VILLAGE OF SILVERTON
GROUNDWATER DEVELOPMENT PROGRAM

Prepared For

The Corporation Of The Village Of Silverton

By

KALA GROUNDWATER CONSULTING LTD.

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1 INTRODUCTION

The present program of groundwater exploration, well completion and aquifer testing was carried out to develop an alternate source of water supply for the Village of Silverton. The project was undertaken by Kala Groundwater Consulting Ltd. on a subconsulting basis to Urban Systems Ltd. of Kelowna, B.C.

The Village of Silverton has a population of approximately 250 residents. Up until the present time, water for the community has been obtained from Bartlett Creek, which is a triburtary system to Silverton Creek. Generally, the surface water source has provided a sufficient supply of water for the Village, however, in recent years recorded flows of water in the creek have been low, particularily towards late summer, and in addition, there has been some concern about the possible contamination of the source. With these factors in view, it was recommended that the available groundwater resources be explored as a option to the existing surface water supply.

The present program has involved the drilling of an eight-inch testhole to a total depth of 157 feet (47.9 metres), the completion of a test/production well and finally, a 24-hour continuous rate pumping test. The following report outlines the nature of the program, provides a discussion of the results and recommendations for a safe, long-term pumping rate and pump setting. Detailed information relating to the program, including driller's litholog, sieve analyses, pump test data and water quality are included in the Appendix.

2 BACKGROUND

The Village of Silverton is located on the east side of Slocan Lake, approximately 4 kms south of New Denver. The community at Silverton is situated on an alluvial fan-delta complex, which was built out into Slocan Lake as Silverton Creek downcut its present day course into the bedrock upland area.

In general terms, the alluvial fan is comprised of granular material ranging from cobbles and boulders to sand and gravel, mixed with varying proportions of silt and clay. The quantity and extent of silt and clay material, depends on the amount of fines carried by Silverton Creek during deposition and also, on the lake level when these sediments were laid down. During periods when the lake level was relatively high and flows within the creek were not excessively turbid, clean deposits of sand and gravel were deposited. These sand and gravel formations, because of their water transmitting capacity, form the major aquifers in this type of geologic setting.

The available groundwater resources at Silverton have never been developed up until the present program and consequently, there was no existing well log information available for the community. We did however obtain the existing well log data for New Denver, which has a similar geologic environment. At present, the water supply for New Denver is obtained from two water wells, both completed in alluvial fan deposits. Well No. 1, located north of the arena, is completed to a total depth of 138 feet (42.1 metres) in a sand and gravel formation containing some silt and clay. It has a projected well capacity of 175 USgpm. The second well is constructed towards the toe of the fan, along the shore of Slocan Lake. This well is completed to a total depth of 110.5 feet (33.7 metres) with a safe yield exceeding 1000 USgpm. In each case the water quality from the existing wells is good.

3 DESCRIPTION OF PRESENT PROGRAM

The drilling site selected for the completion of the eight-inch test/production well, was made with the following considerations in view:

1) To essentially eliminate the possibility of contamination from local septic systems, the well site was selected near the upper part of the alluvial fan complex.

2) Secondly, the choice of location was based on the design of the existing distribution system.

Following an on-site inspection, it was decided to drill on the south side of Silverton Creek, near the intersection of 5th Street and Alpha Street (see Figure 1).

All of the drilling operations under the present program were carried out by Owen's Drilling Ltd. of Cranbrook, B.C. This Firm uses a "Barber Drill", which operates by the air rotary method and advances the casing by a rotation technique and hydraulic pull-downs. The well was drilled with 8-inch (203 mm) diameter casing, which was advanced as drilling progressed. Once a suitable water-bearing formation was encountered, samples were collected and sieve analyses performed. On this basis a screen assembly was selected and following installation, the well was developed with air until the water lifted to surface was essentially sand free. During the development phase, the screen was exposed by pulling back the casing in 5-foot (1.5 metre) sections. Each section was then fully developed before proceeding with the next interval.

Upon completion of the well, a 24-hour pumping test was conducted to evaluate the long-term capacity. This portion of the program was carried out by Lingo Pump Service of Vernon, B.C. During the pumping

FIGURE 1 WELL LOCATION PLAN

test, the well was pumped at a constant rate of 390 USgpm and drawdown was monitored in the well. Near the end of the test, water samples were collected for chemical and bacteriological analyses.

4 RESULTS OF PROGRAM

4.1 Geology

A copy of the detailed driller's litholog is attached to the Appendix of this report. During the drilling of the exploratory testhole, three distinct hydrogeologic units were encountered. These intervals are briefly described as follows:

Depth Interval in feet	Lithologic Description
0 - 12	Silty sand and gravel with cobbles and boulders
12 - 136	Silty to clayey sand and gravel
136 - 157	Sand and gravel, water-bearing

The first occurrence of groundwater (i.e. samples returned to surface by air were actually wet) was not observed until 80 feet (24.4 metres) below surface. The water-bearing formation encountered at 136 feet (41.5 metres) consisted of relatively clean sand and gravel, grading from fine sand up to medium sized gravel.

With respect to the possibility of contamination from local septic systems, the silty to clayey sand and gravel material encountered form 12 to 136 feet (3.7 to 41.5 metres) will provide an excellent filtering media and protective zone above the aquifer.

4.2 Well Completion

As previously noted, the test/prduction well was drilled with 8-inch (203 mm) diameter steel casing. A screen assembly, which is described later in this section, was selected on the basis of sieve analyses, and

set opposite the water-bearing sand and gravels. Finally, the casing was pulled back in 5-foot intervals, and each section developed by jetting with air.

The screen assembly is comprised of the following:

Depth Interval in feet	Completion Details
133.8 - 134.3	Figure "K" packer
134.3 - 136.3	7-inch steel pipe riser
136.3 - 141.6	#30 slot (30 thousandths of an inch openning), Johnson's stainless steel, 8-inch telescopic water well screen
141.6 - 146.9	#40 slot, Johnson's well screen
146.9 - 152.2	#15 slot, Johnson's well screen
152.2 - 157.5	#40 slot, Johnson's well screen
157.5	Bail bottom

The screen assembly, following installation was developed for a total of 7 hours with compressed air.

4.3 Aquifer Testing

The final phase of the program involved a 24-hour pumping test to evaluate the capacity of the new well. During the test, the well was pumped at a constant rate of 390 USgpm, and drawdown was monitored.

Prior to the start of the test, the water level in the well was 61.32 feet (18.69 metres) below ground level. During the test, the observed drawdown was 16.5 feet (5.03 metres) and this remained essentially stable throughout the 24-hour pumping interval. The stabilized drawdown condition indicates that the quantity of water discharged from

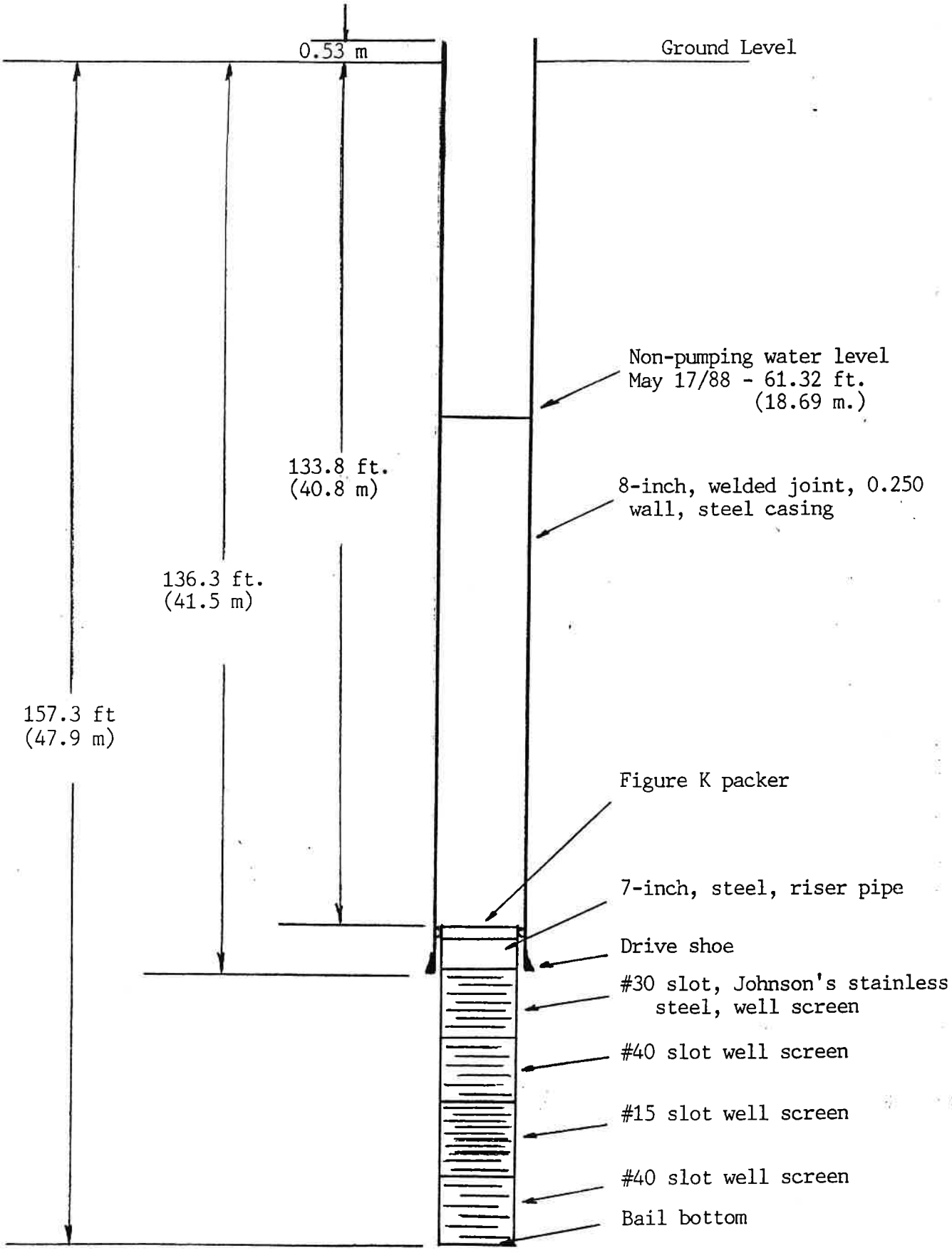


FIGURE 2 WELL COMPLETION DIAGRAM

the well is balanced by the rate of recharge to the aquifer. The drawdown observed, represents only 22.7 percent of the total available drawdown in the new well.

Based on the test results, the well has a theoretical safe yield of approximatley 1000 USgpm. However, the screens in the new well are designed to transmit 450 USgpm at an entrance velocity of 0.1 feet per second. This is the recommended entrance velocity and flow velocities exceeding this amount could result in encrustation of the screens. We would recommend a safe, long-term pumping rate of up to a maximum of 450 USgpm for the new well.

Based on the results of the chemical analysis, the water quality is excellent.

5 CONCLUSIONS AND RECOMMENDATIONS

During the present program, an eight-inch test/production well was completed for the Village of Silverton to provide an alternate source of water supply. Based on the results of the program pertinent information with respect to the new well and aquifer is summarized as follows:

1) The new well is constructed to a total depth of 157 feet (47.9 metres) and is completed with 21 feet (6.4 metres) of well screen (a well completion diagram is shown in Figure 2).

2) Upon completion of the well, a 24-hour pumping test was conducted, pumping the well at a constant rate of 390 USgpm (23.9 L/s).

3) The maximum drawdown recorded during the test was 16.5 feet (5.03 metres) and after a few minumtes of pumping, steady-state conditions were observed. This occurs when the quantity of water discharged from the well is balanced by the rate of recharge to the aquifer and no further drawdown is experienced.

4) Based on the test results, the well has a specific capacity (i.e. quantity of water pumped per unit of drawdown) of 23.6 USgpm per foot of drawdown. Taking all factors into consideration, including design entrance velocity into the well screens, we would recommend a maximum safe, long-term pumping rate of 450 USgpm.

5) The top of the screen assembly is set at 133.8 feet (40.8 metres) below ground level, and on this basis we would recommend a pump setting of 125 to 130 feet (38.1 to 39.6 metres) below ground level.

7) For purposes of pump selection, the following table outlines our projected drawdown with varying pumping rates.

Pumping Rate USgpm	Depth to water from ground surface in feet	in metres
200	69.8	21.3
250	71.9	21.9
300	74.0	22.6
350	76.1	23.2
400	78.2	23.8
450	80.4	24.5

8) Based on the water analysis report, the chemical quality of the new water source is excellent.

APPENDIX

VILLAGE OF SILVERTON

GROUNDWATER DEVELOPMENT PROGRAM

NEW TEST/PRODUCTION WELL

Date test started: May 17/88
Time test started: 12:00 AM
Pre-test water level: 19.22 m

Reference point: Top of csg.
Ht. of ref.: 0.53 metres
Depth of well: 47.9 metres

PUMPING INTERVAL

Time (t) since pumping started in minutes	Depth to water (metres)	Drawdown in metres	Comments
1	24.19	4.97	Pump rate: 390 USgpm
2	24.21	4.99	Water clear
3	24.23	5.01	
4	24.23	5.01	
6	24.23	5.01	
8	24.24	5.02	
10	24.23	5.01	
13	24.22	5.00	
16	24.22	5.00	
20	24.23	5.01	
25	24.23	5.01	
32	24.23	5.01	
40	24.23	5.01	
50	24.23	5.01	
64	24.23	5.01	Obtain water sample
80	24.21	4.99	
100	24.21	4.99	
120	24.21	4.99	
150	24.21	4.99	
190	24.22	5.00	
240	24.22	5.00	
300	24.22	5.00	Pump rate: 390 USgpm

Cont'd. ./2

Silverton, Groundwater Development, Pumping Test

PUMPING INTERVAL

Time (t) since pumping started in minutes	Depth to water (metres)	Drawdown in metres	Comments
380	24.23	5.01	Pump rate: 390 USgpm
480	24.23	5.01	
600	24.23	5.01	
780	24.25	5.03	
960	24.25	5.03	
1200	24.25	5.03	
1440	24.23	5.01	Pump rate: 390 USgpm

RECOVERY INTERVAL

1	19.17
2	19.29
3	19.30
4	19.30
6	19.295
8	19.295
10	19.29
13	19.29
16	19.29
20	19.285

VILLAGE OF SILVERTON
TEST/PRODUCTION WELL
DRILLER'S LITHOLOG

Depth Interval in feet	Lithologic Description
0 - 4	Silty sand and gravel with cobbles
4 - 12	Boulders, up to 3 feet diameter
12 - 16	Silty sand and gravel with cobbles and boulders
16 - 33	Silty sand with gravelly zones
33 - 57	Silty gravel, grey, moist
57 - 80	Silty gravel with lenses of silty sand
80 - 95	Gravel with silt and silty clay, wet
95 - 98	Silty sand with gravel, moist
98 - 117	Silty gravel, loose intervals, wet
117 - 119	Silty clay, grey
119 - 136	Clayey silt with gravel, wet
136 - 148	Sand and gravel, water-bearing, material grading from fine sand to med. gravel
148 - 151	Sand with some gravel
151 - 158	Sand and gravel

SIEVE ANALYSIS

PROJECT: Village of Silverton

REMARKS:

DEPTH: 136 ft.

SIEVE OPENNING INCH.	MM	U.S. SIEVE NO	CUMULATIVE % RETAINED WT RET.	% RET.	REMARKS
		1/2 inch			
.265		.265			
.187		4	130	12.0	
.132		6	195	18.1	
.0937		8	270	25.0	
.0661		12	340	31.5	
.0469		16	445	41.2	
.0331		20	575	53 2	
.0234		30	715	66.2	
.0165		40	930	86.1	
.0098		60			
.0059		100			
.0029		200			
		PAN	1035		

Total wt: 1080

SIEVE ANALYSIS

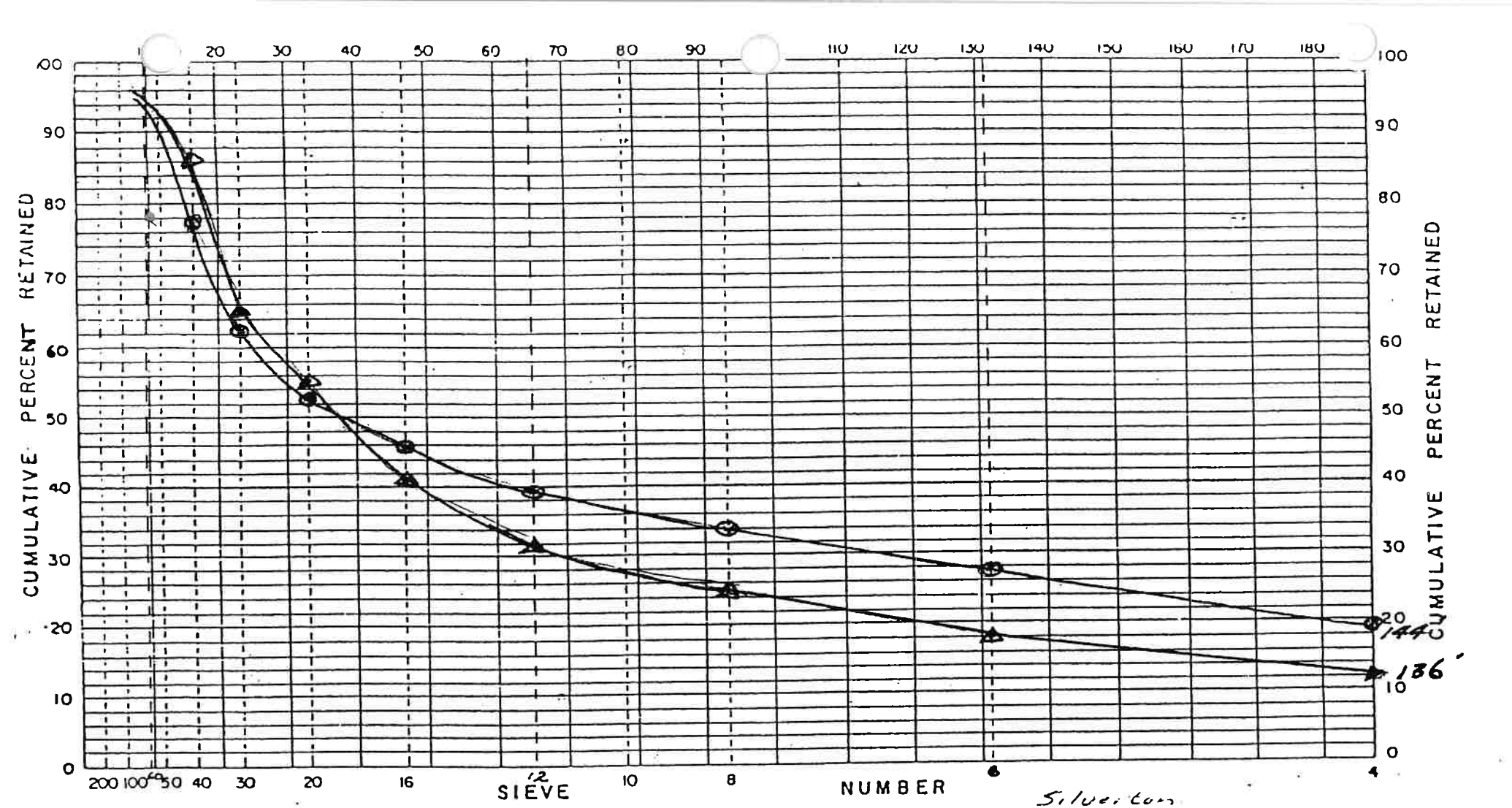
PROJECT: Village of Silverton

REMARKS: _____

DEPTH: 14-4

SIEVE OPENNING INCH.	MM	U.S. SIEVE NO	CUMULATIVE % RETAINED WT RET.	% RET.	REMARKS
		1/2 inch			
.265		.265			
.187		4	160	19.4	
.132		6	230	27.8	
.0937		8	280	33.9	
.0661		12	325	39.4	
.0469		16	375	45.5	
.0331		28	435	52.7	
.0234		30	515	62.4	
.0165		48	635	77.0	
.0098		60			
.0059		100			
.0029		200			
		PAN	825		

Total WT: 825 gms.



SAMPLE DEPTH			FEET
OPENING	RET. ON	WT. RET.	CUM. % RET.

Percent of sample not sieved 1/2" or over _____ %

SAMPLE DEPTH			FEET
OPENING	RET. ON	WT. RET.	CUM. % RET.

Percent of sample not sieved 1/2" or over _____ %

SAMPLE DEPTH			FEET
OPENING	RET. ON	WT. RET.	CUM. % RET.
			—

Percent of sample not sieved 1/2" or over _____ %

PROJECT:
LOCATION:
WELL No.
SAMPLED BY:
SIEVE ANALYS
DATE:

SIEVE ANALYSIS

PROJECT: Village of Silverton

REMARKS: _____

_____

DEPTH: 149'

SIEVE OPENNING		U.S. SIEVE	CUMULATIVE % RETAINED		REMARKS
INCH.	MM	NO	WT RET.	% RET.	
		1/2 inch			
.265		.265			
.187		4	180	13.6	
.132		6	260	19.7	
.0937		8	305	23.1	
.0661		12	340	25.8	
.0469		16	380	28.8	
.0331		20	435	32.9	
.0234		30	535	40.5	
.0165		40	840	63.6	
.0098		60			
.0059		100			
.0029		200			
		PAN	1315		

Total WT: 1320 gms

SIEVE ANALYSIS

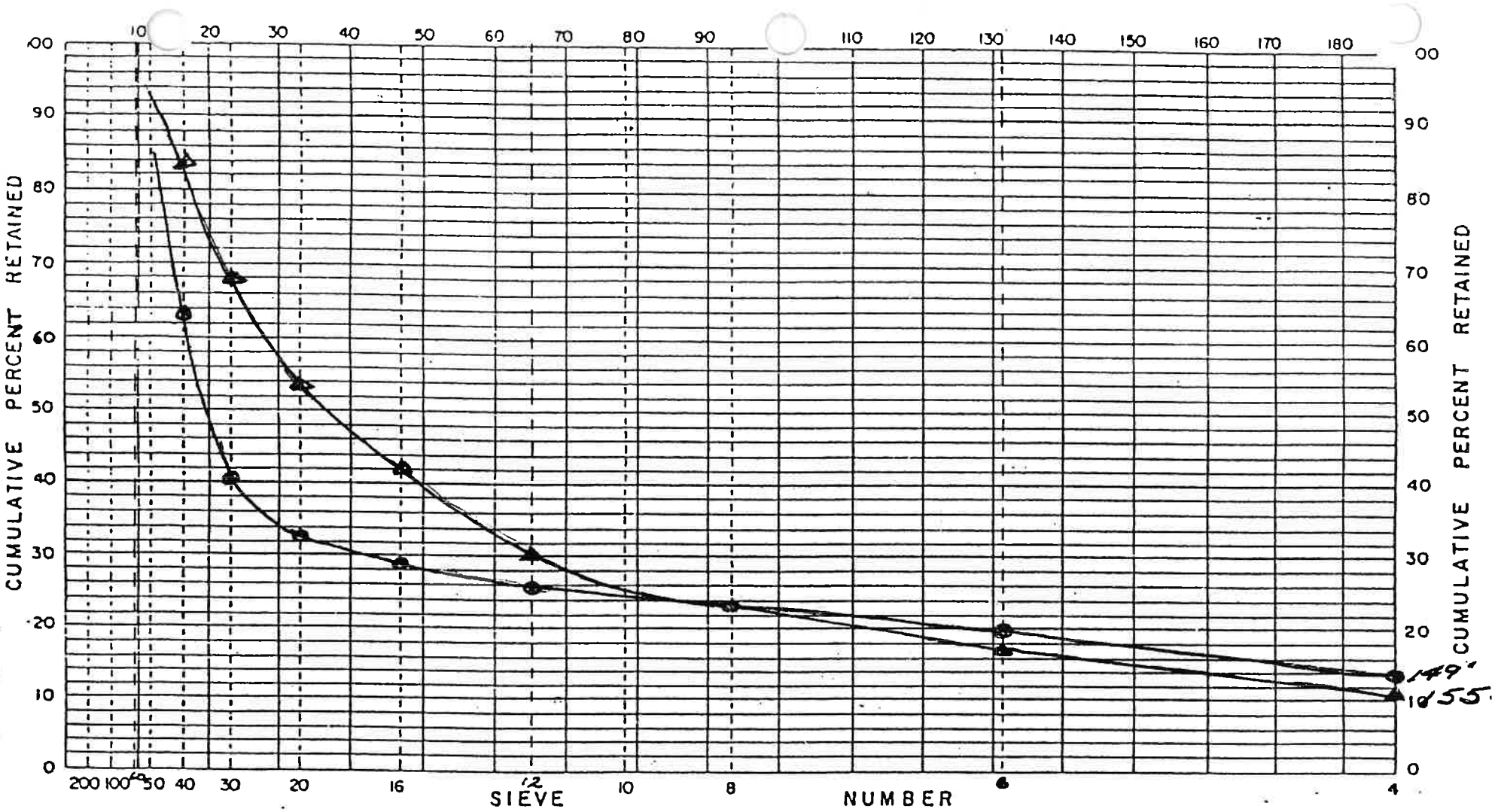
PROJECT: Village of Silverton

REMARKS: _____

DEPTH: 155 ft

SIEVE OPENNING INCH.	MM	U.S. SIEVE NO	CUMULATIVE % RETAINED WT RET.	% RET.	REMARKS
		1/2 inch			
.265		.265			
.187		4	130	11.4	
.132		6	195	17.1	
.0937		8	265	23.2	
.0661		12	345	30.3	
.0469		16	480	42.1	
.0331		28	610	53.5	
.0234		38	775	67.9	
.0165		48	950	83.3	
.0098		60			
.0059		100			
.0029		200			
		PAN	1140		

Total Wt. 1140 gms.



SAMPLE DEPTH FEET			
OPENING	RET. ON	WT. RET.	CUM. % RET.

Percent of sample not sieved 1/2" or over _____%

SAMPLE DEPTH FEET			
OPENING	RET. ON	WT. RET.	CUM. % RET.
15-18			149
40			155

Percent of sample not sieved 1/2" or over _____%

SAMPLE DEPTH FEET			
OPENING	RET. ON	WT. RET.	CUM. % RET.
			—

Percent of sample not sieved 1/2" or over _____%

PROJECT:
LOCATION:
WELL No.
SAMPLED BY:
SIEVE ANALYS
DATE: