bearing, GPS location data, and vegetation type. In the field, UTM coordinates in WGS84 datum were recorded for each transect using a Garmin 12 GPS receiver to provide mapping and additional relocation information. Photographs were taken to further document community types. At the time of the survey, most herbaceous plant species exhibited flower and/or fruit and were identifiable to the species level. Voucher specimens of plant species encountered during general surveys and found on reference area transects were collected. Unknown species were identified when possible to the species level using the 2001 Grubov floral reference, then verified by the plant taxonomist at the Mongolian Institute of Botany on July 24 and 25, 2006. Plant species nomenclature follows the Key to the Vascular Plants of Mongolia (Grubov, 2001). A plant species list for the survey area is presented in Appendix B.

For all sampling methods employed, transect placement was determined by selecting representative areas that exhibited homogenous stand structure and plant species composition. The Daubenmire quadrat sampling method was selected to document vegetation attributes for all community types (USDI, 1996). Starting at 0 meters, a 20 cm by 50 cm frame was placed at ten meter intervals on the uphill side of a 100-meter tape. This provided a total of ten quadrats per transect. Data collection and analysis included percent canopy cover by species, percent plant species composition, and frequency by plant species. Percent ground cover data was also collected at ten points along the frame to document soil, litter, rock, moss, vegetation, and water. The Daubenmire field data collection and summary forms are contained in Appendix C.

Density and age class data by species were collected for tree- and shrub-dominated plant community types. In general, a 1 meter by 100-meter plot was established on the uphill side of the 100 meter tape used to collect the Daubenmire quadrat data. For some tree-dominated transects, this plot size was expanded in order to capture tree density. Numbers of individuals in each age class category of seedling/sprout, young sapling, mature, decadent and dead were recorded for each tree and shrub species encountered. Definitions for each age class by species were determined in the field dependent on plant characteristics. For example, each shrub clump was recorded as an individual within its age class, with the variation in age class determined by stem diameter or by single as compared to the presence of multiple stems. Additionally, tree diameters at breast height (DBH measured at 4.5 ft above ground level) were collected for coniferous species to further characterize that community type. The woody species density and age class field data collection and summary forms are presented in Appendix C.

The double weight harvest method was employed to document vegetative production within herbaceous community types along the 100-meter tape established for the Daubenmire quadrat method (USDI, 1996). A total of ten, one square meter plots (1 m2 hoop) were randomly selected. Even numbered plots were established three paces to the right of the tape, while odd numbered plots were established three paces to the left side of the tape. The standing crop for plots one and eight were clipped and weighed, while the standing crop weights for the remaining eight plots were estimated. Perennial and annual standing crops were estimated and weighed separately. The production field data collection and calculation forms are contained in Appendix C.

3.2 VEGETATION SURVEY RESULTS

The Gatsuurt survey area is located at the interface of the Mongol-Daurian and the Khentei botanico-geographic regions as described by Grubov (2001), and consequently exhibits high species diversity within forest-steppe plant community types. Vegetation types are influenced by elevation, aspect, slope, soils/geology, and landscape position. Elevations in the survey area range from approximately 1,200 meters AMSL on the Gatsuurt River near the eastern edge of the Gatsuurt property, to approximately 1,500 meters AMSL on the hill slopes south of the river. Terrain ranges from lower elevation, gentle slopes supporting forb-dominated meadows and mesic, mixed forest community types, to very steep, drier slopes supporting variations of the mixed forest and pine-dominated community types. A willow-birch riparian community type is located on the Gatsuurt River above the existing placer disturbance. Disturbed soils on the old placer mining deposits and along "grass" roads support a ruderale community type comprised of early successional plant species.

Eight vegetation community types were identified in the survey area based on reference area transects and general vegetation survey results, and are described below. The total area of each plant community present in the survey area areas is presented in Table 3.

Table 3 Total Area of Vegetation Types within the Centerra/Boroo Survey Area.

Community Type	Area (Hectares)
Birch-Larch Forest	483.0
Scotch Pine Forest	30.2
Willow-Birch	5.4
Forb Meadow, including grazed meadow pasture	38.3
Shrub/Forb, including forb meadow-burned birch larch	43.9
Rock Outcrop	(small inclusions)
Wetland	5.86
Ruderal, including vegetated and disturbed placer	123.0

Birch-Larch Forest

The birch-larch community type is comprised predominantly of Asian white birch (Betula platyphylla) in the tree overstory, with Siberian larch (Larix sibirica) and Scotch pine (Pinus sylvestris) providing additional and/or occasional tree cover. Dahurian azalea (Rhododendron dahuricum), intermediate spiraea (Spiraea media), and wild rose (Rosa acicularis) variously dominate the shrub layer. Common understory components include the shrubby groundcover cowberry (Vaccinium vitis-idaea), and grass and grasslike plants including a rhizomatous, thin-leaved sedge (Carex sp.), purple reedgrass (Calamogrostis purpurea), and sheep fescue (Festuca ovina). Common forbs include fireweed (Chamaenerion [formerly Epilobium] angustifolium), tufted vetch (Vicia cracca), northern bedstraw (Galium boreale), false lily-of-the-valley (Maianthemum bifolium), and herb paris (Paris quadrifolia). Variations in this community type are predominantly due to the disturbance associated with fire, windthrow, and timber harvest of coniferous species, as well as aspect and slope position. The birch-larch community type is the dominant community type within the survey area.

Reference area (RA) transects RA transects 1, 3 and 4 documented the variation within this community type. RA transect 1 is located near the base of an east facing, 17 percent slope just above the Gatsuurt River at 1,300 meters AMSL (Photo 1, Appendix D). RA transect 3 and 4 are located near the bottom third of a 22-37 percent slope on a northwest aspect at 1,330 and 1,300 meters AMSL respectively (Figure **). RA transect 4 was comparable to RA transect 1, while RA transect 3 exhibited a more open canopy and consequently drier site conditions. Measured dbh for pine varied from 15–49 cm, with the median value between 20 and 25 cm. For Siberian larch, dbh varied from 15-46 cm, with the median value between 28 and 30 cm. The average mean percent canopy cover respectively for RA transects 1, 3 and 4 was 83 percent, 56.25 percent and 124.75 percent, respectively, with a mean average of 88 percent. Mean average live densities for woody species per hectare were calculated and are presented in Table 4.

Table 4 Mean Average Density of Woody Species for the Birch-Larch Community Type

Plant Species	RA Transect 1 Density (Plants/HA)	RA Transect 3 Density (Plants/HA)	RA Transect 4 Density (Plants/HA)	Total Density (Plants/HA)	Mean Average Density Density (Plants/HA)
Betula platyphylla	2,200	3,700	400	6,300	2,100
Larix sibirica	-	90	160	250	125
Pinus sylvestris	-	60	-	60	60
Rosa acicularis	21,200	10,500	9,700	41,400	13,800
Rhododendron dahuricum	3,300	15,400	20,400	39,100	13,033
Spiraea media	3,900	3,600	200	7,700	2,567

Scotch Pine Forest

Scotch pine is the dominant conifer in the canopy in this community type, with an occasional Siberian larch and rare Asian white birch in the overstory. The shrub understory contributes 18.5 percent of the total canopy cover and is similar to that of the birch-larch community type with thickets of Dahurian azalea, supplemented by wild rose and intermediate spiraea. Understory vegetation consists of cowberry as the predominant groundcover and purple reedgrass, fireweed, stone bramble (Rubus saxitalis), northern bedstraw, and herb paris as common components. This vegetation type was documented by RA transect 5 near the top of a northeast facing, 52 percent slope at 1,300 meters AMSL in the southwestern part of the survey area. This type is also found near the top of the slope above RA transects 3 and 4 in discrete locations. The average mean percent canopy cover was 107 percent. Ground cover values for bare soil were 0 percent, for litter 80 percent, for rock 0 percent, for moss 8 percent, for vegetation 12 percent, and for water 0 percent. Measured dbh for pine varied from 15–42cm, with the median value at 39cm. Live densities for woody species per hectare were calculated and are presented in Table 5.

Table 5 Mean Average Density of Woody Species for the Scotch Pine Community Type

Plant Species	RA Transect 5 Density (Plants/HA)

Betula platyphylla	400
Populus laurifolia	300
Larix sibirica	83
Pinus sylvestris	792
Rosa acicularis	9,500
Rhododendron dahuricum	17,800
Spiraea media	12,200

Willow-Birch

Dewy willow (Salix rorida) and shrub birch (Betula humilis) comprise the dominant overstory, which occurs as a tall shrub layer in this riparian community type. These two species collectively contribute 70 percent of the total canopy cover. This community type is located in the trough floodplain of the Gatsuurt River above the existing placer disturbance, and is characterized by the presence of multiple, defined channels interspersed with moss-covered hummocks that support the dense overstory (Photo 2, Appendix D). Additional shrubs present include Bebb's willow (Salix bebbiana) located at slightly higher, drier elevations present on the periphery of the community. Common low shrubs include shrubby cinquefoil (Dasiphora [formerly Potentilla] fruticosa) and meadowsweet (Spiraea salicilfolia), and contribute collectively almost 15 percent of the total canopy cover. The herbaceous understory layer is sparse, with cespitose sedge (Carex caespitosa) and Pumpelly's brome (Bromus pumpellainaus) the most common components of this layer. RA transect 2 documents this north facing community type with a 2-3 percent slope, at 1,285 meters AMSL. The average mean percent canopy cover for RA transect 2 is 105 percent. Ground cover values for bare soil were 0 percent, for litter 52 percent, for rock 0 percent, for moss 24 percent, for vegetation 3 percent, and for water 21 percent. Mean average live densities for woody species per hectare were calculated and are presented in Table 6.

Table 6 Mean Average Density of Woody Species for Willow-Birch Community Type

Plant Species	RA Transect 2 Density (Plants/HA)
Betula humilis	5,000
Salix rorida	10,200

Forb Meadow

The forb-dominated meadow is comprised of assorted forbs, a few grass and grasslike plants, and an occasional low shrub. Common forbs include Asian yarrow (Achillea asiatica), field mugwort (Artemisia sericea), meadow geranium (Geranium pratense), Jerusalem sage (Phlomis tuberose), big burnett (Sanguisorba officinalis), white campion (Silene repens), small meadowrue (Thalictrum simplex), and tufted vetch. Additional forb species include spike-flowered speedwell (Veronica longifolia), aster (Heteroppapus sp.), northern bedstraw, yellow bedstraw (Galium verum), tanseyleaf cinquefoil (Potentilla tanacetifolia), Mongolian milkvetch (Astragalus mongholicus), and wild iris (Iris sp.). The grass and grasslike plants contribute a total of 12.5 percent canopy cover and include Pumpelly's brome, Siberian bluegrass (Poa sibirica), and a rhizomateous sedge (Photo 3, Appendix D). No annual plant species were documented as occurring within this community type. RA transect 6 documented this community type on a south-facing, 26 percent slope at 1,209 meters AMSL. Tthe average mean percent canopy cover for RA transect 6 was 123 percent. Ground cover values for bare soil were 0 percent, for litter 96 percent, for rock 0 percent, for moss 0 percent, for vegetation 4 percent, and for water 0 percent. Production calculations based on dry weight indicated that the average yield for perennial species is approximately 2,263 kilograms/hectare.

Shrub/Forb

This discrete community type was located adjacent to the forb meadow on a concave slope. Columbineleaf spiraea (Spiraea aquilegifolia) provides the dominant shrub cover, with shrubby cinquefoil and wild rose also present. Many herbaceous species present in the adjacent meadow provide significant cover including the rhizomateous sedge, yellow bedstraw, aster, Jerusalem sage and small meadowrue. Wild rhubarb (Rumex acetosa) and Siberian flax (Linum sibiricum) were unique to this community type. RA transect 7 documented this community type on a south-facing, 54 percent slope at 1,223 meters AMSL. The percent mean average canopy cover for RA transect 7 was 93 percent. Ground cover values for bare soil were 4 percent, for litter 93 percent, for rock 0 percent, for moss 0 percent, for vegetation 3 percent, and for water 0 percent. Mean average live densities for woody species per hectare were calculated and are presented in Table 7.

Table 7.Mean Average Density of Woody Species for the Shrub/Forb Community Type

Plant Species	RA transect 7 Density (Plants/HA)
Artemisia frigida	500
Dasiphora fruticosa	4,200
Rosa acicularis	1,000
Spiraea qquilegifolia	5,300

Rock Outcrop

Dominant vegetation in areas of rock outcrop included low growing perennial plant species such as low cinquefoil (Potentilla acaulis), thyme (Thymus sp.) and fringed sagebrush (Artemisia frigida). Herbaceous species include crested wheatgrass (Agropyron cristatum), rhizomatous sedge, stonecrop (Sedum sp.), chamaerhodes (Chamaerhodes sp.), leuzea (Leuzea uniflora), large-flowered larkspur (Delphinium grandiflorum), and dontostemon (Dontostemon sp.). Small patches of this community type occur within the survey area on rock outcrops located along ridgelines and exposed, steep slopes.

Wetlands

Members of the willow, birch and rose families dominate the tree and shrub layers encountered in wetland areas. Common willow species include dewy willow, Bebb's willow, Miyab's willow (Salix miyabeana) and an unidentified willow (Salix sp.), while laurelleaf cottonwood (Populus laurifolia) may also be found. Shrub and Asian white birches may also be present in the overstory shrub layer, along with meadowsweet. Common emergent vegetation includes sedge species, spikerush (Eleocharis sp.), and narrowleaf cattail (Typha angustifolia). Common reed grass (Phalaris arundinaceae), short foxtail (Alopecurus aequalis), and sloughgrass (Beckmannia syzigachne) are common grasses, while forbs like prostrate knotweed (Polygonum aviculare), narrowleaf smartweed (Polygonum angustifolia), silverweed cinquefoil (Potentilla anserina), tanseyleaf cinquefoil, hispid yellowcress (Rorippa islandica), and horsetail (Equisetum sp.) are also present. Wetlands are encountered along pond margins, within the trough floodplain of the Gatsuurt River, and adjacent to drainages (Photos 2 and 4, Appendix D).

Ruderale

The ruderale or disturbed community type is found adjacent to grass roads and on placer mine deposits. This community type is characterized by opportunistic, early successional plant species. Common tall forbs include stinging nettle (Urtica cannabina), mapleleaf goosefoot (Chenopodium hybridum), lambsquarters (C. album), an herbaceous sage (Artemisa sp.), fireweed, yellow flowered yarrow (Achillea tanacetum/A. vulgaris), thistle (Serratula centauroides), and yellow sweetclover (Melilotus dentatus/M. suaveolens). Other common forbs include Zawadski's chrysanthemum (Chrysanthemum zawadskii), umbel-flowered hawkweed (Hieraceium umbellatum), dandelion (Taraxacum sp.), stickseed (Lappula intermedia), yellow alfalfa (Medicago falcata), and two-forked cinquefoil (Potentilla bifurca). Common grasses include quackgrass (Agropyron repens) and hairy wheatgrass (A. aegilopoides).

4.0 WILDLIFE

This section provides a description of the affected environment and potential effects of the proposed project on wildlife resources. The scope of this analysis includes a general discussion of wildlife in the survey area. A discussion of "special status" species (i.e., rare or endangered species) that may occur in the area is included in Section 5 of this document.

4.1 Methods

Information on wildlife in the area was gathered during baseline wildlife surveys conducted in July, 2006. The area surveyed during the July visit includes the main survey area, located in and above the western end of the existing placer disturbance, and an area along the access road that runs north of the Gatsuurt River to the main survey area (Figure 2). The survey also included establishing macroinvertebrate sampling stations at six locations in the Gatsuurt River channel. Sources used for species identification included Mammalian Species accounts (Angerbjörn, 1995; Danilkin, 1995), A Field Guide to the Birds of China (MacKinnon and Phillipps, 2000; reprinted 2005), the World Wildlife Fund's Biodiversity Assessment and Conservation Planning Document for Mongolia (WWF, 2002), and various on-line and other resources, as cited. Notes on wildlife present were taken throughout the 2006 July surveys.

4.2 WILDLIFE SURVEY RESULTS

Vegetation in the survey area, as described in Section 3, includes a mixed forest community of Asian white birch, Siberian larch, and Scotch pine on north and west-facing slopes and in the higher elevations of the survey area. An herbaceous community occurs in the valley bottoms and on many south and east-facing slopes. Previous placer mining operations have disturbed much of the Gatsuurt River valley bottom in the survey area. This disturbed area varies from approximately 75 to nearly 400 meters in width and is approximately five km in length. Much of the disturbed area is unvegetated, but portions of the area are being colonized by willows, birch, and fireweed. Several ponds have formed within the disturbed placer area. A variety of water and shore birds utilize these ponds.

Wildlife inhabiting the Gatsuurt survey area includes small numbers of large mammals such as Siberian roe deer (Capreolus pygargus), small and medium-sized mammals, and a variety of resident and migrant birds. One species of reptile, one amphibian and one species of fish were also encountered during the July 2006 surveys. Species composition is expected to vary seasonally, and other species in addition to those recorded during the approximately ten-day long field survey are expected to occur in the area.

The greatest species diversity would be expected to occur in the spring and summer months, when migratory breeding birds arrive to nest in the area.

MAMMALS

Three Siberian roe deer were observed in the area during the July surveys. Two were seen near the Gatsuurt River, and one was observed on the slopes south of the river. Deer tracks were found along the river and on the surrounding slopes. This species occurs in forest and steppe habitats. Revegetated burns and clearings are reported to be preferred habitats. Siberian roe deer can tolerate temperature extremes, but the species is known to migrate out of areas that accumulate deep snow during the winter season (Danilkin, 1995). Because Centerra/Boroo has limited human access to the survey area, local populations of larger wildlife species may be increasing due to a reduction in hunting and other human pressures.

Smaller mammals observed in the survey area during the July 2006 visit included mountain hares (Lepus timidus), Eurasian red squirrels (Sciurus vulgaris), Siberian chipmunks (Tamias siberius), pikas (Ochotona sp.), and what was believed to be a red-backed vole (Myodes rufocanus). All these species except the pikas were observed in forested habitats. One of two pikas observed was found in a rock slide. The second was found in a south-facing herbaceous community. Bats were observed foraging about lights at the project area's ger camp east-northeast of the survey area.

BIRDS

A variety of avian species were observed in the survey area. Avian species commonly observed in the survey area included Eurasian cuckoos (Cuculus canorus), red-backed and brown shrikes (Lanius collurio and L. cristatus, respectively), olive-backed pipits (Anthus hodgsoni) and pine buntings (Emberiza leucocephalos). Several species of wagtail (Montacilla, sp.) were observed near the lower end of the existing placer disturbance, and Eurasian tree sparrows (Passer montanus) frequented an equipment yard near the lower end of the disturbance. At least two rudy shelduck (Tadorna ferruginea) pairs and a mallard (Anas platyrhynchos) utilized ponds within the existing placer disturbance as brood-rearing sites. Common sandpipers (Actitis hypoleucos), little ringed plovers (Charadrius dubius), and a territorial pair of common terns (Sterna hirundo) also utilized these ponds.

Raptors and vultures recorded in the area included a single cinereus vulture (Aegypius monachus) flying north of the survey area, Eurasian sparrowhawks (Accipiter nisus) and a single northern goshawk (Accipiter gentilis) observed in or over forest habitat. Common buzzards and a single upland buzzard (Buteo buteo and B. hemilasius, respectively) were also noted in the area. A common kestrel (Falco tinnunculus) pair with young was found near an outcrop on a hilltop south of the Gatsuurt River. Common kestrels typically nest on a bare scrape (Ferguson-Lees and Christie, 2001), and this outcrop probably represents a nest site. Inactive raptor nests were found in trees at four locations in the survey area (Figures 4). Egg shell fragments were found below one of these nests, but no prey remains were found at any site, indicating no young were fledged from any of these nests. A territorial common buzzard pair was observed in pine and larch forest south of the Gatsuurt River and east of the main survey area. This pair may have nested in the area, but no nest site was found. Black-eared kites (Milvus lineatus) were observed east of the main survey area on several occasions. A black-eared kite dove at a mallard brood on a pond in the disturbed placer area, but the young ducks escaped capture by diving underwater.

Other species recorded in the area included hazel grouse (Tetrastes bonasia) with broods, observed near forest edge habitats, Oriental cuckoos (Cuculus saturatus) calling in the main (western) survey area, white-backed woodpeckers (Dendrocopos leucotos), Eurasian nuthatches (Sitta europaea), willow tits (Parus montanus), and Daurian redstarts (Phoenicurus auroreus) observed in forested or forest edge habitats in the main survey area. Appendix E presents a list of avian and other wildlife species recorded in the survey area.

REPTILES AND AMBHIBIANS

A dead snake, possibly a viper (Vipera sp.), was found east of the survey area, and a Mongolian toad (Bufo raddei, [http://amphibiaweb.org]) was found at the ger camp, east-northeast of the survey area (Photo 5, Appendix D).

FISHERIES

A single young fish was caught and released during macroinvertebrate sampling in the Gatsuurt River. This fish had sucker mouthparts and may have been a species of carp (photo 6, Appendix D).

MACROINVERTEBRATE SAMPLING

A variety of insects spend their larval stages in aquatic environments. Certain taxa of aquatic invertebrate larvae are more sensitive to degradation of water quality than others. These differences in sensitivity have been used to establish an index, referred to as the Biotic Condition Index, or BCI, that relates the macroinvertebrate community present in a stream to the condition of aquatic environment in that stream (Winget and Mangum, 1979). The presence of a high percentage of insect larval species that require clean, un-degraded water (i.e., pollution intolerant species), for example, suggests that the water quality at a site is good. Conversely, the presence of a high percentage of pollution tolerant species, and/or an absence of pollution intolerant species, suggests that water quality conditions at the sampling site are poor or degraded.

Macroinvertebrate populations were sampled at six locations in the Gatsuurt River (Figure 4A-D). Four of these six sampling locations were at or near existing water quality sampling locations that have been established in the area. A new station (the upstream-most station) was established in riparian habitat in a relatively undisturbed section of the Gatsuurt River above the existing placer disturbance. A second new station (the downstream-most station) was established at the eastern edge of the mine property, below much of the placer disturbance. The channel at this downstream location is, however, deeply incised and the stream in this area appears quite degraded as a result of the upstream placer mining activities. Table 8 presents the sample site locations and flows recorded at each station.

Macroinvertebrate samples were collected using a Surber sampler fitted with a 500µm mesh net. After collection, samples from each site were transferred to collection bottles and preserved with alcohol. At each site, JBR recorded the location of the sample site using a Garmin 60CSx GPS receiver. Each site was photographed, and a field data form was completed (Appendix F). Water samples were collected at each site, and a cross section of the site was recorded using a tape stretched across the transect (Appendix G). A calculation of flow present at the time of sampling was prepared based on the cross sectional area of the flow and a measurement of the time required for a float to travel a measured distance (30 meters) of the stream, centered on the transect.

Table 8 Location and Conditions at Macroinvertebrate Sampling Stations Established on the Gatsuurt River

Site	Site Location*	Flow (m^3/sec)	Comments
Riparian above Placer Disturbance	0616382 5386041	Not calculated; heavy vegetation in stream	Few-no macroinvertebrates noted. Substrate large, imbedded. Some aquatic vegetation present
Dam 1, Upper Gatsuurt River	0616453 5386559	0.092	Small no. of macro-invertebrates. No aquatic vegetation.
Middle Gatsuurt River	0619455 5387977	0.229	Small no. of macro-invertebrates. Gravels highly imbedded. No aquatic vegetation.
Below Dam 2	0620164 5388140	0.280	Small no. of macro-invertebrates & 1 sucker (fish). No aquatic vegetation.
Below Dam 3	0620575 5387843	0.217	Small no. of macro-invertebrates. Gravels highly imbedded. No aquatic vegetation.
Lower End of Property	0621050 5387622	0.121	Small no. of macro-invertebrates. Gravels highly imbedded. No aquatic vegetation.

*Location taken in UTM WGS 84 Zone 48

Samples had not been analyzed at the time of this writing, but few macroinvertebrates were observed during sampling. A few stonefly (Order Plecoptera) and/or mayfly (Order Ephemeroptera) larvae and a few fly larvae (Order Diptera) were observed. The river had conveyed high flows earlier in the season, and gravels in the river bed were found to be highly imbedded. Such conditions are not conducive to high macroinvertebrate populations.

5.0 SPECIAL STATUS SPECIES

5.1 METHODS

An evaluation of the proposed Gatsuurt Mine survey area was conducted to identify Mongolian Red Book-listed rare and endangered species that may occur within the area affected by the project. Information from the preliminary vegetation report prepared by Gazar Eco Consultants (2005) identified 13 rare or endangered plant species as potentially occurring within the survey area. Table 9 presents potential Mongolian Red Book plant species that may occur within the survey area.

Rare and endangered wildlife species with the potential to occur in the survey area were also researched in the Mongolian Red Book (World Wildlife Fund [WWF], Mongolia and German Development Services, 1997) and the World Wildlife Fund's Biodiversity Assessment and Conservation Planning Document for Mongolia (WWF, 2002). It was found that the black stork (Ciconia nigra) is listed as rare in Mongolia and has the potential to occur in the survey area.

Table 9 Mongolian Red Book List of Rare and Endangered Plant Species.

Family	**Scientific Name**	**Status**	**Habitat[1]**

Cupressaceae	*Juniperus pseudosabina*	rare	Rock fields, moraines, screes in high mountain belt; in shrubberies and cedar-pine forests in lower part of high mountain belt at upper forest limit.
	J. sabina	endangered	Rocks, screes, stony places, stony bottoms of small ravines and stream valleys, banks of brooks and streams in upper and montane-steppe belt, and lower part of high mountains.
Liliaceae	*Lilium dahuricum*	endangered	Forest and floodplain meadows, forest clearings and fringes, shrubberies, pine forests.
	L. martagon	endangered	Larch and pine forests, birch groves, forest meadows and fringes, shady foot of rocks and boulders, bottom of creek valleys.
Caryophyllaceae	*Stellaria dichotoma*	rare	Steppe dry debris and stony slopes, screes, rocks, sometimes on pebbles and sand.
Orchidaceae	*Cypridium macranthum*	endangered	Thinned larch, larch-birch, aspen-birch forests, pine and birch forests, forest meadows and fringes.
Paeoniaceae	*Paeonia anomala*	rare	Larch and mixed forests, forest fringes, birch kolki, up to upper forest limit.
Papaveraceae	*Cheldidonium majus*	rare	Larch and cedar-pine-larch forests and their fringes, birch forests, rocky slopes in forest belt.
Ericaceae	*Rhodedendrom dahuricum*	rare	Larch and cedar-pine-larch forests and their fringes, birch forests, rocky slopes in forest belt.
Gentinaceae	*Gentiana macrophylla*	endangered	Larch and mixed forests, forest fringes, waterside and forest meadows, meadow slopes, bottom of creek valleys, dwarf birch thickets, river and brook banks.
Caprifoliaceae	*Sambucus manshurica*	endangered	Uremas, bottom of canyons, stone fields and screes, below rocks, waterside shrubberies, forest fringes in forest belt and lower part of alpine belt.
Valerianaceae	*Valeriana officinalis*	rare	Larch forests and their fringes, birch groves, forest and floodplain meadows, dwarf birch and willow thickets, shady creek valleys, foot of rocks in forest belts.
Asteraceae	*Solidago dahurica*	endangered	Larch and mixed forests and their fringes, uremas, birch forests in upper part of forest belt, meadow plots, brook banks, soddy rock fields in alpine belt.

[1] from Grubov, V.I. 2001. Key to the Vascular Plants of Mongolia, Vol. I and II

5.2 SPECIAL STATUS PLANTS SPECIES

Only one of the potentially occurring rare or endangered plant species was identified in the survey area. Dahurian azalea (Rhododendron dahuricum), an understory shrub species found in the survey area, is listed as rare in the World Wildlife Fund's Biodiversity Assessment and Conservation Planning Document for Mongolia (WWF, 2002). This common and dominant shrub species occurs within the birch-larch and Scotch pine community types described in section 3. This member of the heath family is found in the Khentei, Khanggai, Mongol-Daurian, and Great Khingan floristic botanico-geographic regions of Mongolia as described by Grubov (2001). Distinguishing characteristics include solitary, light pink or sometimes white flowers situated in the axil, and deciduous leaves that are bright green above and light below and up to 3 cm long. The general aspect of the plant includes sparsely branched stems, with older, mature plants reaching heights up to 1.2 meters in thickets with dead stems present, and more commonly up to one-meter-tall, sparsely branched stems.

The World Wildlife Fund Biodiversity Assessment and Conservation Planning Document for Mongolia (WWF, 2002) identifies unique habitat types in Mongolia. According to the WWF document, "the Scotch pine, larch forests with rhododendron, aureum, pine forests with green moss, and fir forests with ferns and green moss exist in the Khentii mountain[s], but are very common in Siberian Khamar davaa and in the Lake Baikal area." The WWF document states that "this is an example of the disappearance of some types of forest in Mongolia." This forest type occurs in the survey area, particularly on shaded north-facing slopes.

5.3 SPECIAL STATUS WILDLIFE SPECIES

Black storks are listed as rare in Mongoila and were observed in the survey area on several occasions. On three occasions, single birds were seen flying over the Gatsuurt River and the ponds that have formed within the placer disturbance. A pair of black storks circled over the upper end of the placer disturbance on one occasion. Black storks occur in forest habitats, where they build large nests in trees (http://www.explorado.org/solon-new/intro/introen/index.htm). No black stork nest sites were found within the survey area, but suitable nesting habitat appears to exist in the area.

6.0 WATER RESOURCES

6.1 Methods

This section provides a description of surface water resources in the survey area. Baseline surveys of the area were conducted in July 2006. The survey area for surface water resources included the main survey area, which in turn includes the Central Zone and Main Zone pits, as well as adjacent upstream areas on the Gatsuurt River and its tributaries. Downstream sections of the Gatsuurt River as far east as the eastern boundary of the Centerra/Boroo claim area were included within the less intensively inventoried eastern survey area (Figure 2). The survey included a search for seeps and springs near the two proposed pits (in the main, survey area), and collection of water samples from seeps/springs that were found in this area. Water samples were also collected from six macroinvertebrate sampling stations that were established on the Gatsuurt River. River cross sections were developed for each of these stations, and flows were calculated for five of the six macroinvertebrate sampling stations established on the river.

Accepted North America methods were used during the July 2006 survey. These methods and any exceptions to the methods are described in detail below.

6.1.1 Flow Measurements

Flow measurements were taken at each of the five macroinvertibrate sample sites below the riparian area. Flow calculations were made based on the cross sectional area of the flow and a measurement of the time required for a float to travel a measured distance (30 meters) of the stream, centered on the transect.

Flow was also visually estimated from the tributaries feeding the Gatsuurt river as well as from the springs located in the area.

6.1.2 DEFINED CHANNELS

Drainage channels within the survey area were assessed for the presence and extent of channel definition. The presence of defined channel characteristics indicates a channel may regularly contribute flow to downstream waters, and as such may affect downstream water quality. Characteristics of a defined channel include:

- The presence of a defined channel bed – a linear bed in a topographic depression that would transport surface water from a watershed;
- defined channel banks – near vertical or steep-sided banks formed by erosion from flowing water; and
- evidence of ordinary high water mark (OHWM) – some indicator(s) that the drainage is subject to surface water flows on an average annual basis). Such indicators include a scoured bed, shelving, the absence of terrestrial vegetation (partially perennials), and recent alluvial or litter deposition.

The width of channels that showed these characteristics was measured at the OHWM.

6.1.3 WETLANDS

Potential wetlands in the survey area were assessed utilizing the criteria contained in technical report Y-87-1, U.S. Army Corps of Engineers Wetland Delineation Manual, January 1987 (USACE, 1987). This manual describes the standard wetland delineation techniques used in identifying and delineating wetlands in the United States. These same methods were used to identify and delineate wetlands in the Gatsuurt River survey area. As described in the 1987 Manual, representative locations in wetland (hydrophytic) vegetation types found in the survey area were examined for wetland characteristics. Sample sites were established in each hydrophytic plant community in the area. Sites in adjacent vegetation communities or at boundaries of community types were also examined. The "routine" method, as described in the 1987 Manual, was used to characterize the wetlands found in the survey area. At each site, the vegetation, soils, and hydrology were examined for wetland characteristics.

6.1.4 Hydric Soils

Hydric soils are defined as "... soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. In the U.S., hydric soils usually include all histosols except Folists; soils in Aquic suborders, Aquic subgroups, albolls suborder, Salorthids great group, or Pell great groups of Vertisols that are: somewhat poorly drained, poorly drained, or very poorly drained; soils that are ponded for long or very long duration during the growing season; or soils that are frequently flooded for long duration or very long duration during the growing season" (USACE, 1987). Hydric soils often contain such indicators as low chroma color, mottling, gleying, iron or manganese concretions, organic matter streaking, or reddish staining or streaks. Another hydric soil indicator is the presence of a histic (organic - peat or muck) epipedon. Other criteria used to identify hydric soils include such indicators as soil color and the presence of bright mottles. Soil field characteristics are usually identified at 10 inches below the surface or immediately below the A horizon, whichever is shallower.

6.1.5 Wetland Vegetation

Wetland (hydrophytic) vegetation is defined as any macrophyte that grows in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water. The 1987 Manual requires that, in most cases, more than 50 percent of the dominant vegetation consists of plants that meet the wetland plant technical criteria. These technical criteria have been established for plants that occur in the U.S., and specify the probability that a given species of plant will occur in a wetland. Based on this probability, plant species are assigned a wetland indicator status. The wetland indicator status for each species present in an area is then recorded to aid in making wetland determinations. The indicator categories are defined as follows:

Obligate Wetland (OBL). Occur almost always (estimated probability >99%) under natural conditions in wetlands.

Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.

Facultative (FAC). Equally likely to occur in wetlands or non-wetlands (estimated probability 34% - 66%).

Facultative Upland (FACU). Usually occur in non-wetlands (estimated probability 67% -99%), but occasionally found in wetlands (estimated probability 1-33%).

Obligate Upland (UPL). Occur almost always (estimated probability >99%) under natural conditions in non-wetlands.

No Indicator (NI). Insufficient information available to determine an indicator status. If required, status was determined by the investigator using the reference Key to the Vascular Plants of Mongolia, Vol. I and II (Grubov, 2001).

To further refine these categories, a + or - may be used to indicate whether a species of plant is more or less likely, respectively, to occur in a wetland site. An asterisk (*) indicates a tentative assignment to an indicator status, based on preliminary information.

The indicator status of common species in the U.S. has been determined and identified in a series of publications produced by the U.S. Fish and Wildlife Service. Such a list has not been developed for Mongolian species. Accordingly, a tentative indicator status was assigned to plants found at sample sites established in the survey area based on the habitats in which these plants were commonly found, and based on information regarding individual species' habitats found in Grubov (2001). This approach may reflect a local bias, but can be supported to some extent by considering the indicator status of species that occur both in the U.S. and Mongolia (i.e., circumboreal species), and/or species found in Mongolia that are closely related to species that occur in the U.S. Narrow-leaf cattail (Typha angustifolia), for example, is identified as an OBL species in the U.S., and was found only in or immediately adjacent to wetted areas within the Gatsuurt survey area. Accordingly, for the Gatsuurt survey, this species was assigned an indicator status of OBL.

6.1.6 Wetland Hydrology

Wetland hydrology is the driving force behind wetland formation. The term "wetland hydrology" encompasses all hydrologic characteristics of areas that are periodically inundated or have soil saturated to the surface at some time during the growing season (USACE, 1987). During the survey, several indicators were used to determine wetland hydrology. Some of these indicators are: visual observation of saturated soils, visual observation of flooding or ponding, soil permeability and texture, evidence of anaerobic conditions within the upper root zone, root staining, and the amount and type of plant cover.

Other indicators of wetland hydrology are: drainage patterns (i.e., situation in topographical depressions or channels), drift lines, sediment deposits, water marks, oxidized root zones, location in the annual floodplain, water-stained leaves, surface scoured areas, morphological plant adaptations, and algae growth or remnants.

6.2 WATER RESOURCES SURVEY RESULTS

The Gatsuurt River enters the survey area from the south and runs north, then east through the survey area. The upper reaches of the river are relatively undisturbed and support a wide (±100 m) riparian zone (Photo 2, Appendix D). As described in Sections 4 and 5 of this report, this riparian zone includes shrubby birch (Betula humilis) and willow (Salix sp.), as well as an herbaceous understory.

Existing placer mining has disturbed the Gatsuurt River valley bottom from the point above where the river turns toward the east to near the eastern edge of the Centerra/Boroo claim area (Photo 7, Appendix D). This disturbed area is approximately five km long and varies from approximately 75 meters wide at its upper end to nearly 400 meters wide near the mouth of the Biluut River. The disturbed area supports limited vegetation, though some areas have been colonized by pioneering species such as fireweed (Chamaenerion [formerly Epilobium] angustifolium), willow and some shrubby birch. Below the placer disturbance, high flows have resulted in down-cutting of the river's channel, such that the channel is now incised two to three meters or more below the surrounding land surface.

Flow in the Gatsuurt River was measured at five of six macroinvertebrate sampling stations established on the river. These stations were established in the minimally disturbed, upper riparian zone (one station), and throughout the existing placer disturbance as far east as the eastern edge of the Centerra/Boroo claim area (five stations). Four of the five stations located within the existing placer disturbance were established at or near water quality sampling stations previously established by Centerra/Boroo. Universal transmercator (UTM) locations of sampling stations were recorded in World Geodetic Survey 84 (WGS84) datum using Garmin GPSmap 60CSx and Garmin 12 global positioning system (GPS) receivers and are included in Table 8. In addition to collecting macroinvertebrate samples at these stations, stream cross-sections were developed at each sampling site (Appendix G). Flows were measured at the five stations established within the existing placer disturbance. Flows as measured at the five stations below the riparian zone are listed in Table 8. Streamside vegetation at the highest station was too dense to allow the use of a float to measure stream velocity and calculate a stream flow.

Several drainages are tributary to the Gatsuurt River within the survey area. At the time of the July surveys, flow from springs west of the upper section of the river (Figure 4A) reached the river above the existing placer disturbance and just below the highest (riparian) vegetation reference transect. A second spring was found in a drainage that reaches the Gatsuurt River near the upper (western) end of the placer disturbance (Figure 4B).

Flows from an unnamed drainage and from the Biluut River join the Gatsuurt River from the north above the Middle Gatsuurt River macroinvertebrate sampling station (Figure 4C). Based on flow measurements, additional flow, probably from groundwater, appears to contribute to the Gatsuurt River below the Middle Gatsuurt River station and above the Dam 2 sampling site. Flows in the river decreased below the Dam 2 site (Table 8). Flow is probably lost to the substrate as the river enters the wider valley bottom near the eastern end of the Centerra/Boroo Gold claim area. The river channel splits near the eastern end of the claim area, probably resulting in additional loss of surface flow to the valley bottom substrates (Figure 4D).

6.2.1 Defined Channels

Within the survey area, the upper reaches of the Gatsuurt River included a series of braided channels flowing through the riparian area above the placer disturbance. Within the placer disturbance, the river was largely confined to a single channel that varied from approximately two to four meters in width. Appendix G includes depictions of cross sections of the Gatsuurt River at six locations. As described in the Water Resources and Wildlife sections of this document, each of these locations is the site of a macroinvertebrate sampling station.

Approximately 1,000 meters of the river's course pass through the riparian area above the existing placer disturbance (Photo 2, Appendix D). This section of the river occurs as a series of braided channels running through the riparian area, though a single main channel was identified in this area (Appendix G). Downstream, approximately 5.8 km of the river's channel runs through existing placer disturbance (Photo 8, Appendix D). This portion of the river runs in a single channel except where dams created within the placer disturbance have impounded short sections of the river or its tributaries. Most of the impoundments on the river were breached by high flows that occurred in the spring of 2006. Below the existing placer disturbance, another 330 meters of the river run through an incised channel apparently scoured out by high flows passing through the upstream placer disturbance.

Within the main survey area, two defined tributary channels join the Gatsuurt River from the west. When visited in July, 2006, both tributaries supported flow. Flow in the southern tributary originated from two springs located approximately 1,250 and 1,300 meters west of the Gatsuurt River. The majority of flow originated at the higher spring, where an estimated 40-60 liters per minute (0.01-6.66 cubic meters per second) emerged from the spring's source. An estimated 20 liters per minute (3.33 cubic meters per second) issued from the lower source. Flow increased downstream, apparently as groundwater contributed additional flow to the channel. Channel definition in this drainage below the confluence of the two spring forks averaged approximately 75 cm wide and 10 cm deep. Flow in the lower reaches of the channel was estimated to be 150 liters per minute (0.0025 cubic meters per second). Flows in this channel may have been higher than average, due to the very wet conditions present in the area in 2006.

Channel definition in the northern tributary also began at a spring. Flow from this spring was estimated to be 150-190 liters per minute (0.0025-0.0032 cubic meters per second). This flow ran in an approximately 50 cm wide and 20 cm deep channel below the source, then spread over the surface and was lost to the substrate. Flow re-emerged at a rocky break in the channel approximately 120 meters below the higher source. The large flow issuing from this lower source (estimated to be 190-225 liter per minute) ran in a two-meter-wide and 20 cm deep, incised channel to fill a pond impounded by fill at the upper end of the existing placer disturbance (Figure 4B). Seepage through the placer gravels emerged south of the access road. This seepage forms a pond behind a berm south of the access road. Flow exits this pond on the east, and runs southeast toward the Gatsuurt River.

In addition to the two tributaries found within the main survey area, a number of tributaries run south from the hills north the Gatsuurt River. Several of these tributaries cross the access road north of the river. The majority of these tributaries do not include defined channels, or are disturbed. A large channel just east of the main survey area joins the Gatsuurt River from the north. The lower reaches of this channel have been disturbed by previous placer mining activities. Flow in this channel is pooled above the access road. Flow passes under the access road in a culvert, then continues toward the Gatsuurt River in a one-meter-wide, 10 cm deep, incised channel. High flows in this channel appear to have breached a berm that formerly impounded water south of the access road. Hydrophytic vegetation was present at the site of this former pond, but breaching of the berm and down-cutting by flow in the channel has removed the source of hydrology that formerly supported this hydrophytic vegetation.

Farther to the east, the Biluut River is also tributary to the Gatsuurt River from the north Photo 9, Appendix D). The lower reaches of the Biluut River have also been disturbed by previous placer mining activities. Flow seeping through the placer gravels forms a 2-meter-wide and 6 cm deep channel that crosses the access road. This flow and additional seepage through the placer gravels at the mouth of the Biluut River also supports areas of hydrophytic vegetation and another pond south of the access road.

Continuing to the east, the access road crosses a series of seven swales (drainages lacking channel definition) that originate on the slopes north of the access road. East of the camp owned by the former placer mine operator, two culverts convey a 1.5-meter-wide, 20 cm deep defined channel under the access road.

In addition to defined channels, approximately ten larger and several smaller ponds have formed or have been created by berms and dams within the existing placer disturbance. These ponds form approximately 8.53 hectares of pond/open water habitat within the footprint of the existing placer disturbance. Several dams and berms in the area had been breached by high flows that occurred in the area during the spring of 2006. Breaching of these berms and dams reduced the size of some ponds in the area, and entirely eliminated some others.

6.2.2 Wetlands

6.2.2.1 Soils

Soils within the survey area were generally assessed as another part of this survey. Photographs of soil profiles exposed in the survey area were reviewed by Dr. Ochirbat Batkhishig, Head of the Soil Science Laboratory at the Institute of Geography, Mongolian Academy of Sciences. Based on the soil profile photographs, four principal soil types were identified in the survey area. These soils occur primarily on the slopes above the Gatsuurt River and its tributaries. Wetland areas or areas supporting hydrophytic vegetation were found either in the drainage bottoms, in areas where profiles suitable for soil type identification had not been excavated, or within the placer disturbance, in areas of highly disturbed soils. Generally, however, soils found within undisturbed wetland areas tended to be low-chroma clay soils.

6.2.2.2 Vegetation

Vegetation in the survey area includes areas of birch, Scotch pine and Siberian larch forest on north and west facing slopes and higher parts of the survey area, and herbaceous meadows in valley bottoms and on south and east-facing slopes. Less disturbed wet areas supported shrub birch and dewy willow and other willow species, meadowsweet, and shrubby cinquefoil, and an herbaceous understory that often included spike-flowered speedwell (Veronica longifolia), sedges including bottle sedge (Carex rostrata) and cespitose sedge (C. caespitosa), spikerush and several species of hydrophytic grasses. Several ponds within the placer disturbance supported a fringe of narrowleaf cattail. Appendix B includes a list of vegetation species observed in the survey area.

6.2.2.3 Hydrology

Hydrology supporting wetlands in the survey area appears to be derived from seasonal or perennial flow in the Gatsuurt River and its tributaries, and from groundwater occurrences at seep and spring sites. Only a small number of seeps and spring sites were found in the survey area, but flow from these springs supported downstream areas of hydrophytic vegetation. Ponds that have formed in the placer gravels and seepage through these gravels also support areas of hydrophytic vegetation.

6.2.2.4 Sample Sites

JBR established a total of nine sample sites in the survey area in order to investigate the location and extent of wetlands present. Vegetation at each site was recorded on Releve Vegetation Data Sheets (Appendix C). In areas that met the three criteria of a wetland (soils, vegetation and hydrology), paired sample sites were established to help identify wetland boundaries. Table 10 summarizes the findings made at sample sites established in the survey area.

Sample sites 1 and 2 were established in the relatively undisturbed riparian area in the Gatsuurt River valley bottom above the existing placer disturbance. Sample site 1 was established within the riparian community and sample site 2 was established on a bench on the western side of the Gatsuurt River just above the valley bottom. The entire, approximately 100-meter-wide valley bottom in this area was wetted by a series of braided channels and near-surface groundwater. Vegetation at sample site 1 included the hydrophytic species shrubby birch and dewy willow. Soils at the site were a low-chroma (10YR 2/1) clay, and the site was saturated to the surface, meeting the criteria of a wetland (Table 10). Vegetation at sample site 2 included a mixed indicator status community of meadowsweet, prickly rose, Asian white birch, and fireweed (Table 10). Soils below a shallow organic and ash horizon did not meet the criteria of a hydric soil and lacked saturation. The boundary of the wetland community characterized by sample site 1 was established at the break in slope at the valley bottom (Figure 4A).

Sample sites 3 through 6 were established in a tributary channel west of the Gatsuurt River. A spring (northern spring) emerged at the western end of this area. Flow from this spring wetted much of the valley bottom for a short distance, before being lost to the substrate. Flow then re-emerged 120 meters downstream and wetted a second area adjacent to the flow channel, then filled a pond that has formed near the upstream end of the existing placer disturbance (Figure 4B). Sample site 3 was established above the pond in hydrophytic vegetation adjacent to the flowing channel. Sample site 4 was established above a slight break in slope south of the channel bottom. Vegetation at sample site 3 was dominated by hydrophytic species, including meadowsweet. Soils at this sample site were banded, indicating the site may have been disturbed, but included low-chroma soils between the surface and eight cm, and between 13 and 20 cm. The site was not saturated at the time of the delineation, but flow patterns on the surface indicated the site had been wetted earlier in the season. Accordingly, the site was identified as a wetland. Vegetation at sample site 4 included a more mixed indicator status community (Table 10). Soils at this site did not meet the criteria of a hydric soil, and showed no evidence of saturation. The boundary of the wetland at this site was identified as the bottom of the slope surrounding the channel bottom.

Sample sites 5 and 6 were established higher in this same drainage, near the source of the northern spring. Identifiable vegetation at sample site 5, near the spring source, was dominated by hydrophytic species (Appendix C). Two species not identified to genus were also identified as dominants at this site. Soils at this site were a low-chroma rich clay loam. The site was not saturated at the time of the July delineation, but was within 5 meters of the spring source. The vegetation and soils present indicated the site is saturated at some time during the growing season (Photo 4, Appendix D). Sample site 6 was established on slightly higher ground to the north of the wetted area. Vegetation at sample site 6 included a mixed indicator status community. Low-chroma soils were present in the top five inches of the soil profile, but soils below this horizon were lighter and did not meet the criteria of a hydric soil. No evidence of saturation was found at this site. The wetland boundary on the southern side of this wet area was identified as the bottom of the steep slope bordering the drainage bottom. The northern boundary of the wetland was identified as the northern extent of the hydrophytic vegetation-dominated community. The wetland extended to the re-emergence of flow above the pond near sample sites 3 and 4 (Figure 4B).

Hydrophytic vegetation was also found adjacent to several ponds that have formed in the main survey area within the placer disturbance. A narrow fringe of narrow-leaf cattail and willows has become established adjacent to a pond south of the western end of the access road. This pond was apparently fed by flows passing through placer gravels below the spring site characterized by sample sites 3, 4, 5 and 6 (the northern spring). Vegetation at sample site 7, established adjacent to this pond, included narrow-leaf cattail and willow (Table 10). Soils in this area had not, however, developed hydric soil characteristics. An area near the western end of this pond had apparently supported a wider area of hydrophytic vegetation in the past, but the berm impounding this pond had been partially breached. Hydrology supporting hydrophytic vegetation at the eastern end of the pond had been lost due to down-cutting of the outlet channel.

Continuing to the east, a large tributary channel joins the Gatsuurt River from the north. The lower end of this channel has been disturbed by previous placer mining operations. A large pond has formed on this channel north of the access road and within the placer disturbance (Figure 4C). A culvert conveys outflow from this pond under the access road. A berm formerly impounded a second pond south of the access road. An area of hydrophytic vegetation had become established at the site of the former pond. A sample site, sample site 8, was established within this hydrophytic community. While the site supported narrow-leaf cattail, soils at the site did not meet the criteria of a hydric soil. The berm that had formerly impounded this pond had been breached by high flows, and down-cutting associated with this breach had removed any source of hydrology that would have maintained this area of hydrophytic vegetation (Photo 10, Appendix D).

Hydrophytic vegetation had also become established south of the access road at the mouth of the Biluut River. Sample site 9 was established in a hydrophytic vegetation community at this site. Vegetation present included common reed grass (Phalaris arundinaceae), narrowleaf cattail and willows (Table 10). As at sample site 8, soils in this area did not meet the criteria of a hydric soil (Table 10).

Additional areas of hydrophytic vegetation existed near ponds created within the existing placer disturbance, but outside of the main survey area. As at sample sites 7 through 9, however, these sites have formed within areas of disturbed soil, and do not appear to have been wetted for sufficient periods to have developed hydric soils.

TABLE 10 VEGETATION, SOILS, AND HYDROLOGY CHARACTERISTICS FOUND AT SAMPLE SITES IN THE GATSUURT RIVER SURVEY AREA

Sample Site Number/ Description	**Vegetation**		**Soils**		**Hydrology**		**Wetland Determination**
	Species	Indicator Status	Color/ Indicators	(Depth (cm)	Indicator	At: (Depth)	
1 Riparian area above placer disturbance	*Betula humilis* (75%) *Salix rorida* (10%)	FACW FACW	10YR 2/1	0-41	Saturation	Surface	Wetland
2 80 m west-southwest of SS-1	*Spiraea salicifolia* (20%) *Rosa acicularis* (20%) *Betula platyphylla* (15%) *Chamaenerion angusifolium* (15%) *Calamagrostis purpurea* (10%)	FACW FAC FAC FACU NI	10YR 2/1 10YR 3/3	0-3 3-41	None	--	Upland
3 Hydrophytics in channel below re-emergence of northern spring	*Spiraea salcifolia* (60%) *Urtica cannabina* (20%) *Salix rorida* (10%) *Dasiphora fruticosa* (10%)	FACW FACU FACW FACW	10YR 3/1 10YR 4/3 10YR 3/1 10YR 4/3	0-8 8-13 13-20 20-41	Water marks in channel	Saturation assumed	Wetland
4 Bench above channel near SS-3	*Spiraea salcifolia* (20%) *Betula platyphylla* (20%) *Equsetum* sp. (15%) *Rubus saxatillis* (15%) *Rosa acicularis* (10%)	FACW FAC NI UPL FAC	10YR 3/2 7.5YR 4/4	0-5 5-41	None	--	Upland
5 Near northern spring source above SS-3 & SS-4	*Rosa acicularis* (20%) *Spiraea salcifolia* (15%) Pinnate-leaf forb (35%) Bunch Grass (30%)	FAC FACW NI NI	10YR 2/1	0-41	Within 5 m of source	Saturation assumed	Wetland
6 Higher ground just north of extensive hydrophytic veg. as at SS-5	*Rosa acicularis* (40%) *Agropyron* sp. (25%) *Salix rorida* (10%) *Betula platyphylla* (10%)	FAC FACU(?) FACW FAC	10YR 2/1 10YR 3/2	0-13 13-41	None	--	Upland
7 Hydrophytics beside highest pond	*Plantago major* (20%) *Typha angustifolia* (15%) *Polygonum angustifolia* (15%) *Polygonum aviculare* (15%) *Salix miyabeana* (10%) (10percent)	FAC OBL FACU FACU(?) FACW	10YR 3/3	0-41	Soils damp, site adjacent to channel	Saturation probable earlier in season	Upland (recently established hydrophytic community)

Sample Site Number/ Description	Vegetation		Soils		Hydrology		Wetland Determination
	Species	Indicator Status	Color/ Indicators	(Depth (cm)	Indicator	At: (Depth)	
8 *Typha* in former pond	*Typha angustifolia* (30%) *Alopecurus aequalis* (20%) *Phalaris arundinaceae* (20%) *Salix miyabeana* (10%)	OBL FACW FACW FACW	10YR 4/2 10YR 3/1 10YR 3/4	0-10 10-15 15-41	Soils damp, formerly saturated; hydrology lost	Hydrology lost due to breach of berm	Upland (former hydrophytic community)
9 Hydrophytics at mouth of Biluut River	*Phalaris arundinaceae* (50%) *Typha angustifolia* (10%) *Salix* sp. (10%)	FACW OBL FACW(?)	10YR 4/4	0-41	Saturation	Surface	Upland (recently established hydrophytic community)

7.0 CONSULTATION AND COORDINATION

Centerra/Boroo Gold:

Steve McIntosh, Environmental, Health and Safety Supervisor. 2006. Personal communication between Mr. McIntosh and J. Picciani, botanist, July 12 and 24, 2006.

Mongolian Academy of Sciences:

Dr. Ochirbat Batkhishig, Head of the Soil Science Laboratory, Institute of Geography. 2006. Personal communication between Dr. Batkhishig and David Worley, senior biologist, JBR Environmental Consultants, Inc., July 24, 2006.

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