DESIGN DEVELOPMENT REPORT

PHASE 1 – INTAKE AND PUMPHOUSE REPLACEMENT

GN PROJECT NO: 04-4417

PROJECT NAME

Water Systems Improvements

PROJECT ADDRESS

Kugluktuk, NU

PREPARED FOR

Government of Nunavut
Community & Government Services

PREPARED BY

A. D. Williams Engineering Inc.

DATE PREPARED

December 2008

ADWE File No. 13655

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APPENDICES

1.0 INTRODUCTION

A. D. Williams Engineering Inc. (ADWE) is under contract with the Government of Nunavut (GN) to perform design and construction services for the Water Systems Improvement Project for Kugluktuk, NU (GN Project No: 04-4417). The project is to be completed in two phases. Phase 1 is the replacement of the raw water intake and intake pumphouse. Phase 2 is improvements in the water treatment plant (WTP).

A Preliminary Engineering Report was completed and established the design parameters for the project. This report is the design development for Phase 1 – Intake and Pumphouse Replacement. It is to be read in conjunction with the Preliminary Engineering Report where design conditions and assumptions have been established. Phase 1 is expected to be tendered in February 2009 for a summer/fall 2009 construction.

Design guidelines primarily used for this project are:

- Good Engineering Practice for Northern Water and Sewer Systems, GNWT Public Works and Services, April 2004.
- Water and Sewage Facilities Capital Program: Standards and Criteria, GNWT Department of Municipal and Community Affairs, July 1993.
- Guidelines for Canadian Drinking Water Quality, Health Canada, Federal-Provincial-Territorial Committee on Drinking Water, May 2008.
- Cold Regions Utilities Monograph, 3rd Edition, American Society of Civil Engineers, 1996.

Government of the Northwest Territories (GNWT) design standards were used as no Government of Nunavut (GN) water systems design standards were made available or are known to exist.

2.0 DESIGN PARAMETERS

2.1 OBJECTIVE

The objective of Phase 1 is to provide the community of Kugluktuk a new stable, reliable, and economical raw water intake system. The system is to be able to handle the community's needs until 2030.

2.2 WATER FLOW RATE

Population growth and future demand were discussed in the Preliminary Design Report. It was concluded that in the design year of 2030 the system will be required to produce an average of 235,000 L/day. The WTP will be designed for 3.0 x the average day use. Therefore, the pumping capacity of the intake must meet a minimum flowrate of 705,000 L/day or 30 m^3/hr (130 USGPM). Throughput of the system can be further upgraded with additional year round raw water storage.

2.3 TWIN INTAKE SYSTEM

A stable and reliable water supply for Kugluktuk with 100% runtime is required. Redundancy is to be met with a twin system. Each system is to have its own independent pipeline, intake screen, and pump. The twin system enables the operators to maintain one system without disrupting the water supply system.

3.0 SYSTEM CONFIGURATION

3.1 INTAKE PUMPHOUSE

Operation of the potable water system will be required to be maintained throughout the construction period. The existing intake pumphouse is in need of replacement. Therefore, a new intake pumphouse will be constructed while the existing system remains in operation. The raw water reservoir by the WTP can currently store approximately 8 days of water for the community. Any downtime associated with the transfer of services from the old system to the new will require coordination with the Hamlet Foreman to ensure the community does not run of water.

3.1.1 Pmphouse Location

The intake pumphouse is currently in an unstable location and the new pumphouse is required to be built in a new location. The new pumphouse would still require road access for operation and maintenance. Various locations were discussed in the preliminary engineering report and it was decided that the new intake pumphouse is to be located 12 m NE of the existing pumphouse. The proposed location of the new intake pumphouse is shown on the site plan included in Appendix A.

3.1.2 Building Construction

The intake pumphouse building will be similar to the existing intake pumphouse. It will hold electrical services for the pumps, piping, valves, compressor for the air burst system, and access for servicing the pumps. The size requirement of the building is approximately 3 m x 2 m. It is likely the most economical option is for a prefabricated building to be brought in to Kugluktuk on sea lift. The building is to be insulated and supplied with a small electrical radiant heater to be operated at an as and when needed basis.

A crush stone or gravel pad for a steel skid building will form the building foundation. The new location has more stable soils and the new building will not be subject to external strains from the intake lines as the current system is. Foundation preparation and design will be subject to review by the Geotechnical Engineering sub-consultant EBA Engineering.

3.1.3 Electrical Service

The existing pumphouse is fed via 600V service feeders from the existing water treatment building. New pumphouse loading is expected to be a minimal change from existing loading, and new pumphouse location will be located slightly closer to the WTP, as such existing utility feeders will be re-used.

Basic usage of the new pumphouse would be for pump access and servicing as well as raw sampling. Expected electrical services would consist of power to the pumps, lighting, heating, air compressor and convenience receptacles for small hand tools. A small transformer is expected to be required to serve low voltage requirements. No major sources of moisture or corrosion are expected within the pumphouse, as such standard industrial electrical equipment would be utilized.

3.2 INTAKE PUMPS AND PIPES

3.2.1 Piping Route and Support

The proposed route for the intake piping is shown on SK-1 in Appendix A. It is proposed that the pipe run above ground from the pumphouse over the rock face before dropping into the water. Support for the pipe is primarily to be provided by rock anchors. The anchors can either be horizontally mounted into the rock for hanging supports or drilled down into the rock for vertical stands. Vertical piles will support the submarine portion of the intake system. The exact type and placement of the supports will be dependent on the terrain.

At the water/ice interface the intake piping will require protection. This can be achieved by rock excavation and burial of the piping. Rock excavation by use of blasting would require approval of the Department of Fisheries and Oceans (DFO). Alternatively, a type of rock anchored guard system of either steel or concrete construction could be designed to protect the pipe. It is also proposed that the pipe enter the water at a notch in the rock downstream from the furthest protruding point of the river bank.

3.2.2 Intake Pumps

The system is to include two independent pumps that can each handle the full load of the system. The WTP is approximately 33.5 m higher than the river level. Total minor losses for the system are estimated to be the equivalent of 11.5 m of head. Therefore, each pump will be required to meet the 30 m^3/hr flowrate at 45 m of head. Total losses for the system will be recalculated once the design drawings have progressed to a stage where all the minor losses can be properly accounted for.

A potential pump has been sized from Grundfos. Grundfos pump 150S75-4 is a 4 stage 7.5 hp pump. It is 1267 mm long, 137 mm in diameter, and has a shipping weight of 135 lbs. Pumps from other manufacturers should be comparable.

It should be noted that the existing intake pumps are larger. A pump was pulled this fall and it was an Electric Motor Service pump Model: S6-230 with a Franklin Electric motor 15 HP, 3 Phase, 575 Volts, 16.7 Amps. The existing system operates for shorter periods of time, while the proposed system is designed to operate more continuously.

3.2.3 Intake Casing Pipe

Intake casing pipe is to be constructed of HDPE pipe due to the durability and flexibility of the pipe. The proposed route of the intake piping has the pipe follow a minimum radius of curvature of 173 m. The casing pipe must be large enough in diameter to hold the intake pump with the given curvature of the route.

The casing pipe is not to carry pressurized water but only to provide protection and a path for the submersible pump. Therefore, a non-pressure rated DR-41 HDPE should be sufficient. HDPE pipe can be bent to a minimum radius between 200 to 30 times the nominal diameter before breaking. Therefore, for a 225mm (8”) pipe, a bending radius of 45 m is acceptable, and for a 355mm (14”) pipe, a 71 m bend is acceptable. See Table 1.0 – Intake Casing Pipe Size Options for a chart of pipe sizes options and relative clearances total clearance from the intake pump.

Table 1.0 – Intake Casing Pipe Size Options

Pipe		**Pump Clearance**				
OD	DR-41 ID	Straight Pipe	r = 173m	r = 71m	r = 10.65m	r = 8.4m
225mm (8”)	214mm	77mm	76mm	74mm	58mm	54mm
250mm (10”)	238mm	101mm	100mm	98mm	82mm	78mm
280mm (11”)	266mm	129mm	128mm	126mm	110mm	106mm
315mm (12”)	300mm	163mm	162mm	160mm	144mm	*fail*
355mm (14”)	338mm	201mm	200mm	198mm	182mm	*fail*

It is evident from the above table that bending the pipe up to a radius of 71 m as little effect on the pump’s clearance. In addition to the pump’s 137 mm diameter, an additional 25 mm on each side is required for a slider to be attached to the pumps. 50 mm clearance on both sides is desirable as a factor of safety. Therefore, a minimum of 150 mm of clearance is required in the pipe at the design bending radius. An intake pipe casing of 315 mm OD is preferable as the pipe would see a failure in bending before the pump would get stuck.

The intake casing pipe is also to be insulated with 50 mm rigid polyurethane with HDPE casing. Additional freeze protection will be provided by self regulating heat trace tape. When the pump is not in operation the carrier pump will drain into the river. The risk of freezing is primarily at and around the water/ice interface. Should a catastrophic freezing event happen, this area could be thawed out by a hot water probe. Access to the freeze zone could be improved by the addition of a clean-out access point in the casing just before the pipe goes under the water.

3.2.4 Carrier Piping

The proposed submergible intake pumps have a nominal 80 mm (3”) outlet. This could be flared out to 100 mm (4”) to reduce line loss along the carrier pipe. An 80 mm carrier pipe would see approximately 9 m of equivalent head in line loss where a 100 mm pipe would see about 2 m of line loss.

3.2.5 Intake Screens

Each proposed intake line would have its own independent intake screen with one available for temporary backup. Each screen would be located at a different elevation in order to achieve the best raw water quality at any given time. The upper intake would be located approximately 3 m below the water level. This would place the intake below the maximum ice thickness of 2 m and place it beneath major ice scour as the average river depth is around 3 m. Some ice scour may occur and it is therefore recommended that the vertical riser pipe be fastened with a flexible connector that would bend down when struck by moving ice. The lower intake would be located approximately 1 m above the bottom of the river bed at the identified depression. Flanged connectors at both locations on both lines would ease future maintenance and modifications to the system.

In accordance with DFO guidelines, the suction inflow velocity is to be below 11 cm/s. The screens will be constructed of 1.8 mm diameter wire with 0.38 mm gaps between the wires. This gap is less than the median size of the sediment in the river bed. In order to meet the design flow of 30 m^3/hr, the screen will have a diameter of approximately 324 mm. This screen will be connected to the 315 mm intake pipe and a 25 mm air pipe.

In order to reduce plugging of the intake screens by aquatic life, a copper-nickel alloy will be used. This will also allow for easy removal of animal or vegetable matter by scrubbing or high-pressure washing. The intake screen will be cleaned every 2-3 days by an airburst system, which will force compressed air inside the screen via the 25 mm pipe.

To further reduce sediment around the intakes, a skimming wall in front of intakes is suggested. This would have the effect of deflecting the current that carries sediment towards the shore, as well as guiding bed sediment past the intakes. The proposed wall could be a temporary structure built from sandbags.

3.2.6 Groundwater Intake

ADWE will continue to work with Nuna Burnside Engineering and Environmental Ltd. to investigate the possibility of a groundwater intake in the talik beneath the riverbed. A winter drilling program is being planned and the intake system may be modified depending on the outcome of that program.

3.3 CONNECTION TO EXISTING SYSTEM

3.3.1 Pipeline to WTP

Water from the existing intake pumphouse flows to the WTP along a 345 m long 150 mm (6”) pipeline. This pipeline is to be re-used in the new intake system. A small addition of approximately 12 m of 150 mm (6”) pipe will be required to connect the new pumphouse to the existing pipeline.

3.3.2 Electrical and Controls

As mentioned in section 3.1.3 the electrical service for the old intake system will be reused for the new intake system. Therefore, the control switch for the pumps from the WTP will continue to operate the new system.

Additional online controls for turbidity and salinity can be added to the intake pumphouse. These levels can then be monitored and incorporated into the WTP upgrades scheduled to happen in the following season.

4.0 COST ESTIMATE

4.1 GENERAL NOTES ON COST ESTIMATES

Cost estimates provided below were made with the level of effort consistent with a Class B Cost Estimate. A Class B Cost Estimate is generally of sufficient detail for project approval, budgetary control, and design cost control. Class B Cost Estimate's are traditionally considered to have an accuracy of 10-20%. However, factors such as a volatile market, remoteness, and a small contractor pool increases the variability of the cost estimate. Therefore, a contingency factor 15% was added to the total budget value.

4.2 MAJOR EQUIPMENT

Pricing for major equipment was obtained from manufacturers' quotes. An additional 10% for shipping and 24% for overhead and profit was added to each quote. More accurate shipping and installation data will be used for the Class 'A' Cost Estimate, which will be prepared with the tender documents. Some quotes requested were not received in time and therefore quotes from previous projects and/or estimations were used.

4.3 LABOUR

A labour rate of $85/hr was used as a base for the cost estimate. It is assumed that for every 10 hours of labour, one night of accommodations will be required. Assuming the contractor sets up their own labour camp in the community an accommodation rate of $200/night/person was used. Additionally, it is assumed for every 140 hours one fly out at $1000 will be required. Therefore, an effective labour rate of $112/hr was used for construction in Kugluktuk, NU.

4.4 COST ESTIMATE TOTALS

Civil/Mechanical	
Mob/demob	$100,000
Intake Pumps	$25,812
Intake Screens	$7,000
Airburst System	$50,000
Sandbag Wall	$35,000
Intake Piping	$143,943
Connection to Pipeline	$4,564
Rock Anchor Supports	$80,000
Pumphouse Foundation Prep	$35,000
Pumphouse Building	$7,500
Electrical	
Distribution	$38,905
Wiring Devices	$4,320
Control Connections	$24,095
Lighting	$3,640
Mech. Equipment Connections	$15,970
Mobilization & Accommodations	$34,800
O&M, Record Drawings & Commiss.	$5,000
Permits (@ 2%)	$2,535
Sub-Contractor Mark-up	$12,926
TOTAL ESTIMATE	**$631,010**

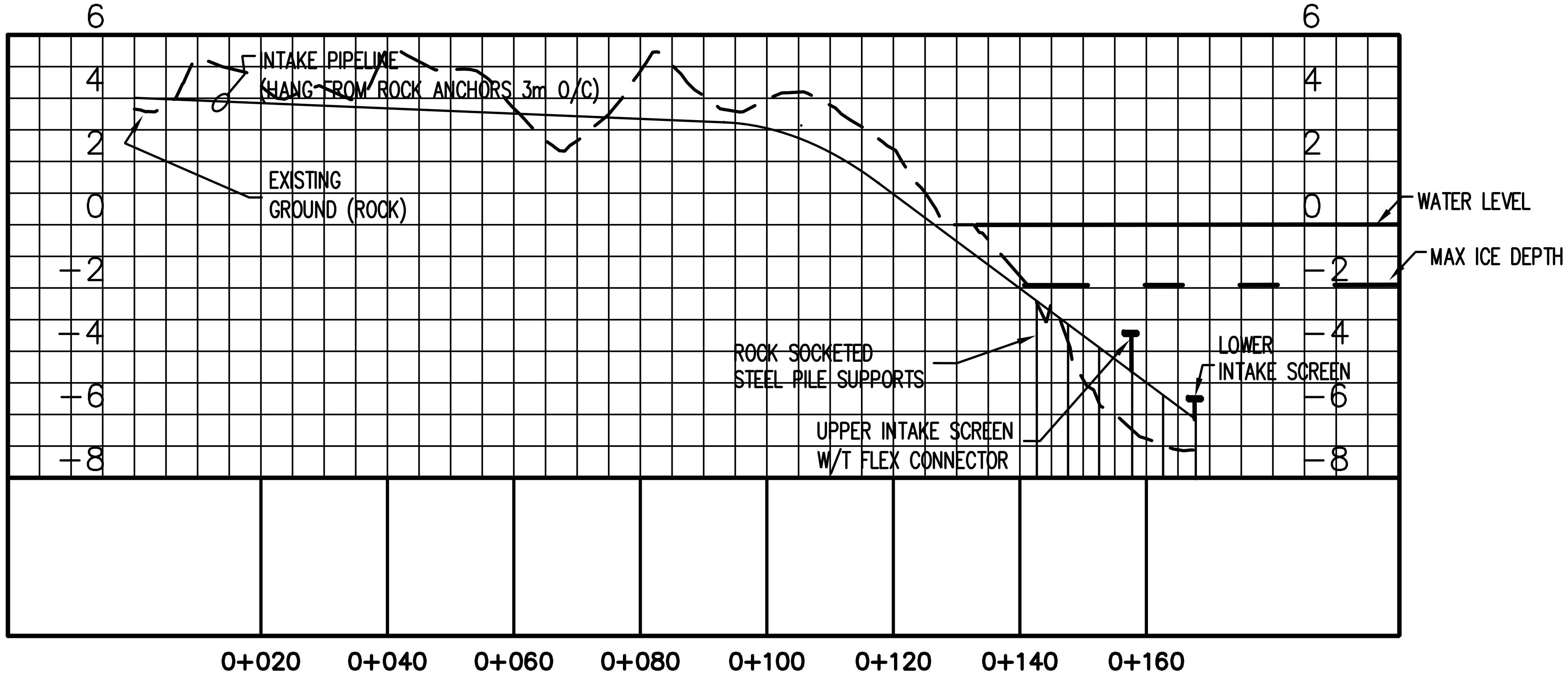
5.0 CLOSURE

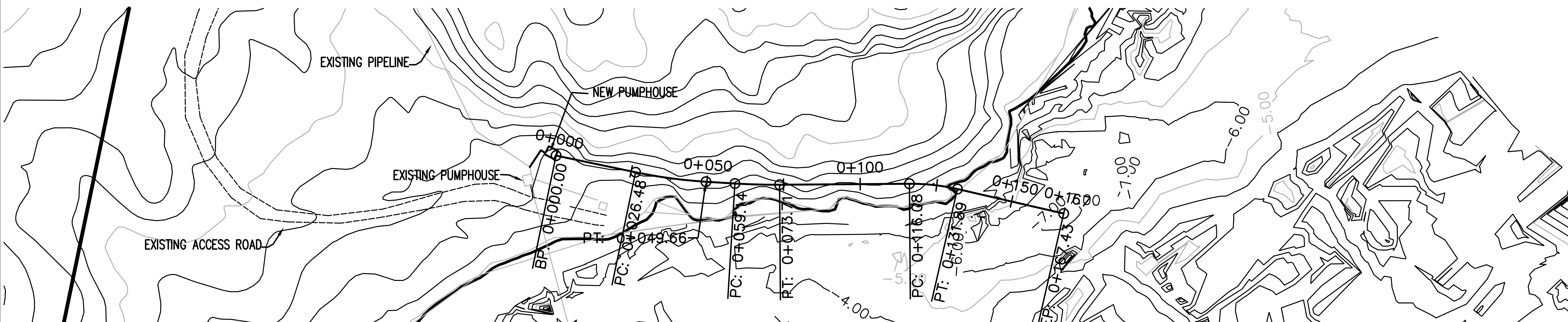
This report was prepared to supplement the Preliminary Engineering Report for the design development for Phase 1 – Intake and Pumphouse Replacement. It is to be read in conjunction with the Preliminary Engineering Report where design conditions and assumptions have been established. Phase 1 is expected to be tendered in February 2009 for a summer/fall 2009 construction.

A P P E N D I X A

INTAKE LINE PLAN & PROFILE

INTAKE PIPELINE PROFILE





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JOB TITLE: **WATER SUPPLY IMPROVEMENTS PH 1 NEW INTAKE & PUMPHOUSE**
KUGLUKTUK, NU

DWG. TITLE: **SITE PLAN PIPE AND PROFILE**

DWN. BY: JG/JH	DES. BY: JH	PROJ. MGR.: JC
PEER REVIEW: JC	DATE: (YY-MM-DD) 2008.12.18	SCALE: NTS
CLIENT PROJ. # –		ADWE PROJ. # 13655.00
DWG # 13655-SK1	OF –	REV # A