Part III: Baseline Conditions

The baseline environmental conditions of the Project area are characterized by physical, chemical, biological, and social attributes. This chapter provides a description and synthesis based upon existing literature, reports, interviews, project investigations and field and laboratory analysis.

1.0 Designation of Project Area Perimeters

As previously discussed in **Part I**, the Project area is located within the Zaamar Goldfield in the Tuul River Valley, north-central Mongolia (48˚22’ North latitude and 104˚28’ East longitude). The Project area is located approximately 225 km northwest of the capital city Ulaanbaatar, 180 km southwest of Darkhan, 100 km southeast of Erdenet and 30 km northwest of the local administrative center, Zaamar Soum.

The Project area perimeters are identified in the three mining licenses of the Project. Copies and English translations of these licenses are provided in **Appendix A**. **Figure I-3** delineates the mining license perimeters. **Table III.1-1** provides the coordinates of each mining license area.

Table III.1-1 Project Area Perimeter by Mining License

License No.	Mongolian National Coordinates					
4121A	1.	104º28’19”	48º22’05”			
	2.	104º28’43”	48º22’05”			
	3.	104º28’43”	48º21’43”			
	4.	104º28’19”	48º21’43”			
7712A	1.	104º23’30”	48º21’10”	12.	104º26’50”	48º20’00”
	2.	104º26’50”	48º21’10”	13.	104º26’50”	48º19’35”
	3.	104º26’50”	48º21’43”	14.	104º22’40”	48º19’35”
	4.	104º29’20”	48º21’43”	15.	104º22’40”	48º19’05”
	5.	104º29’20”	48º21’28”	16.	104º24’42”	48º19’05”
	6.	104º29’29”	48º21’28”	17.	104º24’42”	48º19’40”
	7.	104º29’29”	48º21’14”	18.	104º24’11”	48º19’40”
	8.	104º29’35”	48º21’14”	19.	104º24’11”	48º19’05”
	9.	104º29’35”	48º19’40”	20.	104º23’46”	48º19’14”
	10.	104º28’20”	48º19’40”	21.	104º23’37”	48º19’05”
	11.	104º28’20”	48º20’00”	22.	104º23’30”	48º19’05”
7713A	1.	104º26’50”	48º22’50”	5.	104º28’43”	48º22’05”
	2.	104º29’20”	48º22’50”	6.	104º28’19”	48º22’05”
	3.	104º29’20”	48º21’43”	7.	104º28’19”	48º21’43”
	4.	104º28’43”	48º21’43”	8.	104º26’50”	48º21’43”

2.0 Physical Geography

2.1 Climate and Meteorology

2.1.1 Mongolia's Climate

Known as the "Land of Blue Sky", Mongolia has more than 200 cloudless days annually (Montsame, 2008). Despite this abundance of sunshine, Mongolia is known for cold temperatures and large diurnal and seasonal variations. More than half the country experiences permafrost, which hinders construction, travel, and mine operations; and many rivers and lakes freeze over in the winter months.

Mongolia's mean elevation is about 1,500 m above sea level, which contributes to its extreme continental climate. Winters are renowned for their length, lasting about eight months, and low temperatures. Summer generally spans July and August.

The climate of the land-locked country is greatly affected by buffering mountains: the Altai Mountains to the west; the Sayan and Yablonovy Mountains to the north; the Himalayas to the south; and, the Khingan Mountain Ranges to the east. Mongolia is generally at the center of the Siberian high, a region of high atmospheric pressure that greatly influences the climate of central Asia. The Siberian high is associated with winds and atmospheric subsidence. This ultimately results in an arid to semi-arid climate with clear skies.

2.1.2 Local Meteorology

This representative meteorological description of the Project region is based on data collected from the nearest meteorological station and a literature review of previous reports. The meteorological data from the nearby weather station provides a basic understanding of the regional climate. The literature review provides greater detail and fills data gaps.

The Zaamar Meteorological Station is located at the Zaamar Soum Center, located approximately 30 km southeast of the Project area. **Figure I-1** displays the Zaamar Mountains bisecting the two locations. The Project area lies at an elevation of about 1,000 m above sea level, whereas the Zaamar Soum Center is about 1,150 m above sea level.

Eight years of data were available from the Zaamar Meteorological Station. Mean air temperature, mean soil surface temperature, precipitation and relative humidity were recorded. **Table III.2-1** shows the calculated monthly means of these parameters for the eight years of record (2000 to 2007).

Table III.2-1 Monthly Means of the Meteorological Parameters

Date (MM-YY)	Mean Air Temperature (ºC)	Mean Soil Surface Temperature (ºC)	Precipitation (mm)	Relative Humidity (percent)
Jan-00	-24.8	-26	0.1	
Feb-00	-18.0	-19	0.0	
Mar-00	-4.2	-5	0.1	
Apr-00	3.9	2	0.6	
May-00	13.4	14	1.6	43
Jun-00	21.2	23	5.3	49
Jul-00	18.8	21	9.0	73
Aug-00	17.8	18	8.3	72
Sep-00	11.2	10	8.4	66
Oct-00	-2.1	-3	0.5	
Nov-00				
Dec-00	-18.0	-21	0.8	
Jan-01	-25.6	-28	0.2	
Feb-01	-17.4	-19		
Mar-01	-6.8	-8	0.3	
Apr-01	4.6	3	0.2	
May-01	11.0	12	13.8	
Jun-01	18.8	21	6.8	67
Jul-01	20.7	22	3.1	65
Aug-01	18.5	18	5.1	69
Sep-01				
Oct-01				
Nov-01	-8.5	-11	0.3	
Dec-01				
Jan-02	-16.3	-20	0.2	
Feb-02	-12.6	-15		
Mar-02	-4.4	-6	1.0	
Apr-02	2.1	2	0.1	
May-02	12.1	14	1.6	58
Jun-02	19.7	22	2.5	62
Jul-02				
Aug-02				
Sep-02				
Oct-02	-5.3	-6	1.0	
Nov-02	-13.8	-17	2.2	
Dec-02	-22.5	-26	0.5	

Date (MM-YY)	Mean Air Temperature (ºC)	Mean Soil Surface Temperature (ºC)	Precipitation (mm)	Relative Humidity (percent)
Jan-03	-19.5	-23	0.4	
Feb-03	-14.7	-19	0.4	
Mar-03	-7.7	-9	0.4	
Apr-03	3.3	2	0.0	75
May-03	10.1	8	5.1	
Jun-03	18.0	20	0.9	55
Jul-03	19.2	21	9.1	61
Aug-03	15.4	16	3.1	62
Sep-03	10.1	9	7.9	67
Oct-03	-0.4	-6	0.1	
Nov-03				
Dec-03	-18.2	-22	0.1	
Jan-04	-19.6	-24	0.5	
Feb-04	-13.7	-16	0.4	
Mar-04				
Apr-04	4.6	4	0.1	59
May-04	11.6	13	1.6	58
Jun-04	19.2	21	5.2	52
Jul-04	19.1	20	4.8	72
Aug-04	17.0	18	0.7	58
Sep-04	9.4	8	4.2	69
Oct-04	1.1	-2	0.1	
Nov-04	-9.9	-13	0.7	
Dec-04				
Jan-05	-22.6	-26	0.1	
Feb-05	-26.7	-30	0.1	
Mar-05	-8.8	-12	0.4	
Apr-05	3.4	2	0.7	72
May-05	10.5	11	2.2	62
Jun-05	17.1	19	2.4	59
Jul-05				
Aug-05				
Sep-05	9.8	9	4.7	74
Oct-05	2.3	0	0.3	67
Nov-05	-8.0	-12	0.5	
Dec-05	-20.7	-24	0.1	
Jan-06	-18.9	-22	0.0	
Feb-06	-16.1	-19	0.2	
Mar-06				
Apr-06	-0.6	0	2.3	78
May-06	9.5	10	4.3	74

Date (MM-YY)	Mean Air Temperature (ºC)	Mean Soil Surface Temperature (ºC)	Precipitation (mm)	Relative Humidity (percent)
Jun-06				
Jul-06	18.7	21	6.4	82
Aug-06	17.3	19	1.6	65
Sep-06	10.1	9	0.8	69
Oct-06	1.5	0	0.4	70
Nov-06	-7.9	-10	0.1	70
Dec-06	-14.2	-18	0.1	
Jan-07	-18.2	-21	0.4	
Feb-07	-10.3	-15		
Mar-07	-7.3	-9	0.7	
Apr-07				
May-07	12.8	14	1.2	58
Jun-07	18.4	20	4.9	56
Jul-07	22.6	24	5.7	47
Aug-07	17.6	18	3.4	69
Sep-07	12.7	12	0.0	56
Oct-07	-1.1	-3	0.7	64
Nov-07	-8.5	-12	0.7	
Dec-07	-15.6	-19	0.4	

[shaded box] - data not available

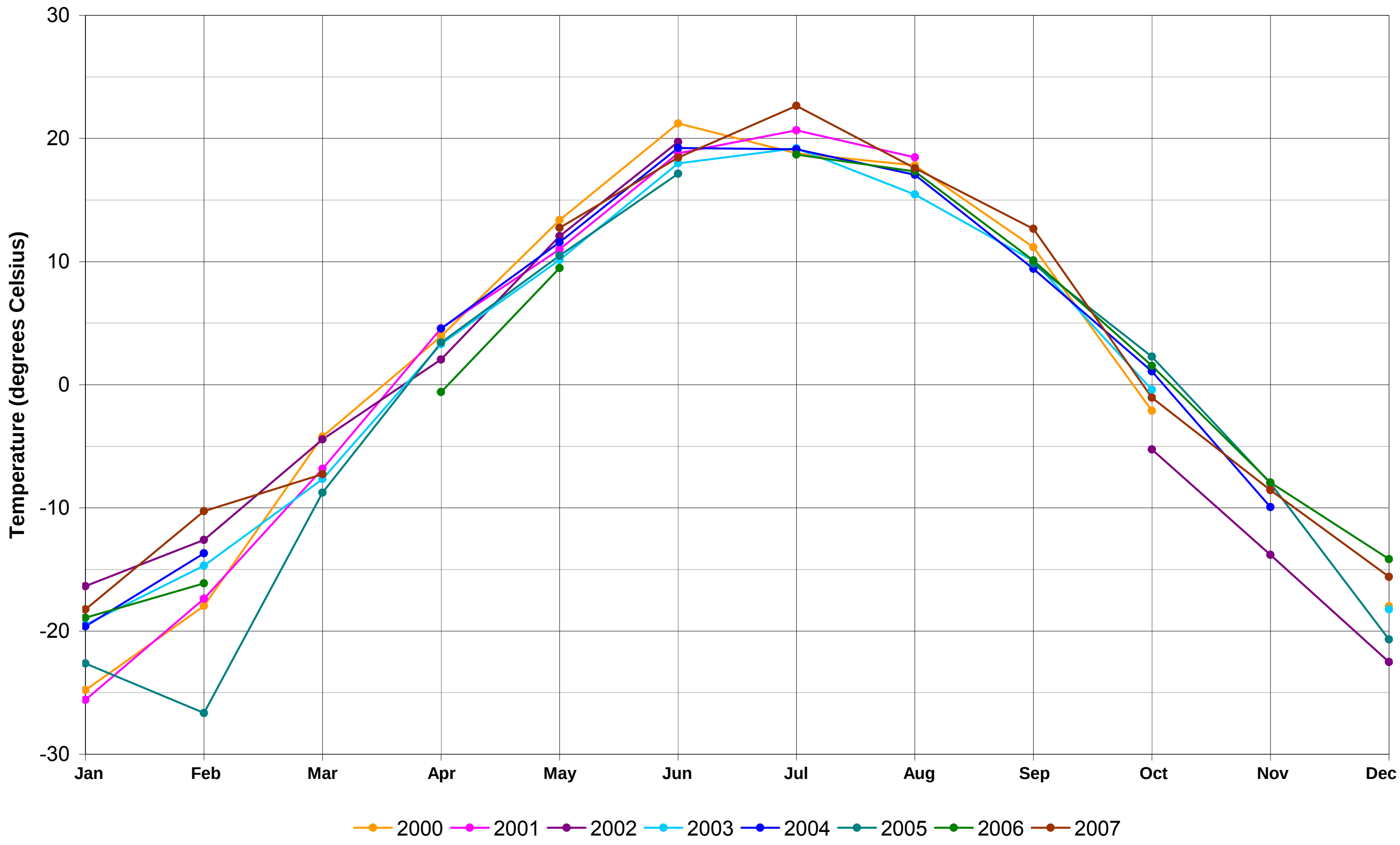
2.1.3 Air Temperature

Records of daily mean air temperature were collected from the Zaamar Meteorological Station. The mean daily temperature was recorded approximately 83 percent of the 2,922 days (2000 to 2007). **Table III.2-2** and **Figure III.2-1** generally show the highest monthly mean temperatures occurring from June through August and the lowest monthly mean temperatures occurring from December through February. January is the coldest month of the year, with a minimum mean daily temperature of -35 degrees Celsius (ºC) recorded in 2001. In 2007, the maximum mean daily temperature of 29.3 ºC was recorded in July, the warmest month of the year. These data demonstrate the seasonal temperature variations.

Table III.2-2 Monthly Mean Air Temperature

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ºC)	-20.7	-16.2	-6.5	3.0	11.4	18.9	19.9	17.3	10.5	-0.6	-9.5	-18.2

Figure III.2-1 Monthly Mean Air Temperature



2.1.4 Soil Temperature

Soil surface temperature data were collected from the Zaamar Meteorological Station. The mean daily temperature was recorded approximately 83 percent of the time. These data generally parallel the air temperature data. The highest monthly mean temperatures occur in June and July and the lowest monthly mean temperatures occur in December and January (**Table III.2-3** and **Figure III.2-2**). The minimum mean daily temperature is -39 ºC and was recorded in January 2001. The maximum mean daily temperature of -31 ºC was recorded in June 2000, July 2004, and July 2007.

As shown in **Table III.2-3** and **Figure III.2-2**, the soil begins to freeze in October, and does not thaw until April and occasionally not until June or July at higher elevations. The depth of freezing can exceed 120 cm.

Table III.2-3 Monthly Mean Soil Surface Temperature

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ºC)	-24	-19	-8	2	12	21	22	18	9	-3	-12	-22

2.1.5 Precipitation

As noted in the Official Yearbook of Mongolia, the country receives little precipitation throughout the year, averaging between 200 to 220 millimeters (Montsame, 2008). Precipitation generally occurs as rainfall during June, July and August. Snowfall is typically minimal. The driest months of the year are from November to March.

Data from the Zaamar Meteorological Station demonstrate this seasonal occurrence of precipitation. This area receives precipitation around the summer months (**Figure III.2-3**). However, it should be noted that this precipitation record is incomplete with values recorded only 15 percent of the number of days in the period of record.

2.1.6 Relative Humidity

Error! Reference source not found. shows the mean relative humidity data gathered at the Zaamar Meteorology Station from 2000 to 2007. At this station, relative humidity was measured and recorded from April to November; however, this record is only 41 percent complete. No data are available from December through March.

Figure III.2-2 Monthly Mean Soil Surface Temperature

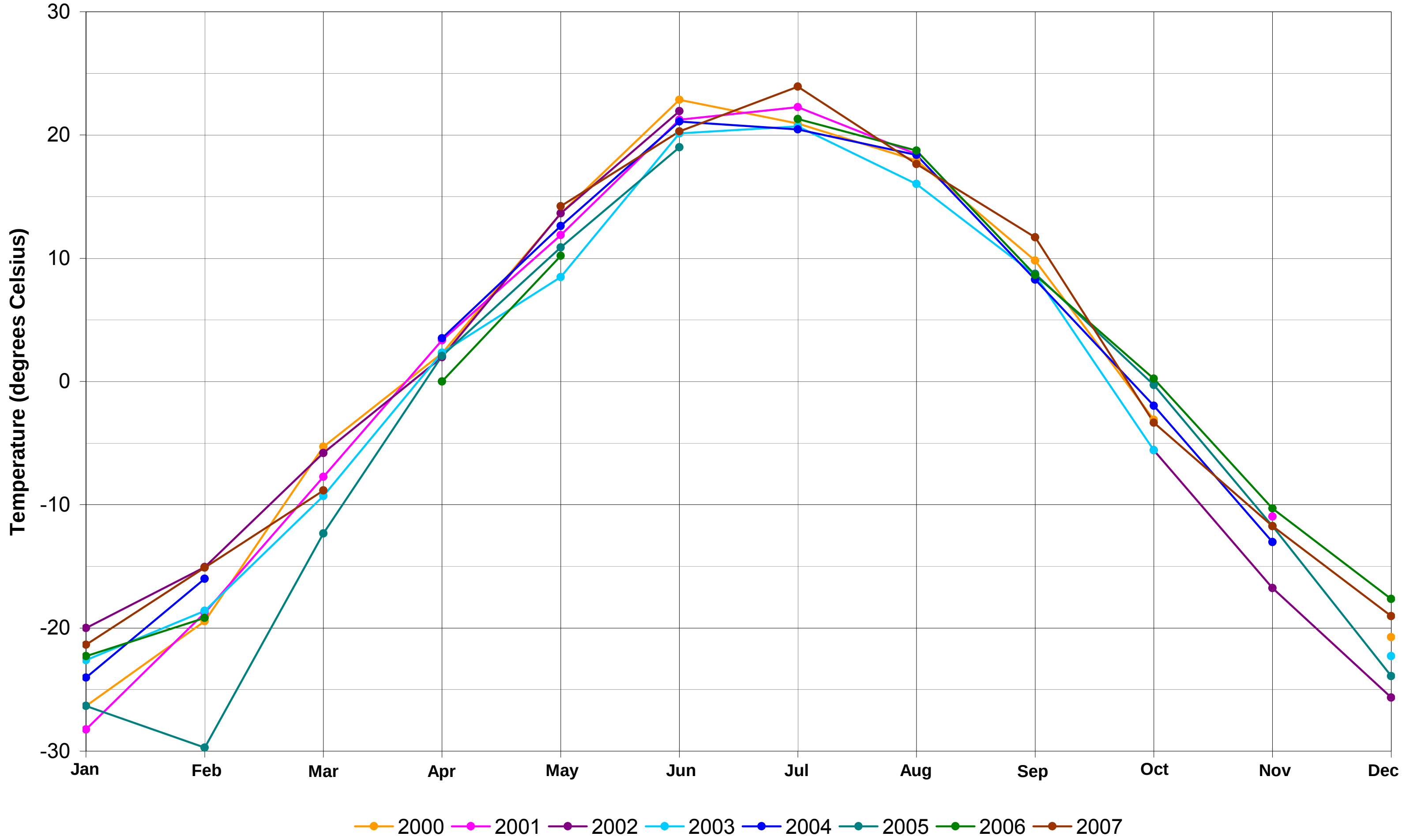


Figure III.2-3 Monthly Mean Precipitation

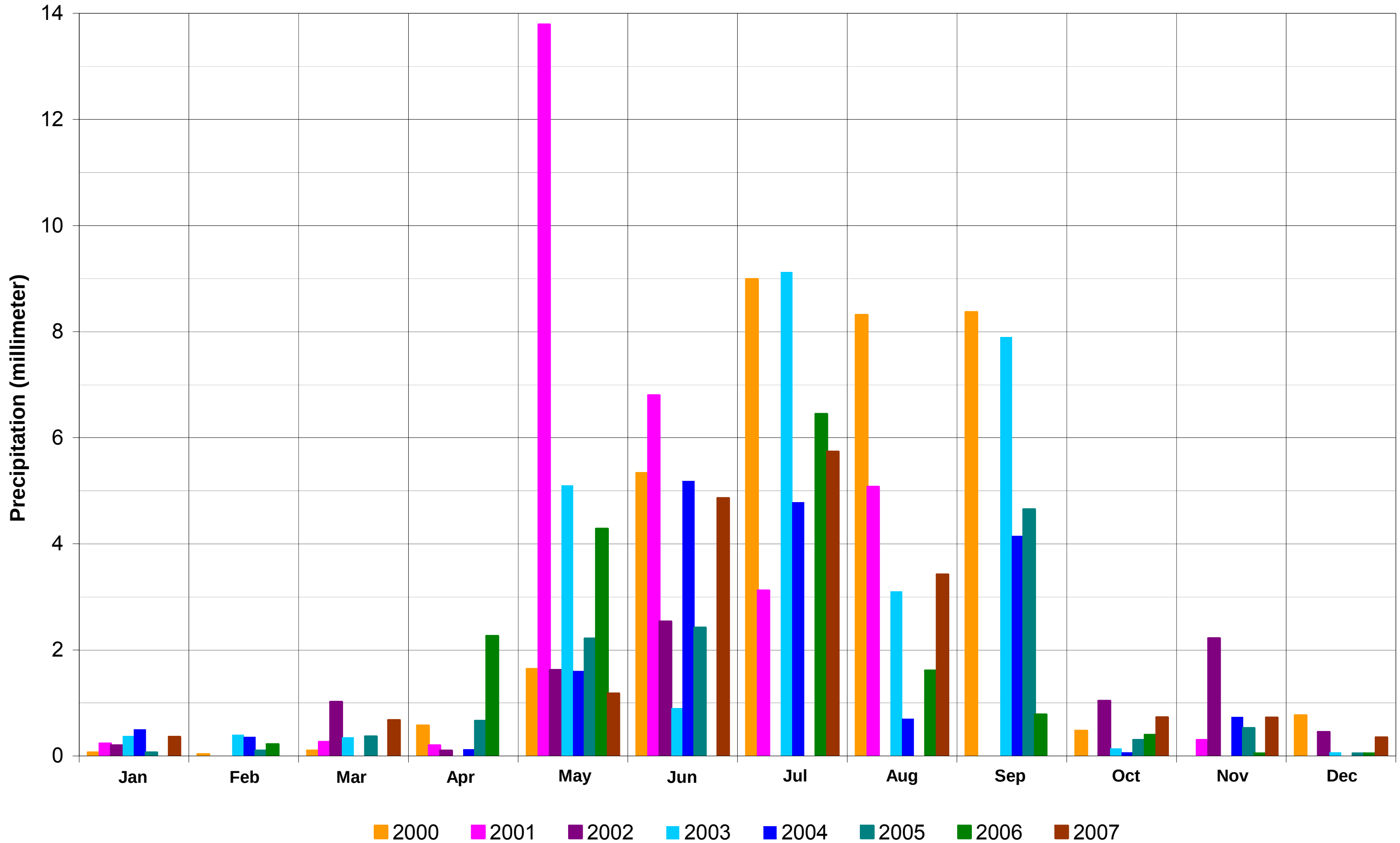
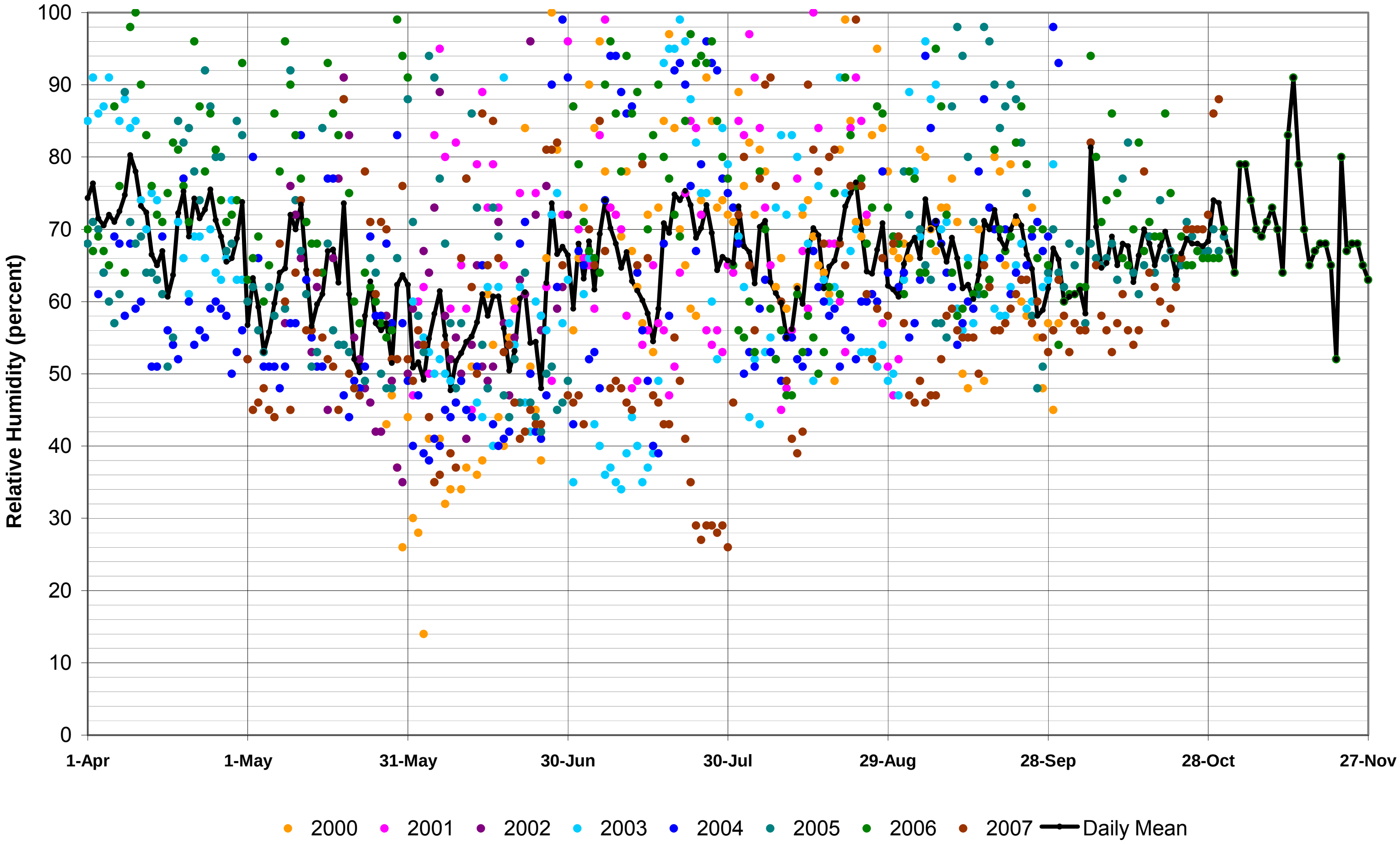


Figure III.2-4 Mean Relative Humidity



The recorded relative humidity ranges from 14 to 100 percent. The daily relative humidity ranges from 50 to 90 percent, with 65 percent as the mean. Relative humidity varies naturally on a diurnal basis, with a characteristic mid-day low and a pre-dawn high.

2.1.7 Wind Speed and Direction

Wind speed is variable in Mongolia and has several influences, including the ambient characteristics of the mid-latitude westerlies, the progression of weather systems across the country, and topography (Elliott et al., 2001). Mongolia is located beneath the mid-latitude westerly jet stream, a globally circling high-speed ribbon of air kilometers above sea level. The topography of Mongolia (e.g., mountain ranges) affects the westerly jet stream and, consequently, the distribution of wind.

A complex mountainous terrain separated by valleys, plains, and basins characterizes north-central Mongolia, where the Project area is located. The variable terrain causes variable wind direction and speed. The predominant wind direction is northwesterly and westerly. Higher wind speeds (about four meters per second) generally occur from March through June; April and May typically have the highest wind speeds (sometimes exceeding 15 meters per second [m/s]). These higher wind speeds are caused by the surface pressure gradients and temperature gradients that happen with the seasonal warming of the surface, which contrasts with the cooler air masses 1,000 to 2,000 m above the ground. The wind then decelerates as the temperature gradient decreases with the mixing of the cooler and warmer air, with minimum wind speeds in July and August (about one to two m/s).

The diurnal wind speed variation depends on several factors, including elevation and topography. However, maximum wind speeds generally occur during the afternoon, when the solar radiation has created the greatest temperature gradient between the lower and higher levels of the atmosphere. Minimum wind speeds are experienced when the atmosphere is the most stable, typically at dawn. Complex terrain with much topographical variation tends to delay the maximum winds speed until evening and early nighttime, with the minimum wind speeds mid-morning.

The predominant wind direction is from the northeast and northwest, with northwest winds occurring mainly in spring. In July and October, winds predominately occur from the northeast. The Zaamar Mountains shelter the Tuul River Valley in the mining district from easterly winds.

2.2 Topography

Geographically, the Project area is located in the southwestern part of the Khentei mountain range approximately 225 km north-northwest of Ulaanbataar. The topography of the area is shaped primarily by the process of the Tuul River (**Figure III.2-5** and **Figure III.2-6**). The elevation of the Tuul River Valley floor in the Project area is about 930 meters above sea level.

The sediments of in the Tuul River Valley of the Project region are of composite origin and complex in geometry. In general, the bedrock on both sides of the valley consist of metamorphosed basement rocks covered by colluvial materials (including the so-called "solifluction placers" in minor valleys).

The Tuul River Valley is dominated by a sequence of terraces, with placers and alluvial sediments interbedded with colluvial materials towards the foot of the hills. Up to five alluvial terraces have been recognized with the earliest lying as high as 30 meters above the current river channel. The terraces slope towards the river at a gentle yet persistent gradient.

The modern Tuul River has large meanders that occupy most of the width of the floodplain, often in association with cut-off meanders. The width of the floodplain (where wet mining is practical) is in a range of 400 to over 2,000 meters. The top of the floodplain is usually 1.5 to 2.5 meters above the summer water level of the Tuul River.

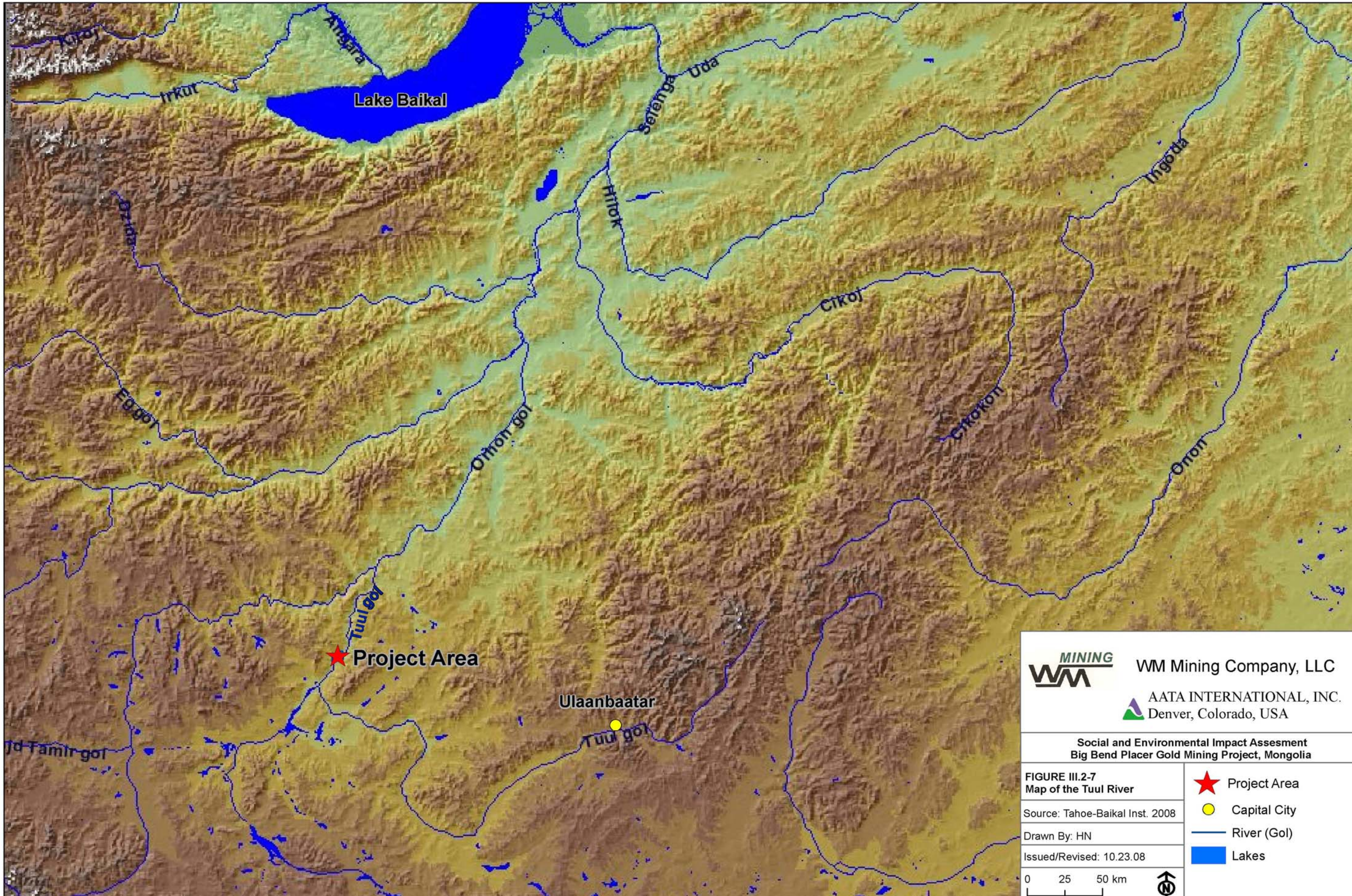
Both the trench-like feature of the floodplain and the consistently wide yet non-meandering form of the main valley floor placer suggest that the Tuul River was once substantially larger than its current size. It is possible that the large Orkhon River was temporarily using the Tuul Valley as its route north during the middle to late Quaternary time, and the presence of a trough valley just south of the Project region supports this hypothesis.

2.3 Surface Water Hydrology

The Big Bend Project area is situated in the Tuul River watershed, extending for about 15 km along the Tuul River proper. The river separates the Aimags of Tov and Bulgan and also the Soums of Zaamar and Buregkhangai. Its northwest boundary is the watershed of the Zagtsag Range and southeast boundary is the Zaamar Range. The Tuul River dominates the study area, generally flowing from south to north until the confluence with the Orkhon River, which flows northeast into the Selenge River (**Figure III.2-7**). The Tuul River watershed is part of the greater Lake Baikal Basin.

Figure III.2-5 North-Facing Panorama of the Project Area

Figure III.2-6 South-Facing Panorama of the Project Area



WM Mining Company, LLC

AATA INTERNATIONAL, INC.
Denver, Colorado, USA

Social and Environmental Impact Assesment
Big Bend Placer Gold Mining Project, Mongolia

FIGURE III.2-7
Map of the Tuul River

Source: Tahoe-Baikal Inst. 2008

Drawn By: HN

Issued/Revised: 10.23.08

2.3.1 Tuul River

The Tuul River, together with its tributaries, is the largest river in the region. The total length of the Tuul River is 891 km. The headwaters of the Tuul River are located in the southwestern slopes Khentii Mountains east north east of Ulaanbaatar. The Tuul River has eight tributaries, the largest of which are the Hagiin River and the Terelj River.

Subsequently, the Tuul River merges with and becomes the Orhon River, downstream of the Project area. Thereafter, it merges with the Selenge River, which is the largest river in Mongolia. The Selenge River discharges to Lake Baikal approximately 600 km downstream of the Project area. Lake Baikal is the world's largest (in volume), deepest, and oldest freshwater lake (Tahoe-Baikal Institute, 2008). It is located in Russia about 120 km from the border with Mongolia. Baikal's watershed stretches across the border and into Mongolia. Over 70 percent of Lake Baikal's water catchment area lies in the Selenge watershed. Lake Baikal is designated as a World Heritage Site, which covers both cultural and natural features of world importance (adopted by UNESCO in 1972). The proposed project activities will not have any impact on Lake Baikal water quality due to the project remoteness from the lake and the proposed preventive and mitigative measures (see **Parts IV** and **V**).

In historical times, the Tuul River appears to have ceased down-cutting and trenching. Today, the Tuul River is generally confined to a single channel with some stretches displaying a very high sinuosity in a single meandering channel. Numerous ox-bow lakes are characteristic of the Tuul River flood plain, especially in the southern half of the Project area. Other stretches of the Tuul River display low sinuosity with almost a linear single channel.

The Tuul River catchment area is 49,840 km^2 (UNESCO, 2006). The river valley width, upstream, varies from 0.1 to 0.5 km and in some downstream locations it varies from 1 km to 4 km. The river width, upstream, varie on average from 20 to 25 m and in its middle and downstream reaches it increases to 40 to 75 m. River depth varies on average from 0.5 m to 4.0 m, while in the study area it varies mostly from 0.5 m to 1.5 m with occasional areas up to 4.0 m. In the upstream areas the riverbed is composed mostly of gravel, while downstream it is composed with a finer material and at the Orkhon River confluence the riverbed has a high silt content which has apparently been exacerbated by deposits from the Zaamar gold mining areas.

The river flow velocity ranges from 0.5 m/s to 1.7 m/s. Long-term annual river flow averages about 35.6 m^3/s, with an observed minimum flow of 11.7 m^3/s and an observed maximum flow of 1,447 m^3/s. Flow data for the Tuul River are shown in **Table III.2-4**, **Table III.2-5**, and **Table III.2-6** based on the hydrological studies by the Darkhan Geological Exploration Unit in 1989; by a team of Mongolian, Russian and American scientists sponsored by Tahoe-Baikal Institute (Stubblefield and Smallwood, 2001); and by an AATA team in 2008.

Monthly flow characterstics of the Tuul River in 1989, as measured by the Darkhan Geological Exploration Unit, show that the Tuul River experiences its highest flows during months of July through August (**Table III.2-4**). The lowest flows are in the winter months of January through March when the river is frozen.

Table III.2-4 Monthly Flow Characteristics of the Tuul River, 1989

Month	**Minimum Flow** m^3/s	**Maximum Flow** M^3/s	**Average Flow** m^3/s
January	ND	ND	ND
February	ND	ND	ND
March	ND	ND	ND
April	ND	12	6
May	8	15	11.5
June	15	16	15.5
July	14.5	32	23.25
August	26.5	32	26.25
September	22	27.5	24.75
October	17	22	19.5
November	2.5	17	9.75
December	1	2.5	1.75

NOTES: The flow data were measured by the Darkhan Geological Exploration Unit.
ND – no data indicates that the River was frozen during these months and measurements were not taken.

An international team of scientists sponsored by Tahoe-Baikal Institute calculated the Tuul River's average streamflow from various locations along the Zamaar Goldfield (**Table III.2-5**). The data show that the streamflow was fairly constant along the upper reach of the Zamaar Goldfield and there was a slight decline in streamflow before the Orkhon River confluence. Not all of these measurements were made on the same day, except for the August 23 streamflow. The streamflow that was measured on this date, upstream and downstream from the Project area, was 16.6 m^3/s at most locations. At 35 km downstream of the Zamaar bridge (about 25 km downstream of the Project area), the flow increased slightly to 17.0 m^3/s.

Table III.2-5 Flow Characteristics of the Tuul River, August 2001 (after Stubblefield and Smallwood, 2001)

Date (M-DD-YY)	Location	Average Flow m^3/s	N LAT	E LONG
Aug-22-01	Upstream of all Zamaar mines	14.9		
Aug-22-01	2 to 4 km upstream of Zamaar bridge	16.6	48° 12' 7.42"	104° 17' 32.4"
Aug-23-01	3 km downstream of Zaamar bridge	16.6	48° 14' 6.24"	104° 21' 25"
Aug-23-01	10 km downstream of Zaamar bridge	16.6	48° 20' 17.7"	104° 24' 60.8"
Aug-23-01	20 km downstream of Zamaar bridge	16.6	48° 23' 33"	104° 30' 48.1"
Aug-23-01	25 km downstream of Zaamar bridge	16.6	48° 26' 9.32"	104° 32' 9.46"
Aug-23-01	35 km downstream of Zaamar bridge	17.0	48° 31' 8.1"	104° 32' 47.1"
Aug-11-01	Upstream of the Orkhon River confluence	10.8		
Aug-21-01	Upstream of the Orkhon River confluence	15.0	48° 54' 18.0"	104° 46' 7.90"
Aug-25-01	Upstream of the Orkhon River confluence	15.5	48° 54' 7.5"	104° 46' 7.15"

During the July 2008 baseline study, streamflow was measured 500 meters upstream of S-130. At the time of measurement, the streamflow was 54.2 m^3/s. This streamflow was the above the average flow of 23.25 m^3/s recorded in July 1989 (**Table III.2-6**). During the August 2008 site visit, the stream levels were observed to have dropped considerably (see **Attachment 5** of **Appendix E**). Another streamflow was measured between S-120 and S-130 on October 8, 2008. The discharge of Tuul River at this time was 15.27 m^3/s, lower than the average flow of 19.5 m^3/s recorded in October 1989 (**Table III.2-7**).

Table III.2-6 Flow Characteristics of the Tuul River, July 2008

Location: 500 meters upstream of S-130 (48deg 21min 37.1sec N 104deg 28min 53.2sec E) Total Width: 38 meters Mean Velocity: 0.74 meters per second Method: 0.6 * Meter: Marsh McBirney					Date: 14 July 2008, 1800 hrs Party: John Aronson Total Area: 57 square meters Total Discharge: 54.2 cubic meters per second (about 1910 cubic feet per second) Number of Sections: 14		
Section	**Distance (meters)**	**Width (meters)**	**Depth (feet)**	**Depth (meters)**	**Velocity (meters/ second)**	**Area (square meters)**	**Discharge (cubic meters per second)**
1 (LEW)	0	1.5	0	0	0	0	0
2	3	3	1.5	0.42	0.07	1.37	0.10
3	6	3	4.0	1.22	0.71	3.66	2.60
4	9	3	5.5	1.68	0.81	5.03	4.07
5	12	3	6.5	1.98	1.20	5.94	7.13
6	15	3	6.5	1.98	1.07	5.94	6.36
7	18	3	6.5	1.98	1.13	5.94	6.72
8	21	3	6.5	1.98	1.04	5.94	6.18
9	24	3	6.3	1.92	1.16	5.76	6.68
10	27	3	6.0	1.83	1.02	5.49	5.60
11	30	3	5.2	1.58	0.82	4.75	3.90
12	33	3	4.5	1.37	0.78	4.11	3.21
13	36	2.5	4.0	1.22	0.53	3.05	1.62
14 (REW)	38	1	0	0	0	0	0
Total	**--**	**38**	**--**	**--**	**--**	**57**	**54.2**

*Rantz, S.E. et al. 1982. Measurement and computation of streamflow. United States Geological Survey Water-Supply Paper 2175, 2 Volumes, 631 p.

Table III.2-7 Flow Characteristics of the Tuul River, October 2008

Location: about midway between S-120 and S-130 (48deg 22min 20.4sec N 104deg 29min 3.4sec E)	Date: October 8 2008 Party: Ethan Brown
Total Width: 45 meters	Total Area: 25 square meters
Mean Velocity: 0.47 meters per second	Total Discharge: 15.3 cubic meters per second (about 540 cubic feet per second)
Method: 0.6*	
Meter: Marsh McBirney	Number of Sections: 11

Section	Distance (meters)	Width (meters)	Depth (feet)	Depth (meters)	Velocity (meters/ second)	Area (square meters)	Discharge (cubic meters per second)
1 (REW)	0	2.25	0	0	0	0	0
2	4.5	4.5	1.1	0.35	0.31	1.575	0.488
3	9	4.5	1.9	0.58	0.73	2.61	1.91
4	13.5	4.5	2.5	0.75	0.59	3.375	1.99
5	18	4.5	2.5	0.76	0.70	3.42	2.39
6	22.5	4.5	2.5	0.76	0.72	3.42	2.46
7	27	4.5	2.3	0.70	0.62	3.15	1.95
8	31.5	4.5	2.3	0.70	0.62	3.15	1.95
9	36	4.5	2.1	0.64	0.48	2.88	1.38
10	40.5	4.5	1.2	0.36	0.46	1.62	0.75
11 (LEW)	45	2.25	0.1	0.03	0	0.068	0
Total	**--**	**45**	**--**	**--**	**--**	**25.27**	**15.27**

*Rantz, S.E. et al. 1982. Measurement and computation of streamflow. United States Geological Survey Water-Supply Paper 2175, 2 Volumes, 631 p.

In summary, the flow regime of the Tuul River is characterized by extremely high flows during spring and summer time. About 90 to 95 percent of the annual water flow occurs during the spring and summer. River water level increases most from July through September, with monthly average flows reaching 23.25 m^3/s in July, 26.25 m^3/s in August, and 24.75 m^3/s in September.

During April and May, there are floods due to ice and snow melt. During floods, the water level increases 1.5 to 2 times. Major floods of the Tuul River occurred in 1915, 1934, 1959, 1966, and 1967. The United States Geological Society classifies a major flood as, "A major flood causes inundation of large areas, isolating towns and cities. Major disruptions occur to road and rail links. Evacuation of many houses and business premises may be required. In rural areas widespread flooding of farmland is likely."

The first frost occurs at the end of October to the beginning of November, after which the river starts to freeze; and, the ice remains until the end of April to the beginning of May. For about 140 to 170 days of the year the Tuul River is covered by ice. During wintertime some shallow stretches of the Tuul River freeze to the riverbed.

The temperature in the Tuul River is greatly affected by ambient air temperature and can exceed +25 ^{o}C during summer months. The hydrologic monitoring data for the Tuul River collected by the Soviet Geological Exploration Unit (USSR) in 1986 to 1988 and by the Darkhan Geological Exploration Unit (Mongolia) in 1988 to 1990, respectively, are presented in **Figure III.2-8** and **Figure III.2-9**.

Prior to the rainfall season that begins in late springtime, discharge is quite low and the Tuul River is a gaining stream. During the summer high-flow period, the Tuul River is a losing stream. Groundwater contributes about 25 percent of the Tuul River water flow, about 6 percent is from snow and ice melt, and 69 percent is rainfall. The Tuul River is mostly recharged by precipitation and consequently the water level is very unstable during the summer and fall.

2.3.2 Tuul River Tributaries and Watershed

The Tuul River tributaries include the Galttai, Saridagiinhiid, and many other small rivers and creeks; the Terelj River being the largest. Tributaries to the Tuul River such as the Khailaast, Bayangol, Tsaagan Bulag, Tosongol, Ar Naimgan, and others are typical for sloping lowlands.

Limited research or monitoring has been carried out on the Tuul River tributaries and its watershed. Some characteristics of the small creeks and springs in the Tuul River watershed within and surrounding the Project area are summarized in **Table III.2-8.** Characteristics of the small creeks and springs in the Tuul River watershed presented here are based on the results of an environmental study conducted by Dr. N. Jadamba in 1996 to 1997 (Jadamba and Doloonbayar, 1998). The data from this study show that flow in the creeks and springs ranges from 0.0006 m^3/s in the Tsagaan Bulag spring to 0.27 m^3/s in the Toson Creek. Average flow velocity values range from 0.19 m/s in the Tsagaan Bulag spring to 0.67 m/s in the Khailaast Creek, while maximum flow velocities vary from 0.2 m/s in the Suujiin Am spring to 0.75 m/s in the Khailaast Creek.

2.3.3 Historical Environmental Impacts

There are very limited data on the historical impacts of mining on the Tuul River and its watershed. Therefore, it would not be possible to estimate the extent to which the Tuul River, associated tributaries, and its entire watershed have been affected. Field observations, evaluation of the satellite imagery, aerial photography, and other site related information indicate that the localized historical impact has been very significant (**Section 4.2.5**).

This impact can be characterized through significant alteration of the riverbed, the channelization of diversions, the destruction of river banks, backwaters, and wetlands.

At several sites along the Tuul River, the Tahoe-Baikal Institute (TBI) scientists collected geomorphology samples, including pebble counts, width-depth ratio, and entrenchment ratio of several cross-sections of the river to assess the level of disturbance of the river channel. The level of sedimentation and down-cutting of the Tuul River channel were indicative of impacts from mining activities.

Dr. N. Jadamba estimated that an area of about 620 hectares (6.2 km^2) of alluvial deposits in the Tuul River Valley out of the previous Zamaar study area of 8,975 hectares (89.75 km^2) had been disturbed by mining and associated activities in 1997 (Jadamba and Doloonbayar, 1998).

Remote sensing analysis from a July 2008 IKONOS image of the Zaamar Goldfield covering 10,214 hectares revealed a total mining disturbance between wetland and dryland activities of 930.7 hectares (9.307 km^2), which include the following:

- Mining ponds – 38.5 hectares;
- Dredge ponds – 53.3 hectares; and
- River diversion channels – 7.95 hectares.

Additional mining related disturbances include waste rock piles, mining camps, roads, and others. Details are discussed in **Section 4.2.6**, Remote Sensing Analysis.

Figure III.2-8 Monitoring of Water Levels and Temperature in Observation Wells and the Tuul River

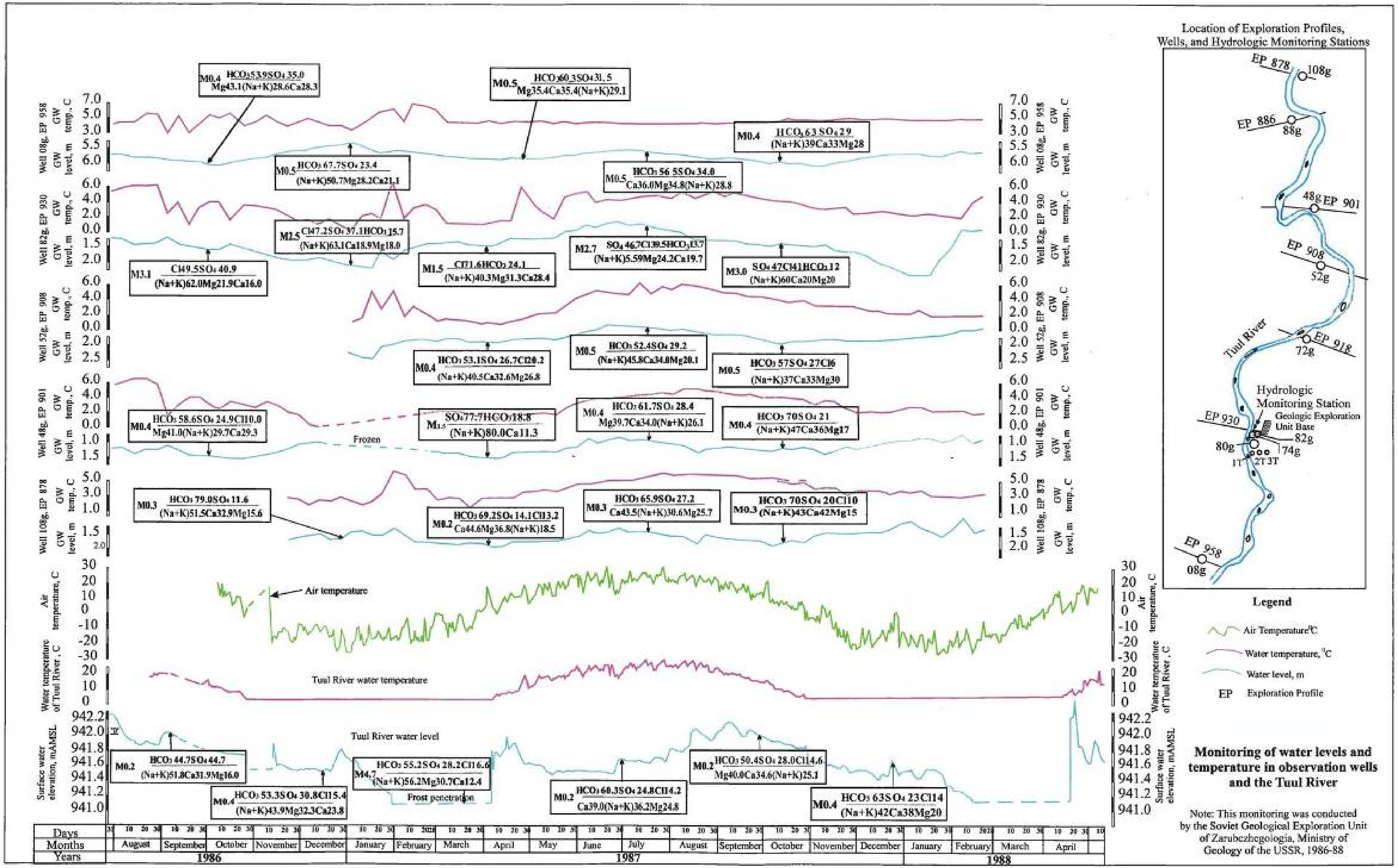


Figure III.2-9 Monitoring of Water Levels, Temperature, and Flow of the Tuul River

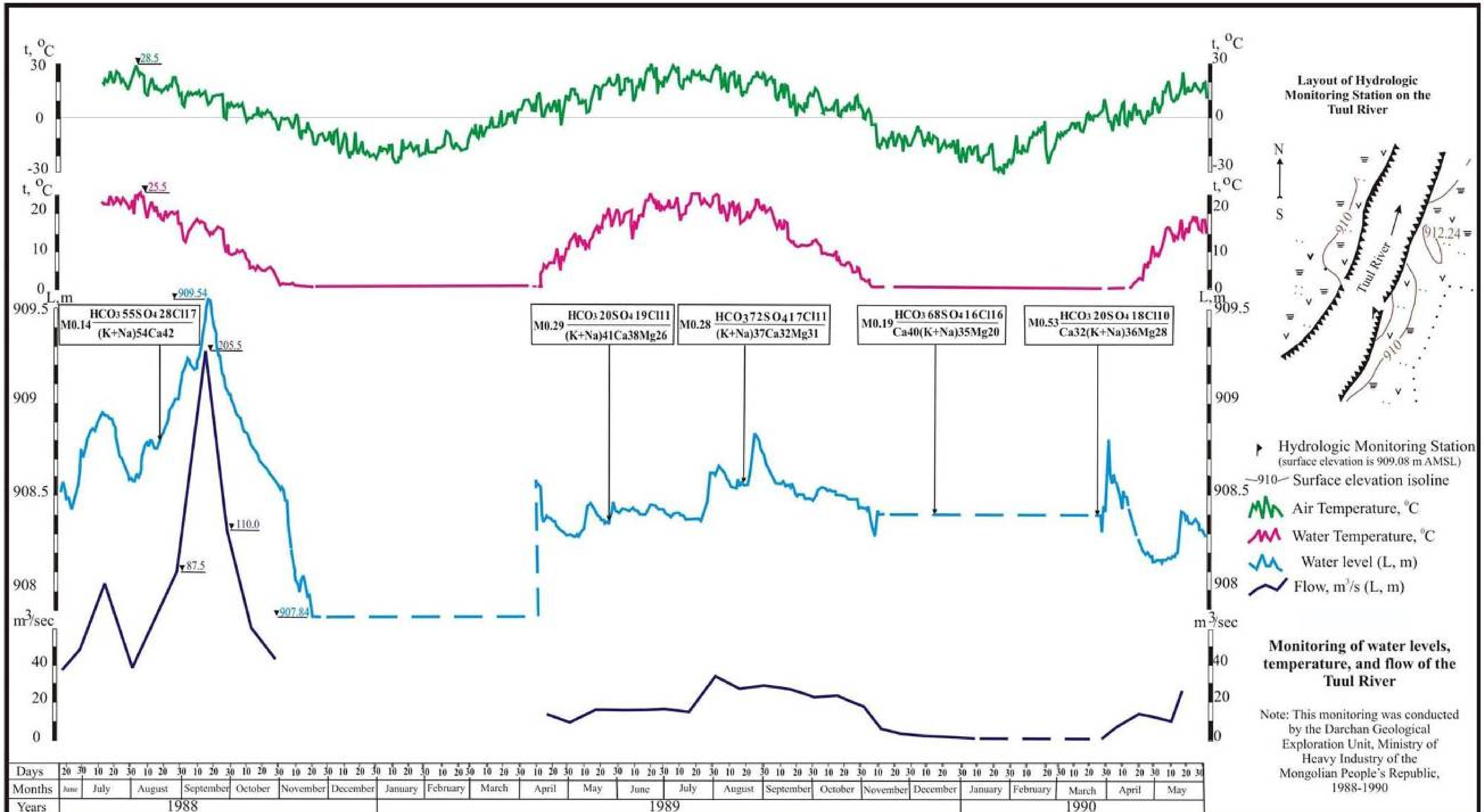


Table III.2-8 Characteristics of the Small Creeks and Springs in the Tuul River Watershed within and nearby the Big Bend Project Area

Sampling Point/Location	Name of Creek/Spring	Length of Creek, m	Width at Water Surface, m	Cross Sectional Area, m^2	Flow, m^3/s	Average Flow Velocity, m/s	Max Flow Velocity, m/s	Average Depth, m	Maximum Depth, m
23	Khailaast Creek	4	0.71	0.06	0.025	0.4	0.53	0.09	0.13
22	Khailaast Creek	5	2.9	0.42	0.13	0.31	0.5	0.15	0.4
21	Khailaast Creek	4.5	0.8	0.03	0.02	0.67	0.75	0.04	0.06
36	Khailaast Creek	2	0.4	0.08	0.022	0.28	0.28	0.2	0.2
24	Baruun shand spring	0.54	0.24	0.004	0.001	0.25	0.27	0.02	0.03
38	Bayangol spring	4.5	1.9	0.16	0.039	0.24	0.3	0.08	0.12
42	Bayangol	5	1.05	0.04	0.02	0.52	0.62	0.04	0.05
Upstream of Tsaagan Bulag	Suujiin Am spring	3	1	0.02	0.004	0.2	0.2	0.02	0.03
Doloon spring origin	Tsagaan Bulag	2	0.3	0.003	0.0006	0.2	0.29	0.01	0.02
Four springs area	Tsagaan Bulag	2.5	0.65	0.02	0.004	0.19	0.24	0.03	0.05
72	Tsagaan bulag	6	2	0.16	0.041	0.26	0.27	0.08	0.16
60	Toson Creek	11	2.7	0.52	0.13	0.25	0.27	0.19	0.3
	Shar hov spring	5	0.5	0.02	0.003	0.19	0.24	0.03	0.04
Toson area, headwaters	Bulag 1	2	0.5	0.02	0.005	0.25	0.33	0.04	0.05
Toson area	Bulag 1	3.5	0.7	0.01	0.005	0.39	0.44	0.02	0.03
Toson area	Bulag 2	3	1	0.05	0.02	0.46	0.5	0.05	0.07
61, 3 spring area	Toson Creek	3	1.2	0.05	0.02	0.3	0.43	0.04	0.05
	Toson Creek	9	3.2	0.49	0.27	0.55	0.6	0.15	0.21
49, Erdenet copper mine	Bulag	0.8	0.3	0.007	0.002	0.23	0.27	0.02	0.03

Source: Jadamba and Doloonbayar, 1998

2.4 Groundwater Hydrology

The regional geology and local geologic conditions are described in **Section 2.5**. The geologic framework served as a basis for regional and local hydrogeologic characterization of the Project area and adjacent areas.

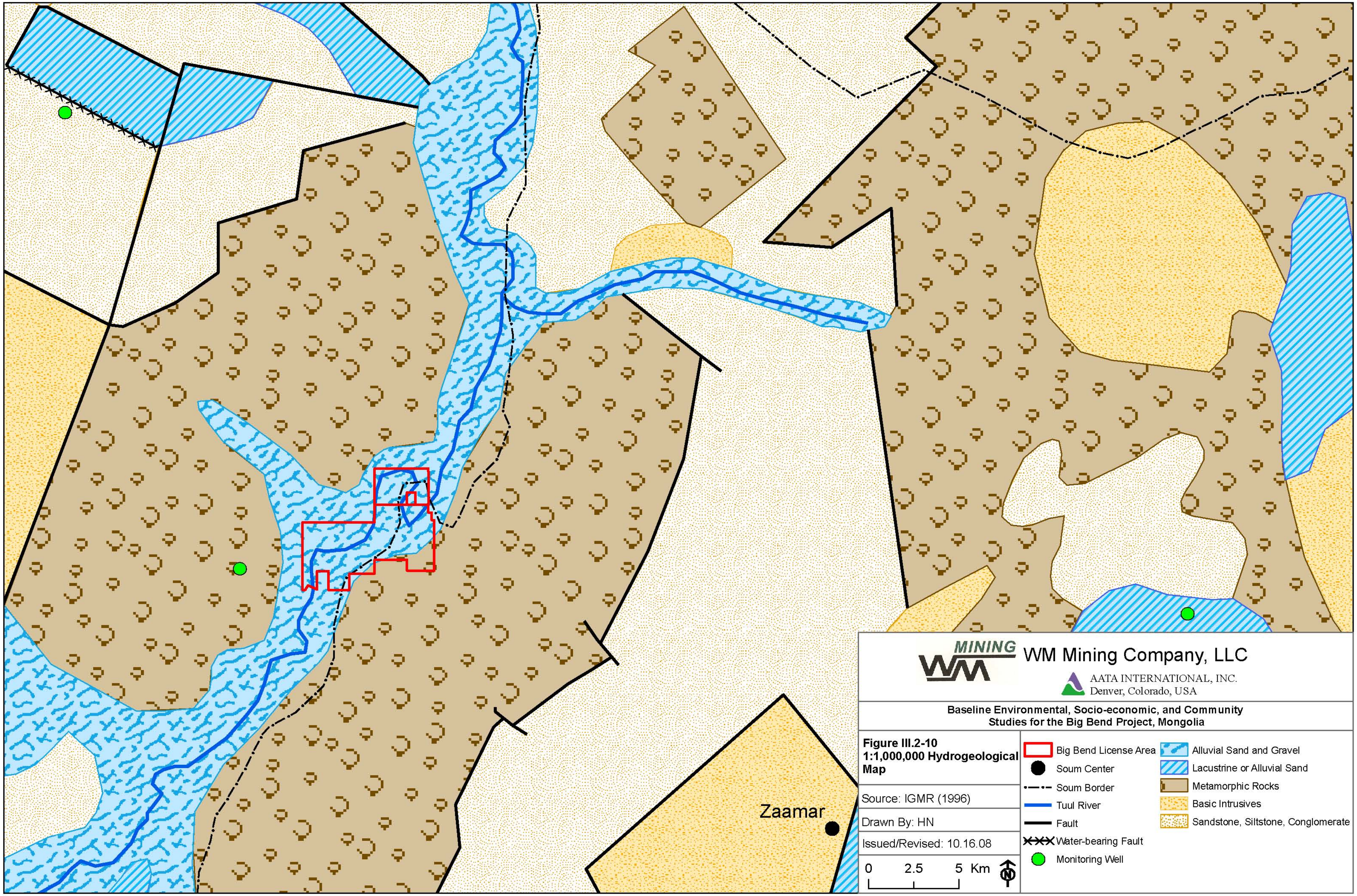
2.4.1 Regional Groundwater Hydrology

The Tuul River Basin, a subbasin of the Selenge River Basin, covers only 3.19 percent of Mongolia's total land area, yet greater than one-half of Mongolia's population resides within the basin (UNESCO, 2008). Groundwater is an important water source for this population, especially in the winter when surface water is frozen.

Hiller and Jadamba (2006) used recently created hydrogeological maps and topographic maps to identify both unconfined and confined groundwater resources within the Selenge River Basin. They estimated the total area of groundwater-bearing resources within the basin to be approximately 280,000 square kilometers (km^2) and an average recharge to the basin to be 5.6×10^9 cubic meters per year (m^3/yr). The total volume of water has not yet been calculated.

The hydrogeology of the Selenge River Basin is varied and consists of water-bearing alluvial and sedimentary deposits along with granites, metamorphic rocks, and limestone. Zones that do not contain groundwater include some loamy areas, hard rock plate areas, steep rocky mountain slopes, and some permafrost areas (Kartavin and Marinov, 1976). Overall, there are three main hydrogeological units, or aquifers, in the Selenge River Basin: (1) alluvial aquifers; (2) fractured limestone aquifers; and (3) bedrock aquifers (**Figure III.2-10**). Conceptually, the Basin can be divided into southern and northern parts. The water-bearing rocks in the southern part are predominately Mesozoic sedimentary rocks and in the northern part they are predominately Archezoic to Cenozoic magmatic metamorphic and sedimentary rocks (Buyankhishig and Udvaltsetseg, 2007).

Over the entire area, unconfined groundwater is generally present where there are hard rock outcrops at the ground surface or alluvial deposits. Confined groundwater is generally found along inter-mountain depressions (Hiller and Jadamba, 2006). The depth to the groundwater table commonly ranges from around 2 m to greater than 20 m. Groundwater is found at the shallowest depths in alluvial aquifers.


Zaamar
MINING
WM Mining Company, LLC
AATA INTERNATIONAL, INC.
Denver, Colorado, USA
Baseline Environmental, Socio-economic, and Community Studies for the Big Bend Project, Mongolia
Figure III.2-10
1:1,000,000 Hydrogeological Map
Source: IGMR (1996)
Drawn By: HN
Issued/Revised: 10.16.08
0 2.5 5 Km
N
Big Bend License Area
Soum Center
Soum Border
Tuul River
Fault
Water-bearing Fault
Monitoring Well
Alluvial Sand and Gravel
Lacustrine or Alluvial Sand
Metamorphic Rocks
Basic Intrusives
Sandstone, Siltstone, Conglomerate

2.4.2 Local Groundwater Hydrology

Overall, there is limited information on the local groundwater hydrology of the Project area. The Soviet Geological Exploration Unit (USSR) in 1986 to 1988 installed several monitoring wells in the Tuul River Basin and performed a number of single-well pumping tests. The Darkhan Geological Exploration Unit (Mongolia) in 1988 to 1990 conducted further studies including multiple well pumping tests.

Groundwater in the Project area consists of the Tuul River alluvial aquifer which is a Meso-Cenozoic formation of the Quaternary period. It is mostly composed of well-sorted, rounded proluvial sands, gravels, and sandy loam with some insignificant silt content. This alluvial aquifer is classified as a local extensive aquifer with low to moderate productivity (Jadamba et al., 2003). The aquifer is about 1,000 m to over 3,000 m wide in the Tuul River Basin, and stretches along the Tuul River. The groundwater in the alluvial aquifer is recharged by precipitation and, most importantly, by floodwater during spring water runoff. The Tuul River alluvial aquifer is underlain by the Pre-Mesozoic aquifer. This aquifer is composed of sedimentary and metamorphic rock. Very limited data is available on the Pre-Mesozoic aquifer.

The alluvial aquifer thickness ranges from about 3 to over 8 meters. Depth to groundwater varies from about 1 to 6 meters below ground surface (bgs), and some reports indicate that the groundwater level in the alluvial aquifer ranged from 8 to 16 meters bgs. Groundwater flow direction generally follows the topography and the river flow direction (**Figure III.2-11**). The hydraulic gradient in the alluvial aquifer is approximately 0.0005 to 0.0007.

The resources of the alluvial aquifer have not been estimated, although the results of the aquifer testing conducted in the late 1980s by the Mongolian and Soviet specialists indicate that the aquifer has a good potential for industrial and domestic water supply. The results of their pumping tests are summarized in **Table III.2-9** and **Table III.2-10**.

Wells drilled for the pumping tests were between 6 to 18 meters deep. Well yield and specific capacity values estimated during the test ranged from 1.1 to 5.5 liters per second (L/s), and from 0.36 to 5.7 liters per second per m (L/s/m), respectively. Other sources also indicated that well yields were as high as 8 to 12 L/s. Hydraulic conductivity values for the alluvial aquifer ranges from 1.23 to 97.13 meters per day (m/day) with the mean value of 40 m/day.

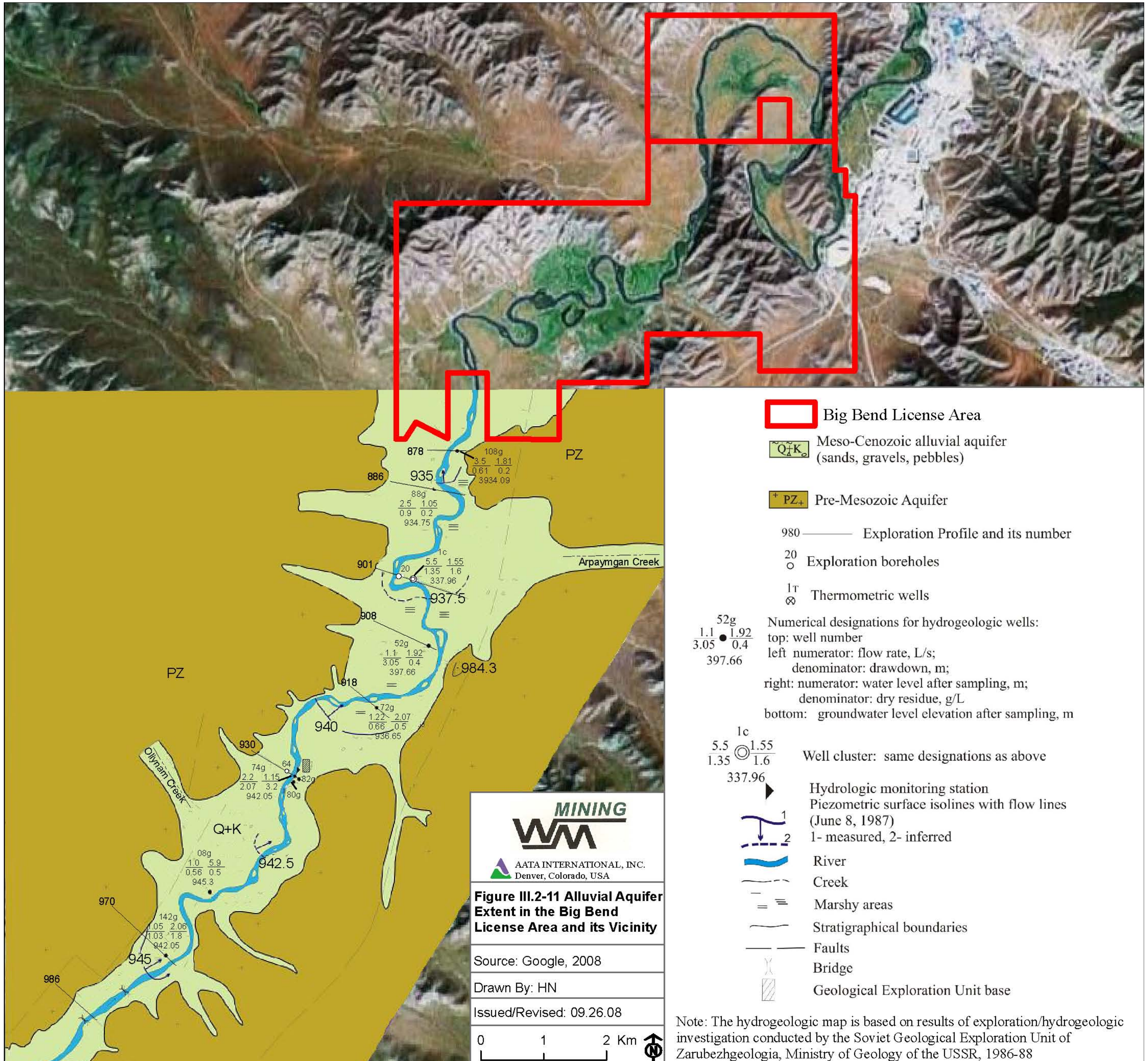


Figure III.2-11 Alluvial Aquifer Extent in the Big Bend License Area and its Vicinity

Table III.2-9 Results of Single-Well Pumping Tests in the Tuul River Alluvial Aquifer

Well		Exploration Line	Ground Elevation amsl, m	Well		Groundwater Level, mbgs		Drawdown, m	Aquifer Thickness, m	Screen		Well Yield		Specific Capacity, L/s/m	Hydraulic Conductivity, m/day
ID	Location			Total Depth, m	Diameter, m	Static	Dynamic			Diameter, m	Length, m	L/s	m^3/day		
108-g	30 meters from the right bank of the Tuul River	878	935.9	7.2	0.668 to 6.5; 0.221 to 7.2	1.81	2.42	0.61	5.40	0.108	4.6	3.5	302.0	5.70	53.90
88-g	40 meters from the left bank of the Tuul River	888	935.8	6.0	0.668	1.05	1.95	0.9	4.95	0.127	3.5	2.5	216.0	2.78	55.80
52-g	85 meters from the left bank of the Tuul River	908	939.6	6.6	0.668 to 6.0; 0.221 to 6.6	1.92	4.97	3.05	2.88	0.127	3.9	1.1	95.0	0.36	22.70
72-g	On the right bank of the Tuul River	918	940.9	8.0	0.645	2.07	2.73	0.66	4.90	0.127	4.0	1.2	103.7	1.85	36.80
74-g	On the right bank of the Tuul River	930	943.2	9.2	0.645	1.15	3.2	2.07	3.70	0.273	5.7	2.2	190.1	1.06	28.40
08-g	On the left bank of the Tuul River	958	951.2	17.8	0.219	5.9	6.46	0.56	5.40	0.127	5.3	1.0	86.4	1.80	31.80
142-g	On the left bank of the Tuul River	970	947.8	8.8	0.645	2.66	3.69	1.03	3.40	0.127	4.0	1.1	90.7	1.02	32.50
76-g	50 meters from the right bank of the Tuul River	608		10.0	0.645	1.4	3.63	2.23	7.00	0.168	6.0	2.3	201.3	1.00	1.23
104-g	52 meters from the left bank of the Tuul River	636	912.45	10.0	0.203	3.49	3.92	0.43	3.74	0.0022	5.5	1.7	149.5	4.02	97.13

The data is based on the studies of the Darkhan Geological Exploration Unit (Mongolia) in 1988 to 1990
"amsl" – above mean sea level

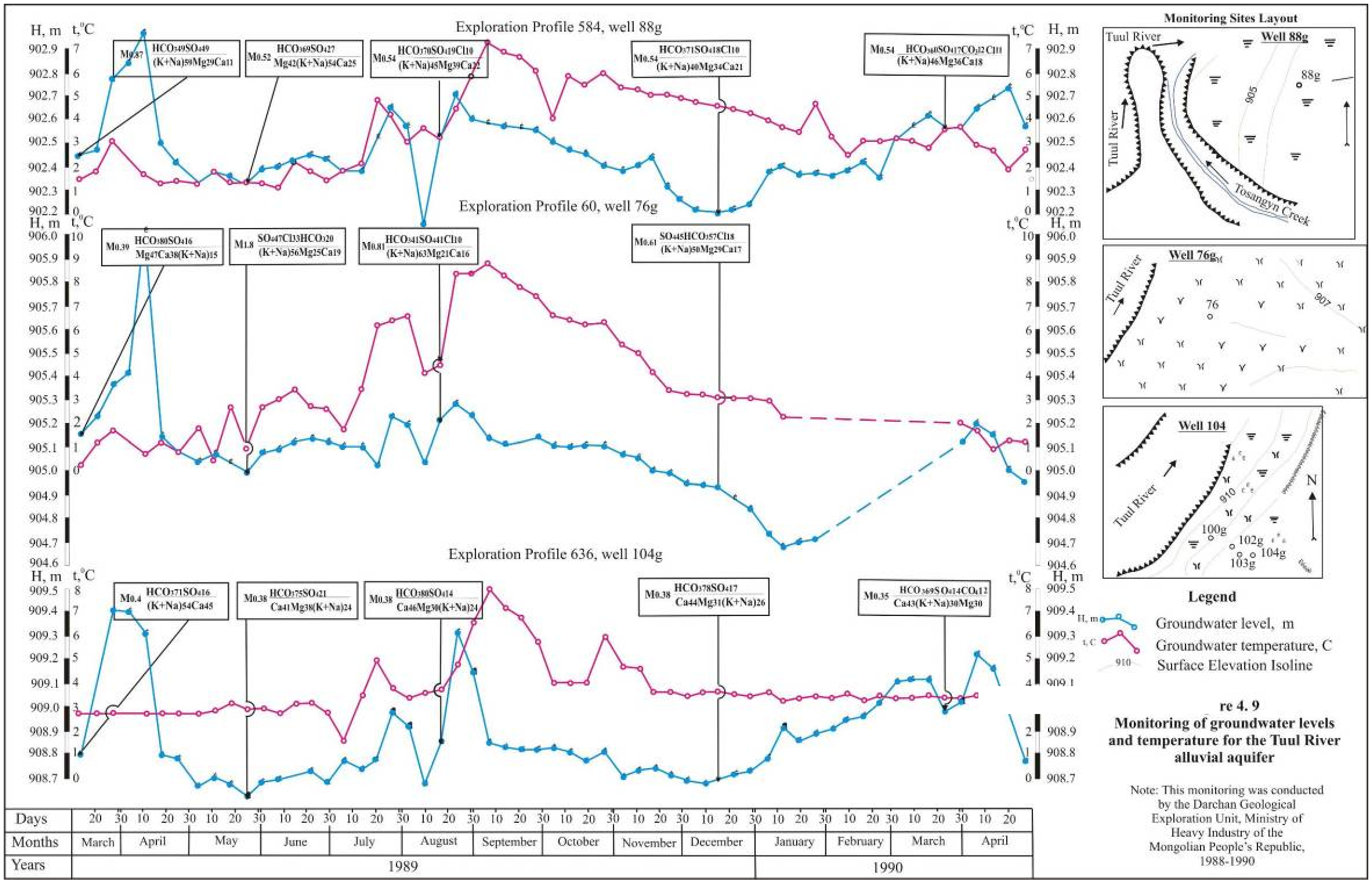
Table III.2-10 Results of Multiple-Well Pumping Tests in the Tuul River Alluvial Aquifer

Well	Location	Distance to the Pumping Well, m	Ground Elevation amsl, m	Total Well Depth, m	Well Dia-meter, m	Static Ground-water Level, m	Draw-down, m	Aquifer Thickness, m	Screen Dia-meter, m	Screen Length, m	Well Yield, L/s	Well Yield, m^3/day	Specific Capacity, L/s/m
1-c	33 meters at the right bank of Tool River	The pumping well	938.51	10.0	0.219	1.55	1.35	8.40	0.146	4.2	5.5	475.2	43.40
48-n	6 meters from the pumping well, on the parallel beam	6.0	938.49	8.5	0.668	1.55	0.52	8.00	0.127				
49-n	15 meters from the pumping well, on the parallel beam	15.0	938.44	6.9	0.219	1.48	0.33	6.40	0.108				
50-n	3 meters from the pumping well, on the crossing beam	3.0	938.55	7.1	0.219	1.59	0.66	6.60	0.108				
51-n	8 meters from the pumping well, on the crossing beam	8.0	938.56	6.2	0.219	1.62	0.39	5.70	0.108				
52-n	30 meters from the pumping well, on the crossing beam and 3 m at the right bank of Tool River	30.0	938.63	5.9	0.219	1.75	0.18	5.40	0.089				

The data is based on the studies of the Soviet Geological Exploration Unit (USSR) in 1986 to 1988
“amsl” – above mean sea level

In the late 1980s the Soviet Geological Exploration Unit and the Darkhan Geological Exploration Unit also monitored levels, temperature, and cation-anion composition in several monitoring wells screened in the alluvial aquifer and in the Tuul River. The monitoring results are presented in **Figure III.2-12**. The monitoring results show good hydraulic connection between groundwater in the alluvial aquifer and the Tuul River. It also shows that the groundwater temperature varies quite significantly from sub-zero levels to about seven ^{o}C and higher (**Figure III.2-12**). Both the groundwater and the Tuul River water follow the general ambient air temperature pattern that was also measured during this monitoring effort. Fluctuations of the groundwater level were about 1 to 1.5 m during a year cycle. The lowest groundwater levels were measured from December through January, while the highest levels were observed in late March and April.

Figure III.2-12 Groundwater Levels and Temperatures for the Tuul River Alluvial Aquifer



2.5 Geology

2.5.1 Regional Geology

The Big Bend gold deposit is part of the Zaamar Goldfield which extends further north and south from the Project area along the Tuul River Valley. The geology of the Zaamar Goldfield is characterized by the formation of a metamorphosed Late Pre-Cambrian to Early Paleozoic basement and a younger sedimentary cover sequence.

The metamorphosed Late Pre-Cambrian to Cambrian Darkhan Formation (650 to 500 million years before present) makes up the lower part of the basement rocks and is of volcano-terrigenous origin. The Darkhan Formation was covered with Cambrian to Ordovician schists (i.e., the upper part of the basement) named "Zaamar Formation."

The basement rocks were intruded by a series of gabrros and granite plutons during Ordovician to Devonian time (440 to 360 million years before present). Gold-bearing quartz veins that came with the Ordovician to Devonian plutons are widespread in the basement rocks, which could be the major (if not the only) source for the placer gold presently seen in the Project region.

The basement rocks were folded, faulted and eroded at least twice before the unconformable deposition of Carboniferous sandstones and siltstones (360 to 286 million years before present). Another episode of weaker deformation and erosion occurred before the Mesozoic Cretaceous coal-bearing sediments were deposited on top of the unconformity (146 to 65 million years before present).

Early Cenozoic orogeny in the Project region was characterized by gentle faulting and tilting followed by modest erosion. Cretaceous sediments were only preserved in a series of narrow down-faulted basins that were to become the original residence of the modern Tuul River. During Neogene time (23 to 1.8 million years before present), basalt and terrigenous arid red-bed clays and gravels were formed within these linear depressions. Gold-bearing paleoplacers were formed in the Neogene sediments.

Further subsidence, tilting and gentle deformation occurred in the linear depressions in late Neogene to Early Quaternary coinciding with general regional uplift. During Early Quaternary, the modern Tuul River flowed northwards through the area, starting to create the river valley mainly in the red Neogene clays and Cretaceous coal-bearing sequence, eroding gorges through Paleozoic to Pre-Cambrian rocks that constituted barriers between the residual Cretaceous to Neogene basins.

During the Quaternary (1.8 million years ago to Present), regional uplift continued with associated tilting, faulting and subsidence of some segments of the Tuul River Valley. Placer gold deposits of the project region are mostly found in the Quaternary fluvial to alluvial sediments of the Tuul River Valley.

2.5.2 Placer Geology

Most of the placer deposits in the Project region originated from the fluvial process of the Tuul River during the Quaternary time. The host sediments are well-sorted and rounded silts, sands and gravels, typical of river deposits. The average thickness of the overburden is about 8.5 m (3.5 to 16.8 m) and the thickness of the placer gold deposit is mostly 4 to 6 m. Gold content ranges from 0.2 grams per cubic meter (g/m^3) to 1.7 g/m^3.

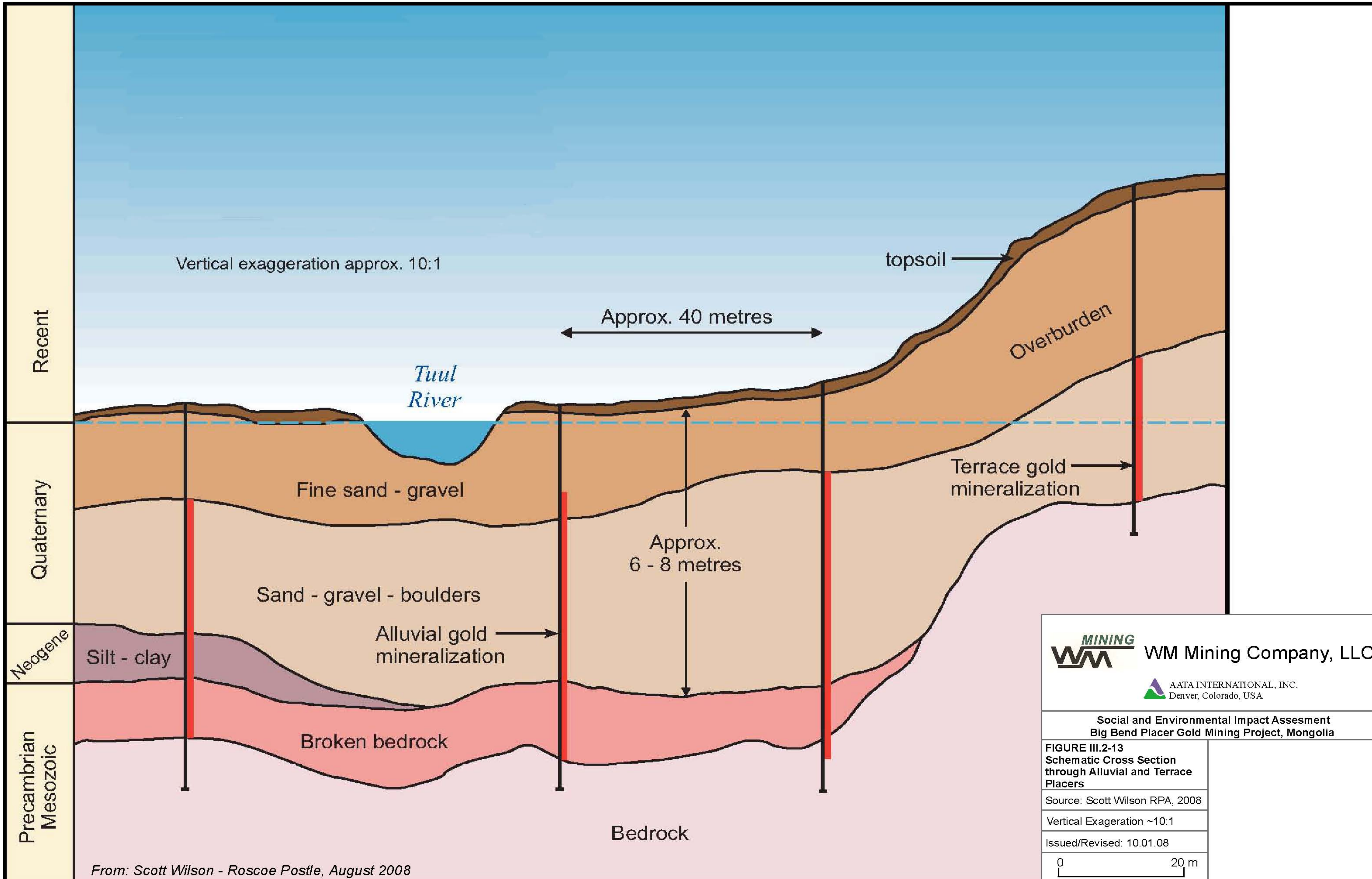
Occasionally, intervals of "solifluction placer" were found in the fluvial placer. Solifluction is a form of soil creep where saturated soil flows downslope very slowly in cold climates due to the permafrost soil beneath. Solifluction placers usually have significantly higher clay content that the fluvial placer and the clasts tend to be angular.

Much of the Tuul River Valley is underlain by red Neogene clays, which in many cases were found to contain placer gold (herein called "paleoplacer"). The red clays were believed to be the product of flash floods. Several companies have been mining (dry-mining) the paleoplacers while also mining the superficial modern placer near the Project area.

Beneath the Neogene red clays are dull gray Cretaceous sediments that seem to contain more paleoplacers and economic coal seams. Some of the gold-bearing red and gray clays, however, are consolidated in a spherical form ("clay balls") and very few of them can be processed with the current on-site equipment.

In places where Quaternary placers directly overlay the Paleozoic schists, the top 50 cm (previously weathered portion) of the bedrock may be enriched with placer gold. A generalized geologic cross-section of the shallow placer deposits is shown on **Figure III.2-13**.

A significant number of exploration boreholes were drilled within the Project area. The drilling started in the 1990s with the Russian drilling exploration lines using large diameter holes. Ikh Tokhoirol and Khan Resources Inc drilled a number of exploration lines in using smaller diameter holes. The holes are generally spaced 40 m apart with the distance between lines around 400 m apart for mineral resource definition and wider intervals for exploration drilling. The locations of the placer exploration lines are presented on **Figure III.2-14** and **Figure III.2-15**.



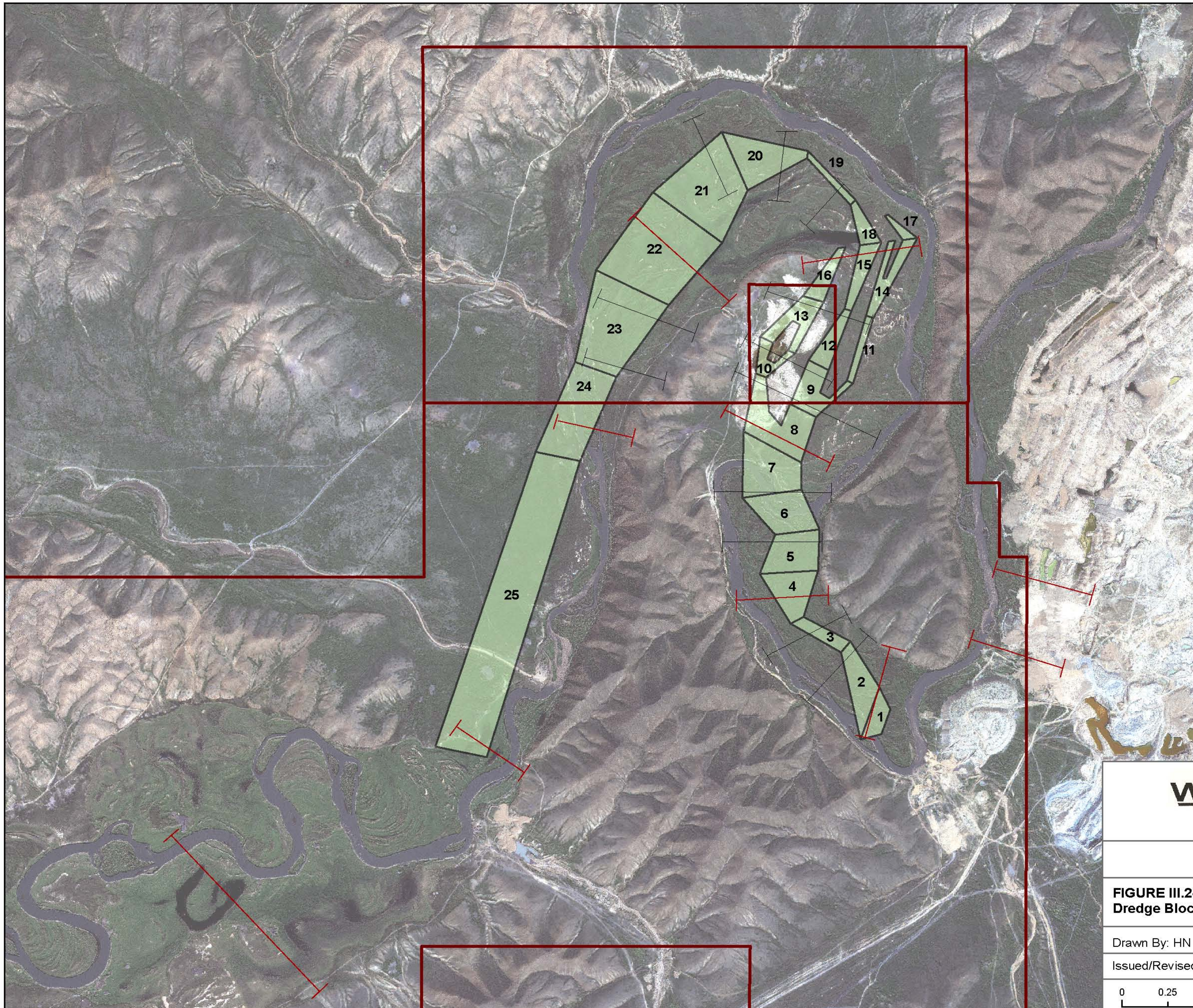
Recent
Quaternary
Neogene
Precambrian
Mesozoic
Vertical exaggeration approx. 10:1
topsoil
Approx. 40 metres
Overburden
Tuul
River
Fine sand - gravel
Terrace gold
mineralization
Approx.
6 - 8 metres
Sand - gravel - boulders
Alluvial gold
mineralization
Silt - clay
Broken bedrock
Bedrock
From: Scott Wilson - Roscoe Postle, August 2008
MINING
WM
WM Mining Company, LLC
AATA INTERNATIONAL, INC.
Denver, Colorado, USA
Social and Environmental Impact Assesment
Big Bend Placer Gold Mining Project, Mongolia
FIGURE III.2-13
Schematic Cross Section
through Alluvial and Terrace
Placers
Source: Scott Wilson RPA, 2008
Vertical Exageration ~10:1
Issued/Revised: 10.01.08
0
20 m

2.5.3 Big Bend Gold Reserves

Proven reserves at Project area are located mostly in the actual bend area (northern portion of the property), where 25 dredge blocks were delineated for development (**Table III.2-11** and **Figure III.2-14**). As shown in the **Table III.2-11** below, the 25 dredge blocks contain a total of 2.51 tonnes of proven gold reserve (pure) ready to be developed. The average grade of the placer is 0.445 g/m^3 and the average thickness of overburden is 8.79 meters.

Table III.2-11 Big Bend Reserves

Block Number	Block Area m^2	Overburden thickness m	Placer Thickness m	Overburden volume m3	Placer volume m3	Average grade mg/m^3	Gold Reserve kg
1	23,100	5.47	1.51	126,280	34,910	403	12.67
2	53,300	5.31	1.42	282,970	75,590	385	26.24
3	22,900	5.10	1.70	116,790	38,930	462	16.21
4	55,000	4.40	2.97	242,000	163,170	578	84.64
5	63,700	4.07	1.98	259,260	126,130	591	67.16
6	67,100	5.16	1.26	346,040	84,350	650	49.44
7	84,600	6.90	2.23	583,740	188,940	414	70.42
8	87,800	5.79	1.84	508,070	161,550	388	56.45
9	41,000	5.31	1.23	217,890	50,370	608	27.58
10	20,200	6.17	2.31	124,660	46,750	721	30.39
11	15,300	5.00	0.60	76,500	9,180	433	3.58
12	28,700	6.15	0.90	176,510	25,830	929	21.62
13	41,500	6.80	2.13	282,200	88,530	708	56.52
14	43,700	4.76	2.80	208,010	122,360	229	25.25
15	29,100	4.40	3.85	128,040	112,040	169	17.05
16	24,200	7.27	2.30	175,850	55,660	471	23.61
17	13,500	4.50	3.30	60,750	44,550	216	8.68
18	19,400	4.10	3.70	79,540	71,780	137	8.87
19	12,900	7.40	1.00	95,460	12,900	984	11.44
20	76,900	10.80	2.98	830,520	228,990	429	90.18
21	174,600	10.12	3.50	1,766,370	611,100	432	229.45
22	240,500	12.25	2.92	2,945,200	703,000	507	329.32
23	174,600	13.81	2.05	2,411,820	357,940	550	182.19
24	131,100	9.31	3.38	1,220,420	443,120	388	158.94
25	470,000	9.44	4.85	4,436,800	2,281,070	427	899.94
Total	2,014,700			17,701,690	6,138,740		2,507.84
Average		8.79	3.05			445	



MINING

WM Mining Company, LLC

AATA INTERNATIONAL, INC.
Denver, Colorado, USA

Social and Environmental Impact Assesment
Big Bend Placer Gold Mining Project, Mongolia

FIGURE III.2-14
Dredge Blocks

Drawn By: HN

Issued/Revised: 10.16.08

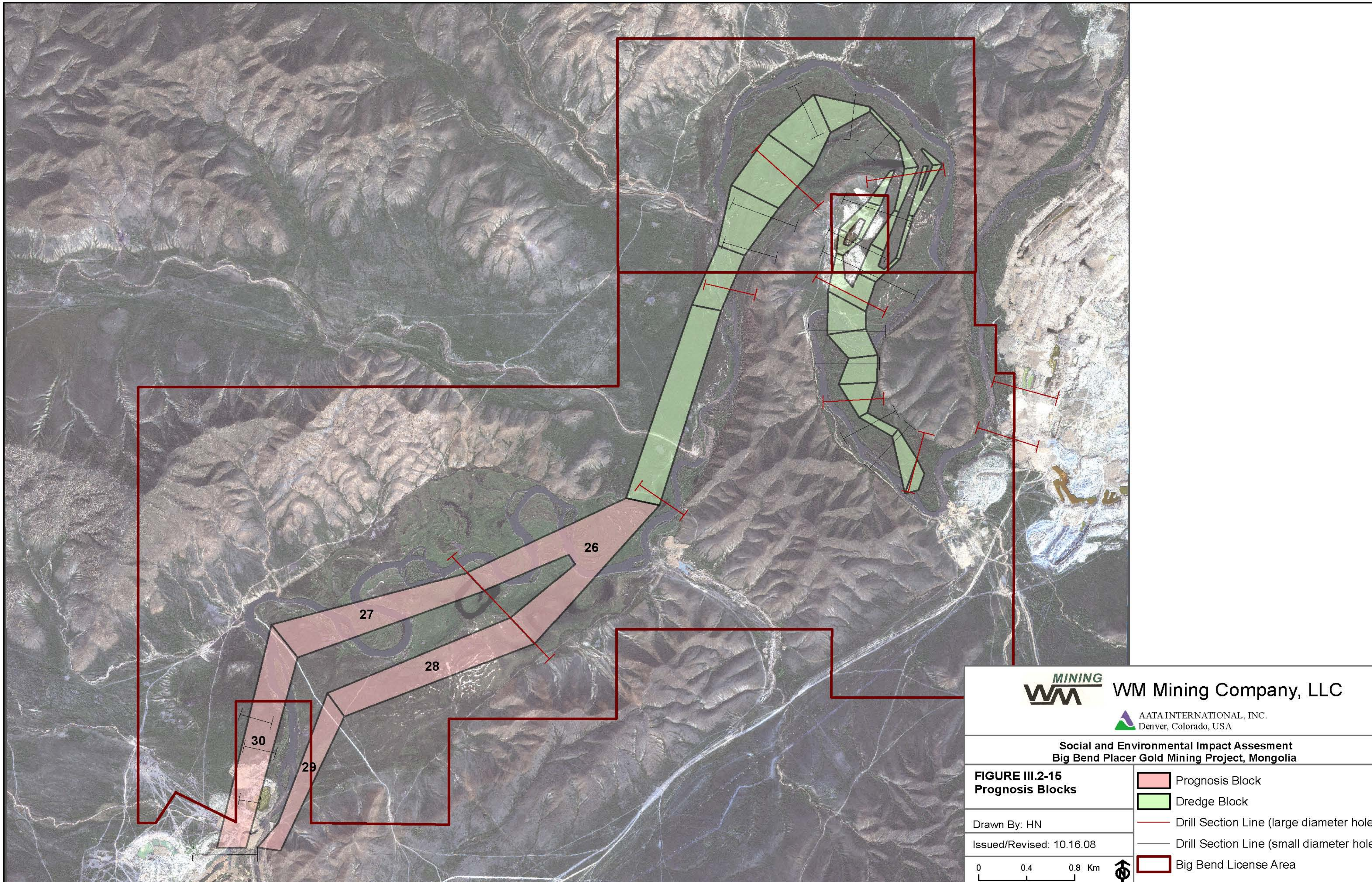
0 0.25 0.5 Km

Dredge Block	
Drill Section Line (small diameter hole)	
Drill Section Line (large diameter hole)	
Big Bend License Area	

Five prognosis blocks were recognized in the rest portion of the property (**Table III.2-12** and **Figure III.2-15**). These prognosis blocks contain economic reserves that need more infill drilling to confirm (i.e., convert the prognosis reserve to proven reserve). Based on existing geologic and drilling data, the prognosis reserve is estimated to be 3.61 tonnes of gold (pure) with grades from 0.48 to 0.833 g/m^3 and overburden thickness ranging from 16.4 to 28.8 m (**Table III.2-12**).

Table III.2-12 Prognosis Reserve

Block Number	Block Area m^2	Overburden thickness m	Placer Thickness m	Overburden volume m3	Placer volume m3	Average grade mg/m^3	Gold Reserve kg
26	680,000	18.29	4.16	12,436,440	2,825,780	483	1,261.81
27	200,000	22.89	2.76	4,577,780	551,110	823	419.07
28	380,000	28.82	2.31	10,950,910	877,450	718	581.74
29	356,000	16.44	2.68	5,852,640	954,080	833	734.31
30	458,000	17.85	2.5	8,175,300	1,145,000	579	612.83
Total	2,074,000			41,993,070	6,353,420		3,609.76
Average		20.25	3.06			615	


26
27
28
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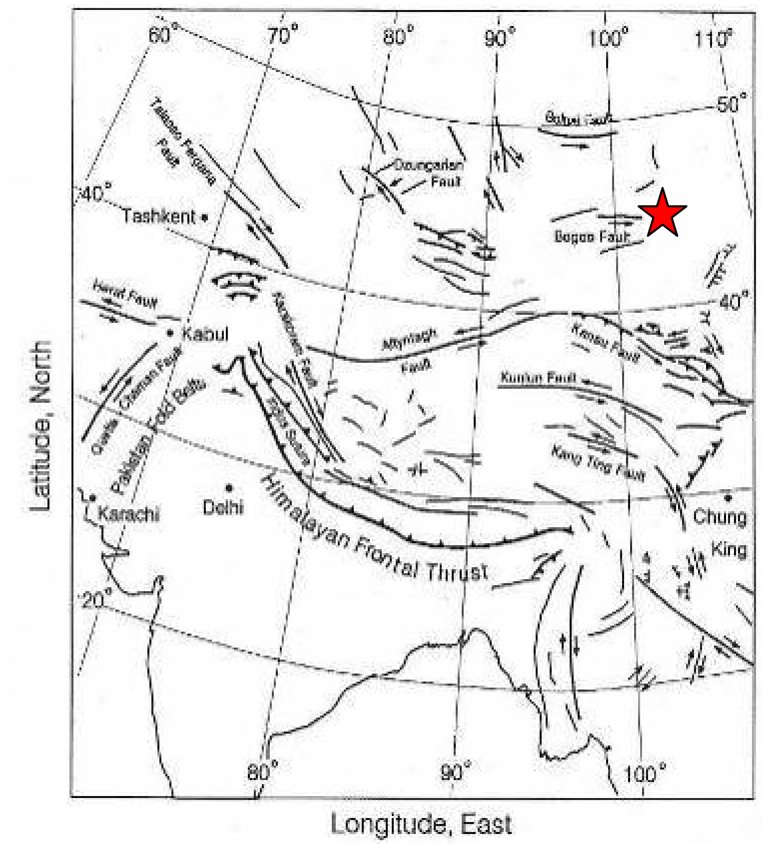
MINING
WM Mining Company, LLC
AATA INTERNATIONAL, INC.
Denver, Colorado, USA
Social and Environmental Impact Assesment
Big Bend Placer Gold Mining Project, Mongolia
FIGURE III.2-15
Prognosis Blocks
Drawn By: HN
Issued/Revised: 10.16.08
0 0.4 0.8 Km
Prognosis Block
Dredge Block
Drill Section Line (large diameter hole)
Drill Section Line (small diameter hole)
Big Bend License Area

2.6 Seismicity

Seismicity relates to the geographic and historical distribution of earthquakes. Earthquakes are occurrences of ground shaking and radiated seismic energy, which can be caused by a sudden slip on a fault, volcanic or magmatic activity, or other sudden stress changes in the Earth. The relative size or intensity of an earthquake is referred to as its magnitude, which most often uses the Richter scale. However, another scale of seismic intensity measures the effects of an earthquake opposed to the magnitude. The Modified Mercalli Intensity Scale is commonly used by seismologists to qualitatively describe the severity of earthquake effects. While earthquakes usually occur in plate boundaries (over 90 percent), some can occur within plate interiors in areas where weakened boundary regions become parts of the plate interiors. These weakened zones can respond to stresses that originate elsewhere and result in earthquakes.

Mongolia is located between the Baikal rift zone to the north in Siberia and the collision zone between India and Asia to the south. This area experienced active tectonic deformation, beginning approximately 55 million years ago with the building up of young mountain ranges, subsidence of sedimentary basins, and rupture of the earth's crust during large earthquakes. A pattern of faults that were formed when the Indian and Eurasian continental plates collided is found in **Figure III.2-16**.

Figure III.2-16 Pattern Faults from the Collision of the Indian and Eurasian Plates



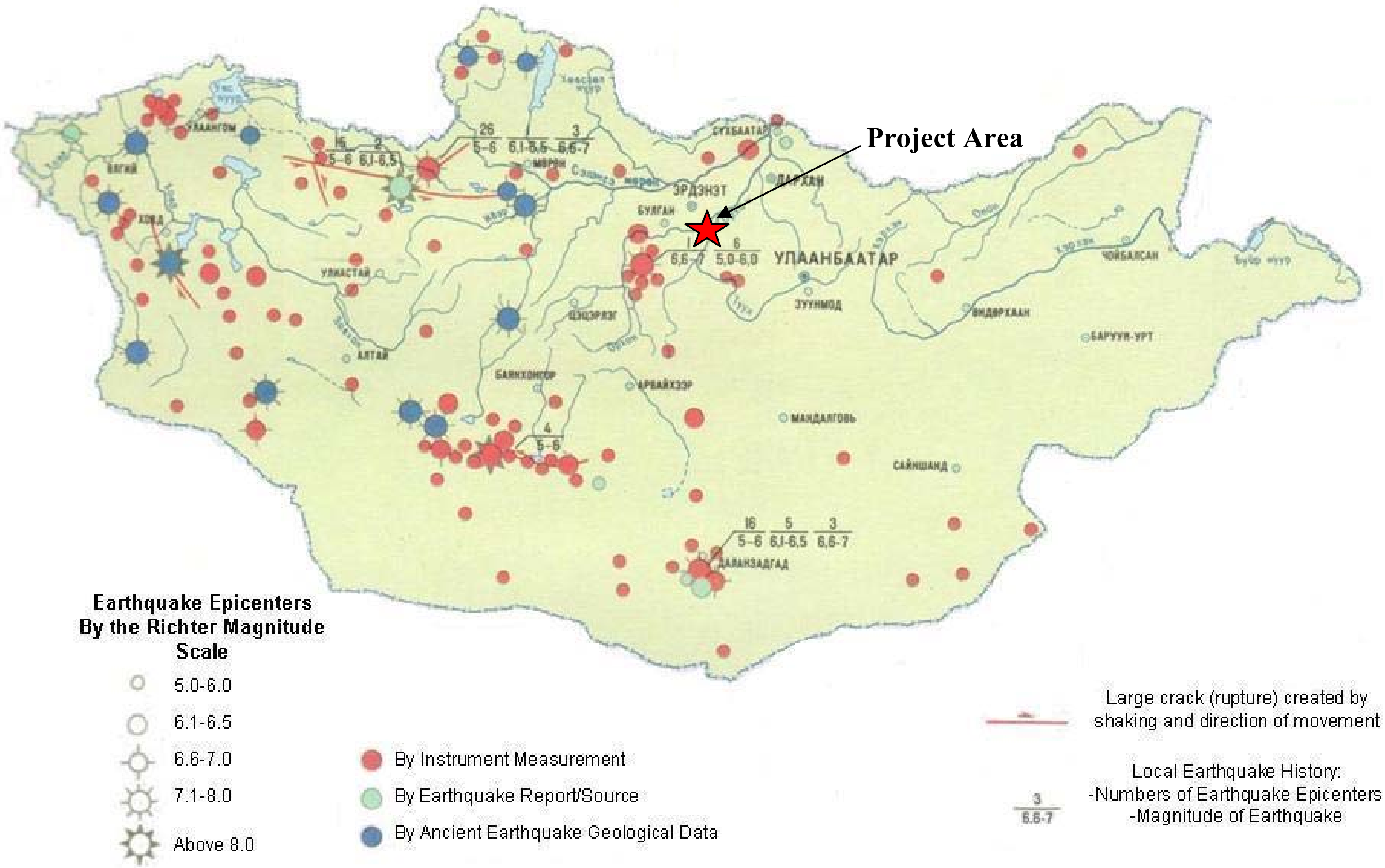
(The red star " ★ " represents the Project area location)

Western Mongolia has been the most seismically active intracontinental region in the world in this century. Since 1905, there have been four earthquakes of magnitude eight or greater since 1905, which ruptured three major fault systems:

- The Bolnai fault to the north: Bolnai earthquake, M=8.5, July 1905; Tsetserleg earthquake, M=8.0, July 1905 ;
- The Altai fault system: Fu Yun earthquake, M=8.0, 1931; and
- The Gobi-Altai fault to the south: Bogd earthquake, M=8.1, 1957.

The Project location along the Tuul River is located close to where earthquake epicenters were historically located. **Figure III.2-17** shows the distribution of these epicenters.

Figure III.2-17 Earthquake Epicenters in Mongolia

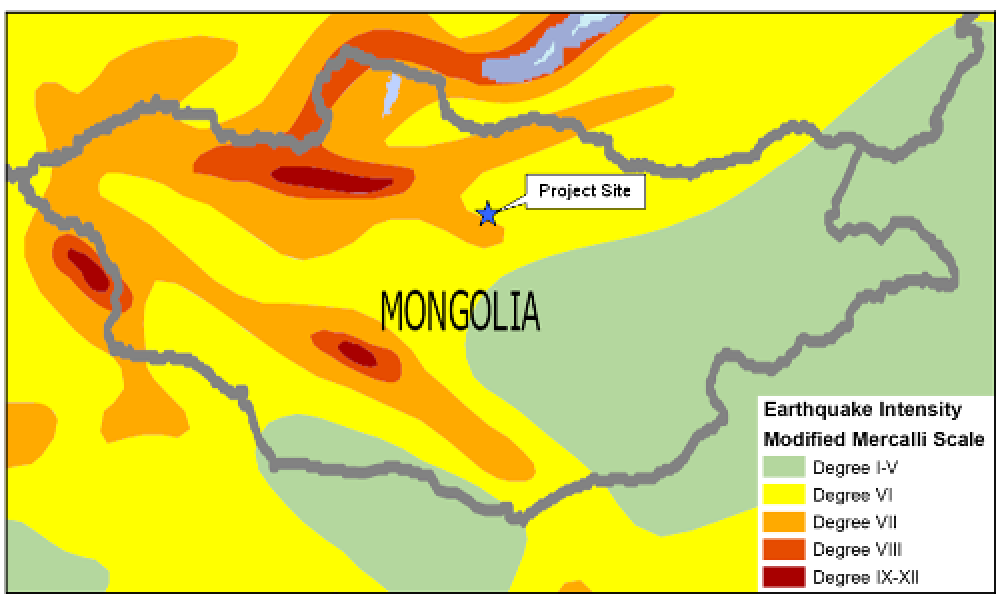


* From the National Atlas of Mongolia, 1990

The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) published an earthquake risk map in the Asian Pacific region (OCHA, 2007). This map shows earthquake intensity zones defined by the effects of an earthquake on the surface of the earth. The intensity of the earthquakes is based on the Modified Mercalli Intensity Scale, a scale commonly used by seismologists seeking information on the severity of earthquake effects. Intensity ratings are expressed as Roman numerals between I at the low end and XII at the high end. The classification considered factors such as ground acceleration, duration of an earthquake, and subsoil effects, as well as historical earthquake records. The Zones indicate where there is a possibility of 20 percent that degrees of intensity shown on the map will be exceeded in 50 years. This probability varies with time, i.e., it is lower for shorter periods and higher for longer periods. Twelve intensity degrees, using the Modified Mercalli intensity scale, were identified: I – instrumental, II – feeble; III – slight; IV – moderate; V – rather strong; VI – strong; VII – very strong; VIII – destructive; IX – ruinous; X – disastrous; XI – very disastrous; and XII- catastrophic (USGS, 2008).

Figure III.2-18 displays the earthquake intensity zones in Mongolia. The Project region is located in Intensity Zone VI, indicating that there is a 20 percent chance for a strong earthquake (though may not be destructive) to occur in the Project region within 50 years.

Figure III.2-18 Earthquake Intensity Zones in Mongolia



Source: Office for the Coordination of Humanitarian Affairs 2007

2.7 Soils and Sediments

The soils in the Project region are characterized by dark (reddish-brown) to black color, thin and low humus content. Based on soil geographic location, structure, and composition, 4 types of soils are recognized: (1) stony thin dark soil; (2) thin dark soil of medium humus; (3) medium thick dark soil; and (4) meadow dark-black soil.

2.7.1 Stony Thin Dark Soil

Located in the upper portion of the mountains along side of the Tuul River valley, this type of soil is usually very thin (humus horizon is 8 to 9 cm; total is less than 60 cm) and with high gravel content. Rock fragments are common on the surface. Clay (grain size < 0.01 mm) content is 20 to 24 percent. Humus content ranges from 2.5 to 3.6 percent.

2.7.2 Thin Dark Soil of Medium Humus Content

Occurring in the middle to lower portion of the mountain slopes the humus horizon is dark grey in color and is approximately 17 to 19 cm thick. This soil type has fewer rock fragments than the soils up slope. The clay content also increases to 33 to 40 percent. The humus content ranges from 4.7 to 5.3 percent.

2.7.3 Medium Thick Dark Soil

Found in the lower part of the slopes and foothills, this soil type has a relatively thick humus layer (26 to 30 cm) and higher humus content (4.9 to 5.8 percent) compared with the soils up slope. The clay content is about 30 percent and total soil thickness reaches 1.0 m.

2.7.4 Meadow Dark-Black Soil

Covering the floor of the Tuul River valley (i.e., on top of the terraces), this type of alluvial soil varies from wet, organic enriched floodplain clays and sands to dry upper terrace clays and sands with residual nutrients. The humus horizon is usually 30 to 70 cm thick and clay content may be as high as 45 percent. The humus content is high in the upper portion of the humus horizon (6.8 to 9.8 percent) and decreases with depth.

Fifteen soil samples were collected within the Project area by AATA during the baseline sampling study in July 2008. Three of the soil samples were collected from site Pit 1. The first pit sample was collected from the A horizon at a depth of

15 cm below ground surface (bgs), the second sample was collected from the B Horizon at a depth of 67 cm bgs and, and the third sample was collected from the C horizon at a depth of 110 cm bgs. The remaining 12 soil samples (S-1 through S-12) were topsoil from the A Horizon collected from 15 to 20 cm bgs. Soil sample locations are shown on **Figure III.2-19.** Laboratory texture analysis results are presented in **Table III.2-13**.

2.7.5 Sediments

The sediment profile currently covering the Tuul River channel and the nearby floodplain consists of sandy loam and mud. Since the flow patterns (or strength of flooding) of the Tuul River change from time to time, sediment depositional patterns also change as one texture is overlain by another, thereby forming a stratified deposit. The periodic addition of nutrient materials to floodplains maintains their relatively high fertility, and supports a higher density and diversity of vegetation. The soil classification of the sediments is alluvial meadow with a thin organic layer. The humus horizon is usually 7 to 12 cm thick for the sediments and rich in plant roots.

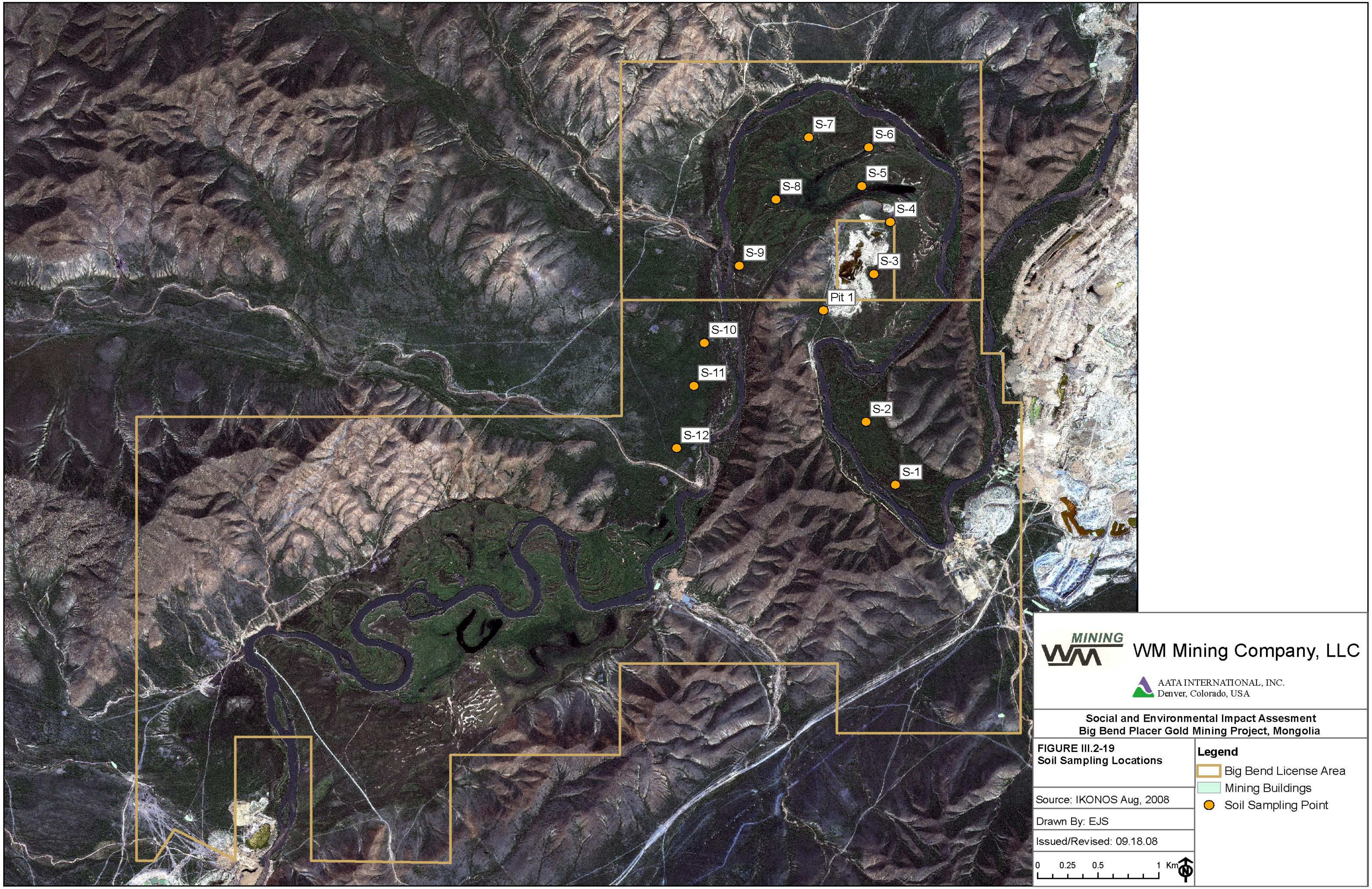


FIGURE III.2-19
Soil Sampling Locations

Table III.2-13 Meadow Dark-Black Soil Analysis Results

Sample ID	Clay (percent)	Sand (percent)	Silt (percent)	+10 Mesh (percent)	Texture Classification
Pit 1 A Horizon	5.36	31.2	63.4	16.1	Silt Loam
Pit 1 B Horizon	5.7	47.4	46.9	23.1	Sandy Loam
Pit 1 C Horizon	11	59.4	29.6	25.9	Sandy Loam
S-1	7.02	63.2	29.8	28.9	Sandy Loam
S-2	4.72	21	74.3	24.7	Silt Loam
S-3	7.72	36.4	55.9	38.2	Silt Loam
S-4	5.98	43.2	50.8	60.4	Silt Loam
S-5	37.9	10.2	51.9	24.8	Silt Clay Loam
S-6	9.78	40.6	49.6	36.5	Loam
S-7	3.64	61.6	34.8	21.8	Sandy Loam
S-8	5.56	41.8	52.6	14.8	Silt Loam
S-9	4.34	74.8	20.9	40.8	Loamy Sand
S-10	7.74	70.8	21.5	41.9	Sandy Loam
S-11	2.02	67	31	35.8	Sandy Loam
S-12	2.84	45.6	51.6	16.6	Silt Loam

3.0 Natural Events History

Natural events in Mongolia include droughts, zuuds (severe winter conditions), blizzards, floods, forest and steppe fires and dust storms. These natural disasters negatively impact land use, especially herding. Droughts and zuuds limit the amount of vegetation available for grazing livestock. Droughts in the spring and summer typically occur once every ten years, except in the Gobi, where they occur more frequently (United Nations Environment Programme, 2001). Zuuds occur in the winter (late October through November) and spring (late March to early April), when heavy snowfall is coupled with low temperatures and frequent strong winds. This creates a situation in which grazing areas are inaccessible, and large quantities of livestock perish. Meteorological data analysis for the period from year 1640 show that zuud events covering 75 percent of the country's area occur once in a 20- to 22-year period.

4.0 Biological Environment

Biological baseline conditions are described with respect to data compiled during literature review and field studies of the Project area. As part of the review of documents, previous EIA studies and published literature were assessed for useful and relevant data. Descriptions of existing floral and faunal components of terrestrial ecology are necessarily general, but supported by remote sensing analysis of recently acquired imagery. Sections on aquatic ecology, benthic macroinvertebrates and periphyton include a detailed analysis of recent data (July 2008) collected at the Project area by AATA as part of the baseline studies for this SEIA.

Severe floods could result in displacement of residencial and grazing areas; even damage or lose of live stocks and herders. Catastrophic floods of the Tuul River were recorded in 1915, 1934, 1959, 1966, and 1967.

4.1 Terrestrial Ecology

4.1.1 Vegetation Communities

The Project area is situated in the Mountain Forest-Steppe biogeographic region of Mongolia, (Wingard and Odgerel, 2001; MNE, 1997; Hilbig, 1995; MPR, 1990; Dariimaa, 2000); which is also often referred to as the Selenge-Orkhon Forest Steppe region of north-central Mongolia (Radnaabazar, 2001). In this region, mixed coniferous forests are found on northern slopes, steppe vegetation predominates on other slopes, and wide river valleys separate the hilly terrain. The Selenge River Basin, inclusive of the Zaamar Goldfield and the Tuul Valley is a transitional to a pocket of Steppe grassland (**Figure III.4-1**). Review of existing floristic data, satellite imagery, and local field conditions demonstrate the Project area as having a greater affinity with the steppe grassland than with the forest-steppe biogeographic regions.

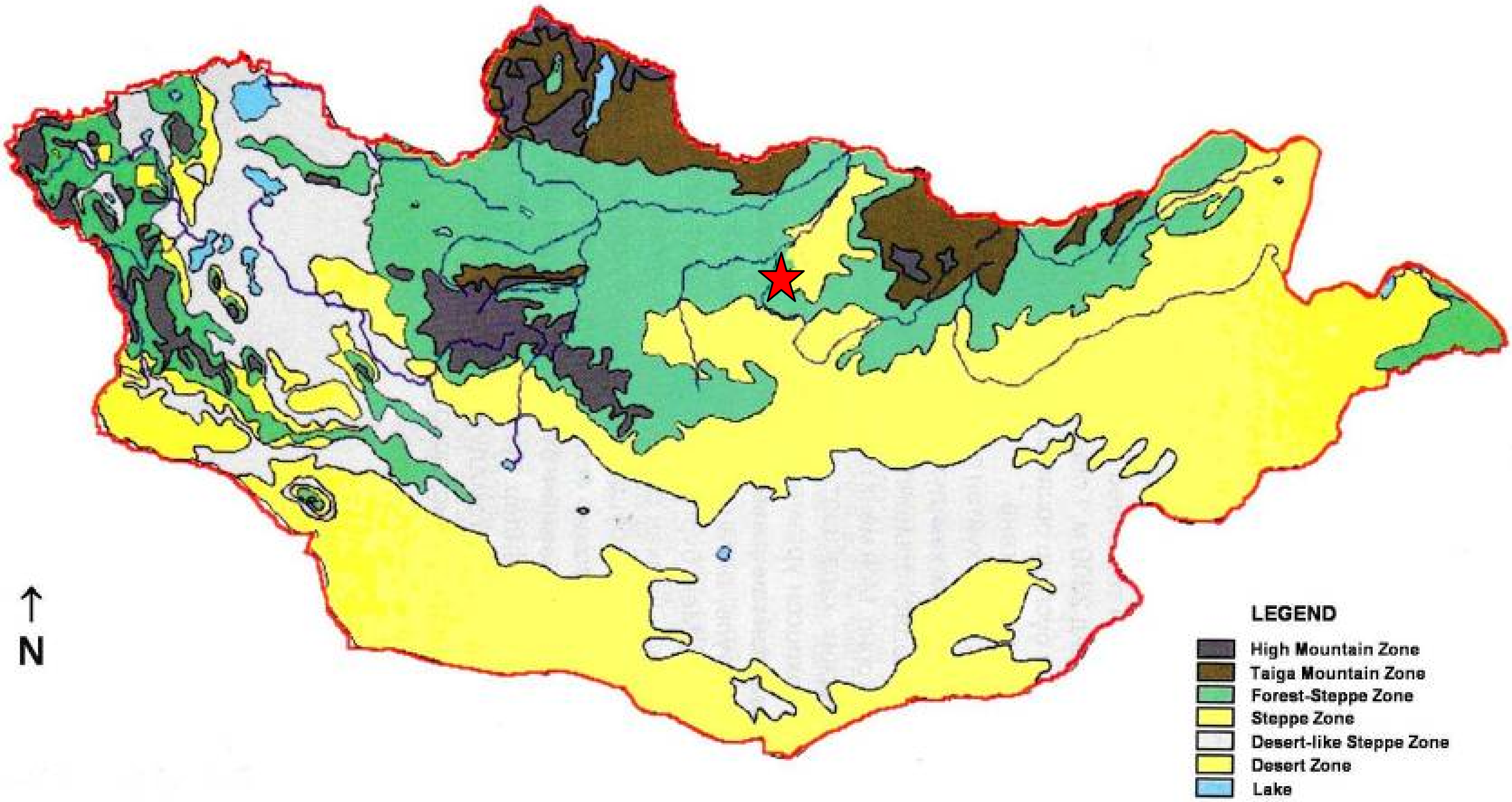
Natural community types of the Project area, as described in literature, include steppe vegetation, riparian/wetland habitat, and willow (*Salix*) thickets.

4.1.2 Steppe Vegetation in the Tuul River Valley

Composition and structural characteristics of the site vegetation cover reflect a Steppe mosaic of grasses and forbs with small patches of woody riparian vegetation on the Tuul River and tributaries. A preliminary study, of the Project area and adjacent areas (EcoTrade, 2002) documents 170 species of vascular plants in 120 genera and in 36 families as occurring. In terms of a cover/abundance and species diversity ratio, the three most important families in order are Gramineae, Compositae, and Leguminosae with 18, 22, and 17 species, respectively recorded for the Project area (EcoTrade, 2002). Gramineae (grasses) is by far the most ecologically important family, with approximately 12 genera found in the Project area.

The Project area is mostly grassland steppe vegetation, characterized and dominated by *Stipa baicalensis*, *S. krylovii*, *Elymus chenensis*, *Festuca lenensis*, *Koeleria gracilis*, *Poa attenuata* (Gramineae), *Carex* spp. (Cyperaceae) and *Filifolium sibiricum* (Compositae); occasional shrubs of *Artemisia frigida* (Compositae) and *Caragana pygmaea* (Leguminosae) are also characteristic, as cited in **Table III.4-1**. The Khos Khas EIA (EcoTrade, 2002) reports preliminary findings that four steppe associations occur in the Zaamar Goldfield, two *Stipa-Cleistogenes* formations and two *Poa-Carex-Elymus* associations are generally described. The *Stipa-Cleistogenes-Poa* formations are described as occurring on the valley slopes to ridgetops, while the *Poa-Carex-Elymus* formations are described as typical of valley bottom steppe (**Section 4.2.5**). A detailed field investigation utilizing standardized sampling methodology would be required to

Figure III.4-1 Vegetation Types of Mongolia



(★ - Project area, adapted from Dariimaa, 2000) substantiate and describe the actual vegetation associations (**Part V**). Along streams and the banks of the Tuul River significant riparian patches of willow (*Salix* spp.) thickets also occur.

Although forest is absent from the actual Zaamar Goldfield, in the adjacent mountains east and west of the Tuul River valley, forest patches of pine (*Pinus silvestris*), larch (*Larix sibirica*), birch (*Betula rotundifolia*) and poplar (*Populus tremula*) occur. Small-scale timber/firewood extraction does occur to support the numerous human activities in the region, including small private mine camps.

Some typical species expected in the steppe of the Project area are listed in **Table III.4-1**.

4.1.3 Wetland/Riparian Zone

The riparian floristic communities along the Tuul River and associated tributaries comprise of two principal associations in the Project area, which are Steppe forb-grassland and willow (*Salix pentandra* and *S. tenuifolia*) thickets. Riparian willow (*Salix*) thickets are especially patchy and discontinuous in distribution; many of these patches are heavily disturbed from grazing and cutting activities. Active woodcutting of willow thickets for firewood in the Project area was observed during the December 2002 field study. Considerable variation exists in the condition of each patch. In general, the extent and distribution of the patches appear to be principally driven by strong historical anthropogenic and edaphic factors. Additionally, willow patches are most commonly observed on the depositing banks of the Tuul River (as opposed to cutting banks) and on some islands in the channel of the river.

4.1.4 Willow (*Salix*) Thickets

The willow thicket patches present a monodominant profile of the trees, *Salix pentandra* and *S. tenuifolia* (Salicaceae), three to eight m in height. *Salix ledebourina* may also occur as cited in the Ecos EIA (1997). Willow (*Salix*) thickets provide a key resource for wildlife and people. In particular, they provide important nesting habitat for birds and small mammals and are a source of high value forage for both wildlife and domestic animals. Willow stands stabilize banks and islands throughout the Project area.

Table III.4-1 Characteristic Plants of the Selenge River Basin Steppe

Family	Species	Vernacular Name	Habit
Apiaceae	*Bulpeurum bicaule*		Herb
Apiaceae	*Phlojodicarpus sibiricus*		Herb
Compositae	*Artemisia frigida*	Sagebrush	Shrub
Compositae	*Filifolium sibiricum*		Herb
Cyperaceae	*Carex duriuscula*	Stable sedge	Graminoid
Cyperaceae	*Carex lanceolata*	Sedge	Graminoid
Gramineae	*Agropyrum cristatum*	Crested wheatgrass	Graminoid
Gramineae	*Aneurolepidium chinense*	Grass	Graminoid
Gramineae	*Cleistogenes squarrosa*	Bridlegrass	Graminoid
Gramineae	*Elymus chenensis*	Black lyme-grass	Graminoid
Gramineae	*Festuca lenensis*	Grass	Graminoid
Gramineae	*Festuca ovina*	Grass	Graminoid
Gramineae	*Koeleria gracilis*	Grass	Graminoid
Gramineae	*Poa attenuata*	Grass	Graminoid
Gramineae	*Poa botryoides*	Grass	Graminoid
Gramineae	*Poa pratensis*	Grass	Graminoid
Gramineae	*Stipa baicalensis*	Grass	Graminoid
Gramineae	*Stipa grandis*	Grass	Graminoid
Gramineae	*Stipa krylovii*	Grass	Graminoid
Gramineae	*Stipa siberica*	Grass	Graminoid
Lamiaceae	*Phlomis* spp.	Herb	Herb
Leguminosae	*Caragana microphylla*	Pea shrub	Shrub
Leguminosae	*Caragana pygmaea*	Pea shrub	Shrub
Leguminosae	*Hedysarum pumilum*	Herb	Herb
Leguminosae	*Oxytropis nitens*	Herb	Herb
Leguminosae	*Oxytropis filiformis*	Herb	Herb
Leguminosae	*Thermopsis dahurica*	Steppe lupine	Herb
Pinaceae	*Larix sibirica*	Larch	Tree
Pinaceae	*Pinus silvestris*	Pine	Tree
Rosaceae	*Spiraea aquilegifolia*	Spiraea	Shrub
Salicaceae	*Populus tremula*	Poplar	Tree
Salicaceae	*Salix pentandra*	Willow	Tree
Salicaceae	*Salix tenuifolia*	Willow	Tree
Scrophulariaceae	*Cymbaria dahurica*	Cymbaria	Herb
Thymelaeaceae	*Stellera chamaejasme*	Herb	Herb

4.1.5 Terrestrial Fauna

This section describes the various fauna that can be expected to occur throughout this region of Mongolia. Despite diverse anthropogenic activities, including mining, animal husbandry and rural settlements, the Project area supports a relatively rich faunal community including 12 species of mammals, 91 species of birds, and various reptiles and amphibians (MPR, 1990).

This section provides a general characterization of the wild fauna of the Project area and surrounding Selenge River Basin based on information from literature, previous EIA studies in the Project area, and field reconnaissance.

4.1.5.1 Mammals

The 12 species of mammals that are documented to occur in the Project area (EcoTrade, 2002) comprise a diverse group of rodents, cannids and ruminant species. In the Selenge River Basin, including the Tuul River valley, the steppe habitat is relatively rich in mammal species diversity, with rodents among the most diverse taxonomic groups (Radnaabazar, 2001). Characteristic large mammal species include the Mongolian gazelle *(Procarpa gutturosa*), Wolf (*Canis lupus*), Corsac fox (*Vulpes corsac*), Steppe polecat (*Mustela eversmann*i), Tolai hare (*Lepus tolai*) and the Long-tailed souslik (*Citellus undulatus*). A list of mammal species reported from the Project area, or believed to occur based on literature and previous collections and their habitat types is presented in **Table III.4-2**.

In forest patches adjacent to the Project area, other notable species occur including the Siberian chipmunk (*Tamias sibiricus*) and the Zabaikalian wild boar (*Sus scrofa*). In winter transient species in the open steppe include wolves (*Canis lupus*) and bears (*Ursus arctos*) (Priobrajenskii et al., 1959).

Table III.4-2 Characteristic Mammals Expected in the Selenge River Basin Steppe

Family	Species	Vernacular Name
Dogs, Wolves and Foxes		
Canidae	*Canis lupus*	Wolf
Canidae	*Vulpes corsac*	Corsac fox
Weasels, Otters and Badgers		
Mustelidae	*Meles meles*	Eurasian badger
Mustelidae	*Mustela eversmanni*	Steppe polecat
Ungulates		
Bovidae	*Procapra gutturosa*	Mongolian gazelle
Cervidae	*Cervus elaphus*	Red deer
Cervidae	*Capreolus pygargus*	Roe deer
Cervidae	*Alces alces*	Elk
Hedgehogs		
Erinaceidae	*Erinaceus dauricus*	Daurian hedgehog
Pikas, Rabbits and Hares		
Leporidae	*Lepus tolai*	Tolai hare
Ochotonidae	*Ochotona daurica*	Daurian pika
Ochotonidae	*Ochotona pallasi*	Pallas' pika
Rodents		
Sciuridae	*Citellus undulates*	Long-tailed souslik
Sciuridae	*Marmota sibirica*	Siberian marmot
Sciuridae	*Sciurus vulgaris*	Ground squirrel
Muridae	*Lasiopodomys brandti*	Steppe vole
Cricetidae	*Microtus oeconomus*	Root vole
Cricetidae	*Cricetulus barabensis*	Striped hamster

In addition to wild fauna, domesticated grazing livestock common in the Project area include the Bactrian camel (*Camelus bactrianus*), horses, and sheep.

4.1.5.2 Birds

The region of the Tuul River Valley supports 91 species of resident and migratory birds (EcoTrade, 2002). Some of the resident breeding bird species characteristic of the steppe in the Selenge River Basin include, the Demoiselle crane (*Anthropoides virgo*), Three-toed woodpecker (*Picoides tridactylus*), Upland buzzard (*Buteo hemilasius*), Steppe eagle (*Aquila rapax*), Saker falcon (*Falco cherrug*), and Mongolian lark (*Melanocorypha mongolica*). Migratory birds consist of various shorebirds and waterfowl. In addition, various multi-cover raptors can be seen in the Project area. A list of bird species reported from the Project area, or believed to occur based on literature and previous collections and their habitat types is presented in **Table III.4-3**.

Table III.4-3 Characteristic Birds expected in the Selenge River Basin Steppe

Family	Species	Vernacular Name
Raptors		
Accipitridae	*Aquila rapax*	Steppe eagle (Tawny eagle)
Accipitridae	*Buteo hemilasius*	Upland buzzard
Accipitridae	*Haleiaeetus albicilla*	White-tailed sea eagle
Accipitridae	*Pandion haliaetus*	Osprey
Falconidae	*Falco cherrug*	Saker falcon
Strigidae	*Surnia ulula*	Northern Hawk Owl
Larks		
Alaudidae	*Melanocorypha mongolica*	Mongolian lark
Ducks and Geese		
Anatidae	*Cygnopsis cygnoides*	Swan goose
Anatidae	*Cygnus cygnus*	Whooper swan
Anatidae	*Eulabeia indica*	Bar-headed goose
Storks and Cranes		
Ciconiidae	*Ciconia nigra*	Black stork
Gruidae	*Anthropoides virgo*	Demoiselle crane
Gruidae	*Grus leucogeranus*	Siberian white crane
Gruidae	*Grus vipio*	Japanese white naped crane
Threskiornithidae	*Platalea leucorodia*	Eurasian Spoonbill
Pipits		
Motacillidae	*Anthus campestris*	Tawny pipit
Flycatchers		
Muscicapidae	*Oenanthe oenanthe*	Northern wheatear
Bustards		
Otididae	*Otis tarda*	Great bustard
Penduline Tits		
Remizidae	*Remiz pendulinus*	Eurasian penduline tit
Sandpipers		
Scolopacidae	*Limnodromus semipalmatus*	Asiatic dowitcher
Woodpecker		
Picidae	*Picoides tridactylus*	Three-toed woodpecker

4.1.5.3 Reptiles and Amphibians

Mounhbayar et al. (2001) cite six amphibian species, five snake species and two lizard species as occurring in the Selenge River Basin (**Table III.4-4**.). In total for Mongolia, there are 13 lizard, 8 snake, and 8 amphibian species recorded from the country (Ananjeva et al., 1997). A list of reptile and amphibian species reported in the Project area, or believed to occur based on literature and previous collections, and their habitat types is presented in **Table III.4-4**.

Table III.4-4 Herpetofauna of North Central Mongolia (Mounhbayar, 2001)

Family	Species	Vernacular Name
Amphibians		
Hynobiidae	*Salamandrella keyserlingii*	Siberian salamander
Ranidae	*Rana amurensis*	Khabarovsk frog
Hylidae	*Hyla japonica*	Japanese tree frog
Bufonidae	*Bufo viridis*	Green toad
Bufonidae	*Bufo raddei*	Siberian toad
Bufonidae	*Bufo bufo*	Common toad
Snakes		
Viperidae	*Agkistrodon halys*	Halys viper
Viperidae	*Vipera berus*	Black adder
Colubridae	*Coluber spinalis*	Racer
Colubridae	*Elaphe dione*	Dione's ratsnake
Colubridae	*Natrix natrix*	Grass snake (water snake)
Lizards		
Lacertidae	*Lacerta vivipara*	Viviparous lizard
Lacertidae	*Eremias argus*	Mongolian racerunner

4.1.5.4 Diversity of the species

The diversity of species, or the total number of species, in the Project area has been estimated at 116, and is discriminated as follows (Finch, 1999):

- 12 species of mammals (8.8 percent of the national total of 136 species);
- 91 species of birds (20.8 percent of the national total of 436 species);
- 7 species of reptiles (31.8 percent of the national total of 22 species); and
- 6 species of amphibians (75 percent of the national total of 8 species).

This region contains a high number of amphibian and reptile species, with average percentages that indicate that almost half (43.3 percent) of the biodiversity.

4.1.5.5 Recreational and Ecotourist Activities

A great number of species of the wild fauna present in the Tuul River Basin are interesting from a recreational point, particularly for the purpose of ecotourism or nature tourism. This type of activity, well organized and controlled, is the best way to use the resource, in association with a well-balanced management plan to include the local population of the region.

In Mongolia, large expanses of relatively unchanged landscape provide for intact ecosystems that support a wide array of distinctive species. All of the animal species that form the wild fauna are the result of a long process of biological evolution, constituting the diversity of the native species and genetic diversity of the different communities and ecosystems. To protect these natural landscapes, Mongolia has set aside several protected areas (see **Section 4.2.4**). National Parks combined with unique and endemic wild fauna facilitate nature-based tourism in Mongolia.

4.1.5.6 Hunting

In 2004, it was estimated that more than 250,000 Mongolians actively harvest wildlife for personal consumption, domestic, and international trade (WWF, 2008). Much of the hunting in Mongolia is for local trade or consumption, but there are species in Mongolia threatened by illegal international trade. Very little information is available on these activities. Because there is a lack of statistics or registries on the number of hunted and removed animals in the area, the effects of hunting in the study area are difficult to predict.

4.1.6 Aquatic Ecology

4.1.6.1 Introduction and Background

This section describes the aquatic ecological aspects of the Project area, with a focus on the fisheries of the Tuul River. Investigations of the local ecology were performed in 2003 and 2008 as part of the AATA baseline study for this SEIA. Historically, studies of the aquatic ecology of the Mongolian portion of the Selenge River drainage, which includes the Tuul River, were conducted by the Joint Russian-Mongolian Complex Biological Expedition. The results of these studies, which were initiated in 1959 and continued for over 30 years, are summarized by Shatunovsky (1983; 1985). A detailed fisheries study, with special reference to the Tuul River drainage, was conducted during 2000 to 2005 by Erdenebat (2006a; b). Additional information on the fishes of Mongolia is presented in Dulmaa (2002) (distribution, life history, commercial fisheries) and Kottelat (2006) (distribution, systematics, nomenclature). Site-specific results of fisheries collections made during the AATA July 2008 baseline study, under license #412427 (Ministry of Nature Protection and Environment) are reported herein.

During the last 50 to 60 years, the rivers of the Selenge River drainage, as well as other rivers in central Asia, have been impacted by climate change (warming and aridization) and intensification of anthropogenic impacts. From 1980 to the present, the human population in the Mongolian part of the Selenge River drainage increased by 60 percent, with the greatest increase in population occurring in urban areas. The increase in population density has been particularly high in the Tuul River basin (Erdenebat, 2006a; b).

All of the primary industrial centers in Mongolia (Ulaanbaatar, Erdenet, and Darkham) are located on tributaries of the Selenge River [Orkhon, Tuul (Tola-Gol), Kharaa-Gol, and Sharyn-Gol rivers]. Moreover, extensive gold mining has occurred in Mongolia since 1990, especially in the Selenge River drainage. Exploitation of placer gold deposits has required the use of large amounts of water and has resulted in disturbance of large areas of riverine and riparian habitat. Most of the past mining projects have been performed without appropriate environmental controls and/or reclamation. These factors have caused considerable changes in Mongolian ecosystems, including the fish populations of the Selenge River drainage, which includes the Tuul River.

Erdenebat (2006a; b) listed the following impacts to aquatic ecosystems of the Selenge River drainage:

1. Climate change (drought);
2. Discharge of improperly treated domestic and industrial wastewater;
3. Discharge of sediment by the mining industry;
4. Increase in the density of livestock and related degradation of vegetation cover;
5. Soil erosion from agricultural activities;
6. Deforestation resulting from forest fires and tree harvesting; and
7. Poaching and unregulated sport fishing.

According to the published data, the fish fauna of the upper Selenge River drainage consists of 24 species, 17 of which occur in the Tuul River (common and scientific names of fishes of the Tuul River drainage are given in **Table III.4-1**). The fish community of the upper reaches of the rivers (Hoid-Tamir-Gol, Bugsein-Gol, Ider-Gol, Dleger-Muren-Gol, Tuul, and Eroo) used to be represented exclusively by species of the Siberian rheophil complex. In such rivers, the prevalent species were taimen, lenok, Siberian grayling, common minnow, and Siberian stone loach. In the Tuul River, this fish community is now limited to its upper reaches upstream of Ulaanbaatar (Erdenebat, 2006a; b).

Table III.4-5 List of Fish Fauna of the Tuul River (Erdenebat, 2006a; b)

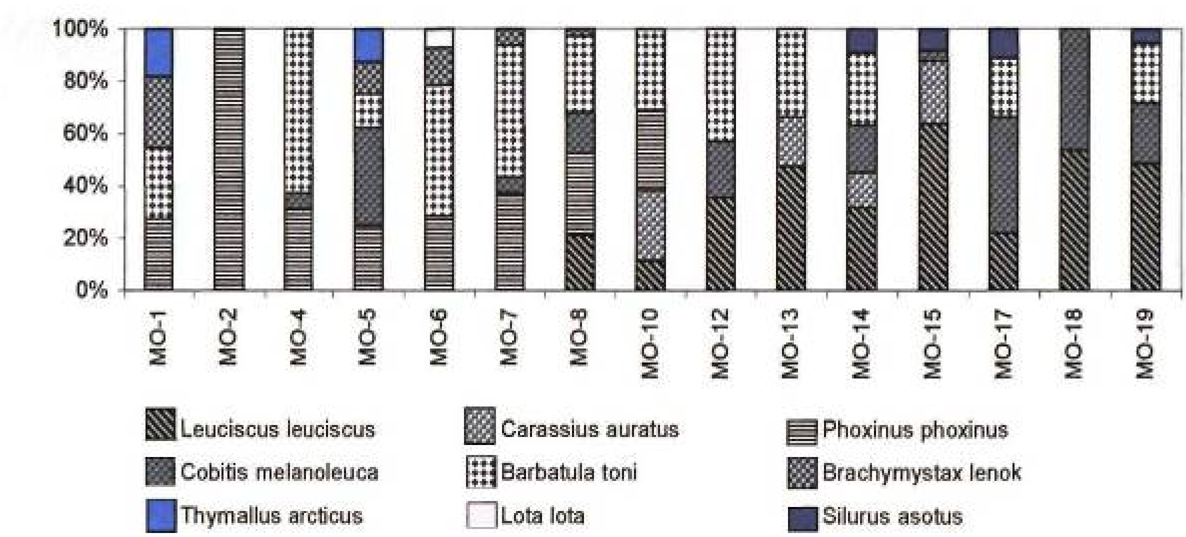
English Name	Species	Comments
Family Trouts and Salmons - *Salmonidae*		
Siberian taimen	*Hucho taimen*	Vulnerable to pollution and overfishing
Lenok (Siberian trout)	*Brachymistax lenok*	Vulnerable to pollution and overfishing
Family Graylings - *Thymallidae*		
Arctic grayling	*Thymallus arcticus*	Vulnerable to pollution and overfishing
Family Pikes - *Esocidae*		
Northern pike*	*Esox lucius*	
Family Carps & Minnows - *Cyprinidae*		
Prussian carp*	*Carassius gibelio*	The species is not native to the Selenge R. drainage. It is numerous in the impacted reaches of the Tuul R.
Roach*	*Rutilus rutilus*	
Siberian dace*	*Leuciscus baikalensis*	The species is dominant in the impacted reaches of the Tuul R.
Ide*	*Leuciscus idus*	
Lake minnow	*Phoxinus perenurus*	
Common minnow	*Phoxinus phoxinus*	
Amur carp*	*Cyprinus carpio*	The species is not native to the Selenge R. drainage
Small osman	*Oreoleuciscus humilus*	Rare fish, present only in some small tributaries
Family Loaches – *Balitoridae*		
Siberian stone loach*	*Barbatula toni*	
Family Spiny Loaches – *Cobitidae*		
Siberian spiny loach*	*Cobitis melanoleuca*	
Family Catfishes – *Siluridae*		
Amur catfish*	*Silurus asotus*	The species is not native to the Selenge R. drainage
Family Perches – *Percidae*		
Yellow perch*	*Perca fluviatilis*	
Family Codfishes – *Lotidae*		
Burbot	*Lota lota*	

* species collected during the July 2008 survey.

In the middle reaches of the Selenge and Orkhon rivers, the dominant species are lenok, grayling, stone loach, spiny loach, and Siberian dace. Subdominant species here are taimen and common minnow. The middle and lower parts of the Tuul River historically supported a fish community of this type, but species composition has changed significantly over recent years as a result of mining, industrial pollution, and the other factors discussed above (Erdenebat, 2006a; b).

Erdenebat (2006a; b) found that the species composition in the middle and lower reaches of the Tuul River was different from the other surveyed rivers (**Figure III.4-2**). He noted the total absence of Salmonids (lenok and taimen) and grayling, which are vulnerable to water quality degradation, from these parts of the river. The dominant species in these reaches are now crucian carp and Siberian dace, while subdominants are spiny loach, stone loach, and northern pike. Amur carp, yellow perch, and Amur catfish are common. All areas below sampling location MO-10 are affected by mining pollution. The decrease of biodiversity and disappearance of oxyphilic species is caused by the deterioration of the stream hydrology and water quality resulting from anthropogenic activities (Erdenebat, 2006a; b)

Figure III.4-2 Fish Species Composition of Different Areas of the Tuul River in June 2004 (Erdenebat, 2006 b)



Fish may be classified based on the type of spawning substrate they prefer (e.g., rocky substrates (lithophilic) vs. plants (phytophilic) and their preference for faster (rheophilic) or slower (limnophilic) currents. Changes in the relative abundance of fish species of the various ecological classifications is indicative of changes in their environment. Erdenebat (2006a; b) found that, since the 1980s, the percentage of lithophiles in the middle and lower Tuul River has decreased by a factor of two, while the percentage of phytophiles has doubled. Similarly, the percentage of rheophilic species declined by 27 percent and the percentage of limnophilic species increased by 36 percent. Species such as northern pike, crucian carp, roach, lake minnow, and yellow perch were not formerly present in the Tuul River. Erdenebat attributed these changes primarily to the impacts of mining.

Erdenebat (2006a; b) found that the fish community in the Zaamar area of the Tuul River, where mining activity has been most intensive, was particularly depauperate. He further reported that 60 percent of the fish collected in the Zaamar area had red spots and skin ulcers. None of the fish collected in the July 2008 baseline studies presented red spots, lesions, or skin ulcers.

4.1.6.2 AATA Baseline Study - July 2008

Materials and Methods

Baseline fish sampling was performed within, upstream of, and downstream of, the Project area during July 13 through 18, 2008. Sampling was performed at seven locations on the Tuul River (S-110 through S-150), in a flooded mine pit (L-125), and in an ephemeral pond (L-105) (**Figure III.4-3**). Descriptions of the sampling locations are provided in **Table III.4-6.**

Fish were collected using 2 x 1.5-m and 9 x 1.5-m seines (both with 7 mm mesh) and gill nets of four sizes (2 x 7.5-m, 10 mm mesh; 2 x 20-m, 18 mm mesh; 2 x 15-m, 30 mm mesh; and 2 x 18-m, 40-mm mesh). Multiple overnight gill net sets were performed at station S-130 on the Tuul River and at station L-125 in the mine pit. High river flow in the Tuul River, resulting from recent heavy rain, precluded the use of gill nets at the other stations. Seine nets were fished opportunistically depending on conditions at each sampling location. The small seine was used to sample pockets along steep banks, among weed beds and submerged snags, and in other places that were not suitable for the large seine. Because of high river flow, it was possible to use the large seine only in limited areas upstream of the Project area (S-105, S-110, S-112, and S-115). No fish were collected at S-105, the ephemeral pond, so this location was not included in the tables.

Collected fish were identified, counted, examined for lesions/abnormalities, and most were individually measured (in mm) and weighed (in grams). For several large catches of Siberian dace and Prussian carp, a representative subsample was individually measured and weighed, while the remaining specimens were counted and weighed together by species. Members of the carp family (Cyprinidae) and yellow perch were measured for both total length (TL) and standard length (SL) (from the tip of the jaw to the end of the scales at the caudal peduncle). Fish from the other families were measured only for total length. Representative specimens of each species of fish were photographed for future reference.

The coordinates of each sampling location were determined using a GPS and the habitat characteristics at each location were recorded.

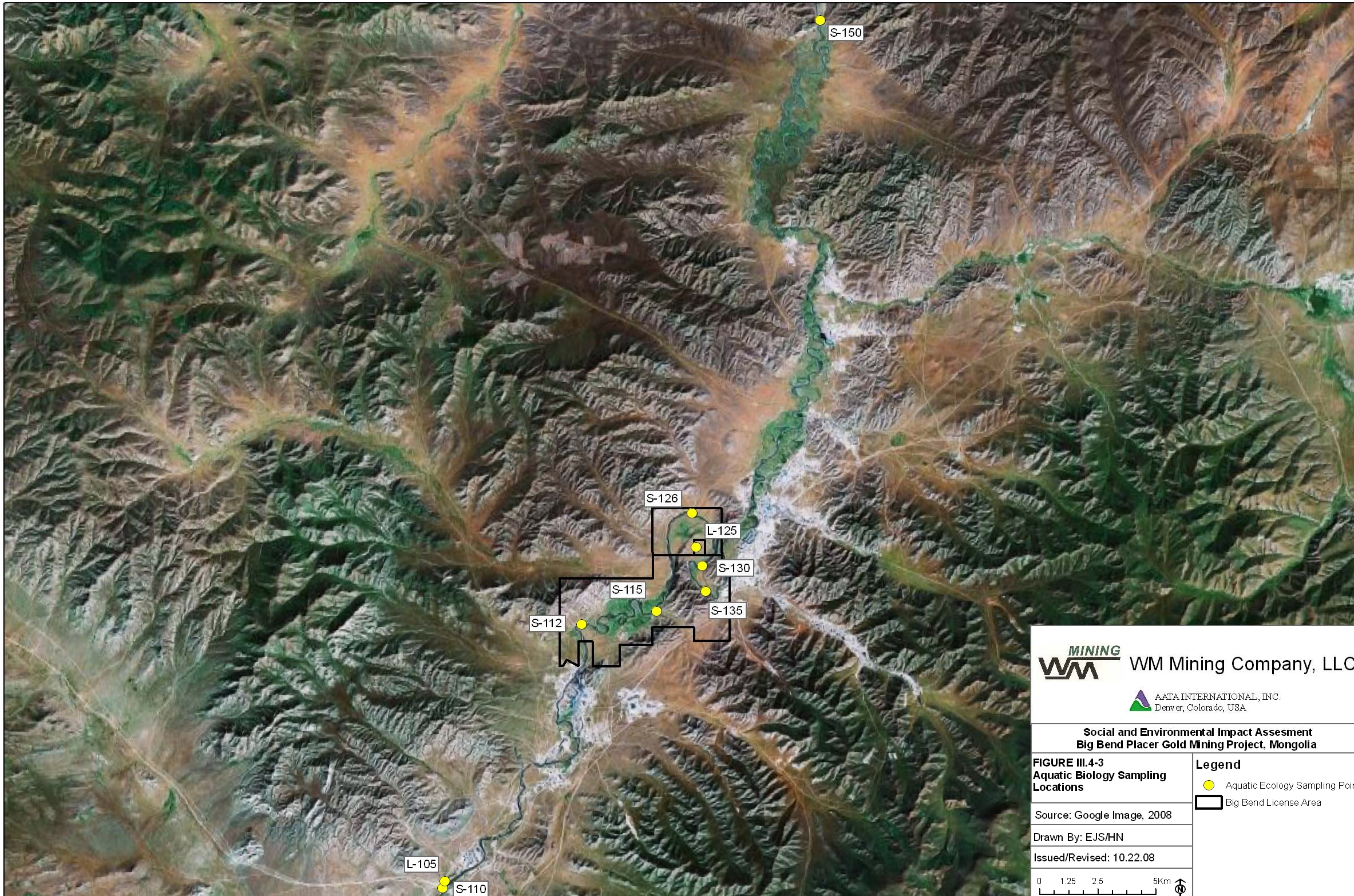

S-150
S-126
L-125
S-130
S-115
S-135
S-112
L-105
S-110
MINING
WM Mining Company, LLC
AATA INTERNATIONAL, INC.
Denver, Colorado, USA
Social and Environmental Impact Assesment
Big Bend Placer Gold Mining Project, Mongolia
FIGURE III.4-3
Aquatic Biology Sampling Locations
Source: Google Image, 2008
Drawn By: EJS/HN
Issued/Revised: 10.22.08
0 1.25 2.5 5Km
N
Legend
Aquatic Ecology Sampling Points
Big Bend License Area

Table III.4-6 Description of Aquatic Sampling Locations in the Vicinity of the Big Bend Project Area, AATA Baseline Study – July 2008

Station	Coordinates	Description
S-110	N 48º 14' 02.3" E 104º 19' 40.0"	On left bank of Tuul River, immediately upstream of the Tuul River bridge. Predominantly mud/silt substrate. Vegetation primarily heavily grazed riparian grasses. Banks eroded from disturbance by livestock.
S-112	N 48º 20' 06.5" E 104º 24' 28.1"	Right bank of Tuul River at ford. Clay/silt substrate on and near banks, gravel in higher current areas. Banks disturbed by livestock grazing.
S-115	N 48º 20' 19.8" E 104º 27' 0.8"	Backwater channel island and main channel of Tuul River; right bank. Substrate predominantly clay/silt, with areas of exposed gravel on bank. Some heavily grazed riparian grasses on bank.
S-126	N 48º 22' 43.39" E 104º 28' 14.91"	Alluvial fan on left bank of Tuul River. Substrate compacted clay with some small gravel and silt. Some flooded riparian grasses.
S-130	N 48º 21' 26.6" E 104º 28' 37.8"	Braided reach of Tuul River within Project area. Predominantly mud/silt substrate, some gravel/cobble in high current areas. Grazed riparian grasses on right bank; shrub/shrub (mostly willows) and undisturbed riparian grasses on islands and left bank.
S-135	N 48º 20' 48.2" E 104º 28' 42.2"	On right bank of Tuul River. Predominantly mud/silt substrate. Beds of submerged aquatic vegetation and flooded riparian grasses along bank.
S-150	N 48º 34' 14.7" E 104º 32' 26.9"	On left bank of Tuul River. Substrate small boulder, with some mud/silt. Vegetation primarily flooded wetland and riparian grasses.
L-105	N 48º 14' 5.1" E 104º 19' 42.3"	Shallow ephemeral pond on right bank floodplain upstream of the Tuul River bridge. Mud/silt substrate. Some rooted aquatic vegetation.
L-125	N 48º 21' 54.7" E 104º 28' 23.1"	Mining pit lake with permanent standing water within Project area. Substrate clay/silt. Some rooted submerged and emergent aquatic vegetation.

Aquatic macroinvertebrates were sampled at selected stations using a dip net of 0.5 mm nylon mesh. Areas that could be effectively sampled for macroinvertebrates were limited because of the high river flow. Macroinvertebrate samples were placed in labeled plastic jars and preserved with 70 percent isopropyl alcohol. Samples were transported to the Water Research Laboratory at the National University of Mongolia, where the specimens were removed from the attendant detritus and identified by Aquatic Specialist Saulegul.

4.1.6.3 Results and Discussion

Fish – Tuul River

Sampling in the Tuul River by seine and gill net in July 2008 was conducted under licensed permission (Scientific Collecting Permit #412427) from the Ministry of Nature and Environment. The sampling yielded a total of 590 specimens (weighing 10,897.2 g) of ten species of fish (**Table III.4-7**, **Table III.4-8**, and **Table III.4-9**). The catch was dominated by members of the Carp family (Cyprinidae), which was represented by five species. The remainder of the catch was comprised of one species each of the Pike, Loach, Spiny Loach, Catfish, and Perch families.

Table III.4-7 Fish Collected by 10-mm Gill Net in the Tuul River in the Vicinity of the Big Bend Project Area, July 2008

Species	No.	Wt. (g)	Percent		Catch Rate	
			No.	Wt. (g)	(no./25-m of net/24 hr)	(g/25-m of net/24 hr)
Siberian dace	80	730	93.0	89.2	187.0	1,709
Roach	5	32	5.8	3.9	12.0	75
Ide	1	56	1.2	6.8	2.0	131
Total no.	86				201.0	
Total wt.		818				1915

Note: Sampling performed at Station S-130 with a 2 x 7.5-m gill net of 10-mm mesh fished for 34.2 hrs.

The catch in the 10-mm gill net was dominated by Siberian dace (n=80), which comprised 93.0 percent of the catch by number and 89.2 percent by weight. Roach (n=5) and ide (1) were also taken by 10-mm gill net (**Table III.4-7**). A total of 14 specimens of five species of fish were collected in the 30- and 40-mm gill nets. Ide were most abundant (n=8), followed by Amur carp (3), and single specimens each of northern pike, Prussian carp, and Amur catfish (**Table III.4-8**). Average catch per unit effort (expressed as catch per 25 m of net in 24 hr) was 201 specimens (1,915 g) in the 10-mm gill net, but only 1.4 (541 g) in the 30- and 40-mm gill net (**Table III.4-7** and **Table III.4-8**). This suggests that larger fish occur in relatively low abundance in the study area.

Table III.4-8 Fish Collected by Seine in the Tuul River in the Vicinity of the Big Bend Project Area, July 2008

Species	S-110		S-112		S-115		S-126		S-130		S-135		S-150		Total		Percent	
	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)
Prussian carp	20	22	20	31	30	432	1	0.4			12	29	3	175	86	689.4	17.6	14.3
Ide											1	18			1	18	0.2	0.4
Roach					11	379									11	379	2.2	7.9
Siberian dace	23	143	48	872	74	1,391	98	76	4	49	90	185	23	190	360	2,906	73.5	60.4
Siberian stone loach	8	4	2	4									3	3	13	11	2.7	0.2
Spiny loach			1	0.4											1	0.4	0.2	0.0
Amur catfish					2	18	1	8			1	0.4			4	26.4	0.8	0.5
Yellow perch					7	452					6	273	1	56	14	781	2.9	16.2
Total no.	51		71		124		100		4		110		30		490			
Total wt.		169		907.4		2,672		84.4		49		505.4		424		4,811.2		
Area sampled (m^2)	300		500		1,300		no data		no data		no data		no data		2,100			

Table III.4-9 Density (n/100 m²) and Biomass (g/100 m²) of Fish Collected by Large Seine in the Tuul River in the Vicinity of the Big Bend Project Area, July 2008

Species	S-110		S-112		S-115		Total		Density (n/100 m^2)	Biomass (g/100 m^2)
	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)		
Prussian carp	20	22	20	31	30	432	70	485	3.33	23.10
Roach					11	379	11	379	0.52	18.05
Siberian dace	23	143	48	872	74	1,391	145	2,406	6.90	114.57
Siberian stone loach	8	4	2	4			10	8	0.48	0.38
Spiny loach			1	0.4			1	0.4	0.05	0.02
Amur catfish					2	18	2	18	0.10	0.86
Yellow perch					7	452	7	452	0.33	21.52
Total no.	51		71		124		246		11.71	
Total wt.		169		907.4		2,672		3,748		178.50
Area sampled (m^2)	300		500		1,300		2,100			

Seine net collections yielded a total of 490 specimens of eight species (**Table III.4-9**). Siberian dace were most abundant (n=360) and accounted for 73.5 percent of the seine catch by number and 60.4 percent by weight. Prussian carp (n=86) ranked second, comprising 17.6 percent of the catch by number and 14.3 percent by weight. Yellow perch were much less numerous (n=14; 2.9 percent by number), but comprised 16.2 percent of the catch by weight.

Table III.4-10 Fish Collected by 30- and 40-mm Gillnet in the Tuul River in the Vicinity of the Big Bend Project Area, July 2008

Species	No.	Wt. (g)	Percent		Catch Rate	
			No.	Wt. (g)	(no./25-m of net/24 hr)	(g/25-m of net/24 hr)
Northern pike	1	884	7.1	16.8	0.1	91
Prussian carp	1	90	7.1	1.7	0.1	9
Ide	8	2,704	57.1	51.3	0.8	278
Amur carp	3	1,127	21.4	21.4	0.3	116
Amur catfish	1	463	7.1	8.8	0.1	47
Total no.	14				1.4	
Total wt.		5,268				541

Note: Sampling performed at Station S-130 with a 2 x 15-m gill net of 30-mm mesh fished for 120 hrs and a 2 x 18-m gill net of 40-mm mesh fished for 56.75 hrs.

Area sampled was estimated only for collections with the large seine. Based on these collections, fish density averaged 11.7 specimens per 100 m^2 (178.5 g per m^2) (**Table III.4-10**). These estimated densities are minimum numbers since they do not account for the collection efficiency of the seine. Correction factors for the large seine typically range from 1.4 to 2.0

Length-frequency distributions of Cyprinid and non-Cyprinid fish collected in the present study are presented in **Table III.4-11** and **Table III.4-12**, respectively.

The fish collected in July 2008 appeared to be healthy, and no abnormalities or lesions, such as the red dots and skin ulcers reported by Erdenebat (2006a), were observed.

Table III.4-11 Length-Frequency Distributions for Cyprinid Fishes Collected in the Tuul River in the Vicinity of the Big Bend Project Area, July 2008

Standard Length (mm)			Prussian carp	Roach	Siberian dace	Ide	Amur carp
21	-	25	1				
26	-	30	11		1		
31	-	35	8		3		
36	-	40	10		7		
41	-	45	1		4		
46	-	50			1		
51	-	55					
56	-	60					
61	-	65		1			
66	-	70		2	2		
71	-	75		3	6		
76	-	80		5	22		
81	-	85		1	24		
86	-	90		1	10		
91	-	95	1	1	9		
96	-	100			4	1	
101	-	105			4		
106	-	110	2		3		
111	-	115			3		
116	-	120			2		
121	-	125			2		
126	-	130	1		3		
131	-	135	1	1			
136	-	140			1		
141	-	145					
146	-	150	1		1		
151	-	155			1		
156	-	160	1		1	1	
161	-	165	1		1		
166	-	170			1		
171	-	175					
176	-	180			1		
181	-	185			1		
186	-	190					
191	-	195					1
196	-	200					
201	-	205				1	
206	-	210					
211	-	215					
216	-	220				1	
221	-	225					1
226	-	230		1			
231	-	235					

Standard Length (mm)	Prussian carp	Roach	Siberian dace	Ide	Amur carp
236 - 240				1	
241 - 245					
246 - 250					
251 - 255				1	
256 - 260				1	
261 - 265					
266 - 270					
271 - 275				1	
276 - 280					
281 - 285					
286 - 290					
291 - 295				1	
296 - 300					1
301 - 305					
306 - 310				1	
Total measured	**39**	**16**	**118**	**10**	**3**

Table III.4-12 Length-Frequency Distributions for Non-Cyprinid Fishes Collected in the Tuul River in the Vicinity of the Big Bend Project Area, July 2008

Total Length (mm)	Northern pike	Stone loach	Spiny loach	Amur catfish	Yellow perch
21 - 25					
26 - 30					
31 - 35		3			
36 - 40		2		1	
41 - 45		5			
46 - 50			1		1
51 - 55					1
56 - 60		2			
61 - 65					
66 - 70					
71 - 75					
76 - 80					
81 - 85					
86 - 90		1			
91 - 95					
96 - 100				1	
101 - 105				2	
106 - 110					
111 - 115					
116 - 120					
121 - 125					
126 - 130					

Total Length (mm)			Northern pike	Stone loach	Spiny loach	Amur catfish	Yellow perch
131	-	135					
136	-	140					
141	-	145					1
146	-	150					1
151	-	155					2
156	-	160					1
161	-	165					2
166	-	170					2
171	-	175					
176	-	180					1
181	-	185					1
186	-	190					1
191	-	195					
196	-	200					
201	-	205					
206	-	210					1
211	-	215					
216	-	220					
221	-	225					
226	-	230					
231	-	235					
236	-	240					
241	-	245					
246	-	250					
251	-	255					
256	-	260					
261	-	265					
266	-	270					
271	-	275					
276	-	280					
281	-	285					
286	-	290					
291	-	295					
296	-	300					
301	-	305					
306	-	310					
311	-	315					
316	-	320				2	
321	-	325					
331	-	335				1	
336	-	340				1	
341	-	345				1	
346	-	350					
351	-	355				1	
356	-	360				1	
451	-	455					
456	-	460				1	

Total Length (mm)	Northern pike	Stone loach	Spiny loach	Amur catfish	Yellow perch
461 - 465					
466 - 470					
471 - 475					
476 - 480					
481 - 485					
486 - 490					
491 - 495	1				
496 - 500					
Total measured	**1**	**13**	**1**	**12**	**15**

Fish – Pit Lake

A groundwater-fed lake formed within the Project area after a placer gold mining pit was abandoned in the 1990s. The pit lake is approximately 402 m long and 168 m wide. It has a number of shallow and deep bays, and several small islands and peninsulas. Average depth is approximately five to seven m. The lake is quite clear, with the bottom visible at a depth of approximately three m. Beds of submerged aquatic vegetation have developed in many areas. A limnophilic macroinvertebrate community containing dragonfly and caddisfly larvae, aquatic bugs (Hemiptera), and mollusks has developed in the lake (see **Section 4.1.7**).

Seven Amur catfish (weighing a total of 1,635 g) and one yellow perch (74 g) were collected gill nets fished over two nights in the former mine pit (**Table III.4-13**). All of the Amur catfish were of a similar size (317 to 356 mm TL) and weight (218 to 262 g). The yellow perch was 130 mm SL (155 mm TL) and weighed 74 g. No fish were collected in two hauls of the large seine in the mine pit, although a number of Mongolian toad (*Bufo raddei*) tadpoles were taken.

Table III.4-13 Fish Collected by Gill Net in the Mine Pit Lake in the Big Bend Project Area, July 2008

Mesh Size (mm)	Species	No.	Wt. (g)	Percent		Catch Rate	
				No.	Wt. (g)	(no./25-m of net/24 hr)	(g/25-m of net/24 hr)
10	---	0	0	0.0	0.0	0.0	0
18	Yellow perch	1	74	12.5	6.6	0.5	39
30	Amur catfish	7	1635	87.5	145.1	7.7	1816
	Total no.	8				8.2	
	Total wt.		1709				1855

Note: Sampling performed at Station L-125 with a 2 x 7.5-m gill net of 10-mm mesh, a 2 x 20-m gill net of 18 mm mesh, and 2 x 15-m gill net of 30-mm mesh fished for 36 hrs.

4.1.6.4 Species Accounts and Life Histories

Northern Pike (*Esox lucius*) (**Attachment 5** of **Appendix E**, **Figure 29**) – is a non-migratory piscivorous species that occurs in many Mongolian rivers and lakes. Northern pike are common in the Mongolian part of the Selenge River drainage, although it was not present in the Tuul River before 1990 (Erdenebat, 2006b). In Mongolia, northern pike spawn from early April, immediately after ice out, through the second half of May, at water temperatures of 3 to 6 ^{o}C. Spawning typically occurs on sand or submerged aquatic vegetation. In the Selenge River, northern pike 360 to 900 mm in length had a fecundity of 7,400 to 270,500 (Dulmaa, 2002). Northern pike grow rapidly, even in the presence of other predators, and attain a maximum length of approximately one m. The principal prey species of northern pike include minnows, dace, roach, perch, carp, and stone loach (Dulmaa, 2002).

One northern pike (493 mm TL; 884 g) (**Table III.4-14**) was collected in the present study. Based on the length-at-age data given in Dulmaa (2002), this specimen was probably age 4+. The absence of young pike suggests that there is little suitable spawning habitat for the species within the study area.

Prussian Carp (*Carassius gibelio*) (**Attachment 5** of **Appendix E**, **Figure 31**) – is a common species in the rivers and lakes of eastern Mongolia and the Selenge River drainage. The Selenge River stock of Prussian carp originated from fish introduced to Lake Baikal in Russia. Prussian carp were not present in the Tuul River before 1990 Erdenebat (2006b). The species' tolerance of high suspended sediment concentrations has enabled it to become common in the mining region of the Tuul River.

Prussian carp typically mature at lengths greater than or equal to 180 mm, although maturity may occur at a much smaller size in some isolated lake populations (Dulmaa, 2002). In Mongolia, the species spawns during the second half of June through August, at water temperatures greater than or equal to 14 ^{o}C. Spawning occurs primarily in shallow beds of aquatic vegetation. Dulmaa (2002) reported that two growth forms of Prussian carp occur in Mongolia, the slow growth form predominating in floodplain lakes of the middle Selenge drainage. Prussian carp are omnivorous, with over 30 animal and plant species identified from the stomachs of specimens captured in lakes (Dulmaa, 2002).

Table III.4-14 Length and Weight Data for Fish Collected in the Vicinity of the Big Bend Project Area, July 2008

Species	Standard Length		Total Length		Weight		No.
	Mean	Range	Mean	Range	Mean	Range	
Northern pike			493		884		1
Amur carp	238	196-295	275	228-340	376	188-674	3
Prussian carp	53	25-165	64	30-200	18	0.39-174	39
Ide	228	100-310	270	120-365	278	17.5-632	10
Roach	98	70-226	116	85-272	34	7.1-252	16
Siberian dace	87	28-183	103	33-206	14	0.37-106	118
Siberian stone loach			46	33-88	0.85	0.8-4.2	13
Spiny loach			48		0.42		1
Amur catfish			263	38-457	177	0.4-463	12
Yellow perch	133	41-193	152	46-208	57	1.32-123	15

In the present study, Prussian carp was an abundant and widespread species, collected at all sampling locations in the Tuul River. Prussian carp ranked second in the seine catch (17.6 percent by number and 14.3 percent by weight). Fingerlings were common in the surveyed area (**Table III.4-11**), indicating that spawning conditions in the Tuul River are favorable for the species. The largest Prussian carp collected in the present study was 165 mm SL (200 mm TL) and weighed 174 g (**Table III.4-14**).

Roach (*Rutilus rutilus*) (**Attachment 5** of **Appendix E**, **Figure 35**) – occurs both in lakes and rivers in Mongolia. In rivers, roach prefer slow current areas and shallow bays, and often occur in association with submerged aquatic vegetation. Roach typically mature in their third year. In Mongolia, spawning occurs from the end of May into June at water temperatures of 14.5 to 16 ^{o}C. Fecundity of age 3+, 4+, and 5+ fish averaged 11,000; 13,500; and 30,000, respectively (Dulmaa, 2002).

Roach were common, but not numerous, in present-study collections in the Tuul River. It ranked second in abundance in the 10 mm gill catch, but was absent in the catch of the 30- and 40-mm gill nets, suggesting a paucity of large specimens in the study area. Roach were collected at only one of the seine stations (S-115), located upstream of the Project area. This species accounted for 2.2 percent of the seine catch by number and 7.9 percent by weight. Young roach were present in our collections, indicating that spawning is occurring within or near the study area (**Table III.4-11**). The largest roach collected was 226 mm SL (272 mm TL) and weighed 252 g (**Table III.4-14**). Like most of the Cyprinid fishes, roach are tolerant of high concentrations of suspended sediment, which allows them to survive the unfavorable conditions in the mining region of the Tuul River.

Siberian Dace (*Leuciscus baikalensis*) – is a common species in the Selenge River drainage and adapts well to a range of environmental conditions. It prefers streams with clear water and high dissolved oxygen concentrations, but can survive and even thrive in rivers with high sediments loads, such as the middle reaches of the Tuul River. It occurs in small schools over sandy and stony substrates, in both fast and slow current areas, and along river banks in association with aquatic vegetation. The fish remains active even in winter months (Dulmaa, 2002). Siberian dace mature at an age of 3 to 4 years. In Mongolia, spawning begins in late April at a water temperature of 5 to 9 ^{o}C, and continues through the end of May. Eggs are deposited in flooded terrestrial vegetation or on sandy substrates in the shallows of rivers. Fecundity increases with age, and ranges from approximately 1,800 to 13,600. Siberian dace feed on a variety of prey, including caddisfly, mayfly, and terrestrial insect larvae; cladocera; copepods; algae; and higher aquatic plants (Dulmaa, 2002).

In the present study, Siberian dace was the predominant species in the seine (73.5 percent) and the 10-mm gill net (93.0 percent) catches. The species was present at all sampling locations on the Tuul River, but was not collected in the pit lake. Based on the length-at-age data for the Tuul River presented in Dulmaa (2002), Siberian dace ranging from age 0+ to perhaps 7+ were present in our collections (**Table III.4-14**). The largest specimen collected was 183 mm SL (206 mm TL) and weighed 106 g. Most of the Siberian dace taken in our collections were small (average length – 87 mm SL, 103 mm SL, weight 14 g) (**Table III.4-14**). The density of Siberian dace fingerlings was high in suitable habitats on the Tuul River (bays, back-eddies near banks), as evidenced by the catch-per-unit-effort in the 10 mm gill net of 187 specimens per 25-m of net in 24 hr (**Table III.4-7**,).

Ide (*Leuciscus idus*) (**Attachment 5** of **Appendix E**, **Figure 28**) – are common in the Selenge River drainage of Mongolia, where it occupies slow flowing areas and oxbows or rivers. It is found in both deep and shallow waters, over clayey and rocky substrates, respectively. Ide mature at age 5 to 6+. In Mongolia, spawning takes place in April and May over flooded terrestrial vegetation at water temperatures of 6 to 8 ^{o}C. Fecundity ranges from approximately 70,300 to 173,600. Ide appear to change food preferences from season to season, but are omnivorous in late summer and fall (Dulmaa, 2002).

In the present study ide were common (n=8) in the 30- and 40-mm gill net collections, comprising 57.1 percent by number and 51.3 percent by weight. The largest specimen in these collections was 310 mm SL (365 mm TL) and weighed 632 g (**Table III.4-14**). Only one ide was collected by seine. This specimen was 100 mm SL (120 mm TL) and weighed 18 g. The paucity of small specimens in our catch suggests that spawning conditions may not be favorable for ide in the Project area.

Amur Carp (*Cyprinus carpio*) – is a species that made its way into the Selenge River drainage in the 1940s from localities in the Amur basin in eastern Mongolia (Kottelat, 2006). It feeds primarily on plant material and dipteran larvae, and is considered a valuable commercial species in eastern Mongolia.

In the present study, sampling with the 30- and 40-mm gill nets yielded a small number (n=3) of Amur carp (comprised 21.4 percent of the catch in these nets by number and weight). The largest Amur carp was 295 mm SL (340 mm TL) and weighed 674 g (**Table III.4-14**). No Amur carp were taken by seine. Adult Amur carp are fast swimmers and may have been able to avoid the seine net. No young carp were collected, suggesting that the species may not spawn in the study area.

Siberian Stone Loach (*Barbatula toni*) (**Attachment 5** of **Appendix E**, **Figure 25**) – Erdenebat (2006b) found that Siberian stone loach were present and generally abundant at 12 of 15 locations on the Tuul River sampled in June 2004. Only a small number of Siberian stone loach (n=13) were collected in the present study, all by seine (comprised 2.7 percent of the seine catch by number and 0.2 percent of the weight). The species was represented mostly by small specimens (average length – 46 mm TL, weight 0.85 g) (**Table III.4-14**). Specimens over 100 mm TL, which were common in Erdenebat's collections, were absent in our catch. This may have been caused by our inability to effectively sample riffle areas, the preferred habitat of adult stone loach, due to high river flow.

Siberian Spiny Loach (*Cobitis melanoleuca*) – Erdenebat (2006b) reported that Siberian spiny loach were common at many of the locations he sampled on the Tuul River in June 2004, and were particularly abundant in its lower reaches. Only one immature Siberian spiny loach was taken in the present study (48 mm TL, 0.42 g) (**Table III.4-14**). The scarcity of Siberian stone loach in our samples may have been related to the high river flow, as discussed above.

Amur Catfish (*Silurus asotus*) (**Attachment 5** of **Appendix E**, **Figure 24**) – made its way into the Selenge River drainage from the Amur basin in the 1930s (Kottelat, 2006). The species occurs primarily in shallow water during spring through fall, but overwinters in deeper channels and pools of large rivers. Amur catfish mature at an age of 4 to 5 years (350 to 370 mm in length). In Mongolia, spawning occurs during late May through the end of July, at water temperatures of 16 to 18 ^{o}C, in shallow water with submerged aquatic vegetation. Amur catfish feed on all types of fish, including crucian carp, ide, and Amur carp (Dulmaa, 2002).

In the present study, Amur catfish were collected at three of the seven sampling locations on the Tuul River, but occurred in low abundance. One specimen was collected by gill net (30-mm mesh) and four were collected by seine. The specimen taken by gill net was 457 mm TL in length and weighed 463 g. Its stomach contained three Siberian dace. The four Amur catfish taken by seine were all immature specimens, ranging from 38 to 104 mm TL in length and weighing 0.4 to 9.2 g.

Seven Amur catfish were collected by gill net (30-mm mesh) in the pit lake. These fish ranged from 317 to 356 mm TL in length and 218 to 263 g in weight. The remains of dragonfly and caddisfly larvae were found in the stomachs of these fish.

Yellow Perch (*Perca fluviatilis*) (**Attachment 5** of **Appendix E**, **Figure 30**) – is one of the most common fish in Mongolia, occurring in both rivers and lakes. In rivers, it prefers embayments, oxbows, and other low current areas. Two growth forms have been identified in Mongolia, with the slower growth form inhabiting shallow areas along river banks and the faster growth form occurring in deeper water. In the middle Selenge drainage, yellow perch may mature at age 4+, although most mature at ages 5 or 6+. In Mongolia, spawning begins is May, when the water warms to 3 to 7 ^{o}C, and continues through the end of June. Spawning generally occurs in water 0.5 to 2 m deep, over sand, stones, dead submerged vegetation, and flooded shrubs and grasses. Yellow perch is a relatively long lived species and fish up to 23 years old have been collected in Lake Hovsgol Nuur in Mongolia (Dulmaa, 2002).

In the present study, 14 yellow perch, totaling 781 g, were collected by seine in the Tuul River (3 of 7 sampling locations). None were taken by gill net in the river. Most of the yellow perch were adults (**Table III.4-12**). Yellow perch comprised 2.9 percent of the seine catch by number and 16.2 percent by weight. The largest yellow perch was 193 mm SL in length (208 mm TL) and weighed 123 g (**Table III.4-14**). One yellow perch (130 mm SL, 155 mm TL, 74 g) was collected by gill net (18-mm mesh) in the pit lake.

4.1.7 Benthic Macroinvertebrates

4.1.7.1 Tuul River

Sampling for macroinvertebrates in the Tuul River was performed using a dip net (0.5-mm mesh) at stations S-112, S-130, and S-135 in July 2008. Sampling at S-130 and S-135, which was performed by sweeping the dip net through beds of aquatic macrophytes near the river bank, yielded no macroinvertebrates.

The sample collected at S-112 (upstream of the Project area) contained 30 specimens of 11 invertebrate taxa (**Table III.4-15**). At this station, the sample was collected from an area of current-swept gravel by placing the dip net on the substrate and repeatedly disturbing the gravel immediately upstream. Although the number of specimens collected at this station was low, the macroinvertebrate assemblage was of relatively high quality and included six genera of mayflies

(Ephemeroptera), two genera of caddisfly (Trichoptera), the Sphaeriid (clam) bivalve Musculium lacustre, the gastropod (snail) Radix aurcularia, and an unidentified leech (Hirudinea). Two specimens of the Unionid mussel (*Anodonta cellensis*) were collected by hand at this station. These specimens were dead, but still contained tissue.

It is evident that macroinvertebrate communities in the study area have been impacted by sediment deposition from mining and erosion caused by overgrazing of livestock. Large areas along the banks and in side channels and bays are now filled with mud and silt that is over 30 to 50 cm deep in many areas. Areas of cobble and gravel, which once were the predominant substrates in the Tuul River, are now restricted to the central part of the main channel and other high current areas. The high river flows during our sampling precluded sampling in most areas with remnant rocky substrates.

4.1.7.2 Pit Lake

Two macroinvertebrate samples were collected by dip net at the pit lake (L-125). These samples were collected by sweeping the net through beds of aquatic macrophytes. These samples contained 167 specimens of eight invertebrate taxa (**Table III.4-15**). Dragonfly larvae of the genus Agriocnemis were most abundant, comprising 49.7 percent of the macroinvertebrate total at this station. Other common taxa included the gastropod Planorbis (29.3 percent), the caddisfly Agrypnia (8.4 percent), and the back swimmer Anisops (4.2 percent).

4.1.7.3 Ephemeral Pond

An ephemeral pond (L-105) located in the floodplain of the Tuul River near the Tuul River Bridge (upstream of the Project area) was sampled with the large seine net. Although no fish were collected, the seine contained hundreds of the tadpole shrimp *Lepidurus apus* (Class Crustacea – Order Notostraca). These ancient invertebrates are common inhabitants of temporary ponds in Mongolia (Naganawa and Zagas, 2002).

Table III.4-15 Macroinvertebrates Collected by Dip Net in the Tuul River and the Pit Lake in the Vicinity of the Big Bend Project Area, July 2008

Location	Tuul R.	Pit Lake	
Station	**S-112**	**L-125/1**	**L-125/2**
Date	**7/18/2008**	**7/16/2008**	**7/16/2008**
Hirudinea	3		
Insecta			
Ephemeroptera			
Baetidae			
Baetis	2		
Procloen	5		
Heptageniidae			
Heptagenia	1		
Ephemerellidae			
Ephemerella	2		
Caenidae			
Caenis	1		
Polymitarcyidae			
Ephoron	5		
Odonata			
Cordulegastridae			
Anotogastera		3	
Aeshnidae			
Aeshna		3	
Coenagrionidae			
Agriocnemis		36	47
Hemiptera			
Corixidae			
Sigara		1	1
Notenectidae			
Anisops		3	4
Trichoptera			
Hydropsychidae	1		
Hydropsyche			
Phryganeidae			
Agrypnia	1	1	13
Mollusca			
Bivalvia			
Sphaeriidae			
Musculium lacustre	6		
Gastropoda			
Limnaeidae			
Radix aurcularia	3		6
Planorbidae			
Planorbis		21	28
Total taxa	11	7	6
Total specimens	30	68	99

4.1.8 Periphyton

Periphyton is a general term used to describe the community of attached algae that occurs in aquatic ecosystems throughout the world (rivers, lakes, streams, wetlands, estuaries, and oceans). Periphyton are mostly primary producers, which produce oxygen and food for invertebrates and fishes. Periphyton have been used as excellent environmental indicators, as different species exhibit environmental preferences and often respond to changes in water quality and habitat conditions. Diatoms (Bacillariophyceae) are among the most useful taxa for biomonitoring, as they are ubiquitous and cosmopolitan, and have been shown to exhibit definite differences in water quality preferences (Lowe, 1974). Diatom cells are comprised of two siliceous shells or "frustules" which can be identified and counted using microscopic techniques.

Previous investigations of the diatom flora of the Tuul River periphyton have been conducted by Nergui (Sonya) Soninkhishig (1997), in the area of Ulaanbaatar. Analysis indicated water pollution impacts of the drainage and discharges from the city, but corroborated recovery downstream. Although no periphyton collections have been made to date in the Project area, water quality analyses indicated that during the winter 2002 period, there were no obvious impacts from Ulaanbaatar based upon normal chemical analyses. Periphyton diatoms of the Tuul River in the Project area can be expected to include those species already identified upstream near Ulaanbaatar, including several representative species of the genera Nitzschia, Navicula, Gomphonema, Cymbella, Pinnularia, Fragilaria, Achnanthes, and Synedra. These are all common taxa that can occur as epilithic (growing on rocks), epipelic (growing on mud), epipsammic (growing on sand), and/or epiphytic (growing on plants) periphyton in the Project area.

Other taxa that can be expected to occur in the Tuul River include green algae (Chlorophyta), blue-green algae (Cyanophyta), red algae (Rhodophyta), as well as other groups. Periphyton will be included in the Environmental Monitoring Program.

4.2 Threatened and Endangered Species

The information presented in the following discussion provides the most current available knowledge regarding the presence or absence of threatened or endangered (T&E) species of plants and animals that may be found at the Project area. Based on a review of the literature, including the International Union for Conservation of Nature (IUCN 2001; 2007), Mongolian Ministry of Nature and Environment (MNE, 1997) checklists, the Mongolian Red Lists (Clark et al., 2006; Ocock et al., 2006; Terbish et al., 2006), and a desktop study by Grayson (2001), a total of 37 threatened and endangered (T&E) floral and faunal species are expected to occur in the Zaamar Goldfield.

Although the presence/absence of all the taxa cited from the literature has not been field substantiated in the Project area, a discussion of potentially present species is given in each of the floral and faunal groups. However, for fish species, a field review investigation using standardized sampling methodologies was conducted during the AATA baseline study in July 2008. As part of this study, information on T&E species of fish was developed and this is presented below in **Section 4.2.3.5**.

4.2.1.1 Threatened and Endangered Classifications of the IUCN and MNE

Information regarding the presence of species that are considered to have special conservation status is presented in two distinct formats. First, sensitive animals are listed according to the internationally accepted standard using the system developed by the IUCN in the IUCN Red List of Threatened Species (IUCN 2001; 2007), in which the conservation status of sensitive species (and lower levels of taxon) are evaluated according to a range of qualitative and quantitative criteria, and classified into discrete categories representing various levels of concern. Second, species have been evaluated according to their conservation status in the Red Book of the Mongolia and by a regional biogeographically based assessment that follows (Grayson, 2001). IUCN and MNE terminology for T&E species is cited in **Table III.4-16**.

Table III.4-16 IUCN and MNE Threatened Species Categories

MNE Mongolian Red Data Book (1997)
Very rare: A species in danger of extinction with a reduced reproductive capacity and limited distribution. May only be used in research (This category corresponds to “extinct” and “endangered” in international T&E classifications.)
Rare: A species potentially at risk of extinction with limited reproductive capacity and distribution. May be used for “household” and “commercial” use with a permit. (This category corresponds to “vulnerable” and “rare” in international T&E classifications.)
Endemic: A species limited to a certain geographical area.
Relict: A species whose geographical range has been subjected to environmental change causing population isolation and fragmentation.
IUCN (2000)
EX – Extinct: A taxon is extinct when there is no reasonable doubt the last individual has died
EW – Extinct in the Wild: A taxon is extinct in the wild when it is known only to exist under cultivation, in captivity, or as a naturalized population.
CR – Critically Endangered: A taxon is critically endangered when it is facing a very high risk of extinction in the wild in the immediate future.
EN – Endangered: A taxon is considered endangered when it is not critically endangered but faces a high risk of extinction in the wild in the near future.
VU – Vulnerable: A taxon is vulnerable when it is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium term future.
LR – Lower Risk: A taxon is considered lower risk when it has been evaluated that it does not satisfy any of the other above categories. Three subcategories exist for LR, including: **cd** – Conservation Dependent: Taxa that are the focus of a continuing taxon-specific or habitat-specific conservation program. **nt** – Near Threatened: Taxa that do not qualify for conservation dependent status. **lc** – Least Concern: Taxa that do not qualify for conservation dependent or near threatened status.
DD – Data Deficient: A taxon is data deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.
NE – Not Evaluated: A taxon is not evaluated when it has not yet been assessed against the criteria.

4.2.2 Flora

4.2.2.1 Vascular Plants

There are twelve T&E vascular plant species listed in the Mongolian Red Book (MNE, 1997) that have known distribution ranges in the open steppe grasslands inclusive of the Selenge River Basin and Tuul River Valley; however, no IUCN (2000; 2007) listings for known species occur (**Table III.4-17**). Orchidaceae is the largest family group presenting Red Book status with four species whose known distribution includes steppe vegetation in the Selenge River Basin followed by Liliaceae with two species, and six other families.

For the Zaamar Goldfield, Grayson (2001) cites several Mongolian Red Book T&E species which occur in the open steppe of the Project area including several additional plant species which also likely occur in this habitat (**Table III.4-17**). Grayson (2001) also cites several other, mostly woody species, which are characteristic of forest vegetation in the Selenge River Basin and therefore not discussed here. Impacts to T&E forest species, while they may occur in areas immediately adjacent to the Zaamar Goldfield from anthropogenic activities, are outside of the scope of this study.

Significant population declines of plant species listed in **Table III.4-17** are due to several factors including habitat destruction, selective harvesting for commerce, food, and medicinal purposes (Grayson, 2001; MNE, 1997).

4.2.2.2 Lower Plants

Two species of fungi are cited in the Red Book as occurring in the steppe vegetation of the Selenge River Basin, the rare *Tricholoma mongolicum* (Tricholomaceae) and *Endophytum agaricoides* (Secotiaceae). Although fungi are treated in the Red Book, standardized methodologies have not been established in the literature to estimate population size for fungal taxa. Attempts to estimate population size of fungal species is confined to identifying fruiting bodies and not the mycelial mass, which may remain dormant underground for many years without producing such structures. This compromises the estimation of population size of fungi as a subjective and non-quantitative endeavor and hence, owing to this limitation, fungi are not evaluated as T&E species.

Table III.4-17 Threatened and Endangered Plant Species of the Open Steppe of the Selenge River Basin

Scientific Name	Family	Vernacular Name	Habitat	Reason(s) for Population Decline	Mongolian Red Book Listing
*Stellaria dichotoma**	Caryophyllaceae	Forked Stichwort	Stony slopes and sandy soils in mountain valleys	Over-collection as medicinal plants	Rare
Saussurea involucrata	Compositae		Exposed rocky and stony locations	Over-collection as medicinal plants	Very rare
Vicia tsydenii	Leguminosae	Tsydeni's Vetch	Sandy dunes in river valleys	Habitat disturbance (overgrazing and cropping)	Very rare, relict
Allium altaicum	Liliaceae		Exposed rocky and stony locations, esp. south facing	Over-collection of plants for food	Rare
*Lilium dahuricum**	Liliaceae		Grasslands along rivers and undergrowth at forest edges	Over-collection as ornamental plants	Very rare
Cypripedium calceolus	Orchidaceae	Yellow Lady's Slipper	River bank grasslands, forest edges and *Betula* forest	Habitat disturbance/destruction (grazing/agriculture), over-collection as ornamental plants	Very rare
Cypripedium macranthon	Orchidaceae	Grand Lady's Slipper	River bank grasslands, forest edges and *Betula* forest	Habitat disturbance/destruction (grazing/agriculture), over-collection as ornamental plants	Very rare
Orchis militaria	Orchidaceae	Military Orchid	Wet grasslands and banks of small rivers, forest and forest edges	Habitat disturbance/ destruction (grazing/ agriculture), over-collection for use as medicinal and ornamental plants	Very rare
Platanthera bifolia	Orchidaceae	Lesser Butterfly Orchid	Grassland and *Larix* and mixed beech forest	Over-collection as an ornamental plant	Very rare
Paeonia anomala	Ranunculaceae	Pink Peony	Moist soils, in understory esp. along rivers	Habitat destruction, over-collection for food, medicinal and ornamental use	Rare
Saxifraga hirculus	Saxifragaceae	Marsh Saxifrage	Montane wetland, stony/rocky areas, grasslands and river banks	Over-collection as a medicinal plant	Very rare
*Valeriana officinalis**	Valerianaceae	Common Valerian	Grasslands and forest edges and ravines	Over-collection as a medicinal plant	Rare

(* - Species cited in Grayson [2001] for the Project area)

4.2.3 Fauna

Based on field surveys and a comprehensive review of available literature, museum collections and unpublished information from credible experts, a list of species of the terrestrial and aquatic fauna that has a probability of occurrence at the Project area was compiled. The impact of the Project on each listed species is also discussed here and in **Part IV**.

4.2.3.1 Mammals

Review of the IUCN, MNE Red Book listings and Grayson (2001) support the potential existence of two T&E mammal species occurring in the Selenge River Basin, including the Daurian hedgehog (*Mesechinus dauricus*) and the East Siberian elk (*Alces alces pfizenmayeri*). Also, the musk deer (*Moschus moschiferus*) may potentially be present.

The Daurian hedgehog is cited as a rare in the Red Book (Clark et al., 2006) and Least Concern in the IUCN Red List (2000; 2007). It is a characteristic species of the semi-desert steppe region, where it coexists with marmots (*Marmota* spp.) and ground squirrels (*Citellus* spp.). It is often associated with wet areas such as willow (*Salix*) thickets, and also with birch (*Betula*), poplar (*Populus*), and larch (*Larix*) dominated areas as well. This species also occurs in steppe areas of pea shrubs (*Caragana* spp.) (MNE, 1997). Population numbers of this species are believed to be in decline owing to habitat destruction of the steppe from overgrazing and agriculture (MNE, 1997).

The elk is cited as a very rare in the Red Book (Clark et al., 2006) and Least Concern in the IUCN Red List (2000; 2007). Elk, known as the moose in North America, prefer river habitat in willow (*Salix*) thickets, and birch (*Betula* spp.) (MNE, 1997). This species does not frequent the open steppe. Illicit hunting for meat and hides has been the main cause of the steady population decline of elk (MNE, 1997).

The musk deer is listed as very rare in the Red Book (Clark et. al., 2006) and Vulnerable in the IUCN Red List (2000; 2007). It is also cited by Grayson (2001) as a species which will likely experience "moderate" impacts due to placer mining activities in Mongolia. Significant impacts to this species however, are considered unlikely for the Zaamar Goldfield as it is outside of the Red Book stated range of the musk deer. The musk deer is found in dense pine and larch forest and on shrub-covered slopes in sub-alpine zones (Clark et al., 2006). Illegal hunting has been a principal threat to the musk deer.

4.2.3.2 Birds

For the Selenge River Basin region, Radnaabazar (2001) cites 18 species that are listed in the Mongolian Red Book in forest-steppe. However, only 12 of these species occur in open steppe of the Selenge Basin, as cited in the Mongolian Red Data Book (Clark et al., 2006). Species believed to occur in the Project area include a diverse array of T&E resident and migratory taxa, **Table III.4-18**. The majority of the listed bird species are resident year-round in the Selenge River Basin.

The decline in populations of bird species listed in **Table III.4-18** results from a diverse array of causal factors including habitat destruction, predation, natural causes and selective hunting pressures; the most common of these being habitat destruction and selective hunting from colonization pressures.

Table III.4-18 Threatened and Endangered Bird Species of the Selenge River Basin

Scientific Name	Family	Vernacular Name	Habitat	Resident status	Reason(s) for Population Decline	Mongolian Red Book Listing	IUCN Listing
Haliaeetus albicilla	Accipitridae	White-tailed sea eagle	Large rivers and lakes	Resident	Disturbance to nest sites and possibly reduction in fish stocks and hunting	Rare	LR (nt)
Pandion haliaetus	Accipitridae	Osprey	Lakes and rivers in the forest-steppe region	Resident	Hunting, reduction in fish stocks and nest disturbance	Rare	
Anser cygnoides	Anatidae	Swan goose	Lakes and rivers especially with reeds (*Phragmites* spp.) and poplar (*Populus* spp.)	Migrant	Hunting and habitat destruction	Rare	
Anser indicus	Anatidae	Bar-headed goose	Montane regions, lakes and rivers in forest-steppe areas. 21 recorded on the Tuul River in 1992.	Resident	Hunting and possibly habitat destruction	Rare	
Cygnus cygnus	Anatidae	Whooper swan	Tall reed grasses (*Phragmites* spp.) along rivers and lakes	Migrant	Habitat disturbance, especially nesting sites, poaching and destruction of reed grass habitat	Very rare	
Ciconia nigra	Ciconiidae	Black stork	Forest-Steppe, Steppe and river valleys	Resident	Hunting and habitat destruction	Rare	
Grus vipio	Gruidae	Japanese white napped crane	Steppe grasslands and river valleys and lakes, esp. with reeds (*Phragmites* spp.)	Resident	Hunting, nest disturbance and habitat destruction	Very rare	VU
Grus leucogeranus	Gruidae	Siberian white crane	Lakes and rivers in steppe. Rare summer resident in north central and north western Mongolia.	Migrant	Habitat disturbance/destruction	Very rare, globally threatened	CR
Otis tarda	Otididae	Great bustard	Steppe grassland	Resident	Hunting, habitat disturbance/destruction (agriculture and fire) and pesticides	Rare, globally threatened	VU
Remiz coronatus	Remizidae	White-crowned penduline tit	Reeds (*Phragmites* spp.) along watercourses	Resident	Habitat disturbance/destruction (reed cutting, fire) and predation	Rare	
Limnodromus semipalmatus	Scolopacidae	Asiatic dowitcher	Moist grassland steppe, along shallow rivers	Migrant	Habitat disturbance/destruction	Rare	LR (nt)
Platalea leucorodia Linnaeus	Threskiornithidae	Eurasian Spoonbill	Swampy areas and rivers with reeds (*Phragmites* spp.) and shallow water with willows (*Salix*)	Migrant	Hunting and possibly habitat destruction	Rare	

4.2.3.3 Reptiles and Amphibians

Mongolian Red Book listed herpetofaunal species cited for the Selenge River Basin include two amphibian species (Grayson, 2001; MNE, 1997; Terbish, 2006). The rare Siberian salamander (*Salamandrella keyserlingii*) is believed to occur in the Selenge River Basin, although the disturbance and destruction of its marsh habitat has led to significant decline in overall population numbers. Similarly, the rare Japanese tree frog (*Hyla japonica*), occurring in moist grasslands and willow thickets of the Selenge River Basin and adjacent regions, is also thought to be in decline owing significantly to habitat destruction. There are no known T&E reptile species occurring in the Selenge River Basin.

4.2.3.4 Invertebrates

The Mongolian Red Book (MNE, 1997) cites numerous invertebrate species with known distributions in the Selenge River Basin with T&E status. Taxa cited include eight insects and one mollusk species for a total of nine invertebrates known to occur in the Selenge River Basin (**Table III.4-19**). The largest invertebrate group, facing potential impacts from anthropogenic activities in the Basin, includes five Lepidopteran species, consisting of four butterfly and one moth species. In a similar review, Grayson (2001) cites seven invertebrates as likely occurring and facing potential impacts in the Zaamar Goldfield (**Table III.4-19**). One additional T&E species, the very rare emperor moth (*Eudia pavonia*), is cited in **Table III.4-19** as likely occurring in the Zaamar Goldfield. It is known to occur in grassland steppe immediately north of the Zaamar Goldfield.

In overview, decline in population numbers of invertebrate species is attributable to many diverse factors including drought, habitat destruction, pollution, and collection for commercial gain (in the case of butterfly and moth species).

Table III.4-19 Threatened and Endangered Invertebrate Species of the Selenge River Basin

Class	Scientific Name	Vernacular Name	Habitat	Reason(s) for Population decline	Mongolian Red Book Listing	IUCN Listing
Insectae	*Aromia moschata orientalis*	Musk beetle	Willow thickets in river valleys	Habitat disturbance, fire, and willow cutting	Rare	
	Parnassius apollo	Apollo butterfly	Open ridge areas and montane glades	Habitat disturbance (agriculture, hay cutting, and overgrazing) and collectors	Rare, globally threatened	VU
	Parnassius phoebus	Small Apollo butterfly	Montane grassland	Habitat disturbance (agriculture, hay cutting, and overgrazing) and collectors	Rare	
	Parnassius tenedius	Tenedius Apollo butterfly	Montane valleys and streams, grasslands and open forest	Habitat disturbance (agriculture, hay cutting, and overgrazing) and collectors	Rare	
	Papilio machaon	Swallowtail butterfly	Open montane slope areas	Habitat disturbance (agriculture, hay cutting, and overgrazing) and collectors	Rare	
	Eudia pavonia	Emperor moth	Grassland steppe with shrubs and forest	Potential threat of over-collection by collectors	Very rare, potentially extinct	
	Bombus muscorum	Bumble bee	Grassland and forest	Habitat disturbance (agriculture, hay cutting and overgrazing), drought, and fire	Rare	
	Bombus sporadicus	Bumble bee	Unknown	Unknown status	Rare	
Molluscae	*Anodonta sedakovi*	River mussel	Selenge, Orkhon and Tuul Rivers	Water pollution of the Tuul River	Rare	

4.2.3.5 Fish

FishBase (Froese and Pauly, 2008) lists four species of fish as endemic to Mongolia. None of these species occur in the Tuul River drainage.

The Mongolian Red List of Fishes (Ocock et al., 2006) provides an assessment of the conservation status of the fishes of Mongolia. Listed species that occur in the Tuul River (except those designated with the UCN "Least Concern" status) are discussed below. Species with the Least Concern designation have large populations and wide distributions.

Of the seven species discussed below, only the ide was taken in the present baseline study collections. The population of ide in the study area appears to be in good condition.

Siberian Sturgeon (*Acipenser baerii*) – The Red List assigns the Siberian sturgeon a regional status of "Critically Endangered", indicating that it faces an extremely high risk of extinction in Mongolia. The Mongolian Law of Fauna lists the Siberian sturgeon as Very Rare and prohibits any fishing for the species. Poaching and habitat degradation, sedimentation from mining, and urban pollution are the primary negative factors affecting the Siberian sturgeon.

The Selenge River is the primary spawning ground for the Siberian sturgeon, which exhibits both resident and migratory subpopulations (Dulmaa, 2002). The non-migratory form was formerly known from the lower Tuul River, where it overwintered in deep pools. Siberian sturgeon no longer occur in the Tuul River because of pollution. It is unlikely that the species ever occurred in the Project area due to the lack of deep pools required for overwintering.

Siberian Taimen (*Hucho taimen*) – The Red List assigns Siberian taimen a regional status of "Endangered", meaning that it faces a very high risk of extinction in Mongolia. Taimen is the world's largest salmonid and is highly sought by sport fishermen. The Mongolian Law of Fauna lists the taimen as rare, although it is still possible to obtain a special permit to fish for the species. Taimen was listed in the Red Book of Mongolia in 1995 (MNE, 1997). Taimen stocks have been decreasing rapidly in many parts of Mongolia. Illegal fishing and habitat degradation, particularly in overwintering and spawning areas, are the primary threats to the species. Pollution impacts have been particularly severe in the Selenge River drainage, including the Tuul, Eroo, Kharaa, and Orkhon rivers.

Taimen have become very rare in the Tuul River. In 2003, it was present only in the very upper reaches of the Tuul River, upstream of the confluence with the Tereldzh River, and was not found downstream of Ulaanbaatar (Erdenebat, 2006b).

Lenok (*Brachymystax lenok*) – The Red List assigns lenok a regional status of "Vulnerable", indicating that it faces a high risk of extinction in Mongolia. This species has a wide distribution, but it is locally threatened by illegal fishing and pollution from mining. It has habitat requirements similar to taimen. On the Tuul River, Erdenebat (2006b) collected lenok only at stations upstream of the area affected by mining pollution.

Artic Grayling (*Thymallus arcticus*) – The Red List assigns Arctic grayling a regional status of "Near Threatened". Arctic grayling is a common species in the upper reaches of the Tuul River and in some of its tributaries. However, its numbers are rapidly decreasing in waters subject to pollution from mining. It is also vulnerable to overfishing. On the Tuul River, Arctic grayling was present only at sampling stations upstream of Ulaanbaatar (Erdenebat, 2006b).

Baikal Cisco (*Coregonus migratorius*) – The Red List assigns the Baikal cisco a regional status of "Data Deficient." The Baikal cisco was listed in the Red Book of Mongolia in 1987 (MNE, 1997). Illegal commercial fishing and habitat loss/degradation associated with mining are the principal threats to the species in Mongolia. Recent data indicates that Baikal cisco use an approximately 200 km reach of the Selenge River upstream of the Russian-Mongolian border for spawning (Ocock et al., 2006). Climate change, pollution, and a decrease in water level during spawning may impact the species' reproductive success. Baikal cisco no longer use the Orkhon River for spawning because of pollution. Pollution inputs from the Tuul and Orkhon rivers may impact the vulnerable Selenge River stock of Baikal cisco.

Ide (*Leuciscus idus*) – The Red List assigns ide a regional status of "Near Threatened". Decline in habitat quality related to gold mining and overfishing of adults in Ugii Lake are reported to be the principal threats to ide in Mongolia. Erdenebat's (2006a; b) data suggested that the ide is a relatively rare species in the lower Tuul River. However, ide were common in present-study collections, however, comprising over 50 percent by number and weight in the 30- and 40-mm gill net catch.

Small Osman or Dwarf Osman (*Oreoleuciscus humilis*) – The Red List assigns small osman a regional status of "Vulnerable". The fragmented distribution of the species, combined with the potential impacts of habitat degradation and climate change are given as the reasons for this designation. Erdenebat (2006a; b) reported that populations of small osman occur in some of the tributaries of the Tuul River (Tarnain-Gol, Kharabukhyn-Gol), but this species does not occur in the mainstem of the Tuul, Orkhon, or Selenge rivers.

4.2.3.6 Non-Native Fishes of the Selenge River Drainage

Impacted habitats are more vulnerable to the successful naturalization of non-native species than pristine habitats. Decreases in current velocity and sedimentation support the wider distribution of resident limnophilous species (e.g., Prussian carp, yellow perch, and northern pike) and non-native fish (e.g., Amur carp, Amur catfish, bream, and Amur sleeper). In recent years the number and relative abundance of non-native fish has increased significantly. Seven non-native fishes now occur in the Selenge River drainage, representing 29 percent of the entire fish fauna. Only two of these species were intentionally stocked into Mongolian waters (Baikal cisco and peled, Coregonius peled). The other five species have moved into Mongolian rivers from the Russian portion of the Selenge River.

Prussian carp (*Carassius gibelio*) were introduced into Lake Baikal in Russia and spread into northern Mongolia through the Selenge River.

Amur carp (*Cyprinus carpio*) were stocked into Lake Baikal in the 1940s. Moving up the Selenge River, the species has reached the Tuul River and Ugii-Nur Lake, where it is now a commercially harvested species.

Bream (*Abramis brama*) were stocked in some lakes of the Selenge River drainage in 1954. The species was found in the Orkhon and Eroo rivers for the first time in 2004.

Amur catfish (*Silurus asotus*) were stocked from the Amur River into Shashka Lake (Russia) in 1932. Shortly thereafter the species appeared in Mongolia and populated the Tuul and Orkhon rivers.

Amur sleeper (*Perccottus glenii*) were accidentally introduced from the Amur River into the Russia portion of the Selenge River. In Mongolia it is found in the Buur River, a tributary of the Orkhon River.

Four of these five species originated in the Amur River and three (Prussian carp, Amur carp, and Amur catfish) were present in our collections in the Tuul River in the AATA July 2008 baseline study. These three species are represented by reproducing populations and appear to be in good condition.

4.2.4 Environmentally Sensitive Areas

In the Project area, the wetland/riparian zone, upland steppe grassland and upland forest can be considered to be Environmentally Sensitive Areas (ESAs). The wetland/riparian zone and upland forest are especially important as habitat for many wildlife species, offering key resources such as moisture and cover. In addition, the larch-birch-poplar forest areas, although outside the Project area concessions, are considered to be locally threatened because the existing patches are the only local potential source of valuable fuel wood and timber.

The upland steppe grassland is also considered to be an ESA. This vegetation occurs on the steeper slope areas of the Zaamar mountains and is consequently relatively more prone to disturbance induced erosion problems from grazing livestock/wildlife in comparison with the lower valley steppe. The presence/absence of Threatened and Endangered species in the Project area requires assessment and may influence the importance and location of these ESAs.

All drainages in addition to areas of chronic erosion are also considered environmentally sensitive areas. The Selenge River Basin is not inclusive of any nationally protected areas.

4.2.5 Protected Areas, National Parks and Ecological Sensitivity

As previously noted in **Part II**, Mongolia has one hunting reserve (Ar-Toul), 16 national conservation parks, 6 natural monuments, 16 nature reserves and 12 strictly protected areas (World Database on Protected Areas, 2007). **Table II-3** lists the different major protected areas in Mongolia. **Figure II-4** shows the spatial distribution of these areas. Other areas have been designated as wetlands of international importance, world heritage sites and biosphere reserves.

Currently, 11 areas have been designated as Ramsar sites for wetlands protection: Ayrag Nuur; Har Us Nuur National Park; Lake Achit and its surrounding wetlands; Lake Buir and its surrounding wetlands; Lake Ganga and its surrounding wetlands; Lake Uvs and its surrounding wetlands; Lakes in the Khurkh-Khuiten River Valley; Mongol Daguur; Ogii Nuur; Terihiyn Tsagaan Nuur; and the Valley of Lakes (Wetlands International, 2007). Ramsar sites are wetlands of international importance as designated under the Ramsar convention. They are defined as having “international significance in terms of ecology, botany, zoology, limnology or hydrology” (WRI, 2008).

Mongolia has two world heritage sites (UNESCO World Heritage Center, 2008). The Orkhon Valley Cultural Landscape was inscribed in 2004; and the Uvs Nuur Basin was designated in 2003.

Mongolia’s six biosphere reserves are (UNESCO-MAB, 2007):

- the Great Gobi National Park (1990);
- the Boghd Khan Uul (1996);
- the Uvs Nuur Basin (1997);
- Hustai Nuruu (2002);

- Dornod Mongol (2005); and,
- Mongol Daguur (2007).

All of these protected areas are more than 100 km from the Project area.

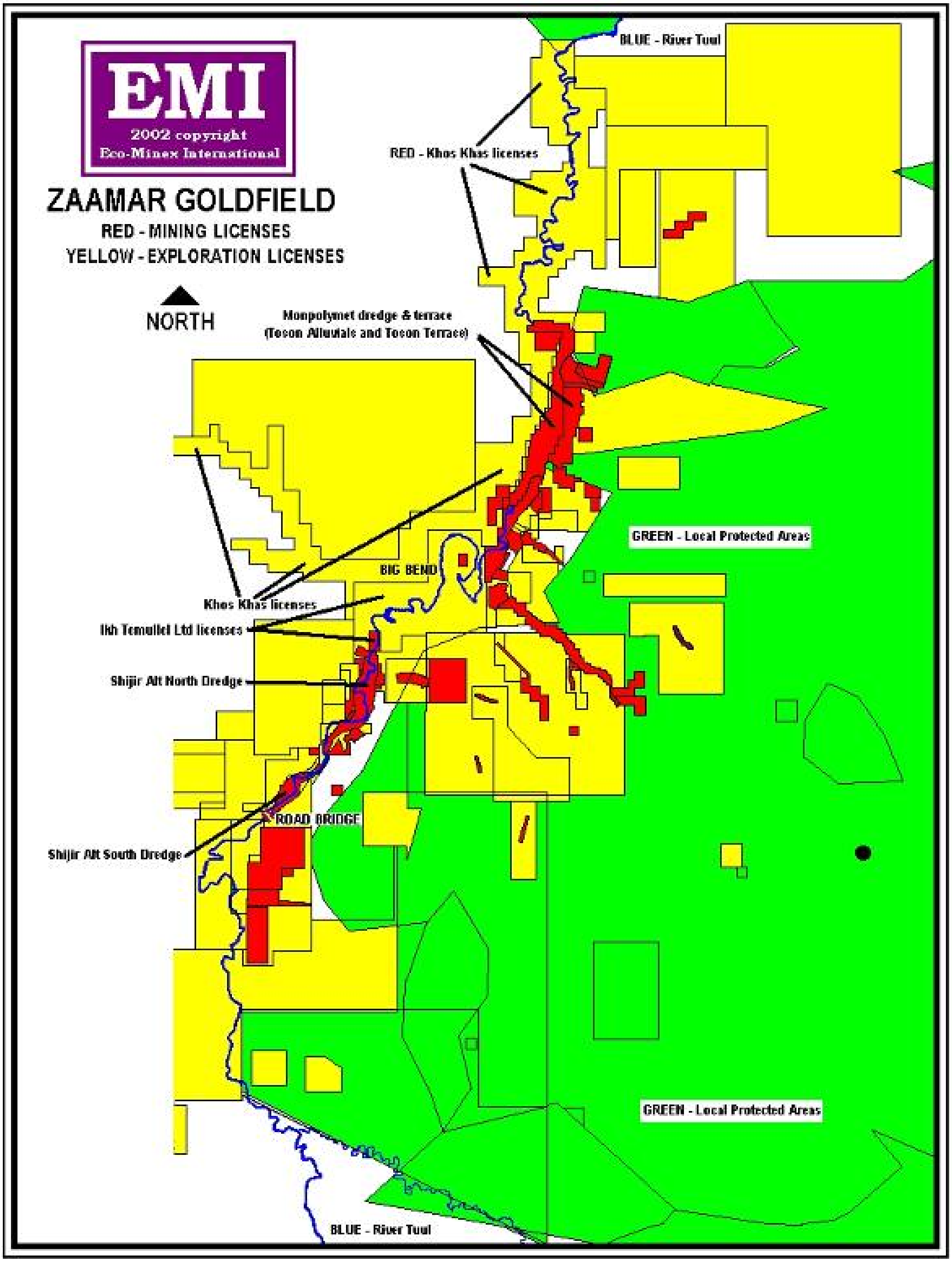
The Law on Special Protected Areas provides authority for Soum Governors to designate certain parts of their territory as Local Special Protected Areas. In such events, it is prohibited to explore or mine natural resources. It is also prohibited to conduct any activities that pollute the soil, water and air. Large sections of the Project area in the east and north sector of the Zaamar Goldfield are recognized locally as Local Special Protected Areas. These Local Special Protected Areas are principally used as rangeland for livestock, where mining activities are not permitted (**Figure III.4-4**). The Project also intends to exclude grazing activities from the immediate concession license areas to mitigate potential rangeland erosion problems.

4.2.5.1 The Tuul River Valley, Ecological Sensitivity and Lake Baikal

The Selenge River Basin, including the Tuul River Valley, is the most important major tributary of Lake Baikal (Siberia, Russia), a UNESCO World Heritage Site, where it contributes almost one half of inflow to the Lake. Because of its importance as the major drainage to the lake, a major portion of the Selenge River Basin (Kabansky Zakaznik, Russia), was designated a Ramsar protected site in 1994 (UNEP, 2008).

In spite of the importance of the Selenge River Basin to the hydrology and general ecology of Lake Baikal, the watershed also carries detectable amounts of industrial pollution and sediment to the Lake, originating from settlements in the watershed, including the Mongolian cities of Darhan and Suhbaatar (Belt, 1992). In contrast regional surface water quality in some parts of the sparsely populated Selenge River Basin does improve with distance downstream in certain regions of the drainage. Three-hundred kilometers upstream from the Project area on the Tuul River, at the capital city of Ulaanbaatar, water quality is Class 4; the water quality rating improves however when it reaches the Project area rising to a Class 2 standard (World Bank, 2000). The Project area on the Tuul River, located approximately 600 kilometers upstream from the discharge point to Lake Baikal, is thus unlikely to have a significant effect on the water quality reaching the Lake. The most significant water quality impacts that may potentially reach an undetermined, though regional distance downstream from the Project area, include episodic and accidental discharges of sediment into the river from mining activities.

Figure III.4-4 Local Protected Areas in the Zaamar Goldfield



Source: EMI, 2002

4.2.6 Remote Sensing Analysis

4.2.6.1 General

As part of the AATA baseline for this SEIA, a remote sensing analysis and study was conducted focusing on the Project area and the immediately adjacent region. The main objectives of this study were to analyze and characterize natural and disturbance features and examine land-use patterns in an assessment of the current overall impact footprint of mining activities in the Project area. A supervised vegetation classification was produced describing both natural and disturbance features. This remote sensing study presents IKONOS 1 m panchromatic fused with 4 m multi-spectral imagery and aerial orthophoto mosaic photographs of the Project area in an analysis of the natural and disturbance classes.

IKONOS 1 m panchromatic and 4 m multi-spectral imagery, taken on July 15, 2008, were used to produce the current supervised classifications for the Project area, including, base images and the supervised vegetation classification. The base images with the Project area are also discussed in the context of verifying and corroborating the remote sensing data with groundtruth observations recorded from field studies at the Project area conducted by AATA in July 2008.

In addition to the IKONOS imagery, an aerial photograph mosaic of the Tuul River Valley was compiled and is discussed with reference to a historical perspective of the Project area. An aerial photograph mosaic was created using 112 black and white photographs. The photographs, taken in 1963 by the Soviet military, were used here to create a seamless orthophoto mosaic of the entire Project area in the Tuul River Valley. The mosaic, which shows pre-project early mining conditions, is a useful frame of reference in gauging the extent of impacts, which have occurred over the past 45 years. Landsat and orthophoto imagery was processed by Information Integration & Imaging LLC (i-cubed), Fort Collins, Colorado, USA; the methodology report is provided in the **Attachment 3** of **Appendix E**.

4.2.6.2 Materials and Methods

Orthorectification of IKONOS Imagery

The source imagery used for the Project is IKONOS 1 m panchromatic and 4 m multi-spectral imagery collected on July 15th, 2008.

The following control sources were used:

- Horizontal Control: The 1 m Panchromatic IKONOS imagery was horizontally controlled using the Rational Polynomial Coefficients (RPCs) provide by GeoEye. The RPCs represent a calculation of the mathematical model of the image geometry of the IKONOS sensor. I-cubed improved the fit of the rational polynomial model to the 3 m seamless orthomosaic that was produced by i-cubed in 2003 for this same Project area in the Tuul River region of Mongolia. The source images for the 3 m seamless orthophoto mosaic were 112 individual orthophotos provided by AATA. The original geographic referencing of the orthophotos was not altered.
- Vertical Control: The IKONOS imagery was vertically controlled using 3 arc second terrain data derived from NASA's Shuttle Radar Topography Mission (SRTM).

The following projection and datum were used for georeferencing.

- Projection: Gauss Kruger Transverse Mercator
  Central Meridian : 105°E
  Reference Latitude: 0°
  False Easting: 18,500,000
  False Northing: 0
- Datum: WGS84

A total of 47 Ground Control Points (GCPs) were collected with an overall Root Mean Square (RMS) error of 1.74 pixels in the X direction and 3.01 pixels in the Y direction. The data was corrected using a first order polynomial transformation using the above reference points.

Image Processing

IKONOS imagery was processed with Peripheral Component Interconnect (PCI) ImageWorks V.9.1 and ArcView Geographical Information System (GIS) software in generating the supervised classification by i-cubed.

Four principle classes for the Tuul River Project area are described including:

1. Natural Riparian
2. Steppe and upland grassland/forest
3. Wetland Anthropogenic features
4. Dryland Anthropogenic features

Land use and vegetation communities provide distinctive spectral signatures in IKONOS imagery.

4.2.6.3 IKONOS Imagery – Tuul River Valley

Unsupervised Classification

The unsupervised classification or "base image" was used to overlay the Project area of the Tuul River Valley, including the adjacent area (**Figure III.4-5**). Many important features are readily evident on the unsupervised classification, Error! Reference source not found..

Table III.4-20 Basic Natural and Disturbance Features on the Unsupervised Classification

Natural Features	**Disturbances**
Ridges	Dredge pond
Wetlands	Mining pond
Forest	River diversion
Steppe grassland	Dry mining
Upland steppe	Roads
Rivers	Camps
Clouds and shadow	

The Project area of interest and key features is presented in **Figure III.4-6**.

Figure III.4-5 Concession/License Boundary on the Unsupervised Classification – Base Image

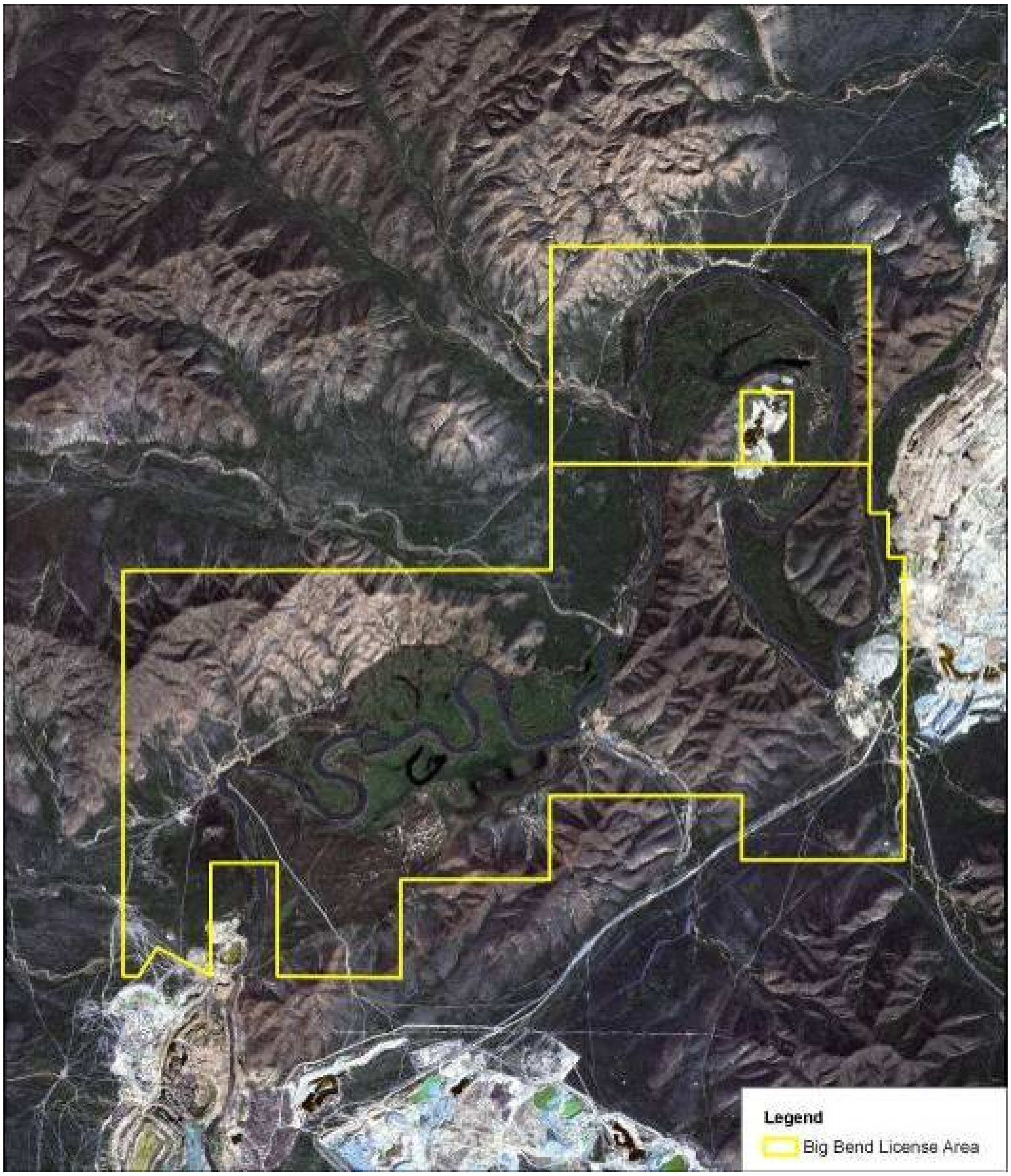


Figure III.4-6 Big Bend Area of Interest

Legend:
1. Main access route from main public road
2. Ikh Temullel mine camp and mining operations
3. Oxbow lake at the Big Bend locality
4. Disturbed area (circular) belonging to Erel Company
5. North end of the North dredge area of the Shijiir Alt Concession

4.2.6.4 Supervised Vegetation Classification

A supervised vegetation classification was interpreted through first visually interpreting the unsupervised image in order to define training areas for various classes. A Maximum Likelihood Classifier Algorithm (MLCA) was used to analyze spectral and textural input information in defining the following specific classes:

- River;
- Grassland;
- Forest;
- Oxbow areas;
- Upland barren steppe;
- Mining disturbances; and
- Mining ponds.

A manual classification was then conducted based on the above eight automated classes, in addition other classes were manually defined (**Table III.4-21**).

Table III.4-21 Categories of Class Analyses

Main Class	Manual Division
Water	Mining Dredge Ponds
Mining Disturbances	Mining Camps
	Mining Roads

It was possible to automatically extract the main river channel, as it exists today, and mining ponds because of their distinct differences in sediment load. Mining dredge ponds were manually extracted from the mining ponds class, based on their distinct linear physical characteristics, or the evidence of dredging equipment.

Mining channel diversions were manually distinguished as waterways that lead from the main river channel into mining ponds. One section of the Tuul River itself was classified as a mining diversion channel based on examination of pre-mining photography.

Mining roads were manually digitized from 2008 IKONOS imagery, and encoded into the classification based on a 5 m estimated thickness.

Mining camps were manually digitized as polygons from 2008 IKONOS imagery, and encoded into the classification.

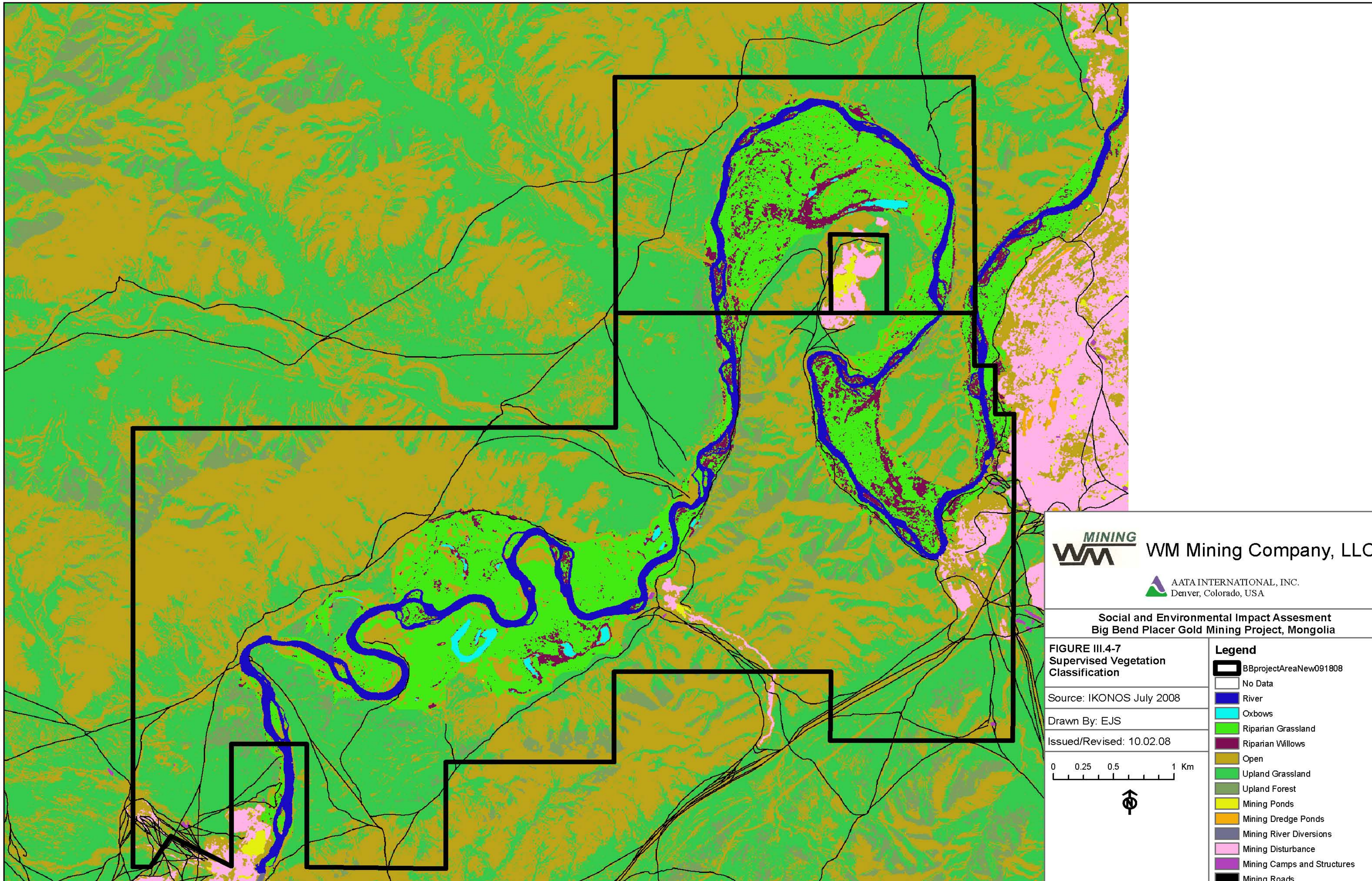
4.2.6.5 Principal Class Descriptions and Area Coverage in the Tuul River Valley

The principal classes described in **Table III.4-21** above, corresponding to natural riparian, steppe/upland grassland and forest, wetland anthropogenic features and dryland anthropogenic features in the Project area are analyzed in terms of the supervised vegetation classification. Certain distinctive features are particularly evident in the supervised classification, such as certain vegetation types (wetland/riparian areas, upland grassland and forest), mining and camp disturbances, and roads, **Figure III.4-7**.

The largest area coverage in the Project area is the uplands/open class at 83.35 percent of the total concession area of approximately 8,500 hectares (Ha). This is followed by dryland anthropogenic features (mining disturbance, camps and roads) at 8.13 percent; natural riparian features at 7.54 percent; and lastly by wetland anthropogenic features (mining disturbance) at 0.98 percent (see **Table III.4-22**). Only limited mining has occurred on this section of the Tuul River in the Project area (**Figure III.4-7**).

Table III.4-22 Big Bend Area of Interest Class Descriptions and Area of Coverage

Class Description	Counts	Sq. Meters	Hectares	Percentage
river	96,948	1,551,168	155.12	1.52
oxbow lakes	7,500	120,000	12.00	0.12
riparian grassland	316,306	5,060,896	506.09	4.95
riparian forest	60,475	967,600	96.76	0.95
Natural Riparian	**481,229**	**7,699,664**	**769.97**	**7.54**
open	2,536,155	40,578,480	4,057.85	39.73
upland grasslands	2,473,414	39,574,624	3,957.46	38.75
upland forest	311,305	4,980,880	498.09	4.88
Uplands/Open	**5,320,874**	**85,133,984**	**8,513.40**	**83.35**
mining pond	24,043	384,688	38.47	0.38
mining dredge ponds	33,327	533,232	53.32	0.52
mining river diversion	4,970	79,520	7.95	0.08
Wetland Anthropogenic Features	**62,340**	**997,440**	**99.74**	**0.98**
mining disturbance	388,214	6,211,424	621.14	6.08
mining camps	5,033	80,528	8.05	0.08
mining roads	126,101	2,017,616	201.76	1.98
Dryland Anthropogenic Features	**519,348**	**8,309,568**	**830.96**	**8.14**
			Total Hectares =	**10,214.07**


MINING
WM Mining Company, LLC
AATA INTERNATIONAL, INC.
Denver, Colorado, USA
Social and Environmental Impact Assesment
Big Bend Placer Gold Mining Project, Mongolia
FIGURE III.4-7
Supervised Vegetation Classification
Source: IKONOS July 2008
Drawn By: EJS
Issued/Revised: 10.02.08
0 0.25 0.5 1 Km
N
Legend
BBprojectAreaNew091808
No Data
River
Oxbows
Riparian Grassland
Riparian Willows
Open
Upland Grassland
Upland Forest
Mining Ponds
Mining Dredge Ponds
Mining River Diversions
Mining Disturbance
Mining Camps and Structures
Mining Roads

4.2.6.6 Principal Classes

Natural Riparian

Natural riparian features including, rivers, oxbows, riparian grassland, and riparian willows account for 7.54 percent (769.97 Ha) of the total area coverage for the supervised classification (**Table III.4-22**).

Steppe/upland grassland and Forest

Open, steppe grassland (upland grassland), and upland forest classes account for the greatest area coverage in the supervised classification area, accounting for 83.35 percent (8,513.40 Ha) of the total area coverage (**Table III.4-22**).

Wetland and Dryland Anthropogenic Features

Although wetland and dryland mining disturbance is commonly observed in the Tuul River Valley and some adjacent drainages, the overall footprint of these two classes in the context of the entire supervised classification area is relatively small. Combined, wetland and dryland mining disturbance accounts for 9.11 percent (930.70 Ha) of the total area coverage of the supervised classification area.

Wetland mining disturbance features account for a relatively small 0.98 percent (99.74 Ha) of the total area coverage, while dryland mining disturbance features represent 8.13 percent (830.96 Ha) (**Table III.4-22**). Most of these disturbances are currently outside the Project Area (**Figure III.4-7**).

4.2.6.7 Key Subclasses in the Supervised Classification

Vegetation

Vegetation coverage for the supervised classification is described in **Table III.4-22**. The supervised vegetation classification presents five principal vegetation types amongst grassland and forest. Three major types of grassland formations are discernable from the classification including, riparian grassland, steppe, and upland grassland. The riparian (wetland) grassland is confined to the Tuul River floodplain and some tributary drainages. Riparian grassland is most continuous along sections of the Tuul River generally outside areas of intensive wet and dry mining. The largest single patch of riparian grassland in the actively mined section of the Tuul River in the Project area is along the river floodplain in the southern section of the Project area.

The steppe grassland of the Tuul Valley and adjacent areas is detectable in two forms from the supervised area coverage of the Project area, steppe and upland grassland. The steppe grassland occurs between the low mountains across characteristic broad valleys. It may be referred to as valley steppe. This form of steppe vegetation is thought to be characterized by relatively tall grasses and forbs dominated by the graminoid formation Poa-Carex-Elymus. In contrast, the upland grassland evident in the supervised classification is restricted to upper mountain slopes and ridges where the Stipa-Cleistogenes-Poa association, another graminoid formation, is characteristic, presenting shorter stems and possibly a greater reflectance signature of soils.

Two forest types occur in the IKONOS area coverage of the Zaamar Goldfield, including willow thickets along the Tuul River floodplain and Larch-beech-poplar forest in mountain valleys. Willow (*Salix cf. ledebourina*) occurs in the Project area concessions where patches of thickets are observed on the depositing (as opposed to cutting) banks of the Tuul River and on some island in the channel. Willow patches are fragmented and occur sporadically. Outside of the Project area concessions in the mountain valleys larch-beech and poplar forest occurs, the closest and most abundant forest patches observed to the east of the Tuul River.

Mining and Camps

Mining disturbances, including a camp and a large pit lake, occur in within the Project area. In the area of interest, wet placer mining in the Tuul River floodplain is clearly evident. On-shore dry mining is extensive in the Tuul River Valley as the supervised vegetation classification indicates (**Figure III.4-7**). Most dry mining has occurred along the east bank of the Tuul River. Additionally, dry mining occurred in the Haailast Valley, east and outside of the Project area. Other dry mining sites have occured south of the Project area. Area coverage for both wet and dry mining classes is described in **Table III.4-22**.

Mining camps, which represent more permanent or semi-permanent structures, are contrasted to the ger camps, which are highly mobile and can be removed in a matter of hours to another location. Ger camps are not detected in this supervised classification.

Roads

Beginning with the main highway, an extensive network of access roads exists in the Tuul River Valley. Most roads (mostly unsurfaced tracks) presently occur on the east side of the Tuul River where mining activities are greatest. The road network penetrates valleys adjacent to the Tuul River and in fact exits the Project area along several of these routes. The main access roads are recognized in the supervised classification and account for 1.98 percent (201.76 Ha) of the total coverage area (**Table III.4-22**).

4.2.6.8 Aerial Orthophoto Mosaic

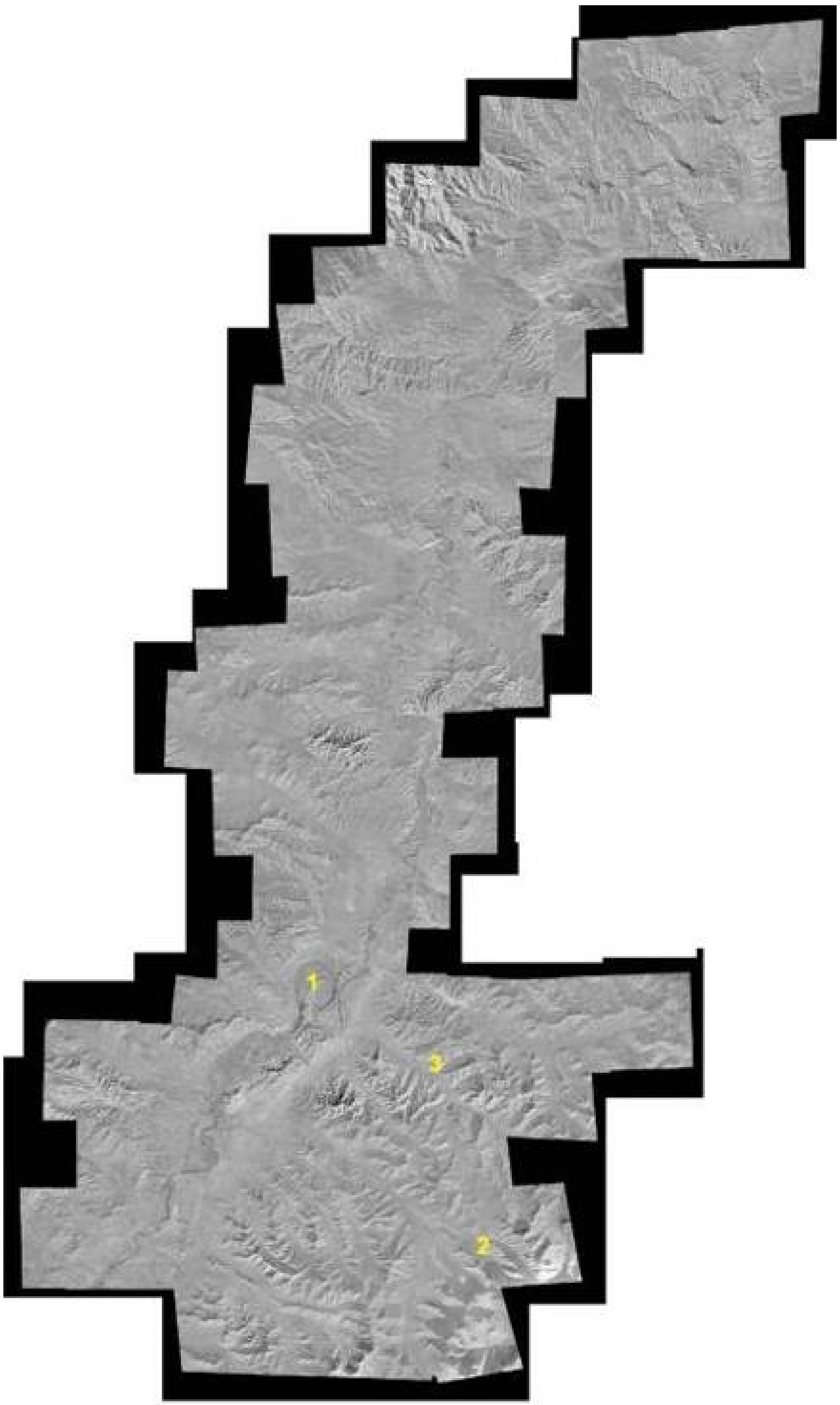
A 3 m resolution, seamless orthophoto mosaic was created of the Tuul River valley. The mosaic was created from 112 black-and-white aerial photographs taken in the fall of 1963 by the Soviet military.

In processing of the mosaic, the geographic referencing of each photo was not altered and each was individual photo was clipped to remove the surround data prior to generation of the completed orthophoto mosaic with OrthoVista software. A composite image results as a photomosaic of the Tuul River Valley, **Figure III.4-8**.

The orthophoto mosaic depicting the pre-project state of the Project area circa 1963, exhibits many natural and anthropogenic features which remain evident and current to the present day including:

- Roads and bridges;
- Small scale artisinal dry mining;
- Forest patches of larch/birch/poplar and willow thickets; and
- River and drainages.

Figure III.4-8 Tuul River Valley Orthophoto Mosaic (C. 1963)



Legend:

1. Big Bend
2. Forest Patches
3. Haailast Valley

4.2.6.9 Key Features of the 1963 Orthophoto Mosaic

Roads

Many of the present day major arterial access routes in the Project area date back to 1963. The bridge crossing of the Tuul River is visible. The bridge crossing location however has changed from immediately north of the southern dredge area to its present location to the south.

Apart from the main road, several secondary un-surfaced roads are evident from the orthophoto and are current to the present day, such as existing in the Haailast Valley and along the east bank of the Tuul River past the present day Project area, indicated in **Figure III.4-8**.

Artisinal Dry Mining

Analysis of the 1963 orthophoto also indicates the pre-project existence of small scale disturbances, perhaps early dry mining activities. Small-scale disturbances are also visible in the valleys east of the Tuul River such as the Haailast and other adjacent valleys (**Figure III.4-8**).

Forest Patches

Forest patches are also clearly visible in the orthophoto. Larch/birch/poplar forest patches are visible in the mountains outside and adjacent to the Project area concessions. In comparison with the present day IKONOS imagery, these patches, although still present, have been significantly reduced in size. This is assumed to be due to woodcutting largely for fuel wood by local inhabitants. The interconnected nature of the forest patches in the extreme southeast of the orthophoto is clearly visible. This is contrasted with the fragmented nature of these present day forest patches as seen in the supervised vegetation classification. Willow thicket patches in the Tuul River floodplain are also evident in the orthophoto, where they tend to occur on the depositing (as opposed to cutting) sections of the riverbanks.

River and Drainages

The Tuul River and adjacent drainages are clearly evident in the orthophoto. Channel alignment of the Tuul River illustrates that slight natural variations have occurred since 1963; however, most of the river channel has largely retained its present day alignment. Because the orthophoto was taken during the winter months, parts of the Tuul River appear to “vanish”, as in the present northern area of the river channel alignment. The river at these two localities appears to be frozen over at the time when the individual photographs were taken.

4.2.6.10 Discussion and Conclusions

Natural and disturbance features in the Tuul River valley were accurately described and quantified using base and an aerial orthophoto mosaic images. These views were used to create a supervised vegetation classification, which identifies natural and disturbance features.

Analysis, utilizing a three-tiered approach that links satellite imagery, aerial, and ground-truthing observations, can provide an effective and accurate method of detecting and monitoring land-use changes in the Project area with respect to natural and disturbance features. The main conclusions of this study are summarized as follows:

- Mining activities are currently locally confined to the Tuul River floodplain and some adjacent valley areas such as the Haailast valley.
- Settlements, such as camps and other similar land uses are discernable from mining disturbances.
- ESAs occur along the Tuul River floodplain.
- Forest patches outside, but adjacent to the Project area, have become reduced and increasingly fragmented based on a pre-Project, early mining, aerial orthophoto mosaic and IKONOS comparisons.
- The 1 m IKONOS resolution allows for remote monitoring of reclamation of the disturbed floodplain and dry mining areas for future projects.
- The use of remote sensing techniques employed here, in terms of long-term monitoring of the Project area, can be used to monitor progress not only of site reclamation and re-vegetation but also the status of local ESA areas.