# Micro-Hydro Power Station in Charkh District – Feasibility Study

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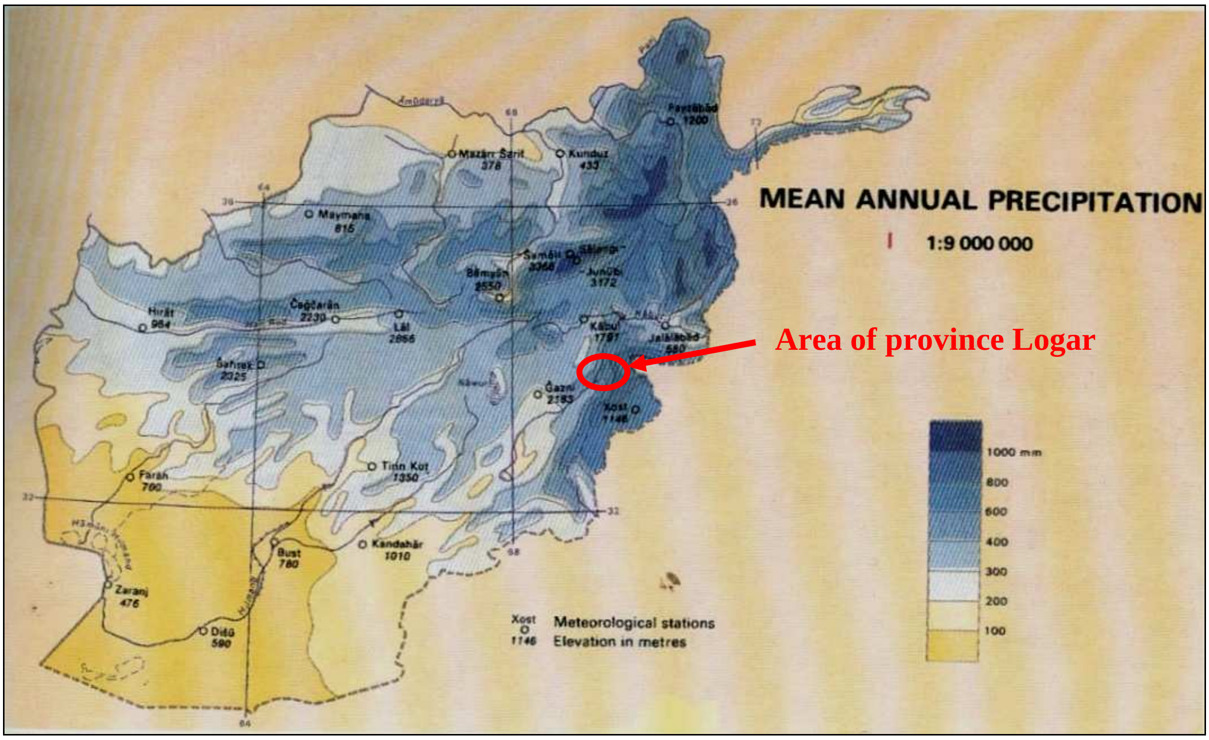
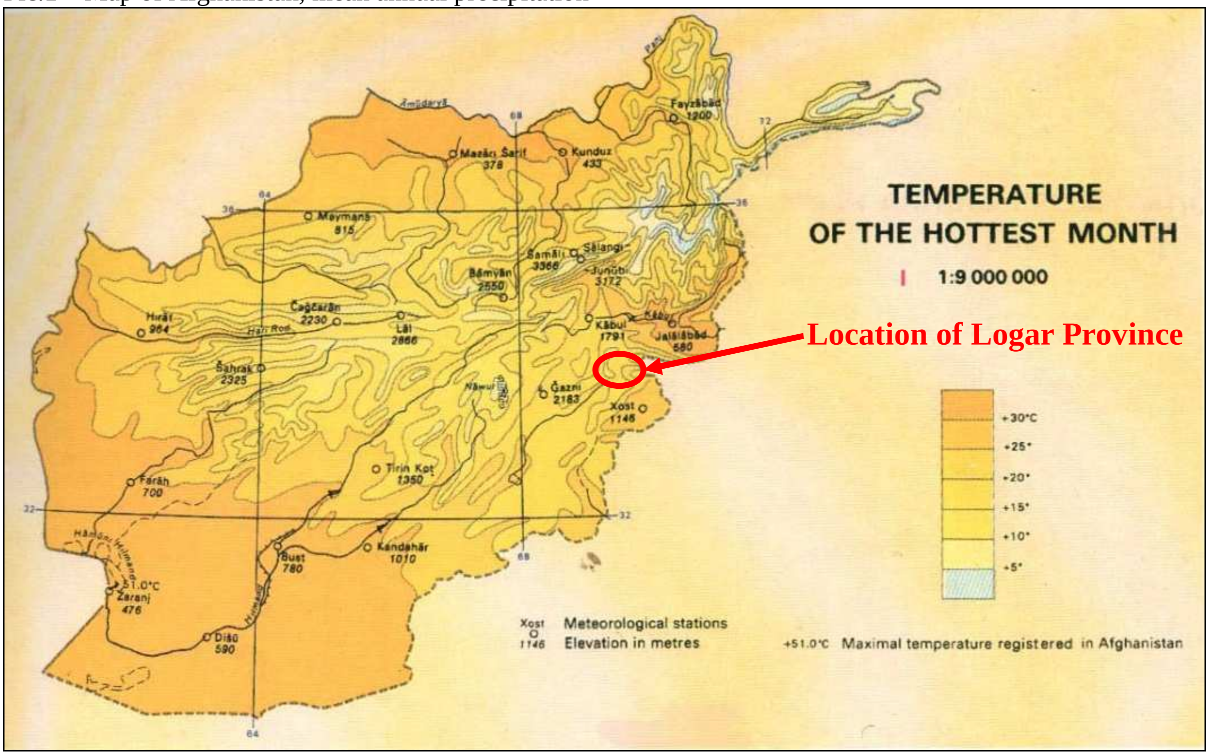
## *Climate situation in Logar province*

Logar is a province situated in eastern Afghanistan. It borders Kabul, Nangarhar, Paktia, Ghazni and Maydan Wardak provinces. The average altitude of the province is 1935 meters above sea-level. The mean annual temperature is 10,7 °C. Temperatures during the hottest month are about 25°C to 30°C and temperatures durig the coldest month are about -5°C to -10°C. The mean annual precipitation ranges from 600 mm to 800 mm. It is obvious from this data that Logar province has a very arid climate.

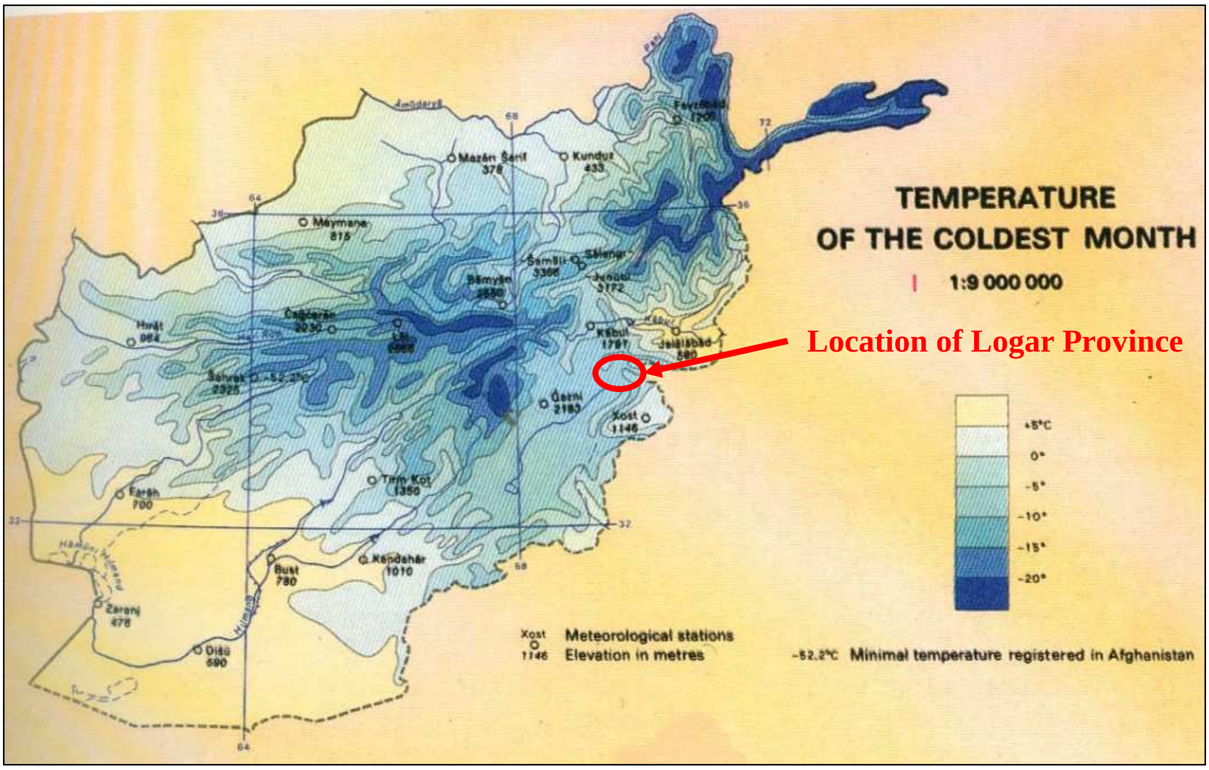
Logar province is divided into 7 districts. Each district has specific geographical features that influence the local climate. Mountainous and lowland regions can be found throughout Logar.




Pic.1 – Map of Afghanistan, mean annual precipitation




Pic.2 – Map of Afghanistan, extreme temperatures during the hottest month.




Pic.3 – Map of Afghanistan, extreme temperatures of the coldest month

## *Hydrological Situation of Logar Province*

Water is a very valued resource in the whole of Afghanistan. Every inhabited area within the country is situated near a stable river basin. Almost every agricultural area needs to be irrigated. Irrigation is necessary from several standpoints. In Afghanistan there is an arid and hot climate. Moreover the quality of agricultural land is affected by low amounts of nutrients in the soil, requiring constant supplementation by farmers. In addition the local soil does not retain much moisture.

Logar province is very dry and the natural water cycle occurs as it does throughout the rest of the country. Precipitation occurs mainly in the mountainous regions and is disbursed by stable river systems that flow through the province. Among the stable rivers within Logar Province are the Logar River, Wardak River, Pangram River, Surkhab River, Khoshi River and Azra River. The Logar River is formed by the junction of the Wardak and Pangram Rivers at the border of Pol-e Alam and Baraki Barak districts which then flows throughout the province. These rivers are crucial for irrigation water supply. The Surkhab, Khoshi and Azra Rivers are minor rivers that flow into the Logar River.  These are seasonal rivers that flow during major precipitation events.

The rivers in Logar Province are fed entirely by surface run-off, undersurface run-off and from underground aquifers. Spring flooding is crucial for circulation of water. Precipitation mainly occurs during the winter in the form of snowfall. Rainfall occurs mainly during the spring. The summer and autumn months are typically dry and hot with very little precipitation. The river systems are recharged by snow-melt during the spring. It is during the spring months that underground aquifers, which serve as the main sources of water during the dry summer months, are recharged.

Water management is critical matter in Logar Province. Eighty percent of the province is used for agricultural purposes and most of these lands need to be irrigated. Large water reservoir projects are not a viable solution. Accurate hydrological data necessary for design of these projects does not exist. To undertake a reservoir project without the hydrological data necessary can lead to a project that's size exceeds the watershed's supply. The effects of an oversized reservoir project could be dangerously low downstream water levels in rivers, causing water-shortages to populations downstream. Another danger is regular project maintenance. Forceful erosion is very common in Logar and annually flooding causes the accumulation of large amounts of sediments downstream. Without regular annual maintenance a reservoir can lose functionality very quickly due to sediment accumulation. Unfortunately the local people do not have the capacity to perform regular maintenance on a reservoir system. Another issue is submerging valuable agricultural land upstream of a reservoir. Not only would land dispute issues arise, but an obvious decrease in annual produce production would occur locally.

Water management construction should be designed with regard to the entire river basin. This approach yields a broader design, encompassing all the aspects of the river basin rather than only a smaller portion of it. Water management construction should be minimal in size with the primary purpose being to retain or recharge water in the local soils, waterways, and aquifers. These projects also serve to reduce seasonal flooding which can result in the loss of topsoil in agricultural areas.

Bad water management can seriously impact water flows, creating many problems in surrounding areas, further compounding humanitarian issues during armed conflicts.

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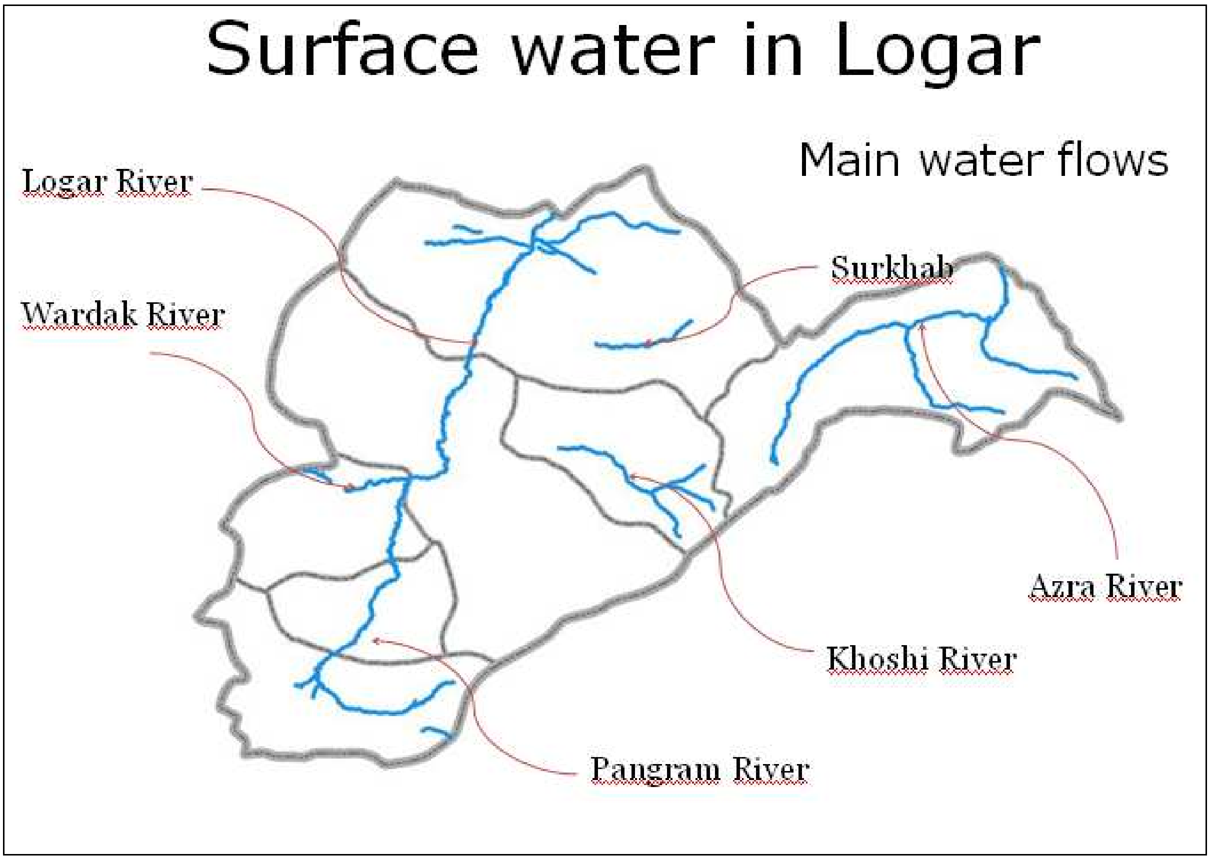
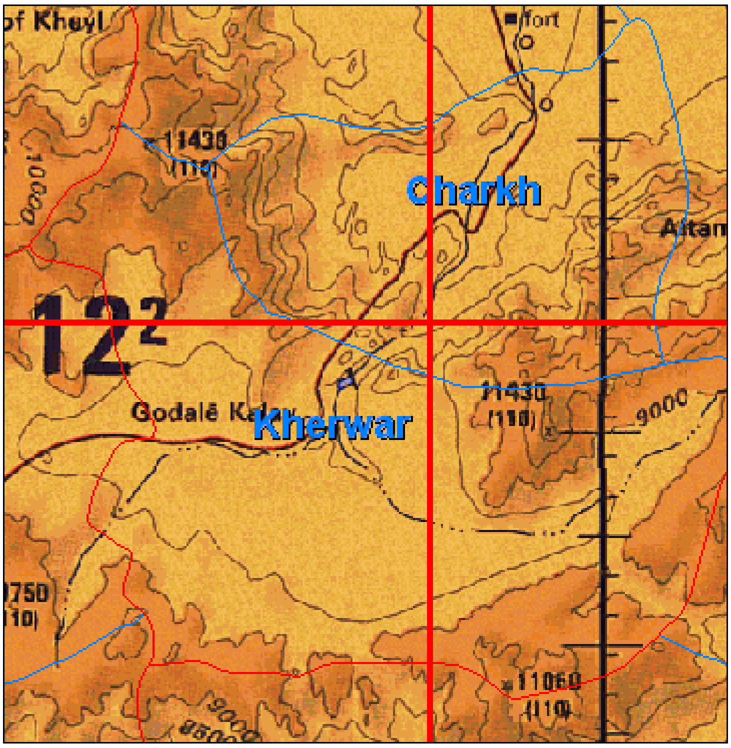


Pic.4 – Map of Logar stable rivers.

## *Location of Micro-Hydro Power Station*

The location of the existing micro-hydro power station is in the southern part of Charkh district, Logar Province. The station has not been completed with only a portion of the total project complete. The power station is located about 4,2 km northeast from the existing dam. The site coordinate is: 42S VC 91962 35288




Pic.5- Location of micro-hydro power station in Charkh district.

**42 S VC 91962 35288**

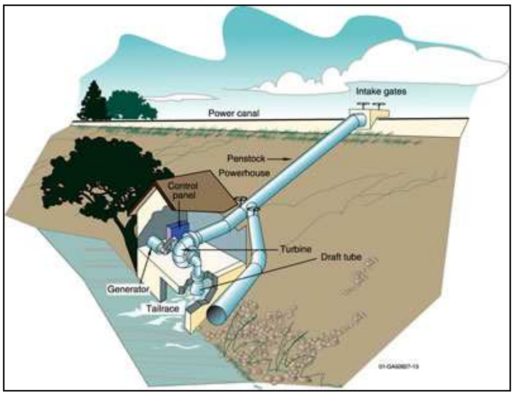
Pic.6 – satellite picture of micro-hydro power station.

## *Components of Hydropower Stations*

The principle behind hydropower stations is the conversion of potential energy of flowing water to electricity. Power stations are hydrological complexes that are formed by several parts, each of which are built consecutively downstream. The first part of the system is a water reservoir, weir or dam, built to retain the water. The second part consists of machine room that houses the turbine and alternator. The amount of useable water energy depends on elevation difference between the highest water level behind the dam, weir, or reservoir, and the level of the turbine, as well as size of the opening at the turbine through which the water flows. The turbine needs stabile water flow volume and velocity which can be a disadvantage.

The following are descriptions of component parts of a hydropower station:

1 – Upper reservoir – serves to stabilize the incoming and outgoing flow of water, collecting enough water for uninterrupted operation of the turbine and alternator. This component can be substituted by the construction of dam or weir.
2 – Inlet - enables water to enter the system of power station. This is basic part of hydrological cycle of power station. Within or upstream of the inlet, a protective device that protects the system from undesirable objects that can cause damages of turbine, i.e.: sediment runoff, snags and other objects, should be installed. An operational baffle should be installed within the inlet that can close whole hydrological cycle during maintenance and repairs.
3 – The inlet structure must allow for free water flow. Whatever structure or device is used as the inlet must also be able to withstand a great deal of pressure.
4 – Plant room – Houses the hydraulic and electrical systems (turbine and generator joined by shaft), such as safety systems, generators and compressors.
5 – Operational equipment - includes cleaning machines, clamps and their mechanisms including pipes, within which anti-fluctuators are usually installed at long supply channel locations. This device provides better regulation of gradient head and shocks during process that can endanger power induction machinery.




Pic.7 – example of a small micro-hydro power station.

The previous list was a very short description of devices and components of a hydropower plant system. All of these parts need to have properly detailed specifications and need to be designed carefully. Two parameters are crucial in hydropower design: flow capacity and gradient head. An under-designed system (parameters are lower than real flow capacity and gradient head) can lead to overstressing of the system and pose dangers to the population downstream. Conversely, an overdesigned system (parameters are higher than real flow capacity and gradient head) can lead to usage of the available water flow with lower efficiency. Under this scenario the turbine would produce less energy than its designed optimum capacity.

Another important component within a hydropower plant is the turbine. There are several kinds of turbines and each of them is suitable for different conditions with different design parameters. For example, the Banki turbine is suitable for horizontal types of hydro power stations and reaches 70 to 80 percent of efficiency. The Kaplan turbine reaches 94 percent efficiency.

## *Current Technical Condition of the Power Station*

The existing hydropower station in Charkh district is one of the many unfinished water projects in Logar. The most recent evaluation of this project was conducted by helicopter. According to information provided by the Ministry of Water and Energy (MOWE) this power station was never activated. From the Ministry's point of view the only problem is that the existing turbine is damaged. Our assessment, however, leads us to a different conclusion.

A sound and efficient hydropower station requires three basic parts. First part is the water management system (reservoir, dam, or weir). It serves to stabilize the available water source and ensure stabile design parameters so that the turbine can function with a high efficiency rate. The second part is the service building for the power station. The service building includes the plant room with the turbine and the generator. The third and final part of the entire system is the electrical distribution network.

The first upstream structure currently in place at the Kherwar micro-hydro power station is the supply channel. In addition to power production this channel is also used for irrigation purposes. The fact that so much water is being used for needed irrigation from the existing channels would be a potential problem for power production, as water levels will be too low during the summer months after irrigation needs have been met. The structural condition of the channel appears to be good and only some minor repair is required. The lack of a distribution reservoir or other construction for afflux of water is however a problem.

The second part of the existing facility is a service building with a turbine and a generator. During our reconnaissance flight there did not appear to be a service room or a plant room. These structures will need to be constructed. Additionally, an applicable design for the turbine, and the design parameters necessary, will be needed. Data about flow capacity and gradient head are collected during year-long monitoring and only then will the data have some value and statistical, predictable value. There is currently no available information about the existence of such data in Charkh. No current information also exists about the type and absorption capacity of the existing turbine.

Distribution of electricity is the third and final major part of every hydropower station. There is, however, no such system at the hydropower facility in Charkh. To design an electrical distribution system the issues of efficiency and turbine production rate need to be considered. Without this information an adequate system cannot be designed to support the facility. The needs and desires of the local population should also be taken into consideration in the design of a power distribution system.


Pic.8 – Aerial photograph of the supply channel.

Pic.9 – Part of the unfinished micro-hydro power station.

Pic.10 – View of supply channel line.

## *Summary*

The clear advantage of hydro-electric power stations is that water is a renewable source of energy, although there are problems with the hydrological cycle as described in the chapter *"Hydrological situation in Logar province"*. The message of this chapter is clear – water is a very valued resource in Logar province and steps must be taken to use it very carefully.

We strongly object to the construction of any new micro-hydro power plants in Logar province other than in Azra district, which is a mountainous region with prospective locations with ideal gradient heads. Construction of a new hydro power station in any other district in Logar Province will damage the hydrological cycle and cause major problem with respect to water management in the surrounding areas. The hydrological cycle in Logar is such that a power station could only be used during part of the year because of dry climate. The efficiency of a power station would be very low.

Construction of the micro-hydro power station at Charkh has not been completed. Previous construction was financed by the NSP program in prior years. This information is from Mr. Shah Zaman but written confirmation regarding this information has not been attained.

The existing micro-hydro plant in Charkh district is located in a very suitable location, about 4,5 km from Kherwar. The gradient head at the supply channel is formed by natural relief of the site. Withdrawal of water has no influence on Pangram River, the river upon which the existing power plant has been constructed. Fears of water withdrawl should not be a deciding factor for not completing this project, but there are reasons that are worth considering with respect to finishing the power station.

## *Conclusion*

Although the benefits of this project are known, the hydrological data necessary to complete this project is not known. **A Hydrological survey (collection and evaluation of hydrological data) is therefore necessary.** For the design and specification of the turbine, data from a hydrological survey is required. The hydrological survey should include collection of data for a period of at least 5 years including both observation and evaluation of results. This data will yield the design flow capacity of the supply channel, the changes in flow volume throughout the year and should consider the effects/benefits of adding a distribution reservoir.

**Detailed Ground Reconnaissance.** A detailed ground reconnaissance should be conducted at the site before any design begins. This survey should be precise on how many and what types of existing structures, both man-made and natural, that impact site conditions exist. This recon should also include evaluation of each structure, as to its structural adequacy, whether or not repairs are required, etc. Special emphasis should be made in evaluating the conditions of the existing channel walls. Ground reconnaissance can detect many issues and details that are not apparent from a reconnaissance flight survey. Determining the exact proportions and of the site and dimensions of the existing structures will be helpful in choosing the type of turbine needed.

**Turbine:** The most important part of the whole project. We do not have any data about the flow capacity through the supply channel, which means we cannot determine the right type of turbine regarding the absorption capacity that will influence the effectiveness of the turbine.

**Security:** The security situation in Charkh can make quality control during implementation of this project very difficult. Another challenge will be finding a contractor capable of completing the work.

Another threat to the sustainability of this project is technical ability of the local population. **Maintaining** such a sophisticated facility, a hydro power station, is not an easy thing. An educational program for the villagers that will be responsible for maintaining the power station is essential for the longevity of this facility. Distribution of electricity will also be a problem for the same reasons mentioned above. Some other issues to be considered before undertaking this project are: sustainability of the facility, distribution system quality, maintenance funding and customer billing. It is our opinion that a portion of the profit should be used for maintenance. We are not sure if the local population is ready for this.

**This is the conclusion of all advantages and disadvantages of the project. In the end we would like to express that implementation of the project needs to be very elaborate. The Czech PRT currently doesn't have an expert for this type of project. This feasibility study was made by a water management construction specialist. This project should be undertaken by hydropower design and water resource management experts.**

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