AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

MAYER RD TW-WTN 83018, 82E 083 441 #22
ROTARY MARSH TH-WTN 83019, 82E 083 443 #8
MEIKLE AVE TH-WTN 83020, 82E 083 411 #4
ELDORADO BOAT LAUNCH TW-WTN 83021, 82E 083 233 #4

GROUNDWATER ASSESSMENT FOR DRINKING WATER

ELDORADO RD INTAKE TH-WTN 83022, 82E 083 213 #53
COLLETT RD TW-WTN 83023, 82E 083 124 #2

AEE WELL #31 (WELL NO. 6 RWD) - WTN 251
AEE WELL #50 (WELL NO. 12 RWD) - WTN 83125
AEE WELL #3 (RELAX INN, 180.8') - WTN 83126
AEE WELL #4 (184') - WTN 83127
AEE WELL #2 (120') - WTN 83128
AEE WELL #5 (152') - WTN 83129

Submitted To:

The City of Kelowna
Kelowna, BC

Submitted By:

AGRA Earth & Environmental Limited

Kamloops, BC

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KX12138

AGRA Earth & Environmental Limited
913 Laval Crescent
Kamloops, BC
Canada V2C 5P4
Tel (250) 374-1347
Fax (250) 374-2944

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EXECUTIVE SUMMARY

The City of Kelowna retained AGRA Earth & Environmental Limited (AEE) to evaluate the potential of developing a groundwater supply within the City Water Supply Area. The study included a review of available hydrogeological information, a test well drilling program, a pumping test and water quality testing and modelling. Specific items to be addressed during the study included:

- Locations where a groundwater supply could be developed, potential yields and impacts.
- The quality of the groundwater, treatment requirements and mixing effects.
- Technologies other than vertical wells that could be used to extract groundwater.
- The cost of constructing and operating the groundwater extraction system(s).

To meet the City Water Supply Area's projected demands (70 ML/day to 205 ML/day) or at least a reasonable percentage of the demand, AEE investigated areas where significant recharge to an aquifer was likely to occur such as adjacent to Okanagan Lake. AEE also investigated the extension of the Rutland Aquifer beneath the study area. AEE selected six drilling which included:

- Rotary Marsh to the north of the Grand Okanagan Resort,
- Meikle Avenue at Okanagan Lake
- The parking lot at the Eldorado Hotel boat launch
- Eldorado Road at Okanagan Lake
- Collett Road at Okanagan Lake.
- Mayer Road midway between Benvoulin Road and Mission Creek (Rutland Aquifer).

The study indicated that the areas suitable for groundwater development were Eldorado Road, Collett Road and Mayer Road. The Rotary Marsh, Meikle Avenue and Eldorado Hotel/Mission Creek mouth areas are not considered suitable for groundwater development.

Groundwater will not be able to meet the entire demand of the City Water Supply Area but could be used as a supplemental source. The estimated combined yield from the Eldorado Road and Collett Road sites is 16 ML/day to 20 ML/day. Additional volume may be available from other areas in the alluvial fan such as the foot of Farris Road to the south of Collett Road. A groundwater supply of 16 ML/day would supply all of the demand from the Eldorado Road pump stations during spring freshet when the intake is vulnerable to lake turbidity, and 80% of the peak summer demand. A groundwater supply of 20 ML/day would meet the 1998 maximum daily demand (July 27, 1998 – 20.1 ML).

The estimated yield from multiple wells constructed in the Rutland Aquifer is in the order of 15 ML/day to 25 ML/day. This volume could supply approximately 25% to 40% of the average daily summer demand of the area serviced by the Poplar Point lake intake.

Developing a groundwater supply in the Bellevue Creek aquifer and the Rutland Aquifer will be subject to an environmental assessment under the *BC Environmental Assessment Act.* Developing a groundwater supply in the Rutland Aquifer will impact other users of the aquifer and the

environmental assessment process may become quite involved with stakeholder participation. The environmental review board may limit the amount of water that the City can pump from the Rutland Aquifer.

Iron and manganese concentrations at the Collett Road site were approximately twice the aesthetic objectives in the Canadian Drinking Water Guidelines (CDWG). Under extended pumping conditions, lake recharge into the aquifer may dilute the concentrations of iron and manganese in the groundwater to levels that meet CDWG objectives. Cost analyses for groundwater development in the Bellevue Creek aquifer should allow treatment for iron and manganese at an estimated cost (City) of $4,000,000.00.

The sand and gravel aquifer positioned between the lake bottom plus a horizontal distance of approximately 20 m between the lake shore and a production well will filter out suspended solids, including organic matter. This filtration would significantly if not totally eliminate lake born pathogens.

The manganese concentration in the groundwater at the Mayer Road site is approximately five times the CDWG aesthetic objectives. Mixing the groundwater and lake water may dilute the concentration of manganese to a level that is not problematic. The confined nature of the Rutland Aquifer provides excellent protection against pathogenic organisms and surface sources of contamination.

Further study should include:

- Constructing a production well at the Collett Road site.
- Assess the groundwater development potential at the Farris Road site.
- Exploring the southern extension of the Rutland Aquifer.
- Construct and pump test (14 day) a midsize (305 mm diameter) pumping well at the Mayer Road site.
- Completing the environmental assessments.

1.0 CONCLUSIONS

The conclusions of the groundwater assessment are presented below.

- Groundwater is available in municipal quantities in two areas within the City Water Supply Area but will not meet the entire City Water Supply Area demand.

- Groundwater development is not considered viable along Okanagan Lake between Poplar Point to the north and Bellevue Creek to the south.

- The first development area is proximate to the mouth of Bellevue Creek (Collet Road and Eldorado Road) in Okanagan Mission. The estimated combined yield from wells constructed at both locations is in the order of 16 ML/day to 20 ML/day.

- The development of additional volume may also be possible at the foot of Farris Road to the south of Collett Road.

- Groundwater could supply the entire demand of the area serviced by the Eldorado Road intake during spring freshet (April, May, June) when the lake water is turbid. Groundwater could also supply approximately 80% to 100% of the maximum daily demand of the Eldorado Road intake during the greatest demands of July and August.

- The groundwater at the Collett Road exceeds the CDWG (aesthetic objectives) for iron and manganese.

- Under extended pumping conditions the lake water, which is low in iron and manganese, may dilute the concentrations of these metals in the groundwater.

- The Bellevue Creek aquifer may be susceptible to contamination by water borne pathogens from lake recharge however, the lack of turbidity and organic particles in the groundwater would make any water treatment such as chlorination more effective. The sand and gravel aquifer positioned between the lake bottom and a well screen would significantly if not totally filter out pathogens.

- The cost of constructing a radial well at Collet Road would be at least twice the cost of constructing verticals wells providing the same volume.

- The second development area is between Benvoulin Drive and Mission Creek (extension of Rutland Aquifer). The estimated yield from multiple wells constructed in the area is in the order of 15 ML/day to 25 ML/day.

- A groundwater supply developed from the Rutland Aquifer could supply approximately 25% to 40% of the average daily summer demand of the area serviced by the Poplar Point Intake.

- There are other users of the Rutland Aquifer.

- The groundwater at the Mayer Road test well met the CDWG with the exception of manganese, which was approximately five times the aesthetic objective.

2.0 RECOMMENDATIONS & COSTS

The groundwater assessment concluded that developing a groundwater supply supplementing the existing surface water system is a viable option for the City of Kelowna. Additional steps should be completed to advance from this assessment stage to the design and build stage. These steps are intended to address quality issues, verify the quantity of groundwater available and satisfy the requirements of the *Environmental Assessment Act*. These steps or recommendations are presented below. GST is not included in the cost estimates.

2.1 Collett Road Site Recommendations

- Verify groundwater quantity and long term quality by constructing and pump testing a 406 mm diameter production well. Cost – $105,000.00

- Complete the environmental assessment. Cost – $5,000.00 to $10,000.00 (estimate)

2.2 Farris Road Site Recommendation

- Construct and pump test a 150 mm diameter well to investigate groundwater quantity and quality. Cost – $20,000.00

2.3 Mayer Road/Rutland Aquifer Recommendations

- Explore the southern extension of the Rutland Aquifer in the vicinity of KLO Road and Mission Creek by drilling a 150 mm diameter test well. Cost – $34,000.00

- Construct a "midsize" 305 mm diameter well at the Mayer Road site to evaluate long term yield and acquire data necessary for environmental review. Cost – $120,000.00

- Complete the environmental assessment. Cost – $20,000.00 to $40,000.00 (estimate)

2.4 Overall Development Costs

- The cost of developing a groundwater supply system (vertical wells) yielding 16 ML/day to 20 ML/day from the Bellevue Creek aquifer is estimated at $1,300,000.00 to $1,400,000.00. Treatment for iron and manganese would increase the overall cost by approximately $4,000,000.00.

- The cost of constructing a radial well at the Collett Road site delivering up to 25 ML/day is estimated at $2,400,000.00 excluding treatment.

- The cost of developing a groundwater supply at Mayer Road yielding approximately 16 ML/day is estimated at $945,000.00 to $1,140,000.00.

3.0 INTRODUCTION

This report presents the results of a study evaluating the potential of developing a groundwater source within the City of Kelowna Water Supply Area. A topographical plan illustrating the study area is included as Figure 1 in Appendix A. Also included in the report is a discussion of development areas, potential yields, groundwater quality and construction and operating costs. The study was authorized by the City of Kelowna (City) and was generally carried out in accordance with the City's Request For Proposal dated June 1, 1998 and AGRA Earth & Environmental Limited's (AEE) proposal dated June 12,1998.

4.0 OBJECTIVE AND SCOPE

The City Water Supply Area includes the downtown/core area and Okanagan/Mission to the south. The City Water Supply Area currently obtains its water from a series of intakes in Okanagan Lake. Outbreaks of disease organisms in Okanagan Lake has led the City to review options in providing the City Water Supply Area with potable water. These options include treating the surface water and using groundwater as an exclusive or supplementary source. AEE understands that the projected 10 year water demands are 70 ML/day on average with maximum daily demand of 205 ML/day

Neighbouring areas or districts within the City are serviced by separate water systems. These water systems obtain their supplies from surface water, groundwater or a combination of both. The Rutland Waterworks District (RID) obtains their entire water supply from groundwater.

The scope of work outlined in the City's Request for Proposal, was to evaluate in detail the local groundwater resource and determine if it can be used as a sole or supplemental source of potable water for the City Water Supply Area. Specific questions to be answered by the study were:

- The groundwater extraction rates available on a long term basis (sustainable yield).
- The quality of the available groundwater and its relation to Canadian Drinking Water Guidelines.
- The necessity for groundwater treatment to meet the guidelines or public acceptance and the implications of mixing groundwater with lake water.
- The influence of recharge, i.e. surface water, precipitation, storm water discharge on the quality and quantity of groundwater.
- The general hydrogeology of the supply aquifer(s) within the City Water Supply Area and the neighbouring water supply Districts including the effect of land use on the aquifer and its potential to be contaminated.
- Alternative groundwater development methodologies.
- The cost of construction, operating and maintaining the pumping facilities.

5.0 METHOD OF INVESTIGATION

The hydrogeological investigation was focussed on providing the City with practical solutions for the development and management of a groundwater supply system. To provide these solutions, AEE designed a drilling program that examined the hydrogeology throughout the study area on a

general scale and then focussed on specific areas with the remaining budget. The project tasks included:

- A project initiation meeting and performance meetings with the City staff.
- Completing an information review and site reconnaissance to collect and evaluate existing data as well as data gaps that should be addressed during the investigation. The test well drilling sites were selected based on the information review and site reconnaissance.
- Drilling five sites adjacent to Okanagan Lake and a sixth site at the east edge of the study area proximate to the Rutland Aquifer.
- Collecting and testing soil samples to develop a comprehensive record of the site stratigraphy and lithology at each drilling location. Soil characteristics were used to calculate the hydraulic conductivity of the formations (aquifers and aquitards), appropriate screen slot openings and theoretical yield of production wells.
- Assessing the groundwater quality at potential development areas and modelling the compatibility of mixing the groundwater with the lake water.
- Installing and developing a well screen in the Collett Road test well to produce an operating well. Two shallow monitoring wells were installed near the well and a pumping test conducted to evaluate the aquifer parameters and hydraulic connection with Okanagan Lake.
- Evaluating the usefulness of alternative groundwater including intake configurations, their practicalities, applications, capital and operational costs, technical advantages and disadvantages.
- Preparing this investigation report.

6.0 INVESTIGATION RESULTS

The results of the investigation are presented in the following sections. At the request of the City, the results area presented in the general format of the deliverables listed in the original Request for Proposal. The deliverables are preceded with a brief description of the area climate, physiography and geology.

6.1 Physiography

The study area is primarily located within the relatively flat lying valley floor along the east side of Okanagan Lake. The study area is illustrated on Figure 1 and Figure 2 in Appendix A. The valley floor rises from the level of Okanagan Lake (342 +/- m ASL) to approximately 370 m ASL near Mission Creek. Steeper terrain is located along the northern edge and southern most portion of the study area. Along the north, the topography is controlled by bedrock bluffs. Okanagan Mission to the south is located within fluvial glacial terrace and bedrock controlled hillsides.

6.5 Surface Drainage

The entire City drainage basin area encompasses approximately 1,445 km^2 (Dayton & Knight 1989). Surface drainage is divided into six basins referred to as Mission Creek (883 km^2), Kelowna Creek (224 km^2), Brandt's Creek (42 km^2), Vernon Creek(137 km^2), Okanagan Mission (147 km^2) and Clifton-McKinley (13 km^2). The basins discharge into Okanagan Lake with the exception of the Vernon Creek basin. The study area encompasses the western edge of the Mission Creek Basin, the Okanagan Mission Basin, the western edge of the Kelowna Creek Basing and the southern edge of the Brandt's Creek basin.

The Mission Creek Basin is the largest basin accounting for approximately 60 % of the entire City watershed. Mission Creek also has the greatest flow with an estimated base flow in the order of 80 ML/day to 300 ML/day. Base flow in Kelowna Creek typically ranges from 17 ML/day to 35 ML/day. (EBA 1997).

6.6 Summary of Information Reviewed (deliverable)

The information reviewed during the study is summarized below.

6.6.1 Water Well Records and Borehole Logs

Approximately 400 water well records in the Ministry of Environment, Lands and Parks (MELP) database were screened for relevant information. A detailed record (location, lithology, static water level, yield) of each water well and borehole incorporated into the study is included in Appendix B. The logs of the six test wells/holes drilled during this study are presented at the beginning of the Appendix with the 50 well records collected from other sources following the study test holes. The locations of the wells and boreholes are plotted on the Area Plan – Figure 2. In addition to the MELP database, water well and borehole information was also collected from:

- Rutland Irrigation Districts (RID) Files
- Southeast Kelowna Irrigation District (SEKID)
- AEE's geotechnical investigations of the Grand Okanagan Lakefront Resort
- Golder Associates Geotechnical Investigation of a Parkade on Smith Avenue
- Golder Associates Geotechnical Investigation of the proposed Library on Ellis Street
- Discussions with the Southeast Kelowna Irrigation District (SEKID)

6.6.2 Previous Consultant Reports and Papers

Previous consultant reports and papers reviewed during the investigation included:

- EBA Engineering Report Hydrogeological and Geotechnical Assessment (1997)
- Kerr Wood Leidal Gore & Storrie Inc Report on Water Quality Assurance Options (1997)
- Hardy BBT Limited (AEE) Report geotechnical Investigation Proposed Lakeside Development (1989)
- MELP Report Okanagan Mission South Wate5 Users Community test Well Drilling (1984)
- MELP Report Mission Creek Groundwater Study (1979)

- EBA Engineering Report Preliminary Assessment of the Groundwater Supply Potential for the City of Kelowna (1997)
- MELP Paper Notes on Surficial Geology of South East Kelowna Area (No date)
- MELP Paper Notes on Pleistocene Geology – south East Kelowna (No date)
- Pacific Hydrology Consultants Report Construction and Testing of 12 inch Production Well Eldorado Estates Subdivision (1981)
- E. Livingston Associates Report Water Analysis 8" well in S.E. Kelowna near Hall Road (1976)
- E. Livingston Associates Report Construction and Testing of Well No. 10 on Springfield Road.
- MELP memorandum Test Drilling RID (1964)
- Pacific Hydrology Consultants Report construction and Testing of Well No. 13 (RID – 1985)

6.6.3 Miscellaneous Information

- Geological Survey of Canada Surficial geology and Bedrock Geology Mapping
- 1976 and 1996 Stereo Aerial Photographs
- RID Files:
- Well head Elevation Data
- Static water level and pumping water level data
- Pumping rates
- City of Kelowna Master Drainage Plan
- City of Kelowna Land Use Map #15.1
- City of Kelowna water use records

6.6.4 Chemistry Data

Groundwater chemistry data reviewed in the study was obtained from RID files and MELP's database. The City supplied chemistry data for Okanagan Lake.

6.7 Groundwater Development Areas and Availability, Piezometric Surface, Flow Patterns (Deliverable)

AEE's study approach was to examine the stratigraphy in areas where significant recharge to an aquifer was likely to occur and to address data gaps in the extension of the Rutland Aquifer. AEE also wanted to drill as many sites as possible to ensure the entire study area was adequately addressed (within the limitations of time and budget). To meet these objectives, five test wells were drilled near Okanagan Lake between the northern edge of the study area and Okanagan Mission to the south. The five "lakeside" test well locations are illustrated on Figure 2 and included:

- Rotary Marsh to the north of the Grand Okanagan Resort,
- Meikle Avenue at Okanagan Lake,
- The parking lot at the Eldorado Hotel boat launch,
- Eldorado Road at Okanagan Lake,
- Collett Road at Okanagan Lake.

The Collett Road test well was drilled with a water well drilling rig to permit the well to be completed as a pumping well for further quantity and quality testing. The stratigraphy at the site basically consisted of sand and gravel extending from the surface to a depth of 33.5 m below grade where clay was encountered. A gravely sand unit was present between a depth of 22.6 m and 25.0 m. At 25.0 m the aquifer graded back into a coarser sand and gravel with occasional cobbles and boulders. Clay lenses were present periodically between 32.3 m and the base of the aquifer at 33.5 m. The clay unit beginning at 33.5 m was proven for 1.2 m. A detailed log of the test well is included in Appendix B. Grains size curves for aquifer samples collected between 21.3 m and 33.5 m below surface, are included in Appendix C.

A short 6.5 hr pumping test was completed on the well to assess the aquifer parameters and potential yield. The results of the test are discussed in Section 4.8 – Groundwater Quantity.

It was originally proposed to drill only one test well in the Bellevue Creek fan however, the drilling program was under budget which permitted the completion of a second well in the fan. The Eldorado Road lake intake was chosen as the second site to evaluate the northern extension of the alluvial fan. Constructing a production well at the site of the intake would also be very cost effective in connecting to the existing infrastructure.

The Eldorado Road site was limited in area therefore the test hole was drilled with the smaller auger drill rig (it will be possible to construct a production well at the Eldorado intake using a cable tool drill rig). The stratigraphy at Eldorado Road consisted of medium to coarse grained sand extending from the surface to a depth of 30.5 m. The base of the sand aquifer has not been determined as 30.5 m was the maximum depth that could be drilled with the auger rig. A detailed log of the well is included in Appendix B. Grain size curves for aquifer samples are included in Appendix D.

At Collett Road, the unconfined aquifer terminated at 33.5 m; AEE suspects that the thickness of the aquifer at Eldorado Road will be similar to the thickness at Collett Road. The geological cross section looking west through the toe of the fan (Figure 4) was constructed using stratigraphic data from the Collett Road test well, Eldorado Road test hole and a domestic well (AEE Well #20) to the north of Eldorado Road. Available data indicates that the alluvial fan is thinning to the north of Eldorado Road.

The toe of the Bellevue Creek alluvial fan is an area in which a municipal groundwater supply can be developed. The recommended area for development is illustrated on Figure 9 and discussed in Section 4.11 – suggested Well Locations.

6.7.5 Mayer Road

The Mayer Road site was chosen to explore the western extension of the Rutland Aquifer. The RID obtains their entire water supply from this aquifer. A geological cross section looking north through the Rutland Aquifer and study area is presented as Figure 3.

The Mayer Road test well was drilled with an air rotary drill rig. AEE felt that the potential existed for flowing conditions to occur at the site therefore, the well was initiated with 12.2 m of 200 mm diameter surface casing. After setting the surface casing, the well was continued with 150 mm diameter casing to a depth of 66 m. Drilling was terminated at 66 m due to flowing conditions (approx. 200 gpm) and the difficulty in drilling under flowing conditions with an air rotary drill rig. The static water level in the well was approximately 4.9 m above ground.

The stratigraphy encountered at the Mayer Road site generally consisted of 1.6 m of clay overlying a silty, clayey sand and gravel extending to a depth of 7.6. A till unit was present between 7.6 m and 10.7 m. The till was underlain by silt extending down to 21.9 m where clay was encountered.

The clay unit was approximately 5.5 m thick. A confined sand and gravel aquifer was present beneath the clay from 27.4 m to the base of the test well at 66.1 m. A detailed log of the test well is included in Appendix B. Grain size curves for aquifer samples collected between 47 m and 66 m below surface are included in Appendix C.

The base of the sand and gravel unit at the Mayer Road site is undefined however, a MELP 440 m deep test hole (AEE well #27) described sand and gravel extending from 13.7 m below surface to 117 m below surface. The MELP test hole was drilled through the Rutland Aquifer approximately 1.5 km east northeast of the Mayer Road well. The MELP test hole indicated that the sand and gravel was underlain by silt extending to a depth of 408 m. Till was encountered at the base off the test hole from 408 m to 440 m below surface.

The Mayer Road test well was not completed with a well screen. The remaining budget for the Mayer Road well was used to seal off the flow inside and outside of the casings. The well head was equipped with valves to permit the collection of water samples and provide a monitoring point for any future testing. It will be possible to set a screen in the well at a later date if necessary.

The Rutland Aquifer extends beneath the eastern edge of the study area. The **estimated** aerial extension of the aquifer and associated development potential within the study area is illustrated on Figure 9. Very little groundwater exploration has been completed in the southern portion of the estimated area (i.e. KLO road). Wells drilled in the southern portion have generally been for domestic use and have not defined the full thickness of the aquifer. A domestic well on KLO road (AEE Well #38) was drilled to a depth 31.6 m and only penetrated the top 1 m of a confined aquifer. The static water level in the well was above ground surface and the well flowed at 3 gpm.

6.7.6 Piezometric Surface and Groundwater Flow Patterns

The piezometric surface and inferred direction of groundwater flow in the Rutland Aquifer and Bellevue Fan aquifer are illustrated on the Area Plan – Figure 2. The piezometric surface was estimated from topographical maps, RID Irrigation District well head elevations and reported static water levels and information on driller's logs in MELP's data base.

The direction of groundwater flow through the Rutland aquifer is south-westerly towards Okanagan Lake at an estimated average gradient of approximately 0.006.

The direction of groundwater flow through the Bellevue Fan aquifer is westerly towards Okanagan Lake at an estimated average gradient of approximately 0.02.

6.8 Groundwater Quantity, Potential Drawdown, Well Interference (deliverable)

Section 6.8.1 provides a discussion of current groundwater use within and adjacent to the study area. Section 6.8.2 provides a discussion of the groundwater development potential within the two identified areas (Bellevue Creek and Mayer Road) and the expected impact (drawdown, well interference) of groundwater use by the City.

6.8.1 Existing Wells

Proximate to the study area, the major users of groundwater are the RID, the Benvoulin area and the SEKID. The RID obtains 100% of their water from wells. In 1997, the RID pumped approximately 2.84 million cubic metres of groundwater from the Rutland aquifer. The RID has 11 wells but primarily use just 3 (AEE Well #s 29, 30 & 50). AEE Well #30 is used as the lead pump operating 24 hours per day. Well #29 is pumped 10 to 20 hours per day in the winter and summer respectively and Well #50 is pumped between 3 hours and 18 hours per day.

The SEKID has four wells (AEE Well #s 39, 40, 41 & 42). AEE understand SEKID only uses groundwater during spring freshest (AEE Well #s 41& 42) and that groundwater supplies less than 2% of the SEKID's annual water requirements. The remaining water is obtained from surface sources. The SEKID indicates that the Hall Road development (160 connections) may separate themselves from the main SEKID water system and use groundwater (AEE Well #s 39 and 40) for their water supply.

The Benvoulin area is rural/agricultural and is not serviced by the City water system. This area is situated between the City Water Supply Area to the west and the SEKID to the east. Groundwater use in the area is generally by individual wells typically supplying domestic quantities. AEE understands that the primary source of irrigation water in the area is from surface sources and that there is not any single large groundwater user in the Benvoulin area.

The City services the Bellevue Creek and Okanagan Mission areas. MELP drilled three test wells to the south of Bellevue Creek in 1984. The wells are used as observation points by MELP. Some homeowners in the Bellevue Creek /Okanagan Mission areas may not be connected to the City water system and are using groundwater. For example, a domestic well was recently drilled on a newly developed lot approximately 80 m south of the Eldorado Road Intake.

A summary of existing high yield wells is presented in Table 1.

Table 1
Summary of Existing High Yield Wells

AEE Well #	Owner (year drilled)	Depth (m)	Static Water Level (m bg)	Current Production Rate (ML/day)	Specific Capacity (US gpm/ft)	Rated Yield (ML/day)
26	RID #10 (1979)	184'56.1	4.6	Not Used	43	12.0
29	RID # 13 (1985)	107'32.6	14.6	3.0 to 5.7	60	10.9
30	RID #15 (1992)	201.861.3	22.9	3.3 to 5.6	20	UNK
31	RID # 6 (1974)	301.8'92.0	7.5	UNK	26	+12.0
50	RID # 12 (1982)	197' 60.0	26.2	2.5 to 2.8	21	UNK
39	SEKID (1976)	161'49.1	7.0	Not Used	44	3.5
40	SEKID (1981)	61.0	13.8	Not Used	UNK	5.2
41	SEKID #1 (1980)	84.4	50.9	4.9	UNK	UNK
42	SEKID #2 (1990)	129.5	52.4	4.9	UNK	UNK
21	OMWU (1984)	78.3	UNK	UNK	UNK	UNK
22	MELP (1984)	40.8	21.3	UNK	13	2.2
23	OMWU (1984)	43.9	64.9	UNK	UNK	2.3
45	OMWU (1984)	50.0	29.6	UNK	54	2.8
33	BWU (1979)	47.9	- 3.5	UNK	19	4.4
34	WKP (1985)	53.6	Above grade	UNK	UNK	1.4

Information on rated yield and specific capacity evaluated and reported by others

RID	Rutland Irrigation District
SEKID	Southeast Kelowna Irrigation District
OMWU	Okanagan Mission Water Users
BWU	Benvoulin Water Users
WKP	West Kootenay Power
UNK	Unknown

6.8.2 Bellevue Creek Alluvial Fan

6.8.2.1 Yield Testing

The Collett Road test well is located approximately 18.6 m from the edge of Okanagan Lake. On August 20, 1998, a 6.5 hour pumping test was completed on the well to investigate the aquifer's performance and potential yield. Prior to completing the test, two shallow (4.6 m deep) PVC monitoring wells were installed into the top of the unconfined aquifer to measure the drawdown cone and evaluate the degree of hydraulic connection of the aquifer with Okanagan Lake. One monitoring well was placed midway between the lake and the pumping well and the second monitoring well was placed an equal distance from the pumping well but parallel to the lake shore

The well was pump tested with a suction pump supplied by the City. Data loggers were installed in the pumping well and the observation well midway between the well and the lake, to record drawdown. Drawdown measurements were also recorded manually in the pumping well and two observation wells. The pumped water was discharged into the lake with permission from MELP.

The well was pumped at an average (± 10 US gpm) rate of 210 US gpm (1.1 ML/day) for a period of 387 minutes. During the pumping test, the water level was drawn down from a static water level at 0.24 m below grade to 4.00 m below grade. The 3.76 m of drawdown represents approximately

13% of the total available drawdown. Approximately 90% of the drawdown occurred during the first minute of pumping. The specific capacity of the well is in the order of 16 US gpm/ft drawdown (3.52 L/sec/m) at a pumping rate of 210 US gpm.

Drawdown data collected by the two data loggers (pumping well and one observation well) are plotted on Figure 5. The change in slope of the drawdown in the pumping well after approximately 2 minutes of pumping indicates that the cone of depression intercepted a recharge boundary which is interpreted to be the lake. Drawdown in the PVC observation well approached stabilisation after approximately 20 minutes of pumping. The maximum recorded drawdown in the observation wells was 0.12 m in the observation well positioned between the pumping well and lake and 0.09 m in the observation well located south of the pumping well parallel to the lake shore.

Drawdown data from the observation well was analyzed with the aquifer evaluation software AQTESOLV. The AQTESOLV data plot is included as Figure 6. The transmissivity of the aquifer is estimated at 3,000 m^2/day. The corresponding hydraulic conductivity of the 33.5 m thick aquifer is approximately 0.001 m/sec. This hydraulic conductivity value is representative of a clean sand and gravel aquifer. The specific yield of the unconfined aquifer is approximately 0.1.

Recovery data from the pumping test are plotted on Figure 7. Approximately 90% of recovery occurred in the pumping well within 1 minute of shutting off the pump. Approximately 99% of recovery had occurred at the end of the 30 minute recovery monitoring period, which was indicative of extensive recharge to the aquifer.

The City surveyed the elevations of the wells and lake. Under static conditions, the groundwater gradient between the test well and the lake was approximately 0.02 m towards the lake. At the end of the pumping test, the water level in the pumping well was approximately 2.9 m below the level of the lake and the water level in the observation well positioned between the pumping well and the lake, was approximately 0.22 m above the level of the lake.

6.8.2.2 Groundwater Quantity and Water Demand

AEE estimates that the yield from a single well constructed at the Collett Road site may be in the order of 11 ML/day (2,000 US gpm) via a 406 mm diameter well.

The drawdown cone during the test well pumping test was fairly limited in aerial extent suggesting that Collett Road site may support two production wells each delivering up to 10 ML/day. However, the first production well will need to be constructed and yield tested to determine if the site will support two production wells.

AEE estimates that the yield from a single well constructed at the Eldorado Pump station may be in the order of 5.5 ML/day (1,000 US gpm) via a 305 mm diameter well.

Daily pumping data for the Eldorado Road intake for the months of July 1997, August 1997, July 1998 and August 1998 indicate that the maximum volume pumped was 20.1 ML on July 27, 1998. July and August 1998 were very dry months and considered to represent the greatest demand. The daily averages pumped from the Eldorado Road intake in July 1998 and August 1998 were 11.8 ML/day and 13.4 ML/day respectively. In comparison, the daily averages pumped from the Eldorado Road intake in July 1997 and August 1997 were 5.1 ML/day and 7.6 ML/day respectively, with a daily maximum of 13.7 ML on August 4, 1997.

The estimated combined yield from a single well at the Collett Road site and a single well at the Eldorado Road site is in the order of 16.4 ML/day. This volume exceeds the daily average summer demand and is approximately 20% less than the maximum recorded single day demand (to date). The 1998 water use record for the Eldorado Road intake indicates that groundwater could meet the entire daily demand for approximately 3 weeks out of each month (July, August). A groundwater/surface water mix would be required periodically during the summer months.

The Eldorado Road intake is relatively shallow and subject to lake turbidity during spring freshet i.e. April, May and June. City records indicate that the 1998 maximum daily demand from the Eldorado Road intake during these months ranged from 1.4 ML/day in April to 10.0 ML/day in June. This demand is within the capacity of the Collett Road and Eldorado Road sites and indicates that groundwater could replace the Eldorado Road intake during periods when the lake water was turbid and difficult to chlorinate.

The topography of the Bellevue Creek fan suggest that the aquifer is continuous between Collett Road and Eldorado Road and therefore may support additional wells similar in capacity to the Collett Road and Eldorado Road sites. Preferably, the well(s) would be constructed adjacent to the lake but could set back from the lake. The recommended area for groundwater development in the Bellevue Creek fan is illustrated on Figure 8.

6.8.2.3 Drawdown and Well Interference

The Collett Road area is serviced by the City water system. Well interference is not considered to be an issue at the Collett Road site however, a localised lowering of the groundwater table may affect some of the trees at the site. The Eldorado Road area is serviced by the City water system however, there are some residences on individual wells water such as the residence under construction approximately 80 m south of the intake. Depending on the depth and location of the domestic wells, a pumping well at the Eldorado Road site may have an impact on shallow wells in the area.

6.8.2.4 Alternative Technologies

An alternative technology would be to construct a radial well at the Collett Road site providing in the order of 25 ML/day. However, alternative technologies are justified only if conventional methods i.e. vertical wells cannot pump all the water supplied by the aquifer. The aquifer should be initially tested by the operation and construction and testing of a large diameter (305 m to 406 mm

diameter) vertical well. The construction and testing of a large capacity well along with a series of observation wells is a requirement in the investigation and design of a horizontal well. International Water Supply Ltd (design/builder) estimates that the investigation would cost $85,000 to $125,000.

The vertical shaft of the radial well can also be sized so that additional laterals can be installed at a later date as demand increases. Radial wells offer the advantage of potentially larger yields from a single location providing the existing infrastructure can carry the additional input. Design and construction costs are much higher for radial wells than conventional vertical wells.

The Collett road site is marginally large enough to construct a radial well and overlying pump house. The Eldorado Road intake site is not large enough to construct a radial well.

6.8.3 Mayer Road/Rutland Aquifer

6.8.3.1 Quantity & Water Demand

The static water level in the Mayer Road well is approximately 4.9 m above grade. The well flows at approximately 0.5 ML/day (100 US gpm) and the specific capacity of the test well is in the order of 1.6 L/sec/m (8 US gpm/ft of drawdown). It should be noted that the well is simply an open casing without a well screen. The construction of a large diameter screened well would have a substantially higher specific capacity. The reported specific capacity of other wells completed in the Rutland Aquifer range from approximately 4 L/sec/m to 15 L/sec/m (20 US gpm/ft to 60 US gpm/ft).

AEE estimates that the yield from a single well constructed in the Mayer Road area could yield in the order of 8.1 ML/day (1,500 US gpm) to 16.2 ML/day (3,000 US gpm).

Groundwater pumped from the Mayer Road area would enter the portion of the distribution system serviced by the Poplar Point Intake. Daily pumping data for the Poplar Point intake for the months of July 1997, August 1997, July 1998 and August 1998 indicate that the maximum volume pumped was 74.1 ML/day on July 27, 1998. July and August 1998 were very dry months and considered to represent the greatest demand. The daily average pumped from Poplar Point in July 1998 and August 1998 was 62.3 ML/day and 63.1 ML/day respectively. In comparison, the daily averages in July 1997 and August 1997 were 48.5 ML/day and 52.4 ML/day respectively.

The Mayer Road site may yield up to 16.2 ML/day. One or two additional wells constructed in other areas of the Rutland Aquifer within the study area may increase the yield to 25 ML/day. This volume would provide 25% to 40% of the daily summer demand and a substantially greater portion of the winter demand.

Developing a groundwater supply of this magnitude will effect neighbouring groundwater users and will require a detailed review under the BC Environmental Assessment Process. Based on the results of the assessment, the environmental review board may limit the volume of groundwater that the City can pump from the Rutland Aquifer.

6.8.3.2 Drawdown & Well Interference

At present, the RID is the main user of the Rutland Aquifer and in 1997 pumped approximately 2.84 million cubic metres of groundwater from the aquifer. This withdrawal averaged approximately 7.9 ML/day and ranged from approximately 5.1 ML/day in the winter to 14.2 ML/day in the summer. The combined pumping rate by the RID and a Mayer Road well could be in the order of 30 ML/day. EBA (1997) estimated that groundwater recharge in the entire Kelowna Basin was in the order of 44 ML/day based on an estimated recharge of 4% of the annual precipitation.

The static water level in the Mayer Road test well is above the ground surface. This upward gradient indicates the aquifer (vicinity of Mayer Road) is not receiving recharge from overlying saturated sediments or surface waters. Recharge to the aquifer beneath the Mayer Road area is by flow through the aquifer from the east.

The RID indicated that there has been a decline in the static water levels in their wells since they started monitoring in 1987. This decline indicates that the aquifer is in a transient mode. The static water level will stop dropping when an equilibrium is reached between recharge and withdrawals i.e. recharge intensifies or alternatively withdrawals decrease. Pumping from a production well at Mayer Road will lower the pressure in the confined aquifer and may reverse the present upward gradient. Under downward gradient conditions leakage from the upper aquifer may occur through the confining clay layer promoting localised recharge to the aquifer.

The RID completed a pumping test on a production well (AEE Well #26) and monitored drawdown/well interference in a second production well (AEE Well #31) located 245 m to the east. Drawdown in the observation well was negligible during the pumping test. The Mayer Road site is approximately 1.4 km from the nearest RID well however, this well is rarely used. The closest RID well operated on a frequent basis is approximately 2.3 km from the Mayer Road site. The closest SEKID wells are located in the Hall Road subdivision and are located 1 km to 1.3 km from the Mayer Road site. At present these wells are rarely used but may come into production if the Hall Road subdivision elects to separate their water system from the SEKID's surface water system. Operating a well at the Mayer Road site is unlikely to cause immediate interference in the RID or SEKID wells. What may happen is a longer term process of a continuation or acceleration of decline in the static water level of the Rutland Aquifer. The management and monitoring of the Rutland Aquifer will require a combined effort from the City, RID and SEKID. Some property owners on Mayer Road are on wells and some are on City water. The operation of a production well at Mayer Road may induce drawdown in the domestic wells.

6.8.3.3 Alternative Technologies

Vertical wells are the only appropriate groundwater withdrawal technology in the Mayer Road area.

6.9 Groundwater Quality and Groundwater/Surface Water Mixing (deliverable)

The groundwater chemistry results are presented in the following section along with a discussion of their relation to CDWG, necessity for treatment and a comparison to the chemistry of Okanagan Lake. AEE recommends that prior to developing a groundwater supply at Collett/Eldorado or Mayer Road, groundwater samples from either sites be made available to the public for a "Taste Test".

6.9.1 Groundwater Quality – Collett Road/Eldorado Road

A groundwater sample was collected from the Collett Road test well and analyzed for potability. The results of selected analyses are presented in Table 2 along with Okanagan Lake (Eldorado Road intake) chemistry and CDWG. The metals in Table 2 are dissolved metals. Detailed lab reports are included in Appendix D.

Table 2
Collett Road Test Well Selected Parameters

Parameter	Units	Collett Rd Test Well	Eldorado Intake (lake sample)	CDWG
PH	Units	7.58	7.99	6.5 – 8.5
Alkalinity		86	118	NG
Hardness (CaCo3)	mg/L	88	119	See notes
Conductivity	uS/cm	210	285	NG
Chloride	mg/L	2.9	3.4	<250
Nitrate –N	mg/L	0.038	0.06	10
Sulphate	mg/L	11.3	27.3	<500
Sodium	mg/L	6.77	10.4	<200
Calcium	mg/L	24.0	32.2	NG
Magnesium	mg/L	6.43	8.59	NG
Iron	mg/L	**0.722**	0.01	<0.3
Manganese	mg/L	**0.091**	0.003	<0.05

NG – No guideline
Bold - Exceeding CDWG
Hardness is an aesthetic objective. Levels above 200 mg/L are considered poor. Less than 100 mg/L is desirable

The groundwater from the Collett Road test well was moderately hard but not as hard as the lake water. Dissolved iron and manganese concentrations were approximately twice the CDWG aesthetic objectives.

6.9.2 Groundwater Quality – Mayer Road

The City collected groundwater samples from the valve on the Mayer Road test well. The results of selected analyses are presented in Table 3 along with RID well data, Okanagan Lake (Cooper Road sampling station) chemistry and CDWG. The metals in Table 3 are dissolved metals. Detailed laboratory reports are included in Appendix D.

Table 3
Mayer Road Test Well Selected Parameters

Parameter	Units	Mayer Rd	RID Well 6 (AEE Well 31)	RID Well 10 (AEE Well 26)	RID Well 12 (AEE Well 50)	RID Well 15 (AEE Well 30)	Okanagan Lake	CDWG
PH	Units	8.03	7.8	7.8	7.6	6.9	7.76	6.5 – 8.5
Alkalinity		159	195	165	367	75	111	NG
Hardness (CaCo3)	Mg/L	134	200	166	339	82	119	See notes
Conductivity	uS/cm	360	NA	NA	NA	NA	285	NG
Chloride	Mg/L	0.8	9.8	6.0	11.8	3.1	3.4	<250
Nitrate –N	Mg/L	<0.05	<0.01	<0.01	2.48	1.58	<0.05	10
Sulphate	Mg/L	29	71	53	105	11	27.3	<500
Sodium	Mg/L	20.6	34.1	27.6	63.1	6.4	10.1	<200
Calcium	Mg/L	41.4	50.3	44.1	67.0	22.3	33.1	NG
Magnesium	Mg/L	7.65	18.0	13.5	41.6	6.27	8.8	NG
Iron	Mg/L	0.031	0.11	**0.47**	<0.03	<0.03	<0.005	<0.3
Manganese	Mg/L	**0.247**	**0.297**	**0.157**	<0.005	<0.005	0.003	<0.05

NA – Not analyzed
NG – No guideline
Bold - Exceeding CDWG
Hardness is an aesthetic objective. Levels above 200 mg/L are considered poor. Less than 100 mg/L is desirable

The groundwater from the Mayer Road test well was moderately hard but generally softer than the water from the RID wells with the exception of RID well #15. The RID uses Well #15 continuously due to the good quality of the groundwater. The dissolved iron concentration at Mayer Road was below CDWG however the manganese concentration was well above CDWG. The manganese concentration at Mayor Road was similar to the two closest RID wells – RID Well #6 and RID Well #10.

6.9.3 Groundwater/Surface Water Mixing

The potential for the formation of mineral precipitates from mixing groundwater with Okanagan Lake water was assessed through the use of a geochemical thermodynamic speciation model. The water chemistry for two different areas were assessed; the Collett Road groundwater mixed with the Eldorado Road intake and the Mayer Road groundwater mixed with Cooper Street surface water supply. The following assumptions were used in the modelling assessment:

1) The model assumes that the system is open to the atmosphere such that the groundwater and surface water are both exposed to atmospheric O_2 and CO_2. This condition represents the conditions under which both the groundwater and surface water samples were collected.

2) The model assumed the mixing ratios listed below, which were based on the expected long-term yields of the production wells and the required addition of surface water to meet daily demands:

   - 80% Collett Road groundwater mixed with 20% lake water from the Eldorado Road intake.
   - Mayer Road groundwater mixed with lake water from the Poplar Point intake (Cooper Street sampling station chemistry data) in two different ratios; 25% groundwater mixed with 75% lake water and 40% groundwater mixed with 60% lake water.

3) The ground water quality results are assumed to be representative of the expected, long term quality of the groundwater from the production wells.

The results of the mixing analysis from both the Collett/Eldorado and Mayer/Cooper areas indicate a low potential for the formation of mineral precipitates. The modelling did not indicate the precipitation of any mineral phase except for $FeCO_3$ and this was only for the Collett/Eldorado mixing simulation. This mineral phase was found to form at very low concentration of approximately 0.2 mg/L. Iron concentrations in the Collett Road test well were approximately 2.5 times higher than the aesthetic drinking water guideline and these higher concentrations are partly responsible for the potential for precipitation of low amounts of $FeCO_3$. No operational difficulties are envisaged from this precipitate.

AEE considers that there is potential for iron concentrations in a Collett Road production well to be reduced and further reduce the potential for $FeCO_3$ precipitation. Firstly, the test well was screened in a zone near the base of the well whereas the proposed production well design utilizes a longer screen length. An increased screen length may intercept groundwater with lower iron concentrations i.e. from shallower zones and/or different aquifer lithologies.

Secondly, the primary source of recharge to a well at the Collett Road and Eldorado Road sites will be Okanagan Lake. The lake water is very low in iron content, and may dilute the iron in the groundwater as the lake recharges the aquifer.

Because of the low potential for the formation of the mineral precipitates there does not appear to be any major concern over the treatment of water supply in terms of the scaling at the Mayer Road or Collett Road site. The current iron concentration of 0.72 mg/L at Collett Road is at a borderline concentration where treatment for iron may improve the aesthetics. The necessity for treatment would best be evaluated during the yield testing of a large capacity production well or actual production into the water system. Water samples would be collected at stages of the yield test and pumping regime and analyzed for trends in iron concentration such as dilution over time.

The modelling did not indicate the precipitate of any mineral phase by mixing Mayer Road groundwater with Okanagan Lake water. Mixing Mayer Road groundwater with surface water would dilute the concentration of manganese in the groundwater by two to three fold. After mixing, manganese concentrations would be approximately twice the aesthetic guidelines and would not be expected to be too problematic. Groundwater treatment to address the manganese concentrations is not recommended for the Mayer Road site at the present time.

6.10 Potential For Groundwater Contamination and Contamination Prevention (deliverable)

6.10.1 Bellevue Creek - Collett Road/Eldorado Road

The Bellevue Creek alluvial fan aquifer is an unconfined aquifer. Unconfined aquifers are susceptible to surface sources of contamination such as chemical spills, sewage disposal and storm water disposal via dry wells. Land use within the Bellevue Creek fan is residential with several schools and a few retail businesses. The area is also serviced by a municipal sewer system.

Under prolonged or continuous pumping conditions the primary source of recharge to wells constructed adjacent to the lake is expected to be lake. The chemical and bacteriological quality of the lake water will influence the quality of the groundwater withdrawn therefore the preservation of the lake water is important in protecting the groundwater resources.

6.10.2 Mayer Road

The aquifer at Mayer Road is confined by a 27 m thick layer of fine grained sediments with a 5.5 m thick layer of clay directly above the granular deposits. Water well records indicate that this clay layer varies in thickness moving eastwards into the Rutland area. The piezometric surface indicates that groundwater is flowing westward from the Rutland area.

The clay layer and general upward groundwater gradient at Mayer Road provide excellent protection against contamination originating in the area of the well head. The groundwater quality at Mayer road will be a function of the quality of groundwater flowing into the area from upgradient locations. Land use and groundwater protection practices in the Rutland area will have a direct bearing on groundwater quality at Mayer Road. The RID's groundwater quality monitoring program could be tailored to provide an early warning to possible groundwater quality issues for down gradient groundwater users. A well head protection plan for the Mayer Road site will require the combined efforts of the City and the RID.

6.11 Suggested Well Locations (deliverable)

6.11.1 Bellevue Creek Alluvial Fan

The preferred locations for production wells in the Bellevue Creek fan are the Collett Road and Eldorado Road sites drilled during this investigation. Additional sites are the beach at the foot of Farris Road to the south of Collett Road, and the intersection of Walker Drive and Cascia Drive between Collett Road and Eldorado Road. The Walker/Cascia Drive location is the least favourable due to its distance from the lake. Pilot wells would be required at the Farris Road and Walker/Cascia Drive sites prior to constructing a production well.

6.11.2 Mayer Road/Rutland Aquifer

AEE has suggested two locations for production wells in the Mayer Road/Rutland Aquifer area. The locations are illustrated on Figure 9. The first location for a production well and pump house is the

undeveloped area immediately east of the Mayer Road test well. A second possible production well site is proximate to the intersection of KLO Road and Mission Creek. This site would first be explored with a test well. Flowing conditions are likely to be present in this area therefore a site should be selected that has ditching or drainage to accommodate the discharge of groundwater during drilling and well development.

7.0 PRELIMINARY COST ESTIMATE (deliverable)

A preliminary cost estimate for the construction, connection and operation of three vertical wells for the City of Kelowna is provided in Table 4. The assumptions in the cost estimate include the following:

Collett Road Site

- 406 mm diameter vertical well
- submersible pump, pit less, control house and variable frequency drive
- 350mm diameter transmission line running approximately 1000 m north into Eldorado Road pump station via Collett Road, Fuller Road, Cascia Drive and Eldorado Road installed at $450.00 per lineal metre
- Groundwater would be treated at Eldorado Road pump station
- Costs also provided for second well at site which would be controlled via a single pump house. Transmission line to Eldorado pump station upgraded to 450 mm diameter at a cost of $560.00 per lineal metre

Eldorado Road Site

- 406 mm diameter vertical well
- Submersible pump, pit less and variable frequency drive
- Existing pump station used to house control equipment
- connected to Eldorado Road mainline
- Groundwater would be treated at Eldorado Road pump station

Mayer Road Site (two options)

- Option 1 - Two 305 mm diameter vertical wells with 406 mm diameter surface casings
- Option 2 – One 508 mm diameter vertical well with 610 mm diameter and 762 mm diameter surface casings
- Submersible pump, pit less, pump control house and variable frequency drive
- 350 mm diameter transmission line running approximately 200 m east into Benvoulin Road main
- 350 mm transmission line installed at $450.00 per lineal metre
- Groundwater treatment at "Mayer Road Pump House"

Alternative Technologies

- A cost estimate is also provided for the construction of a 25 ML/day radial well at the Collett Road site. A 1,000 m long 450 mm diameter transmission line would be connect the radial well to the Eldorado Road pump station

Table 4
Preliminary Cost Estimate

Location	Yield (ML/day)	Well Construction, Testing & Engineering	Pump House Pump, Controls	Connection To mainline	Total	Operation (per anum)
Collett Road	11	$105,000	$500,000	$450,000	$1,055,000	$90,000
Second well	5 - 11	$70,000 – 85,000	$150,000	$110,000	$345,000	$90,000
Eldorado Road	5.5	$75,000	$150,000	$25,000	$250,000	$70,000
Mayer Road						
1-508 mm well	16	$180,000	$750,000	$90,000	$1,020,000	$125,000
1–305 mm well	8	$120,000	$450,000	$90,000	$660,000	$75,000
2nd well	8	$95,000	$150,000	$40,000	$285,000	$75,000
Collett Road Radial Well	25	$1,375,000	$500,000	$560,000	$2,435,000	$150,000

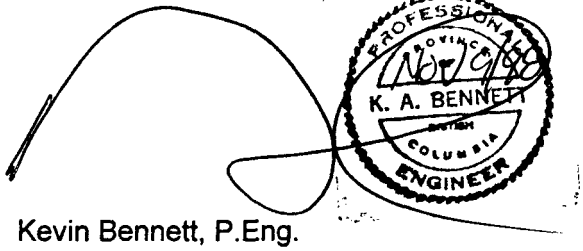
Notes: The connection cost estimate for the second well at the Collett site is an upgrade from a 350 mm diameter transmission line to a 450 mm diameter transmission line.
Operation costs include hydro, chlorine and materials but do not include labour.

8.0 CLOSURE

AGRA Earth & Environmental Limited trusts that we have provided sufficient information for your present requirements. If you have any questions or concerns, please do not hesitate to contact the undersigned at your convenience

Respectfully submitted,

AGRA Earth & Environmental Limited



Kevin Bennett, P.Eng.
Environmental/Groundwater Engineer

Reviewed by:

Andrzej Slawinski, Ph.D.,P.Geol.
Principal Hydrogeologist

KAB/ja

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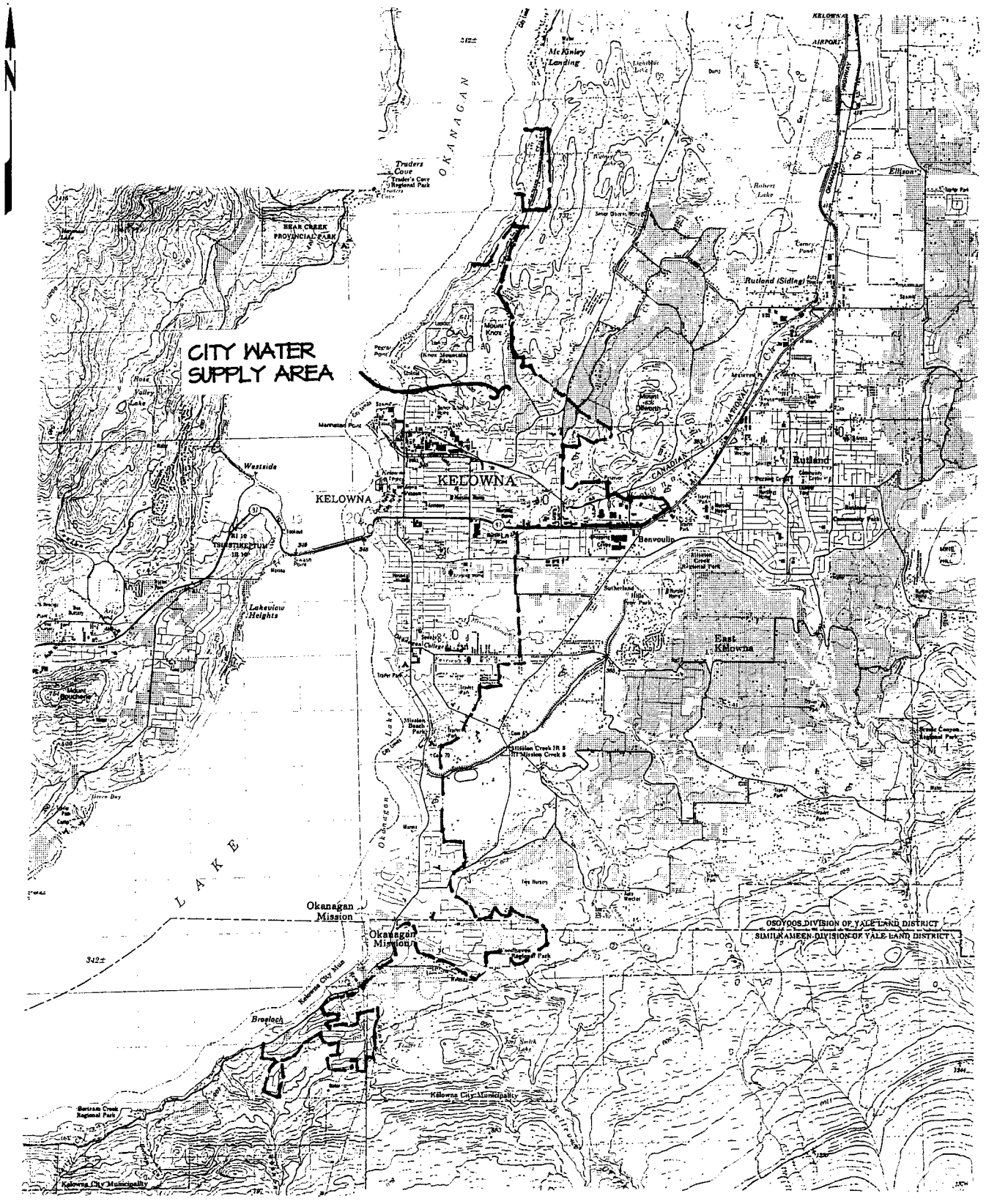


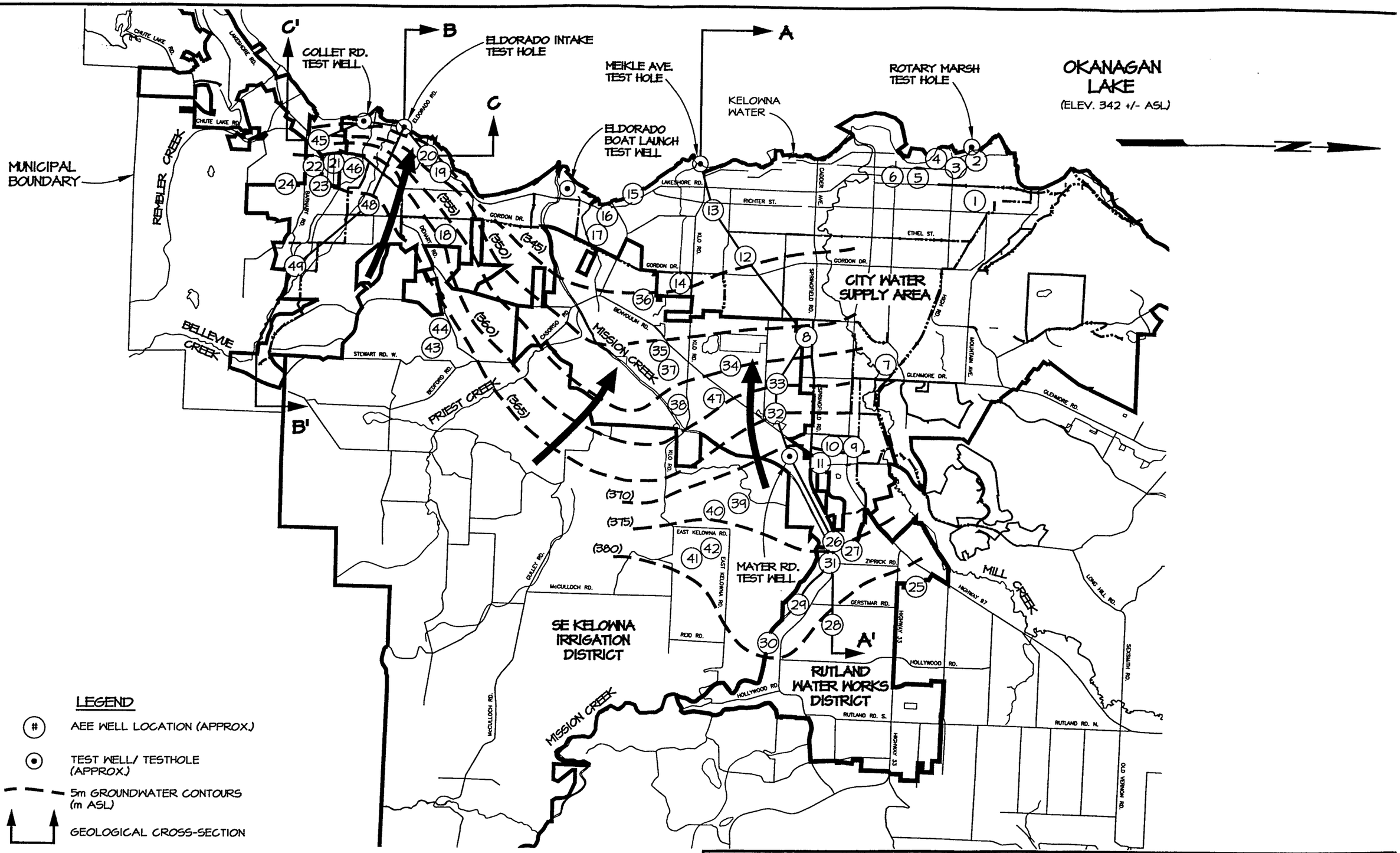
AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

SITE LOCATION

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn by	Project #	
1:100,000	98/09/21	BMD	KX12138	FIGURE 1

CAD FILE: KX12138\12138FIG1.DWG



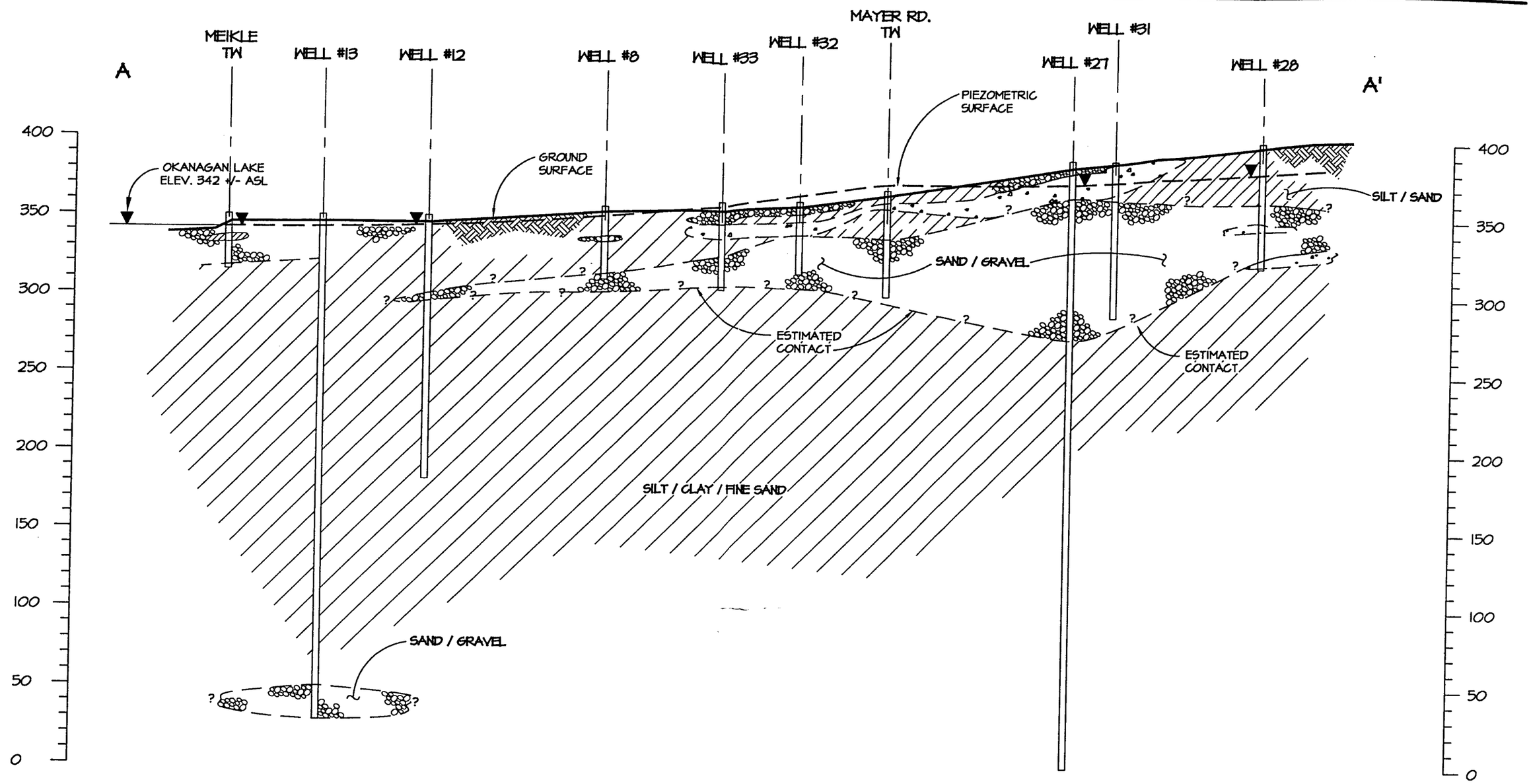
AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

CITY OF KELOWNA AREA PLAN

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn by	Project #	
1:50,000	98/09/17	BMD	KX12138	FIGURE 2

CAD FILE: KX12138\12138FIG2.DWG



SECTION A-A'

HORIZONTAL SCALE 1:25,000
LOOKING NORTH

LEGEND

- SAND & GRAVEL (AQUIFER)
- TILL
- CLAY, SILT & FINE SAND (GLACIAL LACUSTRINE)
- STATIC WATER LEVEL

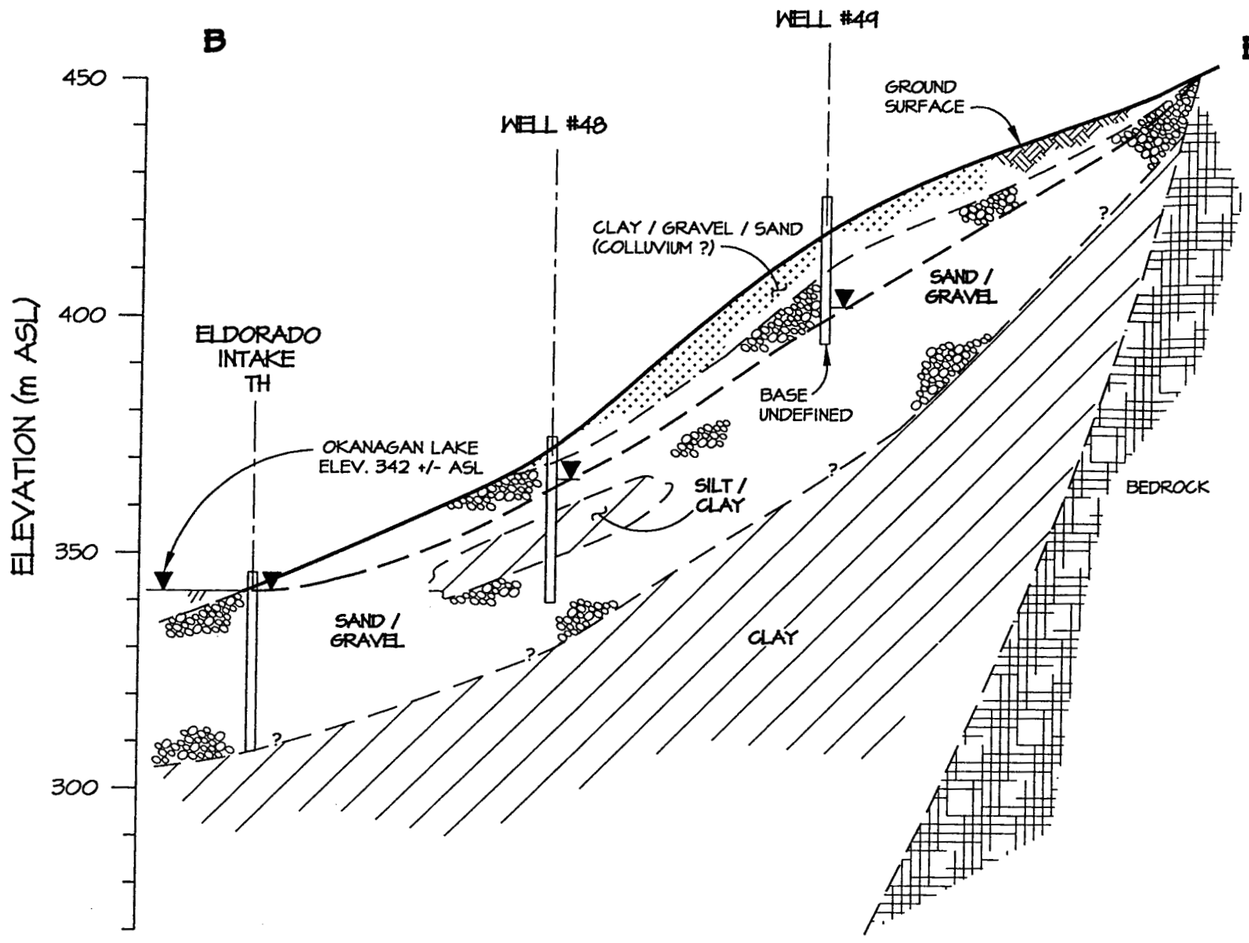
AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

GEOLOGICAL CROSS SECTION THROUGH MAYER RD. AQUIFER

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

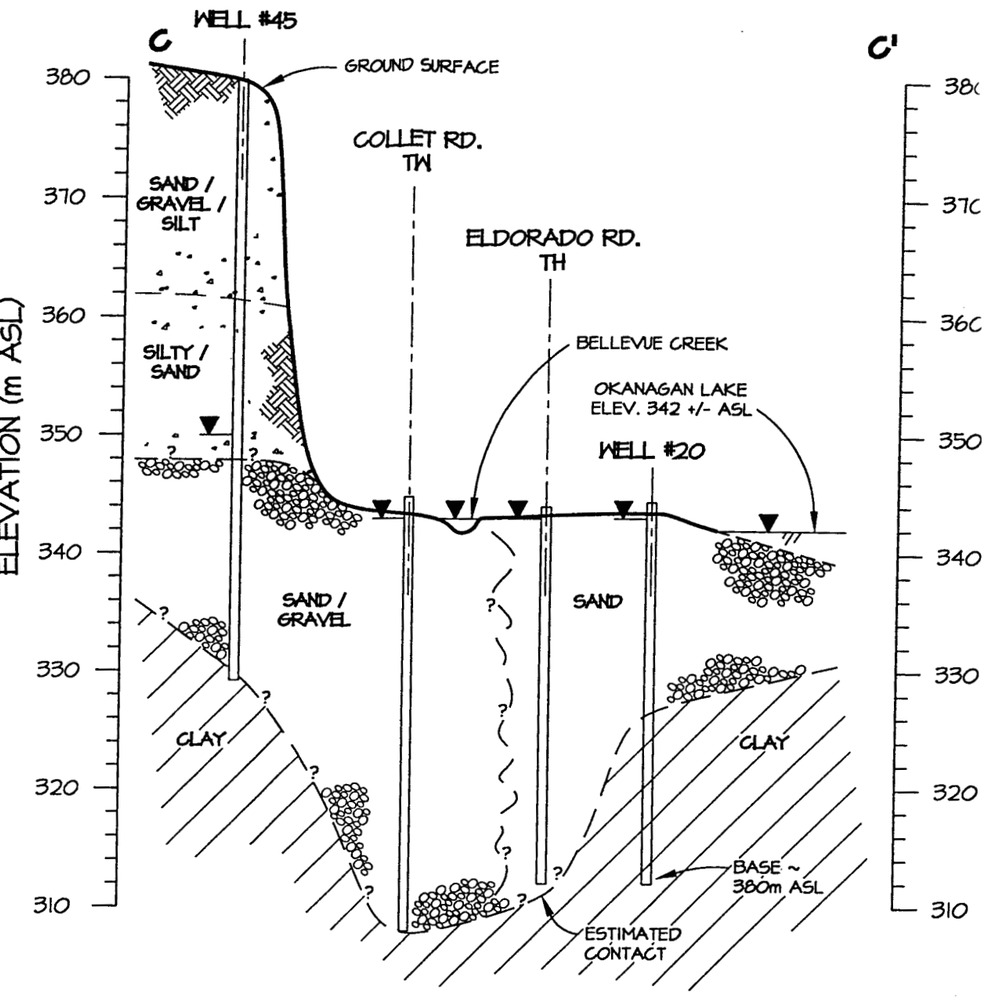
Scale	Date	Drawn by	Project #	
AS SHOWN	98/09/19	BMD	KX12138	FIGURE 3

CAD FILE: KX12138\12138FIG3.DWG



SECTION B-B'

HORIZONTAL SCALE 1:25,000
LOOKING NORTH



SECTION C-C'

HORIZONTAL SCALE 1:25,000
LOOKING WEST

LEGEND

- SAND, GRAVEL & COBBLES (ALLUVIUM)
- CLAY, GRAVEL & SAND (COLLUVIUM) ?
- CLAY, SILT (GLACIAL LACUSTRINE)
- SILT, SAND & GRAVEL (GLACIAL FLUVIAL)
- STATIC WATER LEVEL

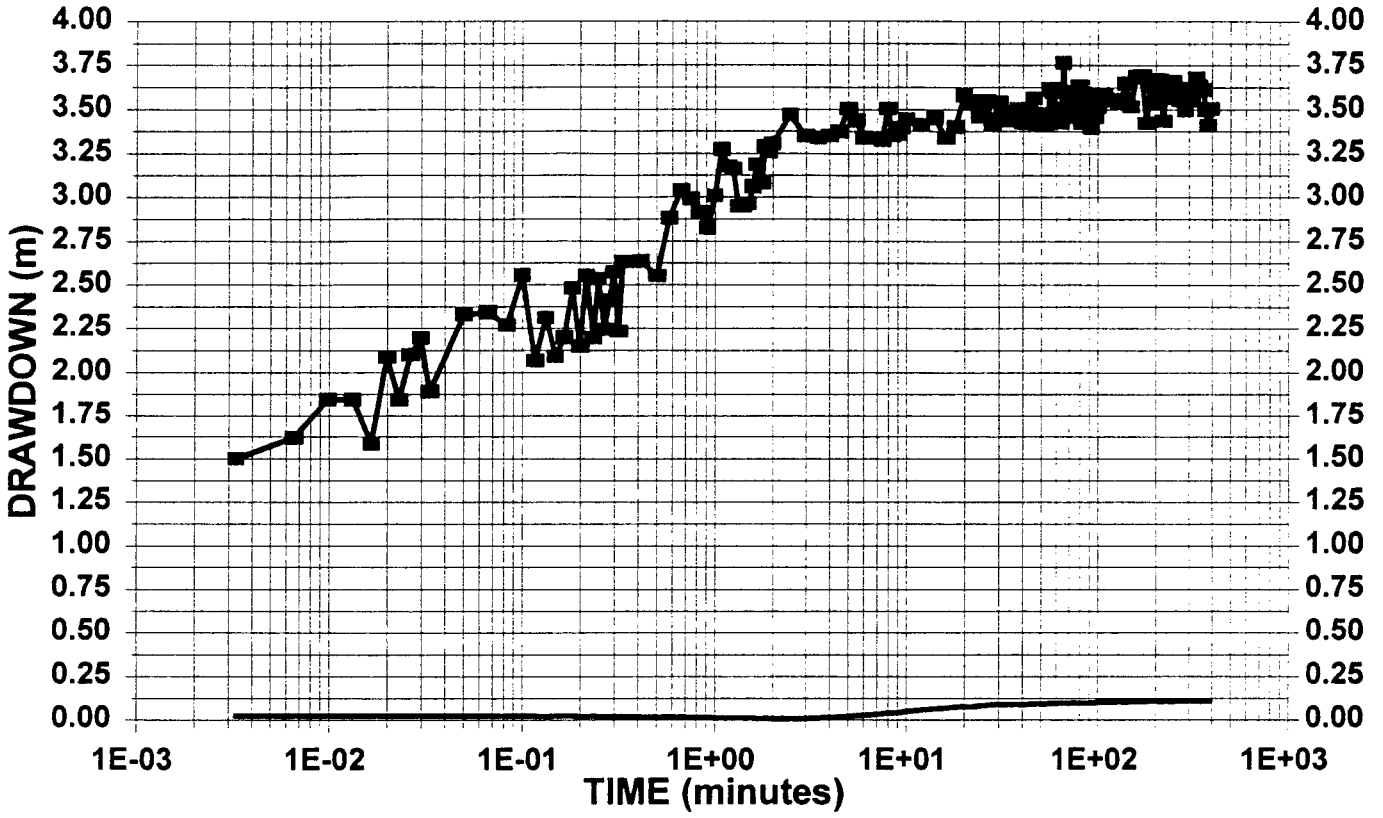
AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

GEOLOGICAL CROSS SECTIONS THROUGH BELLEVUE CREEK FAN AREA

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn by	Project #	
AS SHOWN	98/09/19	BMD	KX12138	FIGURE 4

CAD FILE: KX12138\12138FIG4.DWG

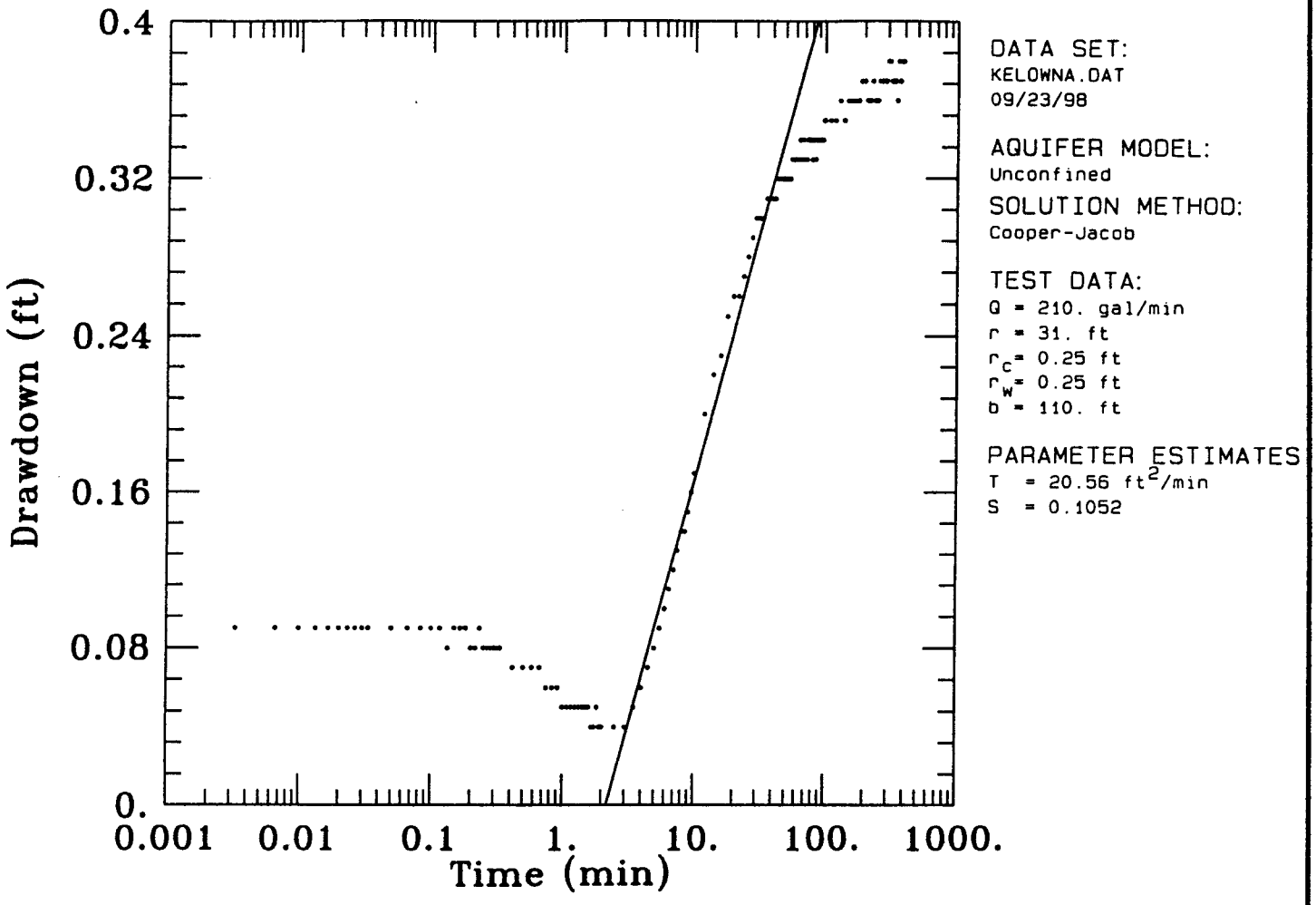


AGRA Earth & Environmental
Engineering and Environmental Services

COLLETT ROAD TEST WELL DRAWDOWN CURVES

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn By	Project #	
NTS	22/7/98	KB	KX12138	FIGURE 5

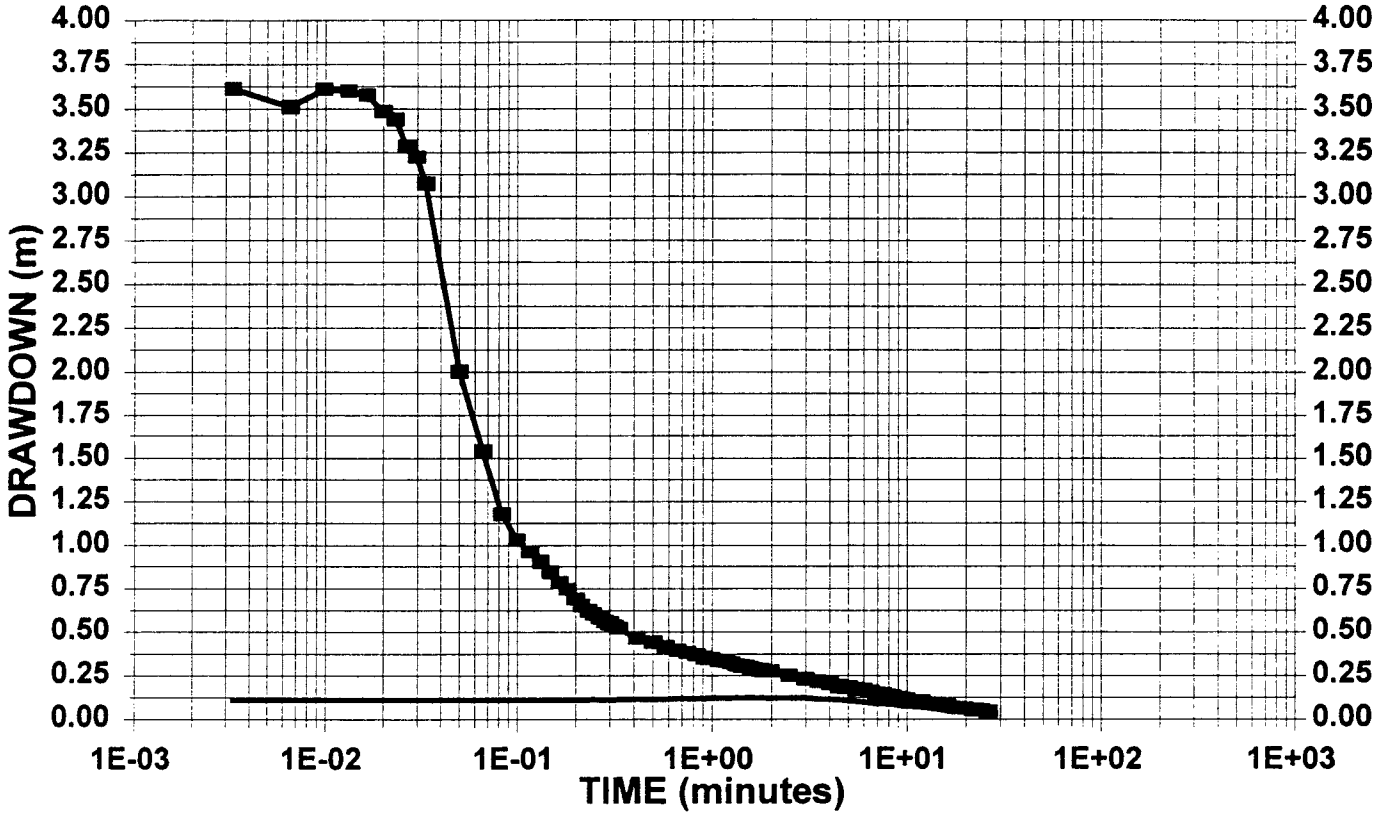


AGRA Earth & Environmental
Engineering and Environmental Services

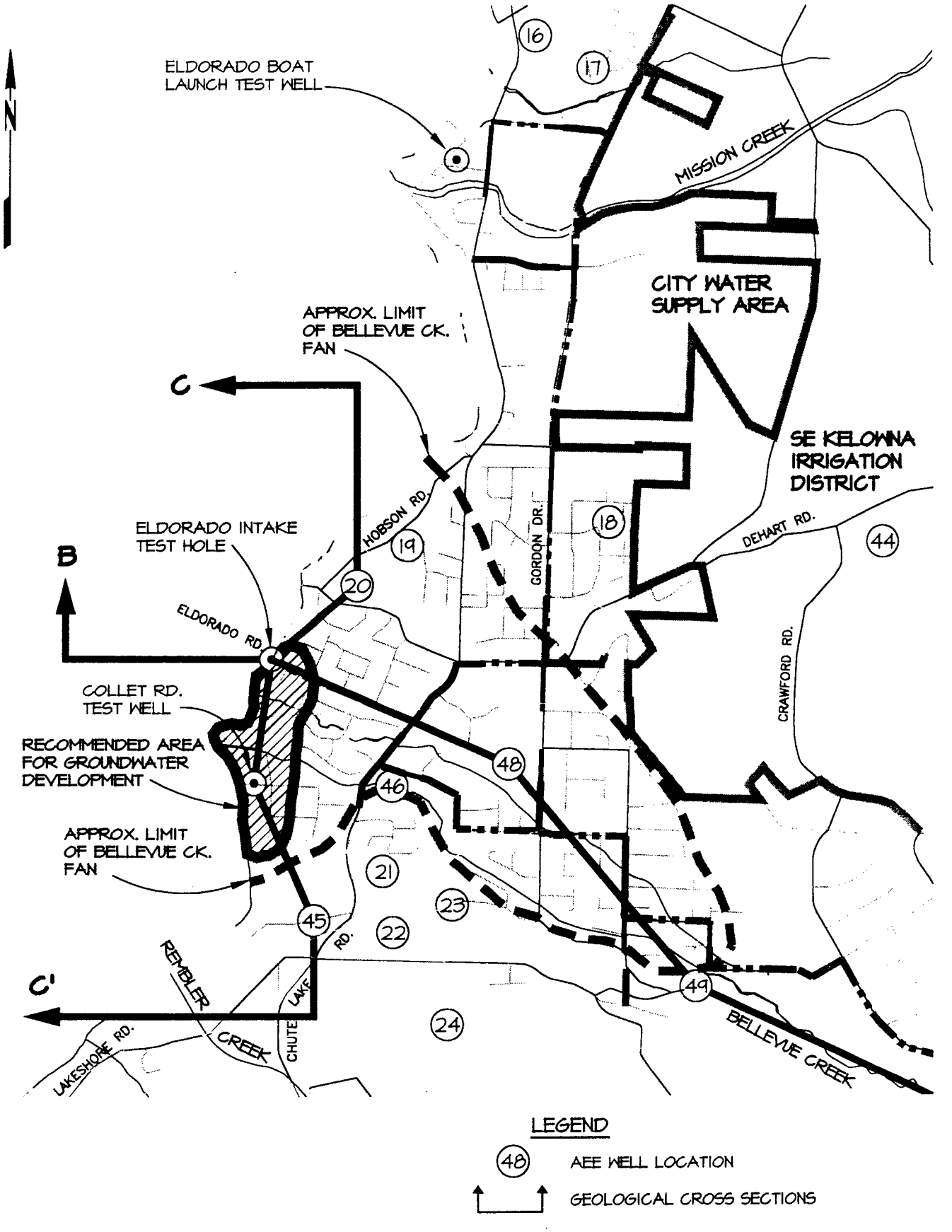
COLLETT ROAD TEST WELL
AQTESOLV DATA PLOT

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn By	Project #	
NTS	22/7/98	KB	KX12138	FIGURE 6



AGRA Earth & Environmental *Engineering and Environmental Services*	**COLLETT ROAD TEST WELL RECOVERY CURVES**					
CLIENT: CITY OF KELOWNA **REFERENCE:** GROUNDWATER ASSESSMENT FOR DRINKING WATER	**Scale** NTS	**Date** 22/7/98	**Drawn By** KB	**Project #** KX12138	FIGURE 7	



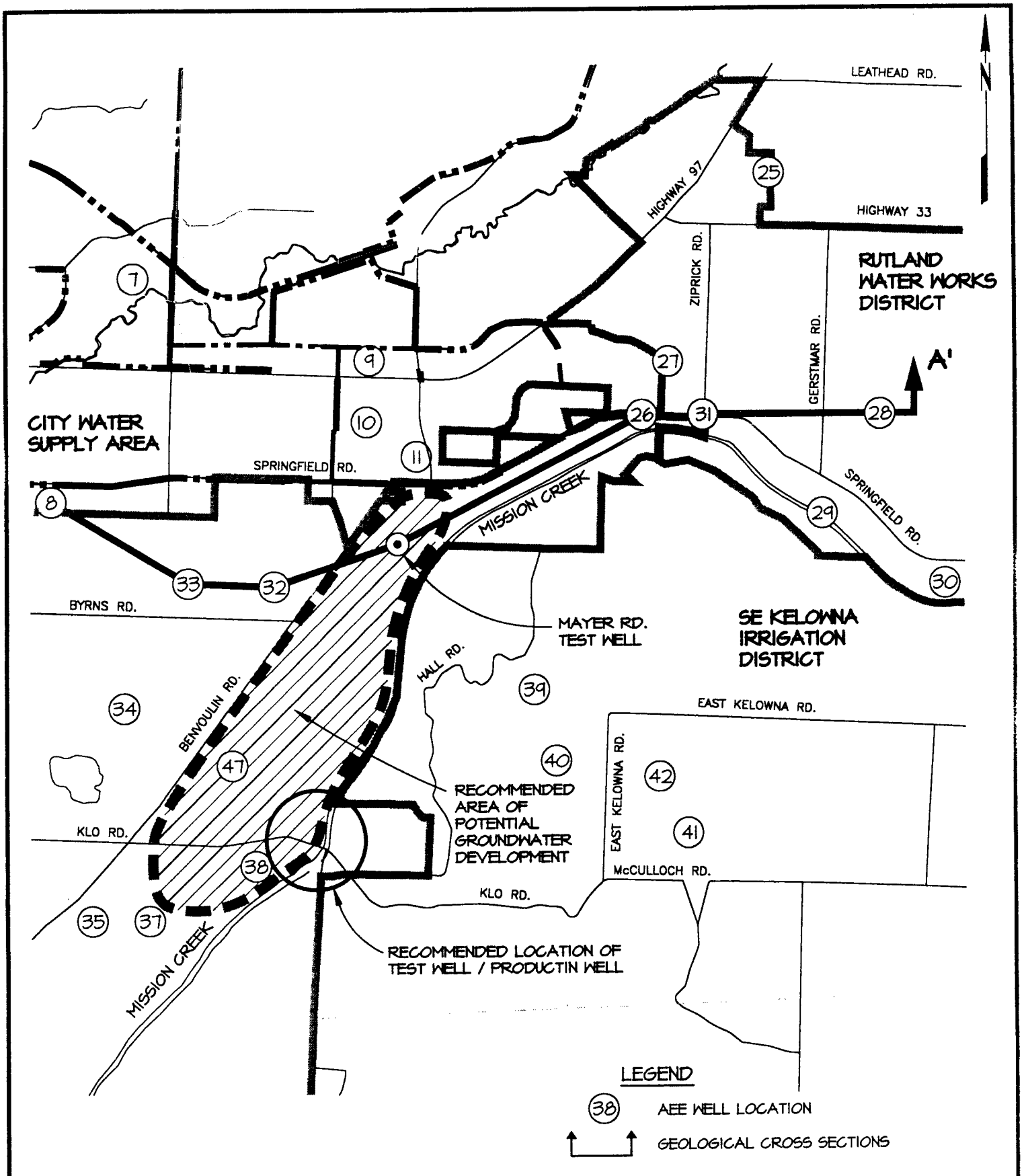
AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

ENLARGEMENT OF BELLEVUE CREEK AREA

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn by	Project #	
1:25,000	98/09/21	BMD	KX12138	FIGURE 8

CAD FILE: KX12138\12138F168.DWG



AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

ENLARGEMENT OF MAYER RD. / RUTLAND AQUIFER AREA

CLIENT: CITY OF KELOWNA
REFERENCE: GROUNDWATER ASSESSMENT FOR DRINKING WATER

Scale	Date	Drawn by	Project #	
1:25,000	98/09/21	BMD	KX12138	FIGURE 9

CAD FILE: KX12138\12138FIG9.DWG

GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: ROTARYMARSH
CITY OF KELOWNA	AUGER DRILL RIG	PROJECT NO: KX12138
ROTARY MARSH TEST HOLE	6" DIAMETER CASING	ELEVATION: 344.424 (m)

SAMPLE TYPE ■ ▨ ☒ SPLIT SPOON ▤ WASH RETURN ▥ ◧ AIR RETURN

DEPTH (m)	PLASTIC M.C. LIQUID (6 12 18 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE	WELL INSTALLATION	ELEVATION(m)
0.0			SAND & GRAVEL, silty (fill), dense, brown, dry		☒		344.0
1.0							343.0
2.0							342.0
3.0					☒		341.0
4.0							340.0
5.0			SAND, fine to medium, loose, grey, wet, heaving		☒		339.0
6.0							338.0
7.0			occ. gravelly lens below 6.7 m		☒		337.0
8.0							336.0
9.0			trace organics below 9.1 m		☒		335.0
10.0							334.0
11.0					☒		333.0
12.0							332.0
13.0							331.0
14.0							330.0
15.0							329.0
16.0							328.0
17.0							327.0
18.0							326.0
19.0							325.0
20.0					☒		324.0
21.0							323.0
22.0			SILT, some fine, sand, trace clay, trace organics, firm, grey, wet, sulphur odour		☒		322.0
23.0			End of Test Hole @ 21.9 m				321.0
24.0			50 mm Diameter PVC Monitoring Well installed to 19.8 m				320.0
25.0							319.0
26.0							318.0
27.0							317.0
28.0							316.0
29.0							315.0
30.0							314.0
31.0							313.0
32.0							312.0
33.0							311.0
34.0							310.0
35.0							309.0
36.0							308.0
37.0							307.0
38.0							

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LOGGED BY: KB	COMPLETION DEPTH: 21.9 m
REVIEWED BY: AS	COMPLETE: 08/14/98
Fig. No:	Page 1 of 1

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GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: MEIKLE
CITY OF KELOWNA	AUGER DRILL RIG	PROJECT NO: KX12138
MEIKLE AVENUE TEST HOLE	6" DIAMETER CASING	ELEVATION: 344.119 (m)

SAMPLE TYPE ■ ▨ ☒ SPLIT SPOON ▤ WASH RETURN ▥ ▮▮ AIR RETURN

DEPTH (m)	PLASTIC M.C. LIQUID (6 12 18 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE	WELL INSTALLATION	ELEVATION(m)
0.0			SAND, medium to coarse, loose, brown				344.0
1.0							343.0
2.0			grey, wet below 1.5 m				342.0
3.0							341.0
4.0							340.0
5.0							339.0
6.0			fine to medium, trace silt below 6 m				338.0
7.0							337.0
8.0			some silt, trace clay below 7.6 m				336.0
9.0							335.0
10.0			CLAY, trace silt, soft, varved olive grey, wet				334.0
11.0							333.0
12.0			SAND, medium, loose, grey, wet, heaving				332.0
13.0			trace fine to medium gravel below 16.8 m				331.0
14.0							330.0
15.0							329.0
16.0							328.0
17.0							327.0
18.0							326.0
19.0							325.0
20.0							324.0
21.0							323.0
22.0			becoming fine, no gravel below 21.3 m				322.0
23.0							321.0
24.0							320.0
25.0			SILT & SAND, fine, trace clay, firm, wet,				319.0
26.0			grey				318.0
27.0							317.0
28.0							316.0
29.0			End of Test Hole @ 28.0 m				315.0
30.0			50 mm Diameter PVC Monioring Well				314.0
31.0			installed to 24.4 m				313.0
32.0							312.0
33.0							311.0
34.0							310.0
35.0							309.0
36.0							308.0
37.0							307.0
38.0							

AGRA Earth & Environmental Limited Kamloops, B.C.	LOGGED BY: KB	COMPLETION DEPTH: 28.0 m
	REVIEWED BY: AS	COMPLETE: 08/13/98
	Fig. No:	Page 1 of 1

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GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: ELDORADO
CITY OF KELOWNA	INGERSOL RAND TH60	PROJECT NO: KX12138
ELDORADO BOAT LAUNCH TEST WELL	6" DIAMETER CASING	ELEVATION: 344.119 (m)

SAMPLE TYPE ■ ▨ ☒ SPLIT SPOON ▤ WASH RETURN ▥ ▮▮ AIR RETURN

DEPTH (m)	PLASTIC M.C. LIQUID (6 12 18 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE / INSTRUMENTATION DATA	ELEVATION(m)
0.0			ASPHALT PAVEMENT & GRAVEL SUB BASE			344.0
1.0			CLAY, silty, some fine sand, occ. gravel, soft, olive grey, wet			343.0
2.0						342.0
3.0						341.0
4.0						340.0
5.0						339.0
6.0						338.0
7.0			SAND, fine to medium, trace silt, loose, grey, wet			337.0
8.0						336.0
9.0			fine grain, organics below 9 m			335.0
10.0						334.0
11.0						333.0
12.0						332.0
13.0						331.0
14.0			SILT & SAND, loose, grey, wet			330.0
15.0			some organics below 15 m			329.0
16.0						328.0
17.0						327.0
18.0						326.0
19.0						325.0
20.0						324.0
21.0						323.0
22.0						322.0
23.0						321.0
24.0						320.0
25.0						319.0
26.0			occ. clay lens below 26 m			318.0
27.0						317.0
28.0			CLAY, trace silt, soft, medium placticity, grey, wet			316.0
29.0						315.0
30.0			End of Test Well @ 29.6 m Casing pulled			314.0
31.0						313.0
32.0						312.0
33.0						311.0
34.0						310.0
35.0						309.0
36.0						308.0
37.0						307.0
38.0						

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LOGGED BY: KB	COMPLETION DEPTH: 29.6 m
REVIEWED BY: AS	COMPLETE: 08/12/98
Fig. No:	Page 1 of 1

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GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: ELDORINTAKE
CITY OF KELOWNA	AUGER DRILL RIG	PROJECT NO: KX12138
ELDORADO ROAD INTAKE TEST HOLE	6" DIAMETER CASING	ELEVATION: 344.119 (m)

SAMPLE TYPE ■ ▨ ☒ SPLIT SPOON ▤ WASH RETURN ▯ ▮ AIR RETURN

DEPTH (m)	PLASTIC M.C. LIQUID (6 12 18 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE	INSTRUMENTATION DATA	ELEVATION(m)
0.0			SAND, medium to coarse, some fine to medium gravel, sub angular to sub round, compact, brown				344.0
1.0							343.0
2.0					☒		342.0
3.0			wet below 1.5 m		☒		341.0
4.0							340.0
5.0					☒		339.0
6.0					☒		338.0
7.0							337.0
8.0							336.0
9.0							335.0
10.0					▤		334.0
11.0							333.0
12.0					▤		332.0
13.0							331.0
14.0			heaving below 15 m				330.0
15.0							329.0
16.0			gravelly between 15.8 m and 17.7 m		▤		328.0
17.0							327.0
18.0							326.0
19.0					▤		325.0
20.0							324.0
21.0							323.0
22.0					☒		322.0
23.0							321.0
24.0							320.0
25.0					☒		319.0
26.0							318.0
27.0							317.0
28.0					☒		316.0
29.0							315.0
30.0							314.0
31.0					☒		313.0
32.0			End of test hole at 31.0 m				312.0
33.0			No monitoring well installed				311.0
34.0			Base of sand unit undefined				310.0
35.0							309.0
36.0							308.0
37.0							307.0
38.0							

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LOGGED BY: KB	COMPLETION DEPTH: 31.1 m
REVIEWED BY: AS	COMPLETE: 08/19/98
Fig. No:	Page 1 of 1

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GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: COLLET
CITY OF KELOWNA	INGERSOL RAND TH60	PROJECT NO: KX12138
COLLET ROAD TEST WELL	6" DIAMETER CASING	ELEVATION: 344.119 (m)

SAMPLE TYPE ■ ☒ SPLIT SPOON ☰ WASH RETURN ▮ AIR RETURN

DEPTH (m)	PLASTIC M.C. LIQUID (6 12 18 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE / INSTRUMENTATION DATA	ELEVATION(m)
0.0			SAND & GRAVEL, loose brown, dry			344.0
1.0						343.0
2.0			SAND, fine, trace silt, loose, grey, wet			342.0
3.0			trace organics @ 3 m			341.0
4.0						340.0
5.0			some fine gravel, sub angular below 4 m			339.0
6.0						338.0
7.0						337.0
8.0						336.0
9.0						335.0
10.0			SAND & GRAVEL, medium to coarse, sub angular to sub rounded, compact, grey, wet			334.0
11.0						333.0
12.0						332.0
13.0						331.0
14.0						330.0
15.0						329.0
16.0						328.0
17.0						327.0
18.0						326.0
19.0						325.0
20.0						324.0
21.0						323.0
22.0			GRAVEL, fine to coarse, some sand, occ. cobble, compact			322.0
23.0			SAND, medium to coarse, trace to some gravel, compact			321.0
24.0						320.0
25.0			some gravel below 23.5 m			319.0
26.0			SAND & GRAVEL, medium to coarse, occ. cobble, sub angular to sub round, compact, grey			318.0
27.0						317.0
28.0			occ. cobble and boulder below 26.8 m			316.0
29.0						315.0
30.0						314.0
31.0						313.0
32.0						312.0
33.0			occ. clay lens below 32.3 m			311.0
34.0			CLAY, soft, grey			310.0
35.0			End of Test Hole 34.7 m 3.7 m of #120 slot stainless steel well screen installed from 29.8 m to 33.7 m			309.0
36.0						308.0
37.0						307.0
38.0						

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LOGGED BY: KB	COMPLETION DEPTH: 33.5 m
REVIEWED BY: AS	COMPLETE: 08/14/98
Fig. No:	Page 1 of 1

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GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: MAYER
CITY OF KELOWNA	INGERSOL RAND TH60	PROJECT NO: KX12138
MAYER ROAD TEST WELL	6" CASING WITH 8" SURFACE CASING	ELEVATION: 366.979 (m)

SAMPLE TYPE ■ ▨ ☒ SPLIT SPOON ☰ WASH RETURN ▯ ▮ AIR RETURN

DEPTH (m)	PLASTIC — M.C. — LIQUID (6, 12, 18, 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE / PNEUMATIC PIEZOMETER	ELEVATION(m)
0.0 – 7.0			CLAY, silty, some gravel, trace to some sand, firm, brown, dry SAND & GRAVEL, fine to coarse, some silt, compact, brown clayey below 4.6 m			366.0 – 360.0
8.0 – 10.0			CLAY, sandy, some gravel, some silt (TILL) stiff, olive grey			359.0 – 357.0
11.0 – 21.0			SILT, sandy, some gravel, trace clay, firm, grey, wet trace gravel, soft below 19.8 m			356.0 – 346.0
22.0 – 27.0			CLAY, trace silt, soft, grey gravelly below 25.9 m			345.0 – 340.0
28.0 – 38.0			SAND & GRAVEL, fine to medium, sub angular, some silt, trace clay, grey, wet trace silt, no clay below 32.3 m silty between 36.8 m and 37.8 m			339.0 – 329.0

AGRA Earth & Environmental Limited Kamloops, B.C.	LOGGED BY: KB	COMPLETION DEPTH: 66.1 m
	REVIEWED BY: AS	COMPLETE: 08/20/98
	Fig. No: G	Page 1 of 2

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GROUNDWATER DEVELOPMENT STUDY	DAN GARE DRILLING, VERNON	BOREHOLE NO: MAYER
CITY OF KELOWNA	INGERSOL RAND TH60	PROJECT NO: KX12138
MAYER ROAD TEST WELL	6" CASING WITH 8" SURFACE CASING	ELEVATION: 366.979 (m)

SAMPLE TYPE ■ ▨ ☒ SPLIT SPOON ▤ WASH RETURN ▥ ◧ AIR RETURN

DEPTH (m)	PLASTIC M.C. LIQUID (6 12 18 24)	SOIL SYMBOL	Soil Description	COMMENTS	SAMPLE TYPE / PNEUMATIC PIEZOMETER	ELEVATION(m)
38.0–66.0			gravel sub round below 49.7 m			328.0–301.0
66.0			End of test well at 66.1 m No well screen installed Airlifting 500 gpm through base of casing Well flowing at 100 gpm Static water level 4.9 m above ground			
67.0–76.0						300.0–291.0

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LOGGED BY: KB	COMPLETION DEPTH: 66.1 m
REVIEWED BY: AS	COMPLETE: 08/20/98
Fig. No: G	Page 2 of 2

98/08/23 04:17PM

AEE Well #1

BRITISH COLUMBIA

Well Tag Number 000000020608

Owner: CALOWNA WINES LTD

Address: 1125 RICHTER ST KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan 5011 Lot A

Township 26 Section 30 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083433 Well 3

Well Use Unknown Well Use

Construction Method Drilled

Diameter 6 inches

Well Depth 534 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19670414

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:
DRY HOLE

From 0 To 3 Ft. rock and gravel fill

From 3 To 21 Ft. w.b. fine sand and gravel

From 21 To 23 Ft. greyish white clay -organic material

From	23	To	29	Ft.	clean fine sand
From	29	To	30	Ft.	sticky grey clay
From	30	To	36	Ft.	fine sand
From	36	To	122	Ft.	hard greyish clay
From	122	To	204	Ft.	greyish blue clay with layers of silt,
From	0	To	0	Ft.	grey clay
From	204	To	256	Ft.	more silt than clay
From	256	To	300	Ft.	silt -some grey clay and fine sand
From	300	To	474	Ft.	clayish silts
From	474	To	534	Ft.	silty clay with white sand (fine)
From	0	To	0	Ft.	
From	0	To	0	Ft.	No yield.

15 rows selected.

Date entered to WELL

WTN 83128

AEE Well #2

TEST HOLE LOG # 7

A7

PROJECT # 8103 LOCATION See Fig. 2 DRILLING DATE Feb. 12, 19

GROUND ELEV. 343.10m

SAMPLE DATA

HAMMER WEIGHT 0.76 KN (140 lb.)

HAMMER DROP 0.6 m (30 in.)

COHESION — TONS/SQ. FT.

0.2 0.6 1.0 1.4 1.8

FIELD VANE LAB VANE UNCONF.

PLASTIC LIMIT WATER CONTENT LIQUID LIMIT

10 30 50 70 90%

SOIL DESCRIPTION		DEPTH ELEV. m	NO.	O.D. I.D. mm	BLOWS FT.
Loose grey silt pockets of organic and scattered fine organic matter					
		1.1	1	51 / 35	8
		1.5			
Loose grey clean layered sand varying from fine to medium sand to well graded sand, scattered fine organic matter and thin organic partings to 3mm thick, occasional gravel			2	"	9
	10 ft	3.0			
			3	"	5
		4.5			
			4	"	3
	20 ft	6.0			
			5	"	5
		7.5			
	30 ft	9.0			
			6	"	6
		10.5			
	40 ft	12.0			

A7

TEST HOLE LOG #7

PROJECT # 8103 LOCATION See Fig. 2 DRILLING DATE Feb. 12, 1981

GROUND ELEV. 343.10m

SOIL DESCRIPTION	DEPTH ELEV. m	NO.	O.D. mm	BLOWS FT.
			SAMPLE DATA	
			HAMMER WEIGHT 0.76 KN (140 lb.)	
			HAMMER DROP 0.6m (30 in.)	
Loose grey clean layered sand scattered fine organic matter and thin organic partings to 3mm thick		7	51 35	7
	13.5			
	14.1			
Compact grey clean layered sand, varying from fine sand to well graded sand, occasional thin organic partings	50 ft 15.0	8	"	19
	16.5			
	60 ft 18.0	9	"	18
	19.5			
	70 ft 21.0			
	21.9			
Loose grey varved silts and sands varying from silty sand, sandy silt to plastic clayey silt, scattered fine organic matter	22.5	10	"	0
	80 ft 24.0			

COHESION — TONS/SQ. FT.
0.2 0.6 1.0 1.4 1.8
○ FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT
X ○ X
10 30 50 70 90%

TEST HOLE LOG # 7

A7

PROJECT # 8103 LOCATION See Fig. 2 DRILLING DATE Feb. 12, 1981

GROUND ELEV. 343.10m

HAMMER WEIGHT 0.76 KN (140 lb.)

HAMMER DROP 0.6m (30 in.)

SOIL DESCRIPTION	DEPTH ELEV. m	NO.	O.D. mm/m	BLOWS FT.
Loose grey varved silts and sands varying from silty sand to plastic clay silt, scattered fine organic matter	25.5	11	51/35	3
90 ft	27.0	12	"	0
	28.5			
100 ft	30.0			
120 ft	36.0			
	36.5	13	"	0
Bottom of hole				

COHESION — TONS/SQ. FT.: 0.2 (●FIELD VANE) 0.6 1.0 1.4 1.8 (Δ LAB VANE ○UNCONF.)

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT

10 30 50 70 90%

AEE Well #3

WTN 83126

PROJECT: RELAX INN - KELOWNA	CONTRACTOR: Tonto Drilling	BOREHOLE No. H2
CLIENT: RELAX INN	METHOD: Hollow Stem Auger/Mud Rotary	Project No: 0897363
DATE: July 21, 1989	DATUM: Local	ELEVATION 100.46 (m)

SAMPLE TYPE: AUGER | SHELBY TUBE | SPT SAMPLE | A-CASING | NO RECOVERY | CORE

PLASTIC — M.C — LIQUID (20 40 60 80)

DEPTH (m)	USC	SOIL/ROCK DESCRIPTION	SAMPLE TYPE	SAMPLE NO	OTHER TEST COMMENTS
0.0		SAND(FILL) – compact, yellow brown, medium to coarse, occasional subrounded fine to coarse gravel			
1.9m			SPT	01	N = 18
		SAND – loose to very loose, blue grey, medium to coarse, occasional to some subrounded to rounded fine gravel	SHELBY	U1	N = 9
			SPT	02	N = 1
6.1m			SPT	03	N = 2
		SAND – very loose to loose, slightly silty to silty, occasional wood fragments, some bands of medium to coarse sand, some subangular to subrounded fine to medium gravel	SPT	04	N = 5
8.0m		SAND – loose, dark grey green, fine to medium, some coarse sand, occasional fine to medium gravel, occasional wood fragments, occasionally silty	SPT	05	N = 7
			SPT	06	N = 5
			SPT	07	N = 7
			CASING	08	N = 5
18.0m		SAND – loose to compact, dark grey green, fine to medium, interbedded with many bands of loose silty fine sand, occasional very thin organic bands and wood fragments	SPT	09	N = 10
				010	

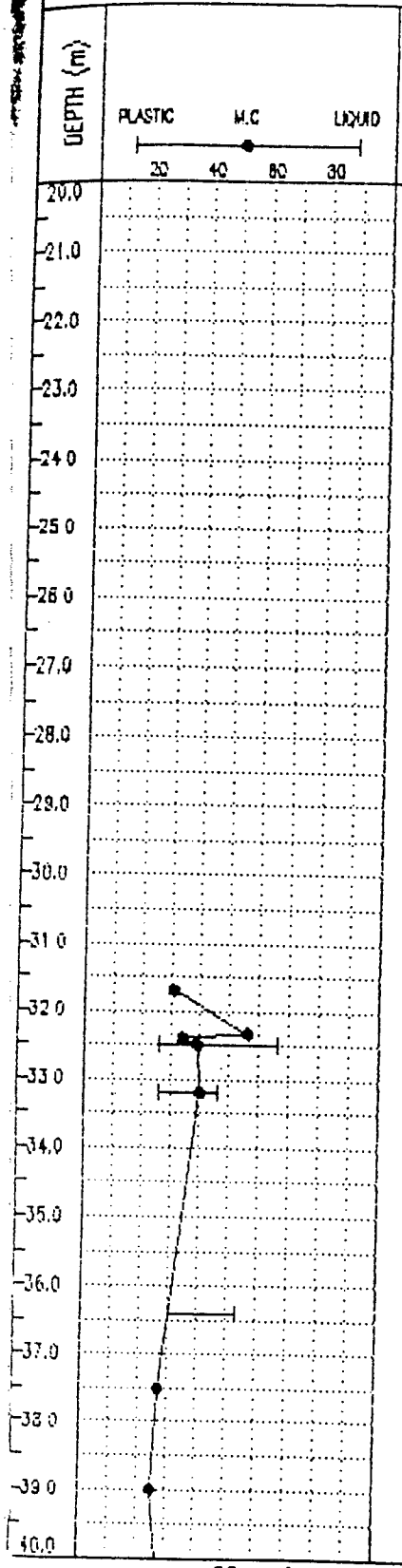
Hardy BBT Limited
Calgary, Alberta

COMPLETION DEPTH 55.1 m (180.8') | COMPLETE

LOGGED BY AS RJ | DWG NO. Plate 1 | Page 1 of 3

PROJECT: RELAX INN - KELOWNA	CONTRACTOR: Tonto Drilling	BOREHOLE No. H2
CLIENT: RELAX INN	METHOD: Hollow Stem Auger/Mud Rotary	Project No: 0007363
DATE: July 21, 1989	DATUM: Local	ELEVATION 100.46 (m)

SAMPLE TYPE: AUGER | SHELBY TUBE | SPT SAMPLE | A-CASING | NO RECOVERY | CORE



USC	SOIL/ROCK DESCRIPTION	SAMPLE TYPE	SAMPLE NO	OTHER TEST COMMENTS	DEPTH (m)
	SAND – above		D10	N = 12	20.0
	21.0m SAND – loose to compact, dark grey, very silty, fine to medium, occasional medium to coarse sand and wood fragments, bedded, occasional layers of silty fine sand		U2		21.0
			D11	N = 8	24.0
	27.5m CLAY – firm, dark blue grey, fissured poorly bedded, thinly laminated medium to high plastic, silty, occasional laminae of light brown very silty clay/clayey silt and fine silty sand, thin sand partings, occasionally oriented at 45, slickensided, occasional beds and layers of silt and fine silty sand		U3		27.5
			D12	N = 9	29.0
			D13		31.0
			U4		
			D14	N = 6	32.0
			U5	Consolidation $\gamma'd$ = 1252Kg/m^3 Organics- 2.7%	33.0
			U6	Triaxial Cu = 40.5kPa $\gamma'd$ = 1488Kg/m^3	36.0
			U7	Triaxial Cu = 930kPa $\gamma'd$ = 1573Kg/m^3	38.0
			U8		40.0

Hardy BBT Limited
Calgary, Alberta

COMPLETION DEPTH 55.1 m		COMPLETE
LOGGED BY AS RJ	DWG NO.Plate 1	Page 2 of 3

PROJECT: RELAX INN - KELOWNA	CONTRACTOR: Tonto Drilling	BOREHOLE No. H2
CLIENT: RELAX INN	METHOD: Hollow Stem Auger/Mud Rotary	Project No: 0307363
DATE: July 21, 1989	DATUM: Local	ELEVATION 100.46 (m)

SAMPLE TYPE: AUGER | SHELBY TUBE | SPT SAMPLE | A-CASING | NO RECOVERY | CORE

DEPTH (m)	PLASTIC / M.C / LIQUID (20 40 60 80)	USC	SOIL/ROCK DESCRIPTION	SAMPLE TYPE	SAMPLE NO	OTHER TEST COMMENTS	DEPTH (m)
40.0			CLAY – as above				40.0
			41.0m				
41.0			INTERBEDDED – SILT, compact to dense, green grey, sandy, trace clay and CLAY, stiff to very stiff, silty, green grey, occasional gravel and wood fragments				41.0
42.0				X	D15	N = 33	42.0
43.0							43.0
44.0							44.0
45.0							45.0
46.0				X	D16	N = 20	46.0
47.0							47.0
48.0							48.0
49.0							49.0
50.0							50.0
51.0							51.0
52.0			52.0m	X	D17	N = 46	52.0
53.0			SAND – silty, dense, dark grey, fine to medium, local zones of gravel, dark grey, fine, subrounded to subangular, sandy				53.0
54.0							54.0
55.0			55.1m	X	D18	N = 76	55.0
56.0			End of hole at 55.1m Hollow Stem to 4.5m Mud rotary to 55.1m 25mm slotted PVC standpipe installed to 2.9m depth Water level at completion 1.05m Borehole relocated twice during drilling				56.0
57.0							57.0
58.0							58.0
59.0							59.0
60.0							60.0

Hardy BBT Limited
Calgary, Alberta

COMPLETION DEPTH 55.1 m		COMPLETE
LOGGED BY AS RJ	DWG NO. Plate 1	Page 3 of 3

AEE Well #4

#4 WTN 83127

TEST HOLE LOG # 1

PROJECT # 8101 LOCATION See Fig. 2 DRILLING DATE Jan. 22 B1

GROUND ELEV. 343.69 (Geodetic)

SOIL DESCRIPTION	DEPTH ELEV. m	SAMPLE DATA: NO.	O.D. I.D. mm	BLOWS/FT.	COMPRESSION TORSION, PT. (0.2 POCKET VANE, 0.8 VANE, 1.0 VANE, 1.0 PENETROM.) / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT (10, 30, 50, 70, 90%)
		HAMMER WEIGHT 0.6 Kn (140 lb.)			
		HAMMER DROP 0.76m (30 in.)			
		15	87.5	pushed	90f
	25.5				
	26.4				
Very stiff light grey to brown varved silty clay to clayey silt to clay, blocky texture and brittle (90 ft.)	27.0	16	"	"	2.5 t. 76f
	28.5				
becoming	29.4				
Firm to stiff grey layered fine sandy silt to silty sand grading to silt, occasional sand seams and scattered fine organic matter. (100 ft)	30.0	17	51/35	5	
	31.5				
(110 ft)	33.0	18	"	12	
	34.5				

TEST HOLE LOG

B1

PROJECT # 8101 LOCATION See Fig. 2 DRILLING DATE Jan. 23, 1981

GROUND ELEV. 343.69 Geodetic

SAMPLE DATA

HAMMER WEIGHT 0.6 Kn (140 lb.)

HAMMER DROP 0.76m (30 in.)

SOIL DESCRIPTION	DEPTH m	NO.	O.D. mm	BLOWS PT.	COHESION TONS/SQ. FT. (0.2 POCKET VANE, 0.5, 1.0 FIELD VANE, 1.0 LAB VANE, 1.0 PENETROMETER) / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT (10, 30, 50, 70, 90%)
		19	87.5	pushed	3.0 t.s.f. 113 pcf
Firm to stiff grey layered fine sandy silt to silty sand grading to silt, occasional sand seams and scattered fine organic matter (130 ft.)	37.5				
	39.0	20	"	"	2.5 t.s.f.
(140 ft.)	40.5				
Compact to dense, grey clean layered sand varying from fine sand to well graded sand, scattered fine organic matter (150 ft.)	42				
	43.5				
	45	21	51/35	36	
(160 ft.)	46.5				
	48				

TEST HOLE LOG # 1

PROJECT # 8101 LOCATION See Fig. 2 DRILLING DATE Jan. 23, 1981 (81)

GROUND ELEV. 343.69 (Geodetic)

SAMPLE DATA

HAMMER WEIGHT 0.6 KN (140 lb.)

HAMMER DROP 0.76 m (30 in.)

SOIL DESCRIPTION	DEPTH ELEV. m	NO.	O.D. I.D. mm	BLOWS/FT.
	49.5			
		22	51/35	34
Compact to dense, grey clean (170 ft.)	51			
layered sand varying from fine				
sand to well graded sand,				
scattered fine organic matter	52.5			
(180 ft.)	54.0			
	55.5			
184'	56.0	23	"	57
Bottom of hole ↗				

AEE Well #5

WTN 83129

RECORD OF BOREHOLE BH 2

SHEET 1 OF 3

PROJECT LOCATION Kelowna

BORING DATE: April 28, 1992

DATUM:

PROJECT NUMBER: 922-4085

BORING LOCATION: See Figure 1

BOREHOLE TYPE: Mud Rotary

Sampler Hammer: 63.5 kg, Drop 0.76m.

DEPTH SCALE (m)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 0.15m.	N	RECOVERY	PENETRATION RESISTANCE BLOWS/0.3m / WATER CONTENT, PERCENT (Wp, W, Wl; 20, 40, 60, 80)	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE									
	Concrete Slab		0.00							
	Compact brown SAND and GRAVEL with a trace of silt. (FILL)		0.13							
	Loose brown-orange slightly mottled fine SAND and SILT.		0.76	1	DO	1,2,2	4		o	
2										▽ April 28/92
	Loose grey medium SAND.		2.44	2	DO	3,3,5	8			
	Compact grey gravelly SAND.		3.66							
4	Loose grey coarse to medium SAND with a trace of fine gravel.		4.00							
6				3	DO	3,2,3	5			
				4	WS					
8				5	WS					
	Very loose dark grey fine silty SAND grading to a SILT with a trace of fine sand, occasional shell fragment and occasional white fine sandy silt layers to 5 cm. thick noted at depth.		8.53							
10				6	DO	Wh				
12				7	DO	Wh,2,2,1	4		o	
14										
16				8	DO	Wh/0.3m,1,1	1		o	
	Soft grey clayey SILT grading to a very soft silty CLAY at depth with occasional thin fine sand seams.		16.75							
18										
20										

CONTINUED ON NEXT PAGE

DRILL RIG: Mobile B53

DRILLING CONTRACTOR: EnviroTech.

DRILLER: SB

LOGGED: RT

CHECKED: RT

DATE: April 30/92

Golder Associates

PROJECT: Library Bldg.

PROJECT LOCATION: Kelowna

PROJECT NUMBER: 922-4085

Sampler Hammer: 63.5 kg., Drop 0.76m.

RECORD OF BOREHOLE BH 2

BORING DATE: April 28, 1992

BORING LOCATION: See Figure 1

SHEET: 2 OF 3

DATUM:

BOREHOLE TYPE: Mud Rotary

DEPTH SCALE (m)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 0.15m.	N	REC/ATT	PENETRATION RESISTANCE BLOWS/0.3m / WATER CONTENT, PERCENT	PIEZOMETER OR STANDPIPE INSTALLATION
	CONTINUED FROM PREVIOUS PAGE									
20	Lab Vane Undisturbed = 26 kPa Remoulded = 21 kPa									
				9	TP	Ph		0.58m		
22										
24	Soft grey clayey SILT grading to a very soft silty CLAY at depth with occasional thin fine sand seams.									
26	Lab Vane Undisturbed = 3 kPa Remoulded = <1 kPa									
				10	TP	Ph		0.58m		
28										
30										
32			32.00							
34	Compact grey SILT with a trace of clay.									
36										
				11	DO	7,7,7	14			
38										
40	CONTINUED ON NEXT PAGE									

PENETRATION RESISTANCE BLOWS/0.3m

WATER CONTENT, PERCENT

Wp 20 | W 40 | 60 | Wl 80

DRILL RIG: Mobile B53

DRILLING CONTRACTOR: EnviroTech.

DRILLER SB

LOGGED: RT

CHECKED: RT

DATE: April 30/92

Golder Associates

PROJECT: Library Bldg.
PROJECT LOCATION: Kelowna
PROJECT NUMBER: 922-4085
Sampler Hammer: 63.5 kg., Drop 0.76m.

RECORD OF BOREHOLE BH 2

BORING DATE: April 28, 1992
BORING LOCATION: See Figure 1

SHEET: 3 OF 3
DATUM:
BOREHOLE TYPE: Mud Rotary

DEPTH SCALE (m)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 0.15m.	N	REC/ATT	PENETRATION RESISTANCE BLOWS/0.3m / WATER CONTENT, PERCENT Wp 20 W 40 60 Wl 80	PIEZOMETER OR STANDPIPE INSTALLATION
41	CONTINUED FROM PREVIOUS PAGE									
43	Compact grey SILT with a trace of clay.									
45				12	DO	3,7,12,20	19		o	
	END OF BOREHOLE		46.33							
47										
49										
51										
53										
55										
57										
59										
61										

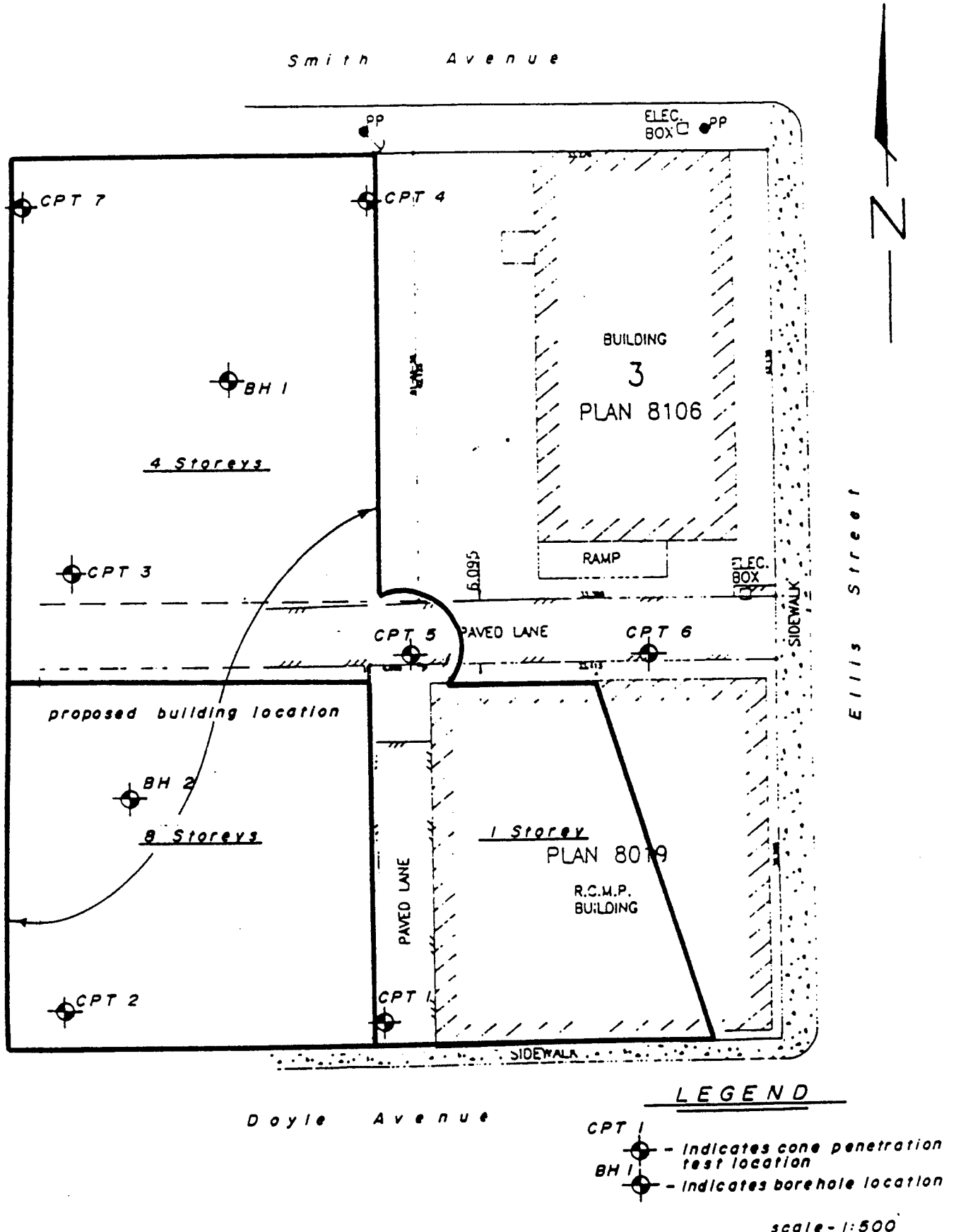
DRILL RIG: Mobile B53
DRILLING CONTRACTOR: EnviroTech.
DRILLER: SS

Golder Associates

LOGGED: RT
CHECKED: RT
DATE: April 30/92

SITE PLAN

Figure 1



LEGEND

CPT 1 – indicates cone penetration test location

BH 1 – indicates borehole location

scale - 1:500

PROJECT No. 922-4085 DRAWN rr REVIEWED rr DATE May/92

Golder Associates

AEE Well #6

BRITISH COLUMBIA

Well Tag Number 000000036855

Owner: NOT GIVEN

Address:

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 139 Plan 462 Lot 10

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083431 Well 1

Well Use Unknown Well Use

Construction Method Drilled

Diameter 2 inches

Well Depth 147 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19770322

Driller Unknown

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 1 Ft. asphalt pavement

From 1 To 3 Ft. sand and gravel fill

From 3 To 7 Ft. loose grey brown silt, grading to soft

From	0	To	0	Ft.	organic clayed silt
From	7	To	18	Ft.	loose to compact grey sand
From	18	To	29	Ft.	loose grey interlayered silty fine sand
From	0	To	0	Ft.	and silty sand, trace of organic
From	29	To	60	Ft.	loose to compact grey fine to medium
From	0	To	0	Ft.	sand, trace of gravel and organic
From	60	To	81	Ft.	loose grey fine sand, pockets of silty
From	0	To	0	Ft.	sand and organic matter
From	81	To	98	Ft.	loose to firm grey interlayered fine
From	0	To	0	Ft.	sand, sandy silt and clayey silt with
From	0	To	0	Ft.	organic partings
From	98	To	147	Ft.	interlayered grey shift to hard silty
From	0	To	0	Ft.	clay with sand partings and dense silty
From	0	To	0	Ft.	fine sand to fine to medium sand

17 rows selected.

Date entered to WELL

AEE Well #7

BRITISH COLUMBIA

Well Tag Number 000000041321

Owner: DR KNOX SEC SCHOOL

Address:

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan 8377 Lot 1

Township 26 Section 20 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083432 Well 3

Well Use Unknown Well Use

Construction Method Drilled

Diameter 2 inches

Well Depth 102 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19790101

Driller Unknown

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 1 Ft. loose brown silty sandy topsoil

From 1 To 5 Ft. loose brown silty sand to organic silt

From 5 To 26 Ft. compact grey brown sand and gravel grad-

From	0	To	0	Ft.	ing to medium to coarse sand, some
From	0	To	0	Ft.	gravel at depth, scattered cobbles near
From	0	To	0	Ft.	the top
From	26	To	97	Ft.	stiff grey silty clay to clay
From	97	To	102	Ft.	dense grey silty fine sand to fine sand

8 rows selected.

Date entered to WELL

AEE Well #8

BRITISH COLUMBIA

Well Tag Number 000000044882

Owner: G E DAY

Address: KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 129 Plan 415 Lot 25

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083432 Well 16

Well Use Irrigation

Construction Method Drilled

Diameter 8 inches

Well Depth 141 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 131 to 141 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19800427

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 114 GPM
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 28 Ft. black and blue clay

From 28 To 56 Ft. coarse gravel with layers of silt

From 56 To 67 Ft. coarse gravel

From	67	To	90	Ft.	brown clay
From	90	To	129	Ft.	clay silt till and gravel
From	129	To	141	Ft.	gravel - silty

6 rows selected.

Date entered to WELL

AEE Well #10

BRITISH COLUMBIA

Well Tag Number 000000025830

Owner: MARATHON REALTY CO L

Address:

Area:

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan Lot

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083441 Well 13

Well Use Domestic

Construction Method Drilled

Diameter 8 inches

Well Depth 56 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 45 to 56 feet
Slot Size 1 50 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19720101

Driller Unknown

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 332 USGM
Artesian Flow 0

Static Level 8 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag Y

File Info Flag Y

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 2 Ft. blacktop and fill

From 2 To 6 Ft. clay, silty

From 6 To 15 Ft. till

From	15	To	44	Ft.	sand and gravel, clean, w.b. SWL (75')
From	44	To	46	Ft.	sand -fine/med. some gravel
From	46	To	49	Ft.	gravel -to 3" some med./crs sand
From	49	To	50	Ft.	sand -fine/crs. some pebbles
From	50	To	56	Ft.	sand -fine/crs. and pea gravel
From	56	To	0	Ft.	clay -blue, silty, pebbles

9 rows selected.

Date entered to WELL

AEE Well #11

BRITISH COLUMBIA

Well Tag Number 000000025832

Owner: MARATHON REALTY CO L

Address:

Area:

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan Lot

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083441 Well 11

Well Use Other

Construction Method Drilled

Diameter 12 inches

Well Depth 47 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 36 to 47 feet
Slot Size 1 50 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19720101

Driller Unknown

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 490 USGM
Artesian Flow 0

Static Level 9 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag Y

File Info Flag Y

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 2 Ft. blacktop and fill

From 2 To 9 Ft. sand and gravel, silty, compact (till?)

From 9 To 47 Ft. sand - fine/crs. and pea gravel, silty, w.b.

0 47 stg silty no water

AEE Well #12

BRITISH COLUMBIA

Well Tag Number 000000005028

Owner: INTERIOR ENGINEERING

Address: KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 136 Plan 1562 Lot 3

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083413 Well 2

Well Use Unknown Well Use

Construction Method Drilled

Diameter 0 inches

Well Depth 534 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19500101

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet
Wellhead ~ 3'6

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:
AT 150 FT TO 162 FT HE TRIED PUMPING THE FORMATION. FOR THE FIRST 3000 GALLONS IT CAME CLEAR (PUMPING AT 480 GPH) THEN THE SILT INCR. AND NEVER CLEARED.IR 5PPM

From 0 To 1 Ft. top black soil

From 1 To 10 Ft. coarse gravel with silt

From 10 To 18 Ft. somewhat cleaner gravel (w.b.) 4'6"

From	0	To	0	Ft.	static
From	18	To	21	Ft.	layer of silty hard clay
From	21	To	96	Ft.	gravel with layers of gray sticky clay
From	0	To	0	Ft.	and grey silt layers, silt is grey when
From	0	To	0	Ft.	wet and lime white when dry, last 10 ft
From	0	To	0	Ft.	had some stones
From	0	To	0	Ft.	1' to 96' had vegetation throughout this
From	0	To	0	Ft.	formation
From	96	To	118	Ft.	hard clay, somewhat more free of silt,
From	0	To	0	Ft.	very sticky, dark grey when wet, lime
From	0	To	0	Ft.	white when dry
From	118	To	142	Ft.	this is somewhat soft grey sticky clay
From	0	To	0	Ft.	with silty clay layers
From	142	To	144	Ft.	clean gravel (w.b.)
From	144	To	146	Ft.	layer of hard silt
From	146	To	148	Ft.	clean gravel (w.b.)
From	148	To	150	Ft.	layer of soft silt
From	150	To	162	Ft.	very loose gravel (w.b.), static 17 ft
From	162	To	255	Ft.	hard dark grey clay, free of silt layer
From	255	To	410	Ft.	layers of hard sticky clay and silty
From	0	To	0	Ft.	clay
From	410	To	470	Ft.	first stone at 410', formation same as
From	0	To	0	Ft.	from 225' - 410' only there was an odd
From	0	To	0	Ft.	stone
From	470	To	476	Ft.	first sign of fine silty sand, there was
From	0	To	0	Ft.	a very mild odour of sulphur in this
From	0	To	0	Ft.	area
From	476	To	498	Ft.	very hard clay, silt came up in good
From	0	To	0	Ft.	size samples, very hardpacked
From	498	To	534	Ft.	some fine sand, few stones, small amount
From	0	To	0	Ft.	of gravel, all mixed in soft silty clay
From	534	To	0	Ft.	2' sand layers with 2' silty clay layers

From	0	To	0 Ft.	static 70 ft., while bailing, silt
From	0	To	0 Ft.	filled the hole up to 310 ft.

37 rows selected.

Date entered to WELL

AEE Well #14

BRITISH COLUMBIA

Well Tag Number 000000053172

Owner: CITY OF KELOWNA

Address:

Area:

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan 10631 Lot 5

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083412 Well 4

Well Use Domestic

Construction Method Drilled

Diameter 7 inches

Well Depth 220 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19840101

Driller CAPRI DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 20 Ft. sand

From 20 To 51 Ft. sand and silt

From 51 To 55 Ft. clay

From	55	To	80	Ft.	silt
From	80	To	155	Ft.	clay
From	155	To	168	Ft.	silt
From	168	To	172	Ft.	clay
From	172	To	179	Ft.	silt
From	179	To	183	Ft.	clay
From	183	To	195	Ft.	silt
From	195	To	220	Ft.	clay

11 rows selected.

Date entered to WELL

AEE Well #15

BRITISH COLUMBIA

Well Tag Number 000000005030	Construction Date 19500101
Owner: A BOUCHARD	Driller AQUARIUS WATER WELLS
Address: 3514 LAKESHORE DRIVE	License Number
Area:	
WELL LOCATION:	
OSOYOOS (ODYD) Land District	
District Lot 134 Plan 13698 Lot B	PRODUCTION DATA AT TIME OF DRILLING:
Township Section Range	Well Yield 40 GPM Artesian Flow
Indian Reserve Meridian Block	Static Level UNK feet
Quarter	
Island	Water Utility
BCGS Number (NAD 27) 082E083411 Well 1	Lithology Info Flag Y
	Pump Test Info Flag
Well Use Unknown Well Use	File Info Flag
Construction Method Drilled	Sieve Info Flag
Diameter 0 inches	Screen Info Flag
Well Depth 200 feet	Water Chemistry Info Flag
Elevation 0	Field Chemistry Info Flag
Bedrock Depth UNK feet	Site Info (SEAM)
Screen from 195 to 200 feet Slot Size 1 Slot Size 2 Slot Size 3 Slot Size 4	Other Info Flag

GENERAL REMARKS:

From	0	To	48 Ft.	sandy silts and gravels	150 - 183 shale lenses in silt
From	48	To	144 Ft.	varved clays and silts	183 - 200 lensed sand + grae, med to coarse
From	144	To	150 Ft.	fine sand and gravel	

AEE Well #16

BRITISH COLUMBIA

Well Tag Number 000000025829

Owner: SHASTA TRAILER COURT

Address: BENVOULIN AREA EAST OF KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 134 Plan 3779 Lot 2

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083233 Well 2

Well Use Unknown Well Use

Construction Method Unknown Constru

Diameter 6 inches

Well Depth 245 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19720101

Driller S.A.E. DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag Y

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag Y

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 50 Ft. clay and sand

From 50 To 60 Ft. sand

From 60 To 178 Ft. clay

From	178	To	180	Ft.	sand
From	180	To	185	Ft.	gravel -IPPM iron
From	185	To	245	Ft.	clay

6 rows selected.

Date entered to WELL

AEE Well #17

BRITISH COLUMBIA

Well Tag Number 000000022675

Owner: SHASTA TRAILER CT LT

Address: LAKESHORE RD RR 4 KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 134 Plan 10115 Lot 1

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083233 Well 1

Well Use Unknown Well Use

Construction Method Drilled

Diameter 6 inches

Well Depth 64 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19690806

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 180 GPM
Artesian Flow

Static Level 8 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 8 Ft. brown clay

From 8 To 30 Ft. fine grey sand, heavily loaded with mud-

From 0 To 0 Ft. dy, clayish silt

From	30	To	48	Ft.	fine silty grey sand with a lot of big
From	0	To	0	Ft.	pieces of wood
From	48	To	64	Ft.	coarser sand with some rocks and gravel,
From	0	To	0	Ft.	no wood, but small pieces of grass
From	64	To	118	Ft.	rocks in soft mud-like, blackish clay,
From	0	To	0	Ft.	loaded with nica,
From	0	To	0	Ft.	mica is very fine and took a long time
From	0	To	0	Ft.	to settle out

11 rows selected.

Date entered to WELL

AEE Well #18

BRITISH COLUMBIA

Well Tag Number 000000026322

Owner: A H ENGLISH

Address: 4335 HAZELL RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 358 Plan Lot 11

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083231 Well 1

Well Use Unknown Well Use

Construction Method Drilled

Diameter 4 inches

Well Depth 79 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19720526

Driller AQUARIUS WATER WELLS

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 50 GPM
Artesian Flow

Static Level 12 feet
Wellhead -365
∴ SWL -360

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 5 Ft. sandy topsoil

From 5 To 6 Ft. sand, gravel, pea rock

From 6 To 11 Ft. red clay silts

From	11	To	14	Ft.	black clay silts
From	14	To	31	Ft.	rotten vegetation, brown clay silts
From	31	To	33	Ft.	pea gravel, sand silts
From	33	To	34	Ft.	yellow soft clay
From	34	To	35	Ft.	sand gravel, clay
From	35	To	37	Ft.	blue clay
From	37	To	40	Ft.	coarse gravel, water sand
From	40	To	51	Ft.	blue hardpan clay
From	51	To	52	Ft.	coarse gravel, hardpan clay
From	52	To	56	Ft.	spotty gravel, hardpan
From	56	To	60	Ft.	4' gravel, hardpan
From	60	To	64	Ft.	soft blue clay mixed with sand
From	64	To	74	Ft.	water gravel and sand
From	74	To	79	Ft.	4" - 6" rock, gravel water sand

17 rows selected.

Date entered to WELL

AEE Well #19

BRITISH COLUMBIA

Well Tag Number 000000021367

Owner: WILLIAM FINLEY

Address: LAKESHORE RD RR 4 KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 167 Plan 15548 Lot 2

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083231 Well 2

Well Use Unknown Well Use

Construction Method Drilled

Diameter 4 inches

Well Depth 52 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19680327

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 28 GPM
Artesian Flow

Static Level 12 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:
WATER IS VERY GOOD TO TASTE.

From 0 To 3 Ft. topsoil

From 3 To 12 Ft. rock and gravel in brown clay

From 12 To 31 Ft. rock and gravel in silty brown clay,

From	0	To	0	Ft.	water throughout this whole formation
From	31	To	46	Ft.	sand - clean, greyish beach sand & water
From	46	To	48	Ft.	hard, bluish clay
From	48	To	52	Ft.	rock and gravel, formation is clean and
From	0	To	0	Ft.	is a very good water aquifier
From	0	To	0	Ft.	

9 rows selected.

Date entered to WELL

AEE Well #20

BRITISH COLUMBIA

Well Tag Number 000000024810

Owner: R B MCKENZIE

Address: HOBSON ROAD KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 167 Plan 17098 Lot B

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083231 Well 3

Well Use Unknown Well Use

Construction Method Drilled

Diameter 0 inches

Well Depth 164 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19710503

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 16 GPM
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:
"WE TOOK OUT 16 GALS A MINUTE BY AIR LIFT." ODOR - SLIGHT. TASTE - VERY GOOD.

From 0 To 4 Ft. fine sandy clay

From 4 To 14 Ft. rocks and gravel, dry

From 14 To 32 Ft. rocks and gravel, water

From	32	To	41	Ft.	fine sand with very fine mica
From	41	To	54	Ft.	big stones with fine sand with some mica
From	0	To	0	Ft.	sand thats fine is that of beach grey
From	0	To	0	Ft.	sand
From	54	To	114	Ft.	bluish grey clay
From	114	To	164	Ft.	bluish silty grey clay

9 rows selected.

Date entered to WELL

AEE Well #21

BRITISH COLUMBIA

Well Tag Number 000000053618	Construction Date 19840602
Owner: OK MISS STH WTR USER	Driller PACIFIC PUMP & PRESSURE License Number
Address: KELOWNA	
Area: KELOWNA	
WELL LOCATION: SIMILKAMEEN Land District District Lot Plan Lot Township Section Range Indian Reserve Meridian Block Quarter Island BCGS Number (NAD 27) 082E083213 Well 16	PRODUCTION DATA AT TIME OF DRILLING: Well Yield 0 Artesian Flow Static Level UNK feet Water Utility Lithology Info Flag Y Pump Test Info Flag File Info Flag Sieve Info Flag Screen Info Flag Water Chemistry Info Flag Field Chemistry Info Flag Site Info (SEAM) Other Info Flag
Well Use Unknown Well Use Construction Method Drilled Diameter 10 inches Well Depth 257 feet Elevation 0 Bedrock Depth UNK feet Screen from 0 to 0 feet Slot Size 1 Slot Size 2 Slot Size 3 Slot Size 4	
GENERAL REMARKS:	

no rows selected

Date entered to WELL

and measuring the deflection of the drill stem cable approximately every 20-foot interval to just above the screen assembly. Each well was pump tested for a minimum period of 24 hours using a Berkely turbine pump set just a few feet above the screen assembly (Appendices B-1, B-2, and B-3). Discharge was directed into a flume built along the Lakeshore Road ditch downhill to a manhole and through a storm drain sewer into Bellevue Creek to the north. The completed wells were fitted with hinged lids and padlocked. The annular space between the surface casing and well casing was left ungrouted to facilitate future pump installation and pumphouse construction.

2.2 TH1 and TH2

Drilling of TH1 began May 15, 1984 (Picture 2). Thirty-two feet of 10-inch casing was installed as surface casing. The well was continued by drilling and casing an 8-inch hole to 257 feet below ground for exploration purposes. The testhole encountered the following:

0' to 60'	dry uniform fine-medium sand with some clay and gravel
60' to 80'	bouldery till and some clay
80' to 97'	dirty water-bearing sand and gravel
97' to 129'	water-bearing fine gravel and coarse sand
129' to 159'	sticky blue/grey clay
159' to 176'	silt, sand, and gravel, some water
176' to 184'	brown stony clay
184' to 214'	till and clay with some water-bearing sand and gravel seams
214' to 244'	smelly grey clay
244' to 251'	water-bearing gravel and sand
251' to 257'	silt and sand, some water.

Two potential aquifers were identified, an upper aquifer at 97 feet to 129 feet and a lower aquifer at 244 feet to 251 feet. It was decided to screen the upper aquifer. The upper aquifer is confined at the top by

till and the bottom by clay and exists under artesian conditions. The static water level was 69 feet below ground. Two 5-foot sections of 120-slot screen and two 5-foot sections of 100-slot screen were ordered based on the sieve analyses (Appendix A-1). The screen assembly was to be set at 129 feet. Upon pulling back to the proposed completion level, the casing became stuck just above 200 feet. Pulling continued, but the casing broke along a welded joint about 7 feet below ground. A backhoe was used to dig a pit around the well to expose the break and the casing was rewelded. The pit was then backfilled and a kicking head was attached to the top of the casing to aid in pulling by simultaneously bumping up. The casing remained stuck. Hydraulic jacks were then used to pull the casing but the casing broke again, this time about 12 feet below ground, too deep to be repaired (Pictures 3,4,5,6,7,8, and 9). The broken off 8-inch casing was removed and 14 feet of the 32 feet of surface casing was pulled out, a steel lid was welded onto the remaining surface casing, and the surface casing with lid was driven with the drill stem down to rest on top of the 8-inch casing in the ground. The remainder of the uncased hole was backfilled to surface with gravel (Figure 3). The rig was moved about 7 feet southwest of TH1 and a new hole, TH2, was drilled in place of TH1. It was hoped that by drilling close to TH1, the same aquifer conditions would be encountered and the screen assembly already ordered for TH1 could be used for TH2.

Drilling of TH2 began June 1, 1984. Fourteen feet of 10-inch surface casing was installed and 8-inch casing was installed to 134 feet. The aquifer was encountered from 94 feet to 132.5 feet. A few samples of the aquifer collected from TH2 were sieved and compared with those of TH1. Samples from TH2 appeared slightly coarser than those from TH1 and based on sieve analyses from both testholes, the screens were rearranged with the two 5-foot sections of 100-slot screen between one 5-foot section of

2.3 PW1

After completion of TH2, the rig was moved 150 feet southwest to drill PW1. This site was chosen based on the following:

(1) drilling of TH1 and TH2 showed the bottom of the aquifer apparently dips gently southwesterly. By moving in this direction it was hoped the aquifer would be encountered at a lower depth affording more available drawdown.

(2) because the aquifer characteristics could not be determined adequately on the basis of the single well test carried out and interference affects were not definitely known, a site relatively close to TH2 was chosen to develop the same aquifer and obtain better information on the aquifer parameters, transmissivity, and storativity.

It was also decided to drill a 12-inch diameter production well to try to obtain greater well capacity.

Drilling of PW1 began on June 18, 1984 (Picture 14). Fourteen and one-half feet of 16-inch diameter casing was installed. The 12-inch diameter hole was drilled to 144 feet and encountered similar materials and stratigraphy as in the previous holes. The confined aquifer was encountered between 88 feet and 141 feet under artesian conditions. The coarsest zone consists of clean medium-fine gravel with some coarse sand at 110 feet to 138 feet. The static water level was 69.4 feet below ground. Screen design consists of one 5.3-foot section of 100-slot Johnson screen between a 9.5-foot section of 150-slot Johnson screen (the uppermost 2 feet is blank slot) above and an 8.3-foot section of 150-slot

Johnson screen below (Appendix A-2). The transmitting capacity of the screen assembly based on Johnson (1975) is 1,390 USgpm. The screen assembly is completed with a neoprene packer and a bottom plate with bail handle. The hole was backfilled with sand and gravel to 138 feet. The screen assembly was lowered to 138 feet and the casing was pulled back to expose 21.2 feet of screen. The top 1.9 feet of screen formed the riser pipe (Figure 6, Table 1, and Pictures 15, 16, 17, and 18).

PW1 was developed for about 6.6 hours (Picture 19). An alignment test done on the well showed a drift of 14.7 inches over 115 feet; the well appears straight but out of plumb (Figure 7). The plumbness does not fall within the AWWA standards for deep wells.

The well was pump tested for a 30-hour duration from July 10, 1984, 8:40 a.m. to July 11, 1984, 2:40 p.m. at a constant rate of 415 USgpm (Picture 20). The static water level prior to the test was 71.12 feet below top of the 12-inch casing and the pump was set at 105 feet. The water level drewdown at a steady rate for 31.43 feet after 1,300 minutes of pumping. This represents 69% of the available drawdown. A slight recovery in the water level did occur after seven minutes while the pumping rate was cut back slightly during adjustment. Water level in the pumped well began to stabilize and rise after 1,300 minutes to the end of the test (for 8.3 hours). A water sample was collected at 400 minutes and sent for lab analysis. Specific capacity for PW1 after 30 hours of pumping at 415 USgpm was 13.2 USgpm/ft. dd. After pumping was stopped, the water level recovered to 99.0% of the original static after 1,717 minutes.

TH2 and the Gleisner well were used as observation wells to monitor well interference (Picture 21). Water level in TH2 drewdown a maximum of

AEE Well #22

BRITISH COLUMBIA

Well Tag Number 000000053654

Owner: MOE OBS WELL 305

Address: LAKESHORE RD.

Area: OKANAGAN MISSION

WELL LOCATION:

SIMILKAMEEN Land District

District Lot Plan Lot

Township 28 Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083213 Well 19

Well Use Observation Well

Construction Method Drilled

Diameter 10 inches

Well Depth 134 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 110 to 132 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19840615

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 400 GPM
Artesian Flow 0

Static Level 70 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM) 1401956

Other Info Flag

GENERAL REMARKS:
OLD OBS WELL # WR-305-88

no rows selected

Date entered to WELL

AEE Well #23

BRITISH COLUMBIA

Well Tag Number 000000053750

Owner: OK MISS STH WTR USER

Address: KELOWNA

Area: KELOWNA

WELL LOCATION:

SIMILKAMEEN Land District

District Lot Plan Lot

Township 28 Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083213 Well 23

Well Use Unknown Well Use

Construction Method Drilled

Diameter 16 inches

Well Depth 144 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 117 to 137 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19840712

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 415 GPM
Artesian Flow

Static Level 71 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM) 1401957

Other Info Flag

GENERAL REMARKS:

From 0 To 12 Ft. silty gray clay

From 12 To 17 Ft. clayey silt

From 17 To 49 Ft. fine silty sand

From	49	To	50	Ft.	stone clay
From	50	To	60	Ft.	hard gravelly till and boulders
From	60	To	82	Ft.	sandier till making some water at 68-74
From	82	To	88	Ft.	gravelly wet till
From	88	To	90	Ft.	dirty coarse gravel
From	90	To	98	Ft.	clean brown sand and coarse gravel
From	98	To	109	Ft.	dirtier brown sand, some gravel and silt
From	0	To	0	Ft.	lumps
From	109	To	110	Ft.	thin gravelly till layer
From	110	To	118	Ft.	coarse, clean gravel and sand
From	118	To	138	Ft.	very coarse clean gravel
From	138	To	141	Ft.	very dense, hard sand and gravel
From	141	To	144	Ft.	gravelly brown clay
From	0	To	0	Ft.	
From	0	To	0	Ft.	End of hole.

18 rows selected.

Date entered to WELL

AEE Well #24

BRITISH COLUMBIA

Well Tag Number 000000005215

Owner: HILLTOP SAND & GRAVE

Address:

Area:

WELL LOCATION:

SIMILKAMEEN Land District

District Lot Plan Lot 357

Township 29 Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083211 Well 2

Well Use Unknown Well Use

Construction Method Drilled

Diameter 0 inches

Well Depth 420 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19500101

Driller LA GRECA

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level 300 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:
STILL DRILLING, WANT MORE WATER.

From 0 To 300 Ft. sand and gravel

From 300 To 310 Ft. clay

From 310 To 420 0 Ft. ? stopped @ big rock

0 bottom

AEE Well #25

WTN 18811

GOVERNMENT OF BRITISH COLUMBIA

MEMORANDUM

TO Mr. V. Raudsepp
Chief Engineer
Water Investigations Branch

FROM E. Livingston, Chief, Ground-Water Di

November 24th 19 64

SUBJECT Test Drilling - Rutland

OUR FILE 0181761/024

YOUR FILE

Test drilling has now been completed at Rutland although drilling under this contract is still going on in the proposed extension of Black Mountain Improvement District.

The drilling was started July 7th, 1964, on a site on Nickel Road which is north of Joe Rich Road less than ½ mile east of the highway. The log of the first hole is as follows:

0 - 1	Soil
1 - 9	Silty gravel
9 - 43	Silty clay with stones, at 40', one half Ft. Sand
43 - 80	Silty clay with fine sand lenses
80 - 140	Fat silty clay
140 - 148	Flowing silt (Ooze)
148 - 152	Fat silty clay
152 - 154	Flow silt
154 - 222	Silty clay with scattered pebbles and plant remains
222 - 232	Fine to medium coarse sand
232 - 246	Fine to medium sand, some gravel
246 - 252	Fine to medium sand with beds or lenses of silt, wood at 252'.
252 - 266	Silty fine to medium sand compact
266 - 269	Silty fine to medium sand
269 - 274	Coarse to fine sand and gravel
274 - 277	Medium to fine sand, some gravel
277 - 283	Coarse sand and gravel
283 - 289	Coarse to fine sand and coarse gravel
289 - 292	Fine to coarse sand and some gravel
292 - 298	Coarse sand and gravel
298 - 299	Fine sand
299 - 300	Silt with wood
300 - 355	Fine silty sand interbedded with silt
355 - 357	Black organic clay silt
357 - 387	Fine silty sand interbedded with silt

The static level in the sandy zone from 222 to 299 is about 8'.

Well head ≈ 395

∴ SWL ≈ 383

AEE Well #26

BRITISH COLUMBIA

Well Tag Number 000000041982

Owner: RUTLAND WATERWORKS D

Well #10 for Rutland

Address: ZIPRICK RD

Area: RUTLAND

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan 3617 Lot 23

Township 26 Section 22 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083442 Well 60

Well Use Unknown Well Use

Construction Method Drilled

Diameter 16 inches

Well Depth 184 feet

Elevation 1255

Bedrock Depth UNK feet

Screen from 108 to 175 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19790401

Driller Unknown

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 2200 USGM
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 16 Ft. sand and gravel w/cobbles

From 16 To 19 Ft. interbedded grey clay & sand & gravel

From 19 To 30 Ft. gray green silty till

From	30	To	46	Ft.	silty till interbedded with sand &
From	0	To	0	Ft.	gravel
From	46	To	50	Ft.	fine sand w/12" lens of greenish silt
From	50	To	72	Ft.	fine sand w/clay interseds
From	72	To	95	Ft.	fine gray sand
From	95	To	104	Ft.	fine sand w/small gravel at bottom
From	104	To	108	Ft.	fine to med. sand with coarse round and
From	0	To	0	Ft.	subaneular gravel, some cobbles and silt
From	108	To	130	Ft.	med. to coarse round and subaneular sand
From	0	To	0	Ft.	and gravel
From	130	To	134	Ft.	med. to coarse sand and gravel gray cob-
From	0	To	0	Ft.	bles
From	134	To	145	Ft.	fine to coarse sand gravel, cobbles
From	145	To	158	Ft.	fine to coarse sand and gravel, gray
From	0	To	0	Ft.	at 158' greenish silt layer
From	158	To	164	Ft.	med. sand, some gravels
From	164	To	167	Ft.	med. to coarse sand and gravel
From	167	To	168	Ft.	gray silt lens
From	168	To	178	Ft.	med. to coarse sand and gravel
From	178	To	184	Ft.	gray sandy till

23 rows selected.

Date entered to WELL

AEE Well #27

BRITISH COLUMBIA

Well Tag Number 000000019466

Owner: GROUNDWATER DIVISION

Address: N W Q

Area:

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan Lot

Township Section Range

Indian Reserve Meridian Block

Quarter NW

Island

BCGS Number (NAD 27) 082E083442 Well 55

Well Use Unknown Well Use

Construction Method Drilled

Diameter 0 inches

Well Depth 1445 feet

Elevation 1255

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19651001

Driller Unknown

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 16 Ft. coarse gravel

From 16 To 45 Ft. till

From 45 To 385 Ft. sand and gr. with plant remains

AEE Well #30

SWL ~ 65'

RUTLAND WATERWORKS DISTRICT
Well No. 15 - Hollywood Road S.
Driller's Litholog

Depth Interval in feet	Lithologic Description
0 - 17	Crs. sand & gravel with cobbles and boulders
17 - 48	Brown till and cobbles
48 - 67	Brown silty till and crs. gravel
67 - 72	Fine to crs. gravel, brn., some clay lenses
72 - 81	Silty to sandy brn till with fine to crs. gravel
81 - 86	Sandy, gravelly till, making some water
86 - 105	Water-bearing sand, gravel & rocks
105 - 112	Silty brn clay, gravel and stone
112 - 123	Sandy brown till
123 - 131	Water-bearing sand and gravel
131 - 161	As above but coraser
161 - 173	Material becoming finer and bailing open hole about 1 foot below casing
173 - 181	As above but casing driving harder
181 - 189	Starting to loosen-up again, material turning grey in color
189 - 191	Sand and gravel, some minor clay
191 - 201	Sand and gravel, crs. cobbly intervals

AEE Well #31 WTN 251

RUTLAND WATERWORKS DISTRICT

No. 6 WELL LOG

(Re-created from daily drilling reports)

Driller: A. C. DRILLERS LTD. (G. Monkman) Feb./74

DEPTH FROM	DEPTH TO	FORMATION & COMMENTS
0	16'	Coarse to very coarse cobbly gravel
16	25	Light Tan Grey Till
25	34	" " "
34	51	Interbeds of Light Grey Till - Fine to coarse gravel & sand
51	60	Compact medium coarse sand with interbeds of tan grey silt
60	70	Compact medium coarse tan grey sand, some gravel.
70	74	Medium coarse with interbeds of soft grey clay.
74	90	Medium coarse light tan-grey sand, some fine sand, slight amount of grey silt.
90	102	Medium coarse sand, a few pebbles
102	110	Fine coarse sand & gravel, grey silt.
110	120	Coarse to very coarse cobbly gravel with some grey silt. Casing drives hard.
120	135	Coarse to very coarse compact grey gravel.
135	150	Very coarse cobbly gravel, some grey silt
150	160	Medium to very coarse gravel, slight amount of medium coarse sand. Some cobbles, light grey silt.
162	172	Coarse, very coarse gravel
172	175	Coarse gravel, some coarse sand & Fine gravel. Slight amount of grey silt.
175	185	Fine to coarse gravel with a high medium coarse sand content, some grey silt

N°.6 WELL LOG Cont'd.

DEPTH FROM	TO	FORMATION & COMMENTS
185	207	Coarse sand, fine gravel, some medium coarse gravel, some fine - medium sand, occasional thin lens of grey silt.
207	215	Fine gravel, coarse sand and some medium coarse gravel, changing to a tan coloured gravel.
215	230	Fine coarse loose tan coloured gravel & sand.
230	242	Medium coarse tan coloured sand, some pebble gravel, suspended rusty tan silt.
242	247	Fine medium tan coloured sand, occasional thin lens of silty sand, rusty tan silt.
247	262	Fine coarse gravel, some medium coarse sand, rusty tan silt.
262	272	Fine coarse pebbly gravel, tan coloured silt, some medium coarse sand.
272	285	Fine to coarse gravel & sand. Tan colored silt.
285	302	Fine coarse sand & gravel with dark tan coloured silt, high sand content.

Bottom of Hole.

AEE Well #32

BRITISH COLUMBIA

Well Tag Number 000000044789

Owner: WM CAMERON

Address: GUISACHAN RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 128 Plan 2830 Lot 1

Township 26 Section 17 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083423 Well 7

Well Use Domestic

Construction Method Drilled

Diameter 6 inches

Well Depth 129 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 121 to 129 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19800415

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 50 GPM
Artesian Flow

Static Level + feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 18 Ft. black gumbo

From 18 To 42 Ft. coarse gravel

From 42 To 58 Ft. black clay

From	58	To	87	Ft.	till dense
From	87	To	102	Ft.	dirty gravel
From	102	To	112	Ft.	gravel, very dense
From	112	To	116	Ft.	blue silty sand
From	116	To	129	Ft.	coarse sand and gravel with cobbles

8 rows selected.

Date entered to WELL

AEE Well #33

BRITISH COLUMBIA

Well Tag Number 000000041319

Owner: BENVOULIN WATER USER

Address: BYRNS RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 128 Plan 2830 Lot 1

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083414 Well 1

Well Use Commercial and Industrial

Construction Method Drilled

Diameter 10 inches

Well Depth 157 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19790101

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 700 USGM
Artesian Flow 0

Static Level UNK feet 3.5m chae grvl
Wellhead ~ 355 → SWL ~ 359

Water Utility

Lithology Info Flag Y

Pump Test Info Flag Y

File Info Flag Y

Sieve Info Flag Y

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 6 Ft. (metres) clayey silt with thin layers of

From 0 To 0 Ft. gravel

From 6 To 6 Ft. coarse gravel with cobbles to 1.6 cm

From	0	To	0	Ft.	diameter, loose
From	6	To	9	Ft.	coarse gravel, static water level approx
From	0	To	0	Ft.	0.5 m. below ground
From	9	To	9	Ft.	clay
From	9	To	12	Ft.	clay with seams of gravel
From	12	To	13	Ft.	coarse grvl with layers of clay
From	13	To	19	Ft.	clay
From	19	To	27	Ft.	till, very dense
From	27	To	29	Ft.	sloppy gravel with hard layers
From	29	To	32	Ft.	sand and gravel, deep aquifer
From	32	To	34	Ft.	sand and gravel, loose
From	34	To	37	Ft.	sand and gravel, very loose, deep aquife
From	37	To	41	Ft.	sand and gravel
From	41	To	42	Ft.	sand and gravel, layer of very coarse
From	0	To	0	Ft.	gravel, 41.2 to 41.5 m., deep aquifer
From	42	To	45	Ft.	silty sand and gravel with clay binder
From	45	To	46	Ft.	silty sandand gravel to 5 cm. with clay
From	0	To	0	Ft.	binder, can drill approx. 1 m. ahead
From	0	To	0	Ft.	with heavy mud
From	46	To	48	Ft.	silty sand and medium gravel
From	48	To	50	Ft.	dense silt with some clay

24 rows selected.

Date entered to WELL

WATER WELL RECORD

DEPT. OF ENVIRONMENT, WATER RESOURCES SERVICE, WATER INVESTIGATIONS BRANCH VICTORIA, BRITISH COLUMBIA

Z [ ] [ ] WELL NO. [ ] [ ] [ ]

[ ] [ ] [ ] [ ] [ ] [ ] [ ] E

[ ] [ ] [ ] [ ] [ ] [ ] [ ] N

Z X Y NO.

NAT. TOPO. SHEET NO. [ ] [ ] [ ]

LEGAL DESCRIPTION: LOT 1 SEC. ____ TP. ____ R. ____ D.L. 128 LAND DISTRICT Okanagan (40) PLAN 2730

DESCRIPTIVE LOCATION Byrns Road, West of Spall Road, Kelowna, B.C. LICENCE NO. ____ DATE ____

OWNER'S NAME Regional Water Users' Community ADDRESS Kelowna, B.C.

DRILLER'S NAME Pacific Pump & Pressure (109) ADDRESS Box 329 Castlegar, B.C. DATE COMPLETED ____

DEPTH 479m 1574ft. ELEVATION OF ____ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 25 cm. LENGTH ____

METHOD OF CONSTRUCTION Drilling CASING DIAM (10") LENGTH ____

SCREEN LOCATION 22.6m - 47.9m SCREEN ☒ SIZE 25cm - 20cm LENGTH @ 22.6 m TYPE K reducing gasket

SANITARY SEAL YES ☐ NO ☐ SCREEN ☒ SIZE 2.03 - 3.86 mm LENGTH @ 22.9 - 47.9 mm TYPE Johnson Stainless Steel, 20 cm

PERFORATED CASING ☐ LENGTH ____ PERFORATIONS FROM ____ TO ____

GRAVEL PACK ☐ LENGTH ____ DIAM. ____ SIZE GRAVEL, ETC. ____

DISTANCE TO WATER During ☐ ESTIMATED WATER LEVEL

FROM ____ ☐ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT ____ WATER USE ____

PRODUCTION TEST SUMMARY

DATE March 5-6, 1980

TEST BY Pacific Pump & Pressure Installation Ltd.

BAIL TEST ☐ PUMP TEST ☒ DURATION OF TEST 23 hr 14.50 min.

RATE 36.1 Lpm. DRAWDOWN ____

WATER LEVEL AT COMPLETION OF TEST 3.5m above ground

AVAILABLE DRAWDOWN 3m - SPECIFIC CAPACITY ____

PERMEABILITY ____ STORAGE COEFF ____

TRANSMISSIVITY ____

RECOMMENDED PUMPING RATE ____

RECOMMENDED PUMP SETTING ____

CHEMISTRY (See map)

TEST BY ____ DATE ____

TOTAL DISSOLVED SOLIDS ____ mg/l TEMPERATURE ____ °C pH ____ SILICA (SiO_2) ____ mg/l

CONDUCTANCE ____ μmhos/cm AT 25°C TOTAL IRON (Fe) ____ mg/l TOTAL HARDNESS ($CaCO_3$) ____ mg/l

TOTAL ALKALINITY ($CaCO_3$) ____ mg/l PHEN. ALKALINITY ($Ca CO_3$) ____ mg/l MANGANESE (Mn) ____ mg/l

COLOUR ____ ODOUR ____ TURBIDITY ____

ANIONS	mg/l	epm	CATIONS	mg/l	epm
CARBONATE (CO_3)			CALCIUM (Ca)		
BICARBONATE (HCO_3)			MAGNESIUM (Mg)		
SULPHATE (SO_4)			SODIUM (Na)		
CHLORIDE (Cl)			POTASSIUM (K)		
$NO_2 + NO_3$ (NITROGEN)			IRON (DISSOLVED)		
• TKN (NITROGEN)					
PHOSPHORUS (P)					

• TKN = TOTAL KJELDAHL NITROGEN CHEMISTRY SITE NO. ____

NO_2 = NITRITE NO_3 = NITRATE

CHEMISTRY FIELD TESTS

TEST BY ____ DATE ____ EQUIPMENT USED ____

LITHOLOGY

FROM	TO	DESCRIPTION
0	5.5m	clayey silt with thin layers of gravel
5.5	6.1m	coated gravel with cobbles to 11.6 cm diameter, loose
6.1	8.5m	coarse gravel, static water level approx 0.5m below ground
8.5	9.1m	clay
9.1	11.6m	clay with seams of gravel
11.6	12.8m	coarse gravel with layers of clay
12.8	19.2m	clay
19.2	27.4m	tiffen, dense
27.4	29.3m	sloppy gravel with hard layers
29.3	32.3m	sand and gravel
30.3	33.5m	sand and gravel, loose
33.5	37.2m	sand & gravel, very loose
37.2	41.2m	sand & gravel
41.2	41.8m	sand & gravel, layer of very coarse gravel 41.2 to 41.5m
41.8	44.5m	silty sand & gravel with clay binder
44.5	46.3m	silty sand & gravel to 5 cm with clay binder, can drill approx 1m. ahead with heavy mud
46.3	48.2m	silty sand and medium gravel
48.2	50 m	dense silt with some clay

CONTENTS OF FOLDER

☒ DRILL LOG ☒ PUMP TEST DATA ☒ CHEMICAL ANALYSIS (L)

☒ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER ____

SOURCES OF INFORMATION Pacific Hydrology Consultants Ltd. Report See 82 E/14 #28

The attached information has been supplied gratuitously to the Province of British Columbia and has not been independently confirmed. Those persons relying on it do so at their own risk, and all persons to whom it is supplied should be cautioned against its use in making financial and other commitments. Comments on the well records may be obtained on request by contacting the drillers named."

41.8 - 44.5 m.	silty sand and gravel with clay binder
44.5 - 46.3 m.	silty sand and gravel to 5 cm. with clay binder, can drill approx. 1 m. ahead with heavy mud.
46.3 - 48.2 m.	silty sand and medium gravel
48.2 - 50 m.	dense silt with some clay

The static water level in the deep aquifer is in the order of 3.5 m. above ground.

A water sample was collected from the natural artesian flow from the open casing and submitted to Cantest Ltd. in order to determine that the water quality was acceptable, before installing the screen. A copy of the report is included in the Appendix. The analysis is discussed below under Water Quality.

A well screen was selected on the basis of sieve analyses carried out on samples of water-bearing sand and gravel collected every few feet in the aquifer. Copies of the sieve analyses are appended to this report. The following screen assembly was installed in the well:

at top (32.6 m.)	25 cm. to 20 cm. type K reducing packer
32.9 - 34.4 m.	2.03 mm. slot, 20 cm. Johnson's stainless steel nominal screen
34.4 - 38.7 m.	18 cm. pipe blank
38.7 - 40.2 m.	2.03 mm. slot screen
40.2 - 41.8 m.	18 cm. pipe blank
41.8 - 43.3 m.	3.05 mm. slot screen
43.3 - 44.8 m.	3.56 mm. slot screen
44.8 - 46.3 m.	18 cm. pipe blank
46.3 - 47.9 m.	3.05 mm. slot screen
at bottom (47.9 m.)	bail bottom

While exposing the screen the water was weighted down with a mixture of barite and Quick-gel to prevent flow. Additional mud had to be added after exposing each 3 m. of the screen. The well head was completed with a 25 cm. diameter tee and 15 cm. discharge through a 15 cm. valve. Development of the well was carried out by surging and by alternately shutting in and releasing the flow. Final development was carried out using a one-way surge to force the natural flow back into the aquifer to assist in loosening the fines in the aquifer. Following completion of development a pump test was carried out.

cont'd...5

Pump Test

Pacific Pump and Pressure carried out the pump test using a turbine pump powered by a gasoline engine. Water levels during pumping, and recovery of the water level following the termination of pumping were measured by means of an electric water level indicator. The artesian flow of the well is 15 l./sec. To date the precise static water level has not been measured.

Pumping began at a rate of 25.6 l./sec. and was increased in a series of steps to 31.9 l./sec., 38.2 l./sec., 44.5 l./sec. and finally to 50.7 l./sec. at 7, 40, 70 and 105 minutes of pumping respectively. If we assume a static water level of approximately 3.5 m. above ground, the well performance at various rates of pumping may be summarized as follows:

Minutes of Pumping	Approximate Drawdown (metres)	Pumping Rate (l/sec.)	Specific Capacity (l/sec/m.)
0 - 7	5.2	25.6	4.9
7 - 40	6.9	31.9	4.6
40 - 70	8.4	38.2	4.5
70 - 105	9.9	44.5	4.5
105 - 1430	12.8	50.7	3.9

We have attempted to calculate the transmissivity of the aquifer from the drawdown data, and also from the recovery data, by use of standard straight line methods. For the purposes of plotting the recovery data we have used the minutes of actual pumping as minutes since start. The well had been flowing freely for about two days prior to starting the pump. The recovering water level was observed until it flowed over the top of the casing about 0.6 m. above ground. Obviously the flow had not completely recovered. All indications are, however, that the recovery is rapid. Since the well head is now completed with a valve, a shut-in type test can be conducted.

The transmissivity obtained from the straight line method of analysis ranges from 440 to 480 m^2/day for recovery and drawdown data respectively. The transmissivity of this extensive leaky artesian aquifer calculated from data for various of the Rutland wells shows considerable variation.

cont'd... 6

The transmissivity calculated for the Benvoulin well is in the lower range of that of the Rutland wells. The specific capacity indicates that the well is quite efficient for the calculated transmissivity.

The capacity of the well will be restricted by the casing diameter. The terms of reference for this project called for "...Preparing a cost estimate for the drilling, constructing and developing of production wells in the aquifer closest to surface that can supply the flows of: a) 6.3 l/s, 18.9 l/s, 44.2 l/s, and 88.3 l/sec. for a well in the Benvoulin area". The present well is constructed in an aquifer which can supply these flows. The present well can be pumped at each of the flow rates other than perhaps the highest rate of 88.3 l/sec., at the following projected pumping levels:

Pumping Rate (l/sec)	Expected Pumping Level (m.below grou
6.3	Natural flow = 15 l/sec
18.9	1.5
44.2 ≈700 US gpm	6.5 - 7

It will be difficult to obtain a pump capable of pumping 88.3 l/sec. from a 25 cm. diameter casing.

The discussion about expected pumping levels in this situation is very complex. The effect of long term continual pumping of the leaky artesian aquifer at this location is unknown. During pump testing of the Benvoulin well, a resident in BWUC, Mr. Day, who supplies his house directly from the artesian flow of a small diameter shallow (about 30 m. deep) well at a location approximately 0.4 km southwest of the Benvoulin well, reported that the natural flow of his well had declined to about 50% by the end of the test. Long term pumping of the Benvoulin well at high rates will likely cause more severe interference. The complexity of the interfingering leaky artesian aquifer makes it impossible to speculate with any accuracy about what will occur.

The construction of the Benvoulin well has created much local interest in the use of wells. The owner, on whose land the District well is located, has now constructed a well east of the District well. Obviously any new well constructed under these conditions should be properly constructed and equipped to control the artesian flow.

cont'd... 7

Water Quality

Included in the Appendix to this letter report are copies of a complete analysis of water collected from the natural flow from the open end pipe before the well was completed with a screen. Also included is a partial analysis carried out on a sample collected during the latter part of the pump test.

The water may be classed as a calcium-sodium-magnesium-bicarbonate type water. The water is moderately hard and moderately mineralized. It is typical of waters in the Interior in that it contains a large amount of dissolv manganese. The sample collected during the pump test still shows a high turbidity and associated high total iron. The drop in turbidity from the first analysis to the later one corresponds to a drop in the total iron. This seems to confirm that the two are related and further declines in the total iron are likely.

The very high phosphate is quite unusual but similar amounts are present in at least one of the Rutland wells. The fact that the well is constructed in a flowing artesian aquifer where the gradient is upward indicates that the phosphate is from natural sources and is unlikely to be related to local use of septic tank-tile drain field systems or to agricultural fertilizers.

We are not capable of assessing the suitability of the water for irrigation.

SOUTHEAST KELOWNA IRRIGATION DISTRICT

Test Drilling and Well Construction

Drilling at the test well site in South East Kelowna Irrigation District, near the intersection of McCulloch Road and KLO Road, confirms that the thick Rutland aquifer extends at least that far southward. The aquifer is similar to that encountered in a well constructed on Hall Road approximately 750 metres to the northwest. Neither well reaches the bottom of the aquifer. The new well constructed in S.E.K.I.D. is located on a terrace about 45 m. above the Hall Road well.

cont'd...8

AEE Well #34

BRITISH COLUMBIA

Well Tag Number 000000054618

Owner: WEST KOOTENAY POWER

Address: 2850 BENVOULIN RD TRAIL

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 130 Plan 18843 Lot A

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083414 Well 5

Well Use Commercial and Industrial

Construction Method Drilled

Diameter 6 inches

Well Depth 176 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19850329

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 250 GPM
Artesian Flow

Static Level + feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 1 Ft. frozen gravel fill

From 1 To 3 Ft. gravel fill

From 3 To 12 Ft. sandy silt

From	12	To	14	Ft.	watery brown sand and gravel
From	14	To	15	Ft.	very dark silt
From	15	To	19	Ft.	wood - log or stump
From	19	To	36	Ft.	grey sandy gravel, w.b.
From	36	To	50	Ft.	dark silty clay
From	50	To	52	Ft.	grey tan clay, lower 6"
From	52	To	88	Ft.	silty clay
From	88	To	108	Ft.	dark silt w. clay lenses
From	108	To	159	Ft.	dark silt, a few stones at 138
From	159	To	161	Ft.	sandy clay -water rising
From	161	To	175	Ft.	coarse sand and med. gravel
From	0	To	0	Ft.	
From	0	To	0	Ft.	At 170 ft. well flowed at approx. 300
From	0	To	0	Ft.	GPM when bottom plug heaved, washing
From	0	To	0	Ft.	stones to 3" diameter over top of casing
From	0	To	0	Ft.	and had to drive to 177 ft. to stop flow
From	0	To	0	Ft.	Set screen on 2 ft. plug, flowing 15 GPM
From	0	To	0	Ft.	through plug, weighted screen with 1000
From	0	To	0	Ft.	lb., and exposed. Flow through screen
From	0	To	0	Ft.	250 GPM.

23 rows selected.

Date entered to WELL

AEE Well #35

BRITISH COLUMBIA

Well Tag Number 000000055260

Owner: MCFARLANE

Address: RAMPONE RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 131 Plan 186 Lot 61

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083412 Well 7

Well Use Domestic

Construction Method Drilled

Diameter 7 inches

Well Depth 200 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19850904

Driller CAPRI DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 23 GPM
Artesian Flow

Static Level UNK feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 5 Ft. top soil

From 5 To 10 Ft. clay

From 10 To 15 Ft. rot

From	15	To	16	Ft.	gravel (30 GPM)
From	16	To	21	Ft.	clay
From	21	To	35	Ft.	silt
From	35	To	45	Ft.	clay
From	45	To	54	Ft.	silt
From	54	To	62	Ft.	fine sand
From	62	To	75	Ft.	clay
From	75	To	78	Ft.	gravel and sand
From	78	To	79	Ft.	sand
From	79	To	155	Ft.	clay
From	155	To	190	Ft.	silt
From	190	To	200	Ft.	clay

15 rows selected.

Date entered to WELL

AEE Well #36

BRITISH COLUMBIA

Well Tag Number 000000046630

Construction Date 19801117

Owner: S DETMERS

Driller THOMAS WELL DRILLING

License Number

Address: KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 131 Plan 18102 Lot 8

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083412 Well 5

Well Use Unknown Well Use

Construction Method Drilled

Diameter 6 inches

Well Depth 96 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow

Static Level 12 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 68 Ft. brown silty sand, very little water

From 68 To 89 Ft. gray silt

From 89 To 96 Ft. water-bearing sand

AEE Well #37

BRITISH COLUMBIA

Well Tag Number 000000041981

Owner: JOHN STEGEMAN

Address: KLO RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 131 Plan 8472 Lot 2

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083412 Well 1

Well Use Unknown Well Use

Construction Method Drilled

Diameter 4 inches

Well Depth 167 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 146 to 156 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19790401

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 30 GPM
Artesian Flow

Static Level + feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 21 Ft. gravel in silty clay

From 21 To 67 Ft. silty clay with layers of sand, lots of

From 0 To 0 Ft. wood and grass, some water, bad odor

AEE Well #38

BRITISH COLUMBIA

Well Tag Number 000000058754

Owner: FRED KOEHLE

Address: 2075 KLO RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 131 Plan 39954 Lot B

Township 26 Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083421 Well 29

Well Use Domestic

Construction Method Drilled

Diameter 6 inches

Well Depth 104 feet

Elevation 0

Bedrock Depth feet

Screen from 0 to 0 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19890424

Driller CAPRI DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 25 GPM
Artesian Flow 3 GPM

Static Level + feet

Water Utility

Lithology Info Flag

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 3 Ft. sand gravel with cobbles

From 3 To 6 Ft. topsoil and sandy clay

From 6 To 27 Ft. w.b. gravel with silt, trace of clay

From	67	To	100	Ft.	silty grey clay
From	100	To	108	Ft.	very silty dirty sand with some wood and
From	0	To	0	Ft.	a lot of very fine mica (odor)
From	108	To	138	Ft.	silty grey clay with mica
From	138	To	167	Ft.	very clean, fine silty sand, with some
From	0	To	0	Ft.	very fine mica (fresh water)
From	0	To	0	Ft.	
From	0	To	0	Ft.	"We did not drill thru this aquifer.This
From	0	To	0	Ft.	aquifer could yield a lot of water with
From	0	To	0	Ft.	a larger casing. The water is good to
From	0	To	0	Ft.	taste, although this formation has a lot
From	0	To	0	Ft.	of very fine grey silt. When we left,
From	0	To	0	Ft.	the water was very clear, it's controll-
From	0	To	0	Ft.	ed with a well head and two valves."

17 rows selected.

Date entered to WELL

From	27	To	36	Ft.	fine black silt with clay
From	36	To	39	Ft.	peat and old wood
From	39	To	44	Ft.	clay
From	44	To	50	Ft.	w.b. gravel with silt
From	50	To	52	Ft.	w.b. gravel with peat
From	52	To	58	Ft.	sands and clay, trace of water
From	58	To	67	Ft.	silty clay
From	67	To	93	Ft.	tight clay with gravel
From	93	To	101	Ft.	brown sand and gravel with clay
From	101	To	104	Ft.	w.b. sand and gravel

13 rows selected.

Date entered to WELL

AEE Well #39

BRITISH COLUMBIA

Well Tag Number 000000035486

Owner: S.E.K.I.D.

Address: HALL RD./ JOHNSON RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan 1920 Lot G

Township 26 Section 16 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083423 Well 16

Well Use ABANDONED

Construction Method Drilled

Diameter 8 inches

Well Depth 161 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 120 to 158 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19760813

Driller A.C. DRILLERS

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 650 USGM
Artesian Flow 0

Static Level 23 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag Y

File Info Flag Y

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM) 1400186

Other Info Flag

GENERAL REMARKS:
OLD OBS WELL # WR-222-77
AB.83 - S.E.K.I.D. NOW STUDY USING WELL

From 0 To 12 Ft. silty tan sand

From 12 To 17 Ft. med. coarse sand with sm. cobbly gravel

From 17 To 26 Ft. med. coarse gravel and coarse sand (w.b)

From	26	To	39	Ft.	compact tan silt with clay lens
From	39	To	40	Ft.	compact tan silt with gravel
From	40	To	74	Ft.	compact coarse gravel and sand, some tan
From	0	To	0	Ft.	silt, changes to cobbly gravel
From	74	To	86	Ft.	till -hard gravelly, tan colored
From	86	To	96	Ft.	very fine to coarse sand with fine and
From	0	To	0	Ft.	coarse gravel, with thin till lens, high
From	0	To	0	Ft.	tan silt content
From	96	To	103	Ft.	fine and med. loose pebbly gravel, high
From	0	To	0	Ft.	fine to coarse sand content interbeds
From	0	To	0	Ft.	of tan till, high tan silt
From	103	To	108	Ft.	fine to coarse loose pebbly grvl, some
From	0	To	0	Ft.	very coarse grvl, some tan silt
From	108	To	112	Ft.	med. to coarse pebbly grvl tan silt
From	112	To	114	Ft.	fine to crse sand, tan silt
From	114	To	120	Ft.	cemented crse cobb. grvl (till)
From	120	To	128	Ft.	crse, very crse pebb. grvl (w.b.)
From	128	To	129	Ft.	med. crse sand, some fine sand, some
From	0	To	0	Ft.	pebb. grvl
From	129	To	135	Ft.	fine to crse pebb. grvl and med. coarse
From	0	To	0	Ft.	sand (w.b.)
From	135	To	140	Ft.	med. crse pebb. grvl (w.b.)
From	140	To	148	Ft.	very crse cobb. grvl, quite compact,
From	0	To	0	Ft.	traces of till
From	148	To	154	Ft.	med. coarse, loose pebbly gravel, clean
From	154	To	158	Ft.	fine to coarse pebbly gravel with higher
From	0	To	0	Ft.	med. crse sand content (w.b.)
From	158	To	161	Ft.	fine to crse, compact grvl and sand
From	0	To	0	Ft.	(poor w.b.)

32 rows selected.

Date entered to WELL

AEE Well #40

BRITISH COLUMBIA

Well Tag Number 000000047826

Owner: S E KELOWNA IRR DIST

Address: BOX 64 E KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan Lot

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083423 Well 22

Well Use Unknown Well Use

Construction Method Drilled

Diameter 16 inches

Well Depth 200 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 152 to 195 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19810501

Driller A.C. DRILLERS

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 950 GPM
Artesian Flow

Static Level 45 feet
Wellhead ~ 400 mASL
∴ SWL ~ 386?
Water Utility

Lithology Info Flag Y

Pump Test Info Flag Y

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 10 Ft. hard clay

From 10 To 43 Ft. sand and gravel

From 43 To 48 Ft. silt with sand stringers

AEE Well #41

BRITISH COLUMBIA

Well Tag Number 000000044358

Owner: S.E.K.I.D.

Address: MCCULLOCH RD. / KLO RD.

Area: EAST KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan Lot

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083422 Well 1

Well Use Observation Well

Construction Method Drilled

Diameter 6 inches

Well Depth 277 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 230 to 277 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19800201

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 456 USGM
Artesian Flow 0

Static Level 167 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag Y

File Info Flag

Sieve Info Flag Y

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM) 1401808

Other Info Flag

GENERAL REMARKS:
OBS. WELL NO. 262

From 0 To 12 ~~Ft.~~ m (metres) sand and gravel

From 12 To 26 ~~Ft.~~ m (metres) brown clay, layers of sand

From 26 To 29 ~~Ft.~~ m brown clay

AEE Well #42

BRITISH COLUMBIA

Well Tag Number 000000061762

Owner: SE KELOWNA IRR DISTR

Address:

East Kelowna Rd + McCullough + Dunster - nearest.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 10987 Plan 187 Lot 25

Township 26 Section 16 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083422 Well 3

Well Use Municipal

Construction Method Drilled

Diameter 12 inches

Well Depth 425 feet

Elevation 0

Bedrock Depth feet

Screen from 0 to 0 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19900905

Driller ALL WESTERN DRILLING

License Number

Manager - Toby Pike

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow 0

Static Level 172 feet

Wellhead ~ 430 m ASL
∴ SWL ~ 378

Water Utility

Lithology Info Flag

Pump Test Info Flag Y

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 26 Ft. Coarse gravel & clay

From 26 To 77 Ft. Sandy silt - small pebbles

From 77 To 130 Ft. Sandy silt & clay

From	130	To	177	Ft.	Hard clay & small boulders
From	177	To	285	Ft.	Hard till, small boulders, thin layers
From	0	To	0	Ft.	wet coarse sand
From	285	To	306	Ft.	Very hard till & pebbles
From	306	To	420	Ft.	Wet sands & gravel fine to coarse
From	420	To	425	Ft.	Till hard

9 rows selected.

Date entered to WELL 00950316

- outstanding proposal to upgrade Hall Rd well to supply to local residents ~~→ issue~~ rather than.

~160 connections in Hall Rd area

→ to date could not supply residents on year round basis

(typically only run 1 cell in spring for 5-6 week period)

Wells

NE corner of East McCulloch & East Kelowna Rd

Well #1 - adjacent to Hwy - ~900 USgpm

2nd well 300-400m North on East Kelowna Rd #2 - adjacent to or across City of Kelowna

Just North Bewley Rd ~900 gpm

Hall Rd wells

Ortley Rd - 150m ~ 700 USgpm

→ used, ~~peak demands~~ in drought conditions when dont have adequate surface runoff also used in spring when Turbin

% of USG

GW supplies < 2% of demand

AEE Well #43

BRITISH COLUMBIA

Well Tag Number 000000015629

Owner: T MCLAUGHLIN

Address: SAUCIER RD.

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 238 Plan Lot

Township 29 Section 32 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083232 Well 1

Well Use Unknown Well Use

Construction Method Unknown Constru

Diameter 6 inches

Well Depth 341 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19580801

Driller G.&.G. WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 3 GPM
Artesian Flow

Static Level 331 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:
VERY HARD, HAVE A SOFTENER.

From 0 To 31 Ft. glacial till

From 31 To 68 Ft. glacial till, boulders

From 68 To 73 Ft. coarse gravel

From	73	To	108	Ft.	coarse gravel, silty sand
From	108	To	119	Ft.	gravel and sand
From	119	To	122	Ft.	fine gravel, sand
From	122	To	158	Ft.	gravel, sand
From	158	To	197	Ft.	coarse gravel, sand
From	197	To	212	Ft.	fine sand
From	212	To	227	Ft.	fine sand
From	227	To	294	Ft.	coarse sand, gravel
From	294	To	300	Ft.	silty sand
From	300	To	338	Ft.	silty sand and gravel
From	339	To	0	Ft.	fine sand, gravel -some water
From	339	To	341	Ft.	coarse gravel, water

15 rows selected.

Date entered to WELL

AEE Well #44

BRITISH COLUMBIA

Well Tag Number 000000020853

Owner: E GRUENKE

Address: KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot Plan 11460 Lot 1

Township 29 Section 31 Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083232 Well 3

Well Use Unknown Well Use

Construction Method Drilled

Diameter 4 inches

Well Depth 358 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19670815

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 28 GPM
Artesian Flow

Static Level 178 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 20 Ft. clay and shale (brown)

From 20 To 67 Ft. till -rock and gravel in hard silty clay

From 67 To 86 Ft. dry rocks and gravel (lost circulation)

From	86	To	144	Ft.	till -stones and gravel in hard clay
From	0	To	0	Ft.	(grey)
From	144	To	180	Ft.	till -rocks and gravel in sandy clay
From	0	To	0	Ft.	(grey)
From	180	To	220	Ft.	w.b. fine sandy clay (grey)
From	220	To	242	Ft.	till -rocks and gravel in hard silty
From	0	To	0	Ft.	clay (grey)
From	242	To	247	Ft.	sandstone
From	247	To	256	Ft.	rock gravel in hard clay (grey)
From	256	To	260	Ft.	sandstone
From	260	To	269	Ft.	w.b. fine sand
From	269	To	278	Ft.	till -hard sandy grey clay with rocks
From	0	To	0	Ft.	and gravel
From	278	To	284	Ft.	sandstone
From	284	To	292	Ft.	fine sand, w.b.
From	292	To	296	Ft.	clay -light blue, soupy and sticky
From	296	To	304	Ft.	w.b. rocks, gravel and sand
From	304	To	308	Ft.	fine hard sand (grey)
From	308	To	338	Ft.	sandy clay (grey)
From	338	To	358	Ft.	clay with sand, black mud, water,
From	0	To	0	Ft.	reddish

24 rows selected.

Date entered to WELL

AEE Well #45

BRITISH COLUMBIA

Well Tag Number 000000053854

Owner: OK MISSION STH WATER

BCE Report => "PW3"

Address: KELOWNA

Area: KELOWNA

WELL LOCATION:

SIMILKAMEEN Land District

District Lot Plan Lot

Township 28 Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083211 Well 10

Well Use Unknown Well Use

Construction Method Drilled

Diameter 8 inches

Well Depth 164 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 141 to 158 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19840803

Driller PACIFIC PUMP & PRESSURE

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 505 GPM
Artesian Flow

Static Level 97 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag Y

Site Info (SEAM) 1401958

Other Info Flag

GENERAL REMARKS:

From 0 To 3 Ft. pavement - 4' silty gravel

From 3 To 11 Ft. silty tan clay

From 11 To 15 Ft. sandy clay

AEE Well #46

BRITISH COLUMBIA

Well Tag Number 000000024782

Owner: BROME ESTATES LTD

Address: HOBSON RD RR 4 KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 167 Plan Lot 12

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083213 Well 29

Well Use Unknown Well Use

Construction Method Unknown Constru

Diameter 8 inches

Well Depth 62 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 58 to 62 feet
Slot Size 1 Slot Size 2
Slot Size 3 ~~Slot~~ Size 4

Construction Date 19710501

Driller S.A.E. DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 105 USGM
Artesian Flow

Static Level 32 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag Y

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 20 Ft. sand and gravel

From 20 To 32 Ft. clay and gravel, hardpan

From 32 To 62 Ft. w.b. sand with gravel

AEE Well #47

BRITISH COLUMBIA

Well Tag Number 000000053560

Owner: WESTWIND NURSERY

Address: KLO RD

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 131 Plan 8012 Lot A

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083421 Well 33

Well Use Commercial and Industrial

Construction Method Drilled

Diameter 6 inches

Well Depth 135 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 0 Slot Size 2 0
Slot Size 3 0 Slot Size 4 0

Construction Date 19840511

Driller CAPRI DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 80 GPM
Artesian Flow 0

Static Level + feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 21 Ft. sand and gravel

From 21 To 25 Ft. gravel

From 25 To 53 Ft. consolidated clay, gravel

From	53	To	57	Ft.	silty clay and gravel
From	57	To	80	Ft.	consal clay and gravel
From	80	To	100	Ft.	sands and clays
From	100	To	106	Ft.	silts and gravel
From	106	To	124	Ft.	silt and clay
From	124	To	128	Ft.	clay
From	128	To	135	Ft.	sand and gravel

10 rows selected.

Date entered to WELL

AEE Well #48

BRITISH COLUMBIA

Well Tag Number 000000021903

Owner: SCHOOL DISTRICT #23

Address: 599 HARVEY AVE KELOWNA

Area: KELOWNA

WELL LOCATION:

OSOYOOS (ODYD) Land District

District Lot 358 Plan 2872 Lot 4

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083213 Well 24

Well Use Unknown Well Use

Construction Method Drilled

Diameter 4 inches

Well Depth 96 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19681029

Driller OKANAGAN ROTARY WELL DRILLING

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 40 GPM
Artesian Flow

Static Level 21 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 10 Ft. brown clay, sand and gravel

From 10 To 24 Ft. loose sand, gravel and rocks

From 24 To 30 Ft. all big rocks with coarse gravel, loose,

From	0	To	0	Ft.	water
From	30	To	43	Ft.	grey clay
From	43	To	50	Ft.	big rocks with sand and gravel, heavily
From	0	To	0	Ft.	loaded with clay
From	50	To	56	Ft.	grey silt, hard packed, washes easily
From	56	To	70	Ft.	all big granite rocks and gravel
From	0	To	0	Ft.	loaded with clay silt, water
From	70	To	84	Ft.	very fine, silty sand
From	84	To	96	Ft.	very coarse gravel, water
From	0	To	0	Ft.	
From	0	To	0	Ft.	Took out 40 gals/min. by air lift. Water
From	0	To	0	Ft.	is very good to taste.

15 rows selected.

Date entered to WELL

AEE Well #49

BRITISH COLUMBIA

Well Tag Number 000000022932

Owner: DAVE BORDEN

Address: PARET RD SOUTH KELOWNA

Area: SOUTH KELOWNA

WELL LOCATION:

SIMILKAMEEN Land District

District Lot 579 Plan 17060 Lot 3

Township Section Range

Indian Reserve Meridian Block

Quarter

Island

BCGS Number (NAD 27) 082E083212 Well 2

Well Use Unknown Well Use

Construction Method Drilled

Diameter 4 inches

Well Depth 76 feet

Elevation 0

Bedrock Depth UNK feet

Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19691101

Driller ART MOORE & SON

License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 25 IGM
Artesian Flow

Static Level 56 feet

Water Utility

Lithology Info Flag Y

Pump Test Info Flag

File Info Flag

Sieve Info Flag

Screen Info Flag

Water Chemistry Info Flag

Field Chemistry Info Flag

Site Info (SEAM)

Other Info Flag

GENERAL REMARKS:

From 0 To 2 Ft. topsoil

From 2 To 40 Ft. coarse gravel clay and boulders

From 40 To 74 Ft. coarse gravel and sand

74-76 "med clean gravel

WTN 83125

Drilling Tender Rutland Water Works District/12-Inch Production Well Feb. 1st/94

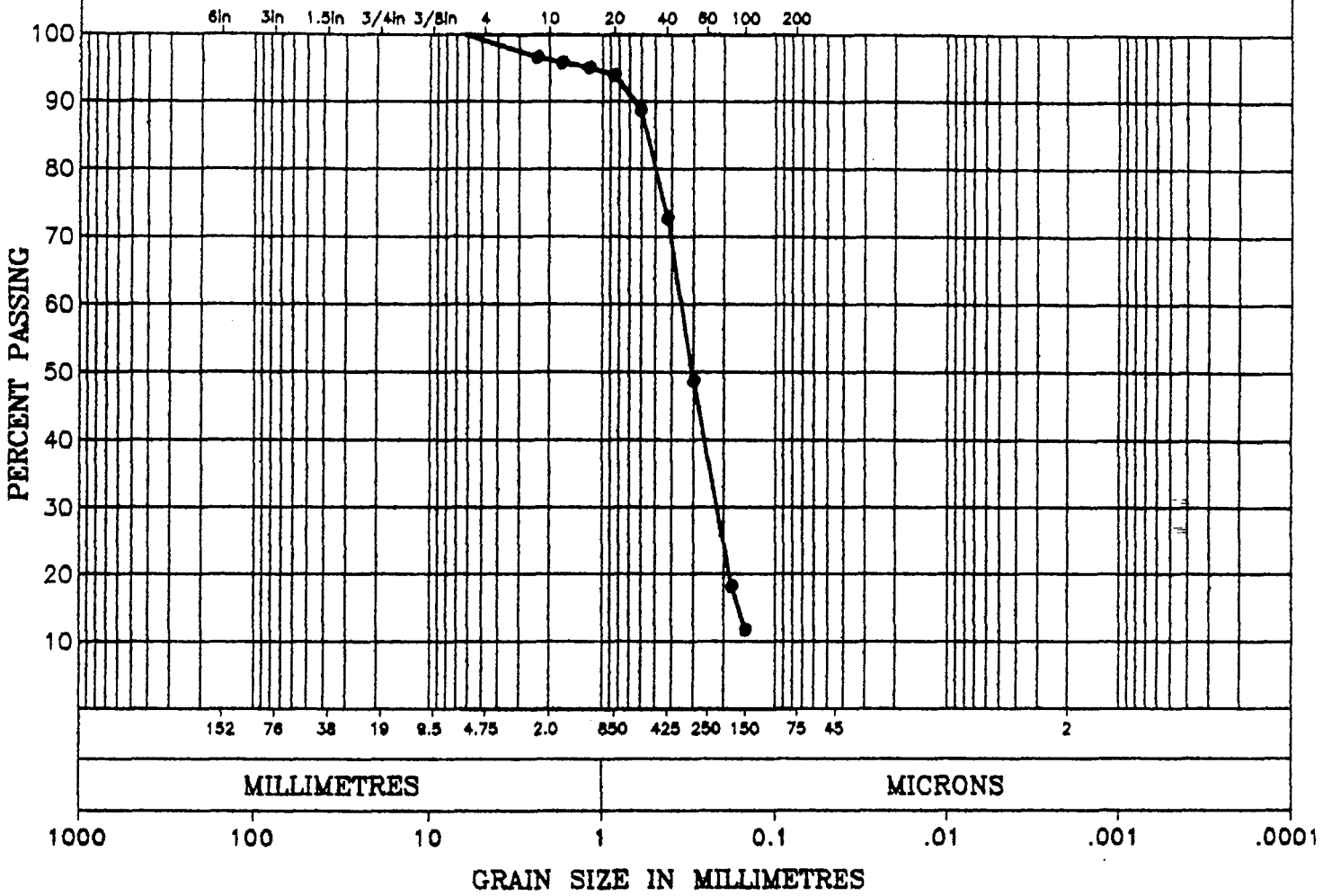
EXISTING WELL NO. 12

DRILLER'S LITHOLOG: **AEE Well #50**

Depth Interval in feet	Lithologic Description
0 - 3	Topsoil, sand & gravel, large cobbles
3 - 13	Sand and gravel
13 - 28	Sandy clay
28 - 38	Silt with sand stringers
38 - 58	Sandy silt with clay lenses
58 - 64	Silt and clay
64 - 108	Clay
108 - 110	Sand and silt with small amount of fine gravel
110 - 115	Silty sand
115 - 130	Sandy silt, grey
130 - 137	Grey sand and silt
137 - 139	Gravelly till
139 - 142	Tight angular gravel with clay lenses
142 - 154	Coarse tight heavy sand and gravel
154 - 163	Sand and gravel with a silt lens at 161 feet
163 - 167	Sand with some fine gravel
167 - 177	Loose sand and gravel, round gravel
177 - 179	Gravel and cobbles with fine sand
179 -182	Coarse sand and gravel, very loose with cobbles
182 - 185	Tan coloured coarse sand and gravel
185 - 188	Tan, medium to coarse sand with some gravel and cobbles
188 - 191	Medium to coarse sand with some small gravel
191 - 197	Medium to coarse gravel and sand with cobbles, loose
197 - 200	Tightened-up, layers of black silt

DOCUMENT NO. 1

COBBLES	GRAVEL SIZES		SAND SIZES			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		



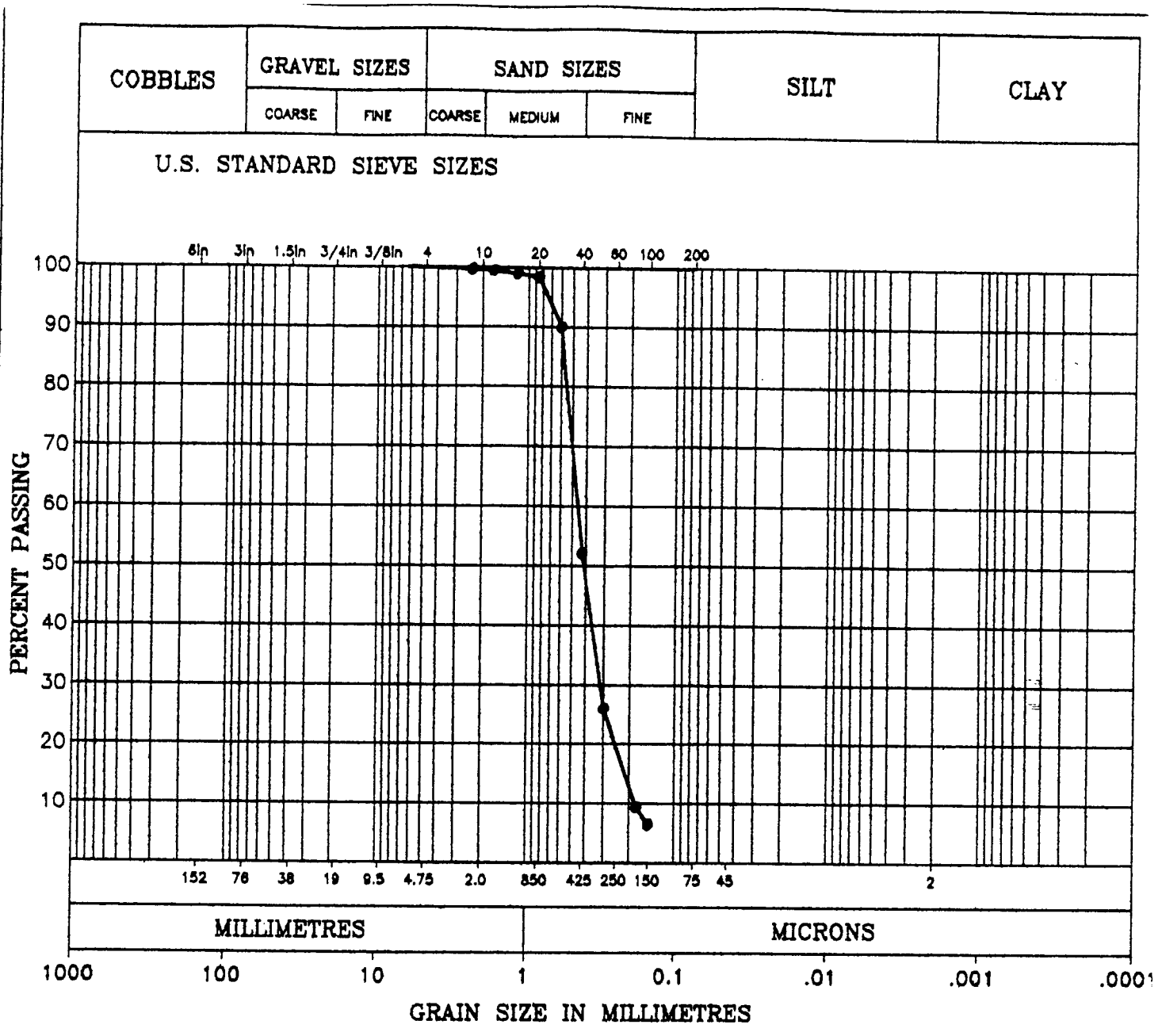
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	%
D_{30} = 0.23	mm	SAND	88. %
D_{60} = 0.36	mm	FINES	12. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna-Rotary Marsh
HOLE: SAMPLE:
DEPTH: 6.6 m
TECHNICIAN: CW



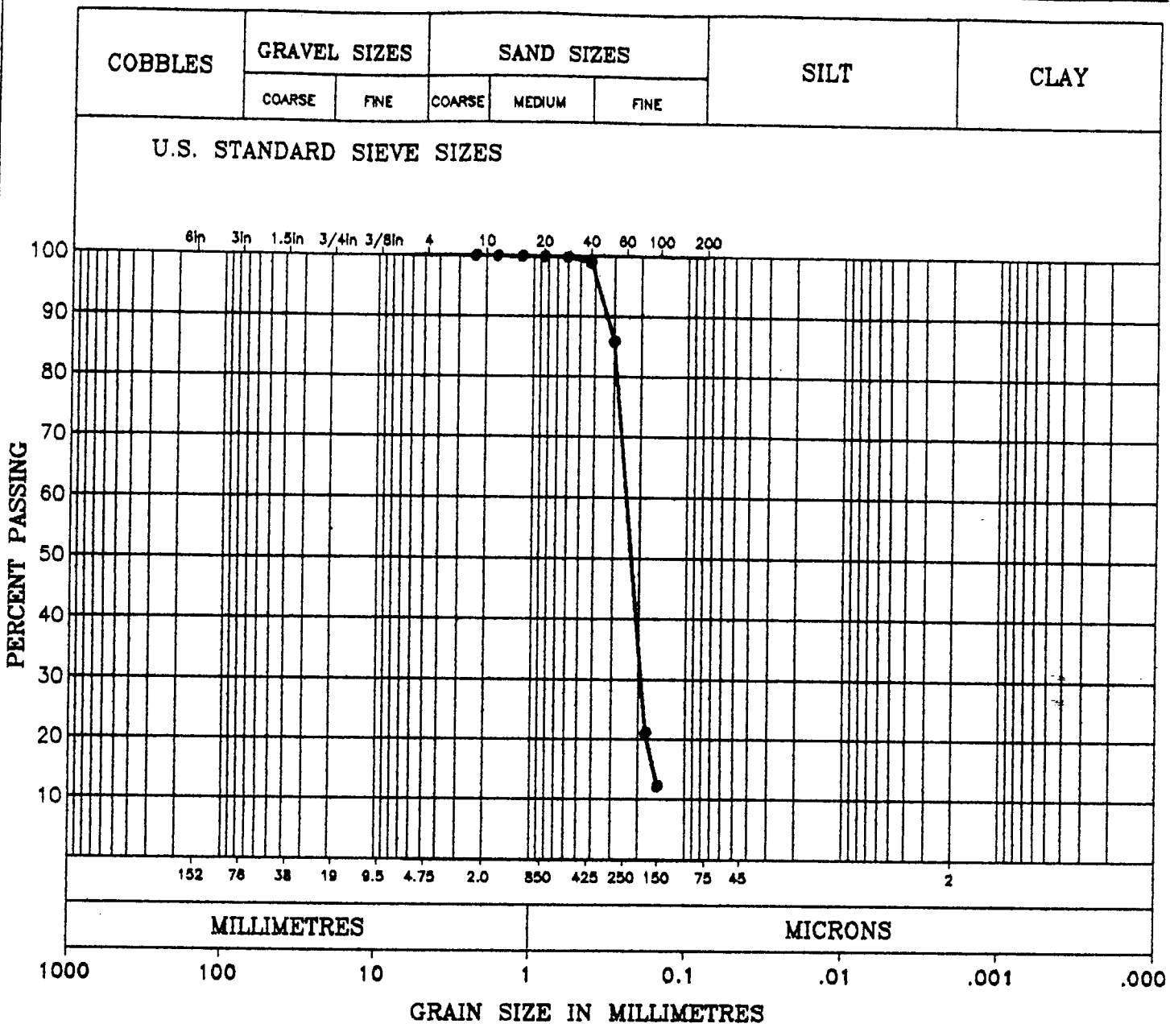
REMARKS:

SUMMARY

D_{10} = 0.18	mm	GRAVEL	%
D_{30} = 0.32	mm	SAND	94. %
D_{60} = 0.46	mm	FINES	6. %
C_U = 2.5			
C_C = 1.2			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna–Rotary Marsh
HOLE: SAMPLE:
DEPTH: 9.8 m
TECHNICIAN: CW



REMARKS:

SAND

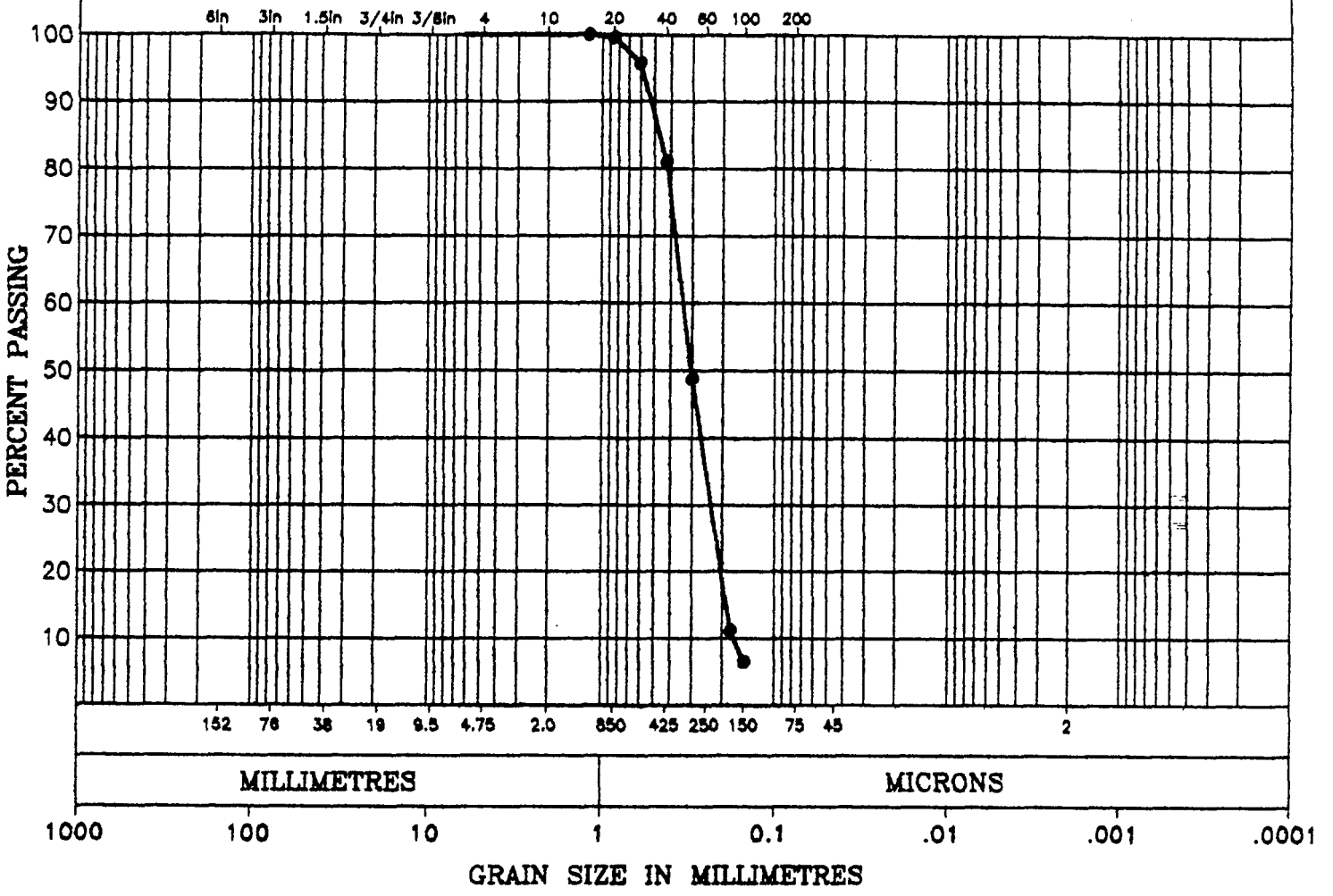
SUMMARY

D_{10} =	mm	GRAVEL	%
D_{30} = 0.20	mm	SAND	88. %
D_{60} = 0.25	mm	FINES	12. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna–Rotary Marsh
HOLE: SAMPLE:
DEPTH: 13.1 m
TECHNICIAN: CW

COBBLES	GRAVEL SIZES		SAND SIZES			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		



REMARKS:

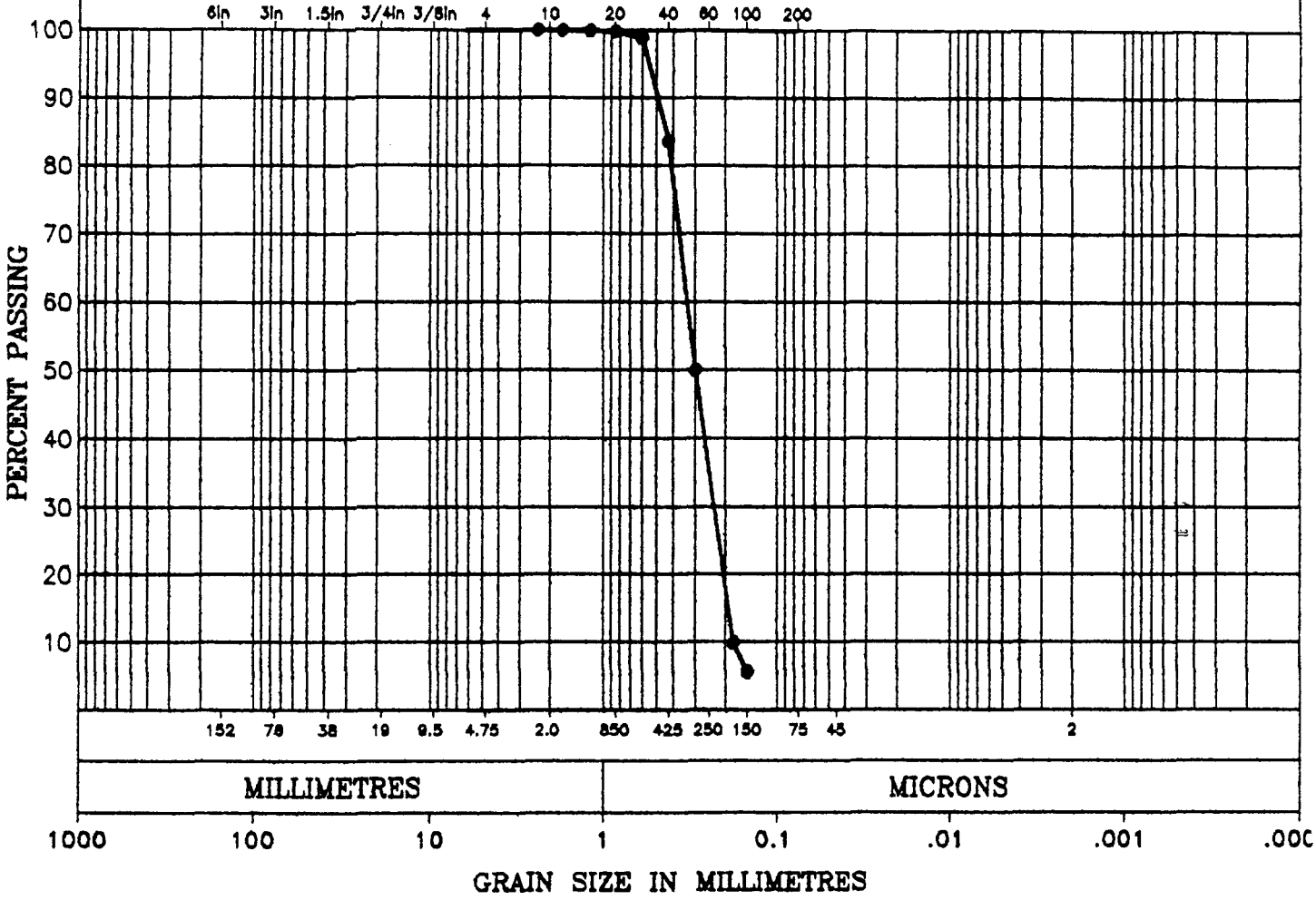
SUMMARY

D_{10} = 0.17	mm	GRAVEL	%
D_{30} = 0.24	mm	SAND	94. %
D_{60} = 0.34	mm	FINES	6. %
C_U = 2.0			
C_C = 0.97			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna-Rotary Marsh
HOLE: SAMPLE:
DEPTH: 16.4 m
TECHNICIAN: CW

COBBLES	GRAVEL SIZES		SAND SIZES			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		



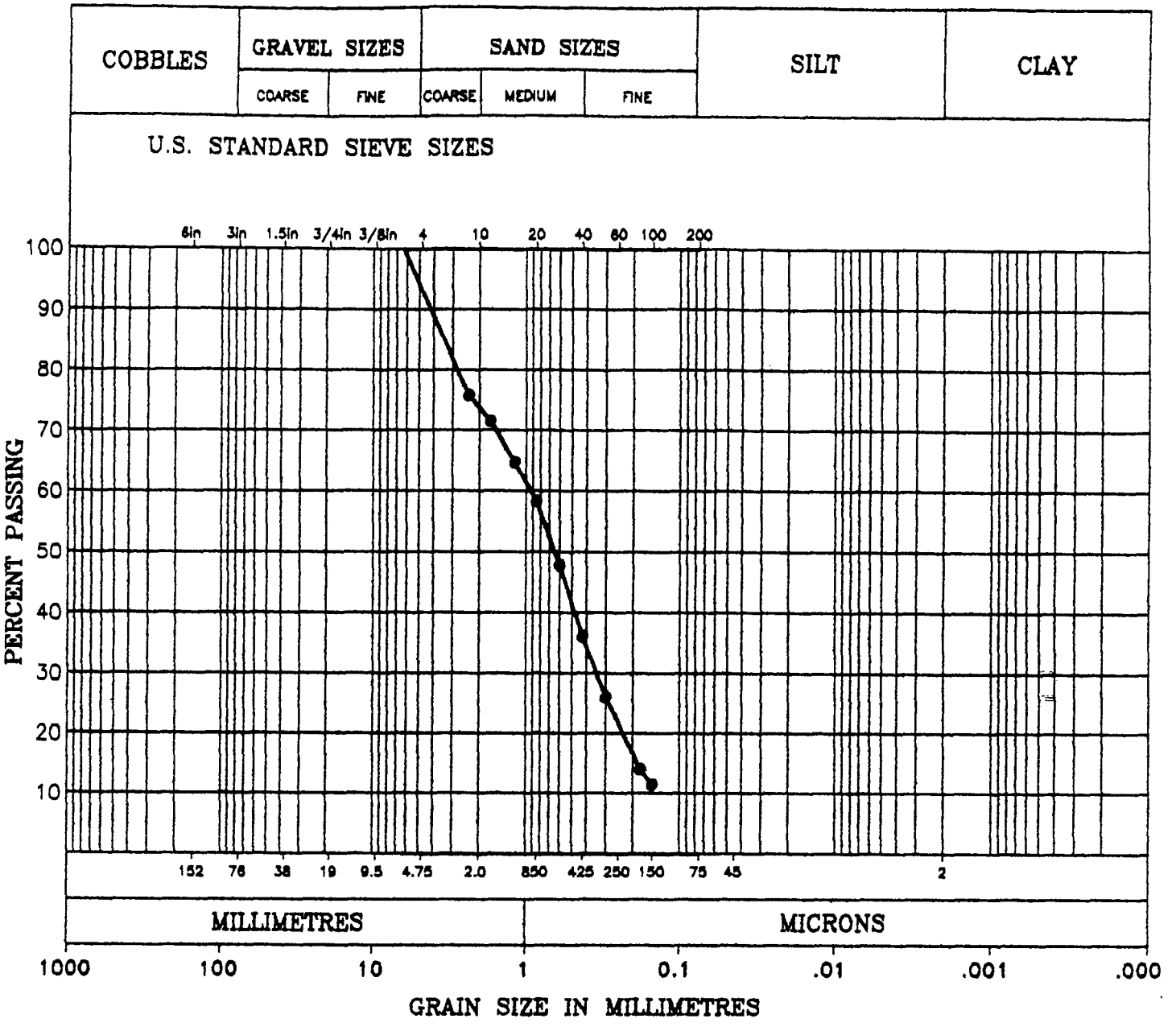
REMARKS:

SUMMARY

D_{10} = 0.18	mm	GRAVEL	%
D_{30} = 0.24	mm	SAND	95. %
D_{60} = 0.34	mm	FINES	5. %
C_U = 1.9			
C_C = 0.95			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna–Rotary Marsh
HOLE: SAMPLE:
DEPTH: 19.7 m
TECHNICIAN: CW



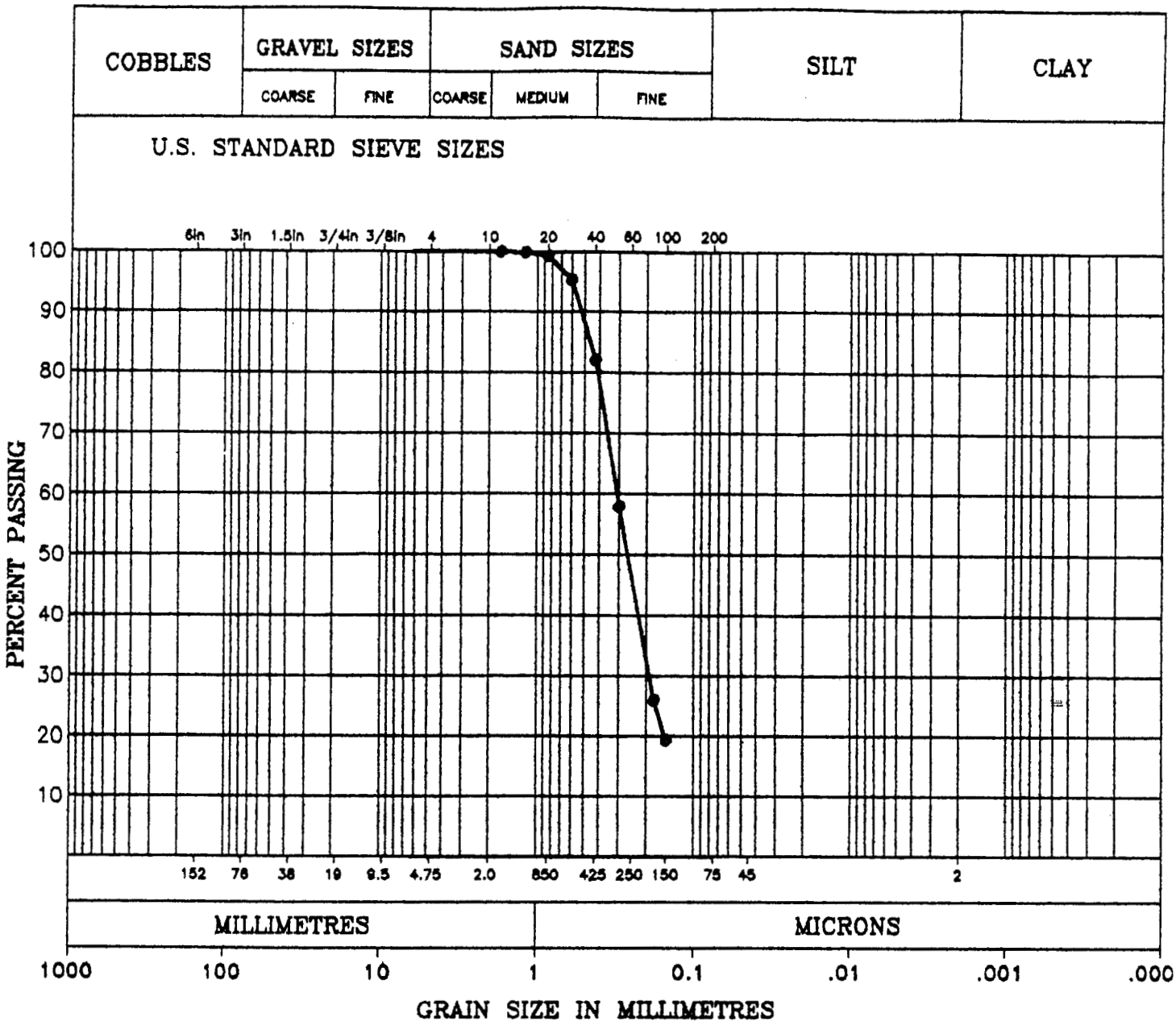
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	%
D_{30} = 0.35	mm	SAND	89. %
D_{60} = 0.94	mm	FINES	11. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Eldorado
HOLE: SAMPLE:
DEPTH: 3.2 m
TECHNICIAN: CW



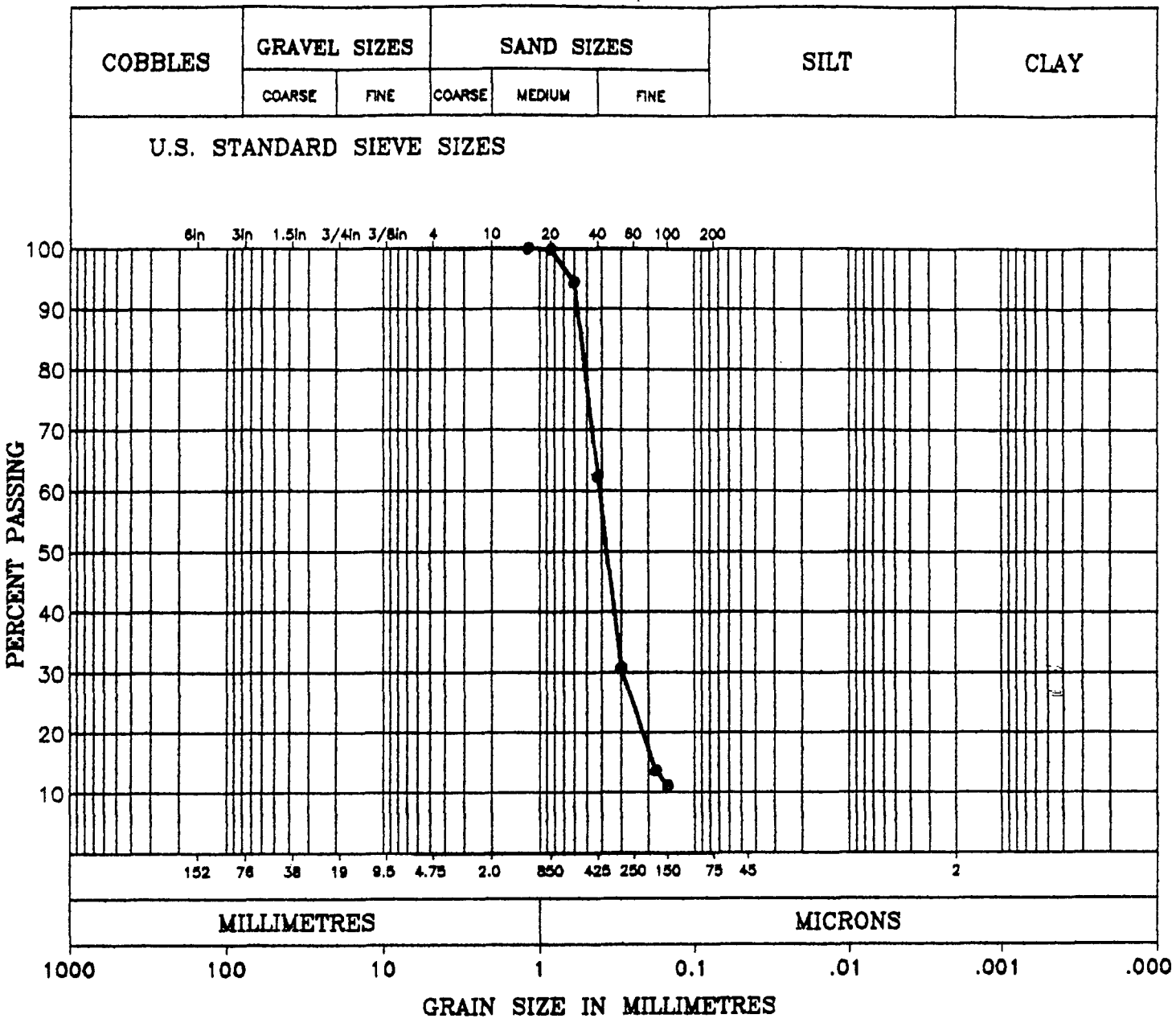
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	%
D_{30} = 0.20	mm	SAND	81. %
D_{60} = 0.31	mm	FINES	19. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Eldorado
HOLE: SAMPLE:
DEPTH: 6.6 m
TECHNICIAN: CW



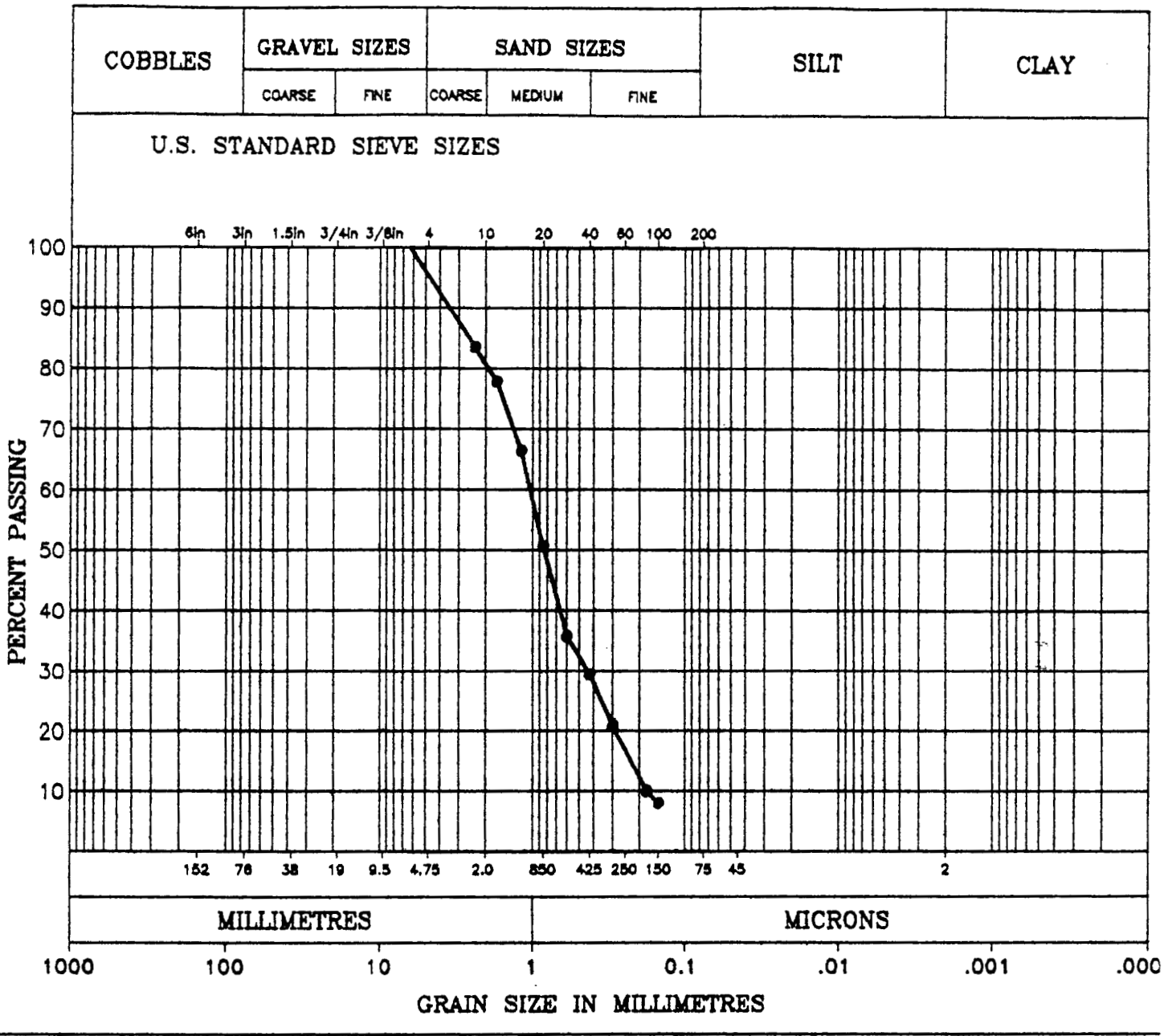
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	%
D_{30} = 0.30	mm	SAND	89. %
D_{60} = 0.42	mm	FINES	11. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Eldorado
HOLE: SAMPLE:
DEPTH: 13.1 m
TECHNICIAN: CW



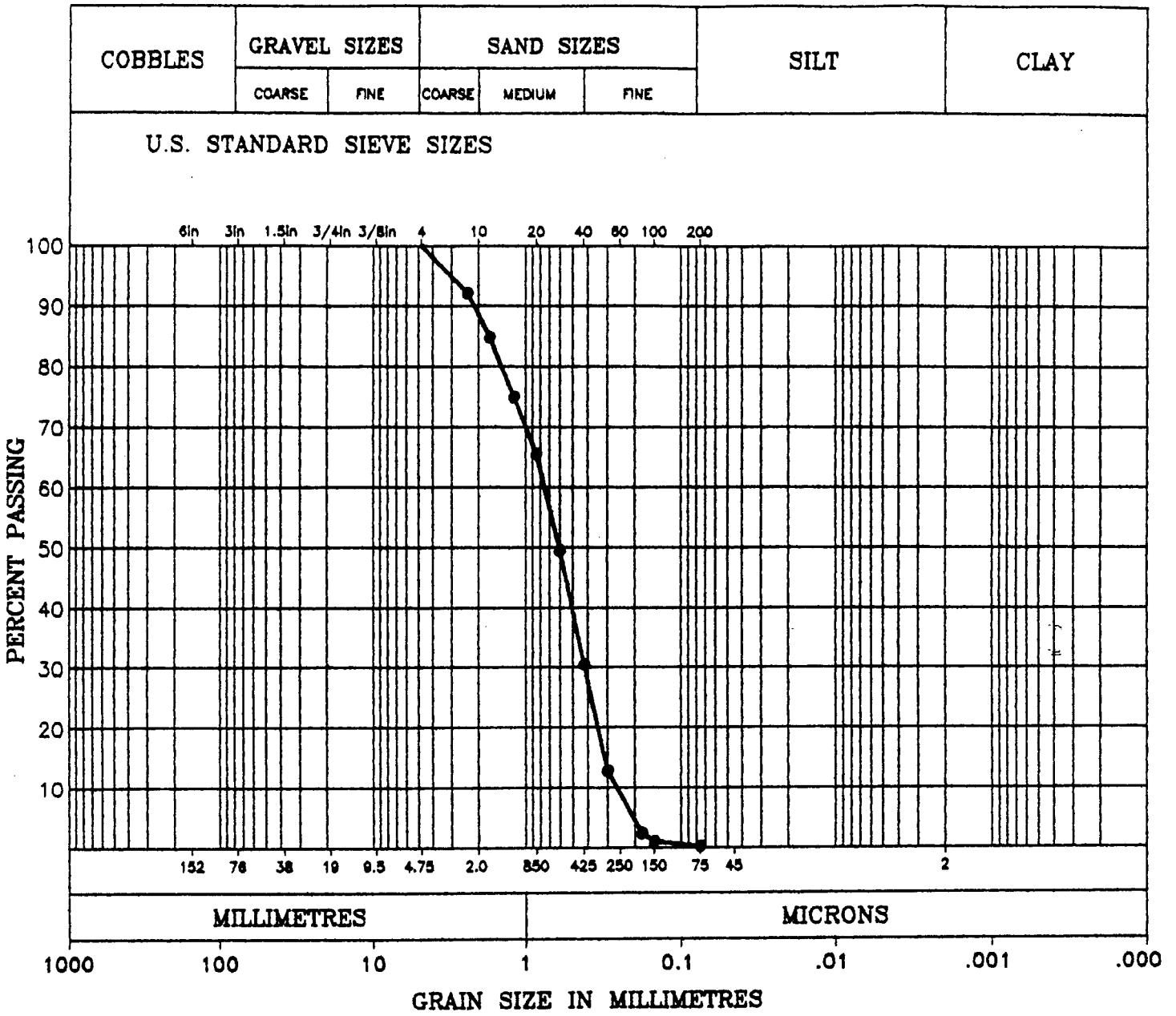
REMARKS:

SUMMARY

D_{10} = 0.18	mm	GRAVEL	%
D_{30} = 0.44	mm	SAND	92. %
D_{60} = 1.0	mm	FINES	8. %
C_U = 5.8			
C_C = 1.0			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Eldorado
HOLE: SAMPLE:
DEPTH: 22.9 m
TECHNICIAN: CW



REMARKS:

SUMMARY

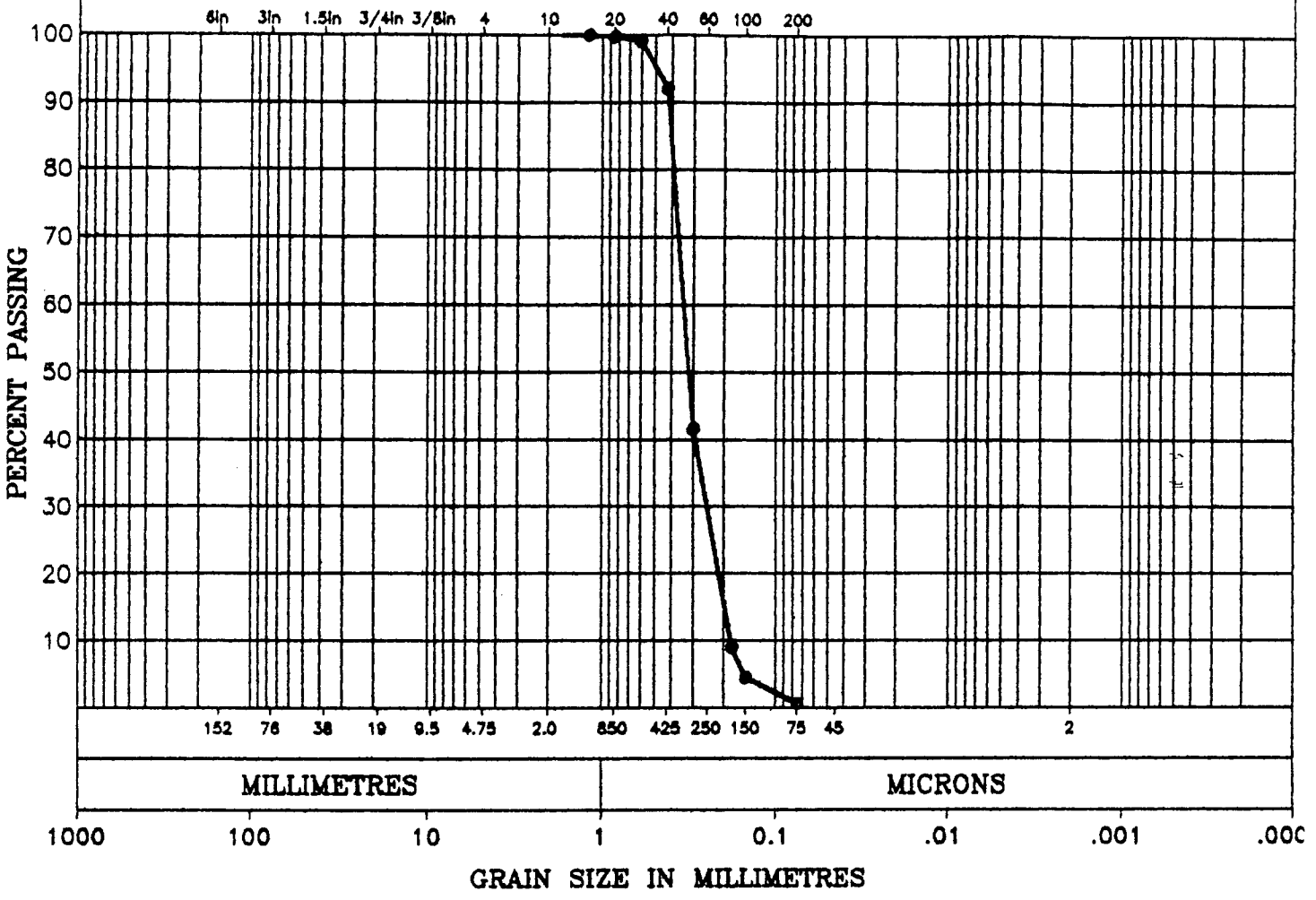
D_{10} = 0.27	mm	GRAVEL	%
D_{30} = 0.42	mm	SAND	100. %
D_{60} = 0.77	mm	FINES	%
C_U = 2.8			
C_C = 0.87			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.29
LOCATION: CITY OF KELOWNA – ELDORADO
HOLE: SAMPLE:
DEPTH: 29.5 m
TECHNICIAN:

COBBLES	GRAVEL SIZES		SAND SIZES			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. STANDARD SIEVE SIZES



REMARKS:

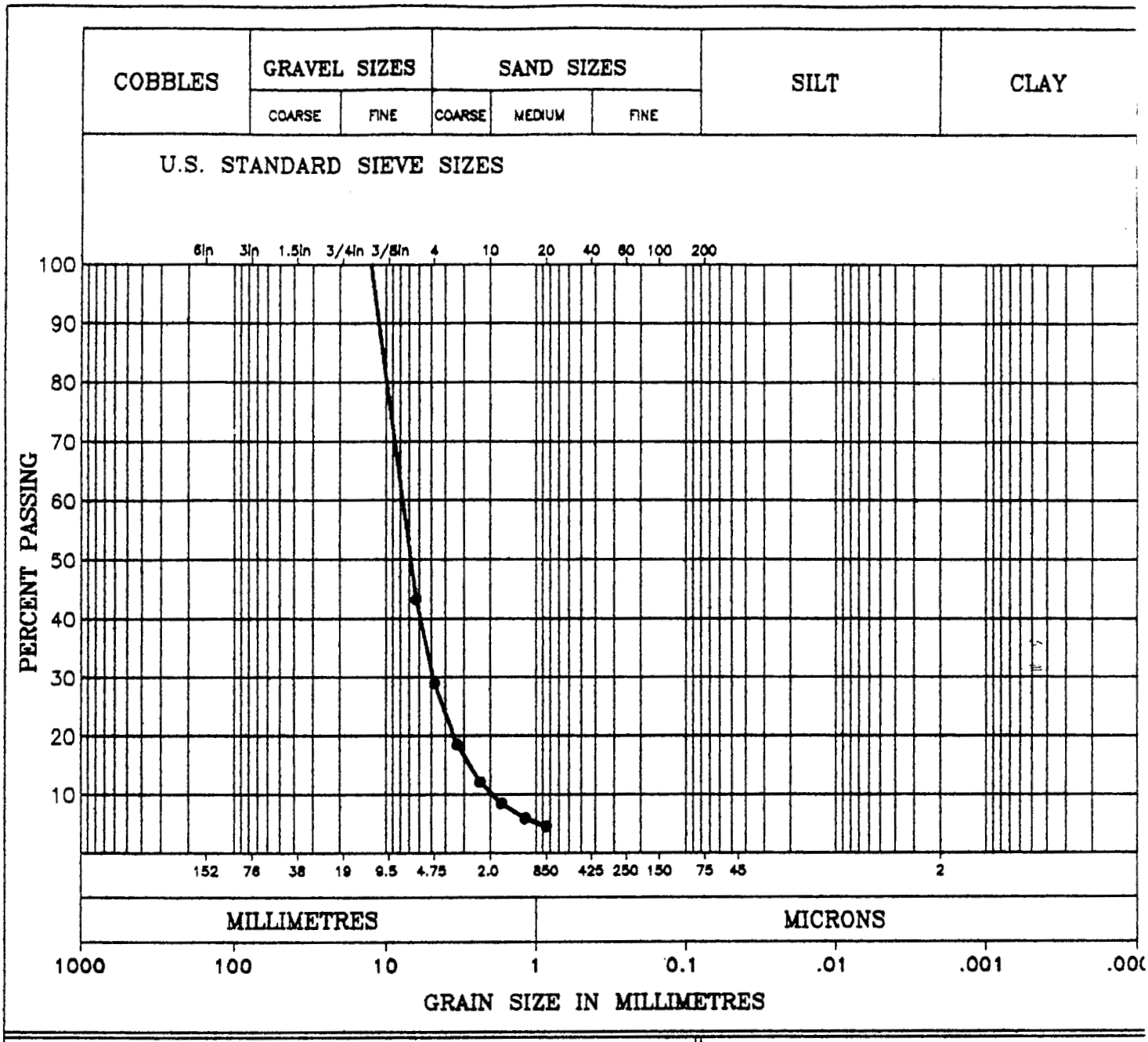
SUMMARY

D_{10} = 0.18	mm	GRAVEL	%
D_{30} = 0.26	mm	SAND	99. %
D_{60} = 0.35	mm	FINES	1. %
C_U = 1.9			
C_C = 1.0			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.29
LOCATION: CITY OF KELOWNA – ELDORADO
HOLE: SAMPLE:
DEPTH: 32.8 m
TECHNICIAN:

62



REMARKS:

SUMMARY

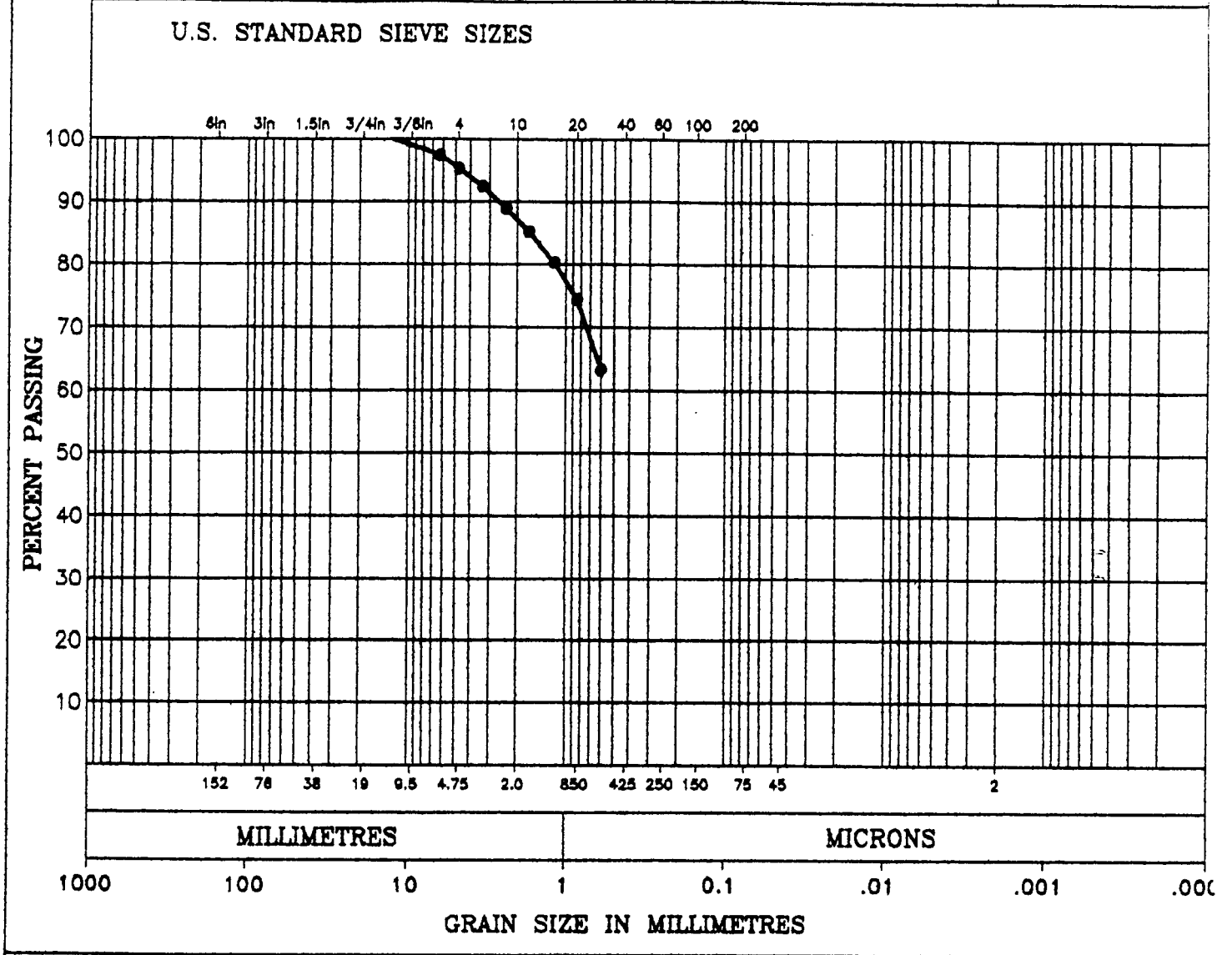
D_{10} = 2.0	mm	GRAVEL	71. %
D_{30} = 4.9	mm	SAND	24. %
D_{60} =	mm	FINES	5. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna– Collet Road
HOLE: SAMPLE:
DEPTH: 22.9 m
TECHNICIAN: CW

5C

COBBLES	GRAVEL SIZES		SAND SIZES			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

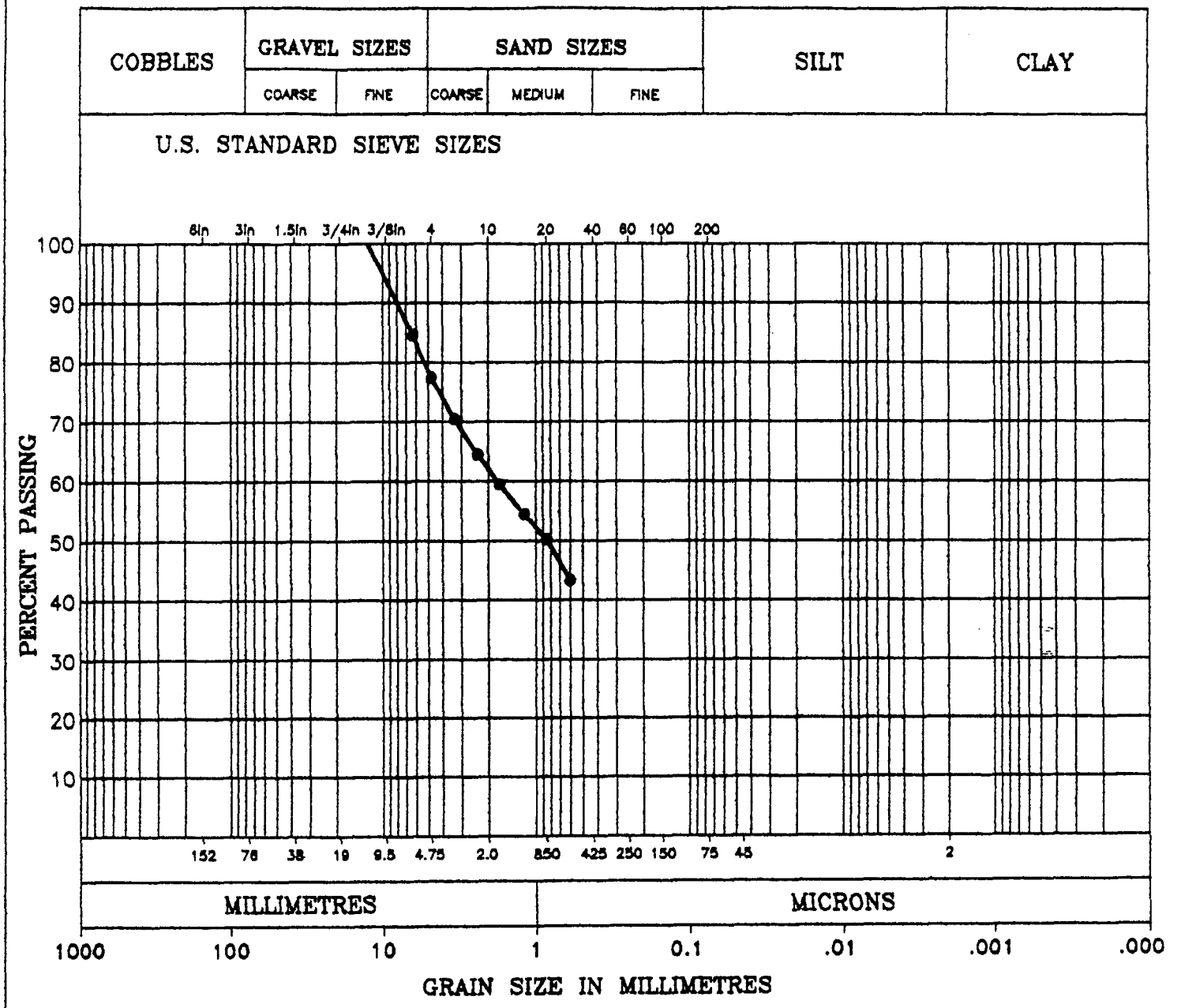


REMARKS:

SUMMARY			
D_{10} =	mm	GRAVEL	5. %
D_{30} =	mm	SAND	32. %
D_{60} =	mm	FINES	63. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna– Collet Road
HOLE: SAMPLE:
DEPTH: 26.2 m
TECHNICIAN: CW



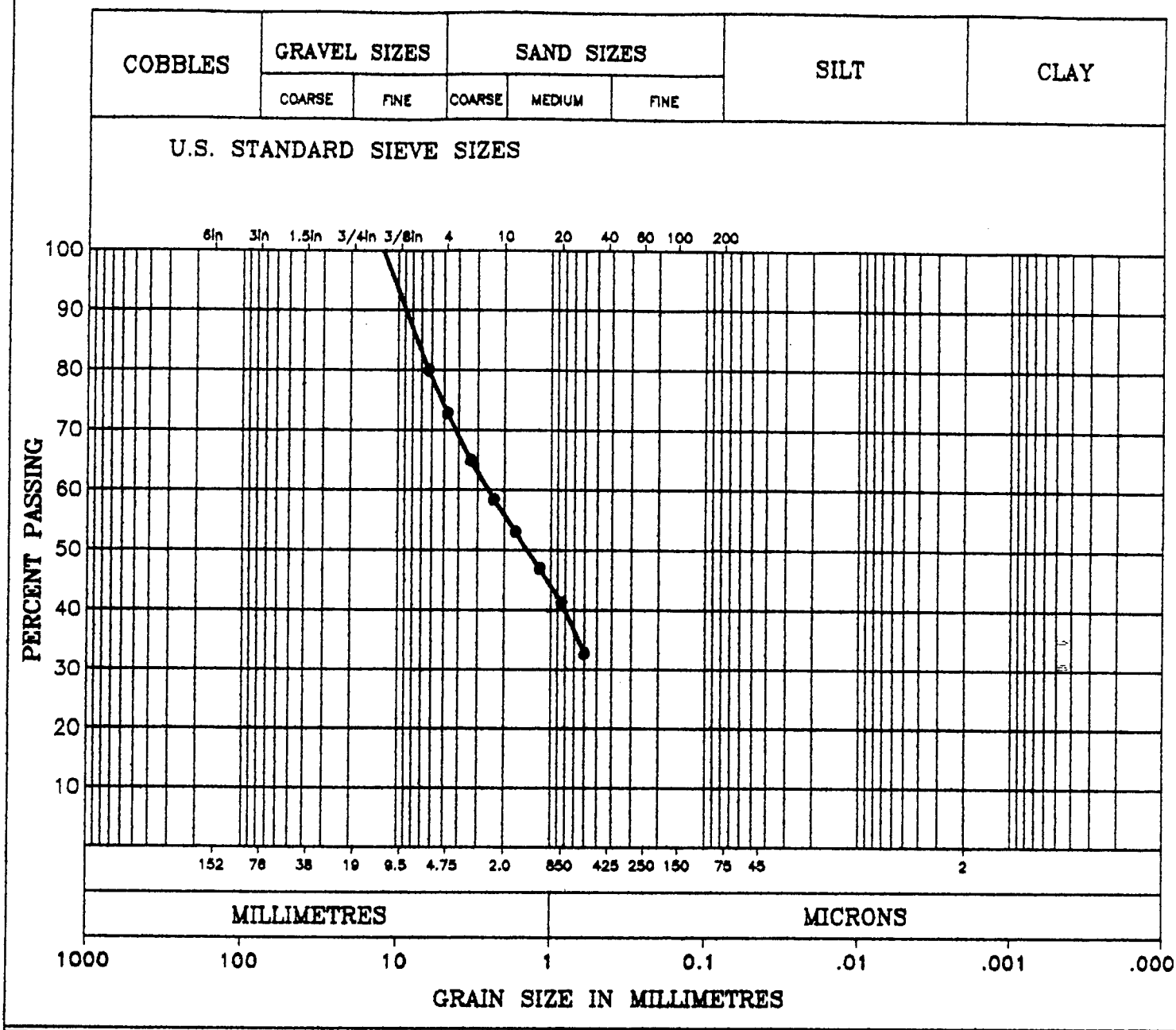
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	23. %
D_{30} =	mm	SAND	34. %
D_{60} = 1.8	mm	FINES	43. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna– Collet Road
HOLE: SAMPLE:
DEPTH: 29.5 m
TECHNICIAN: CW

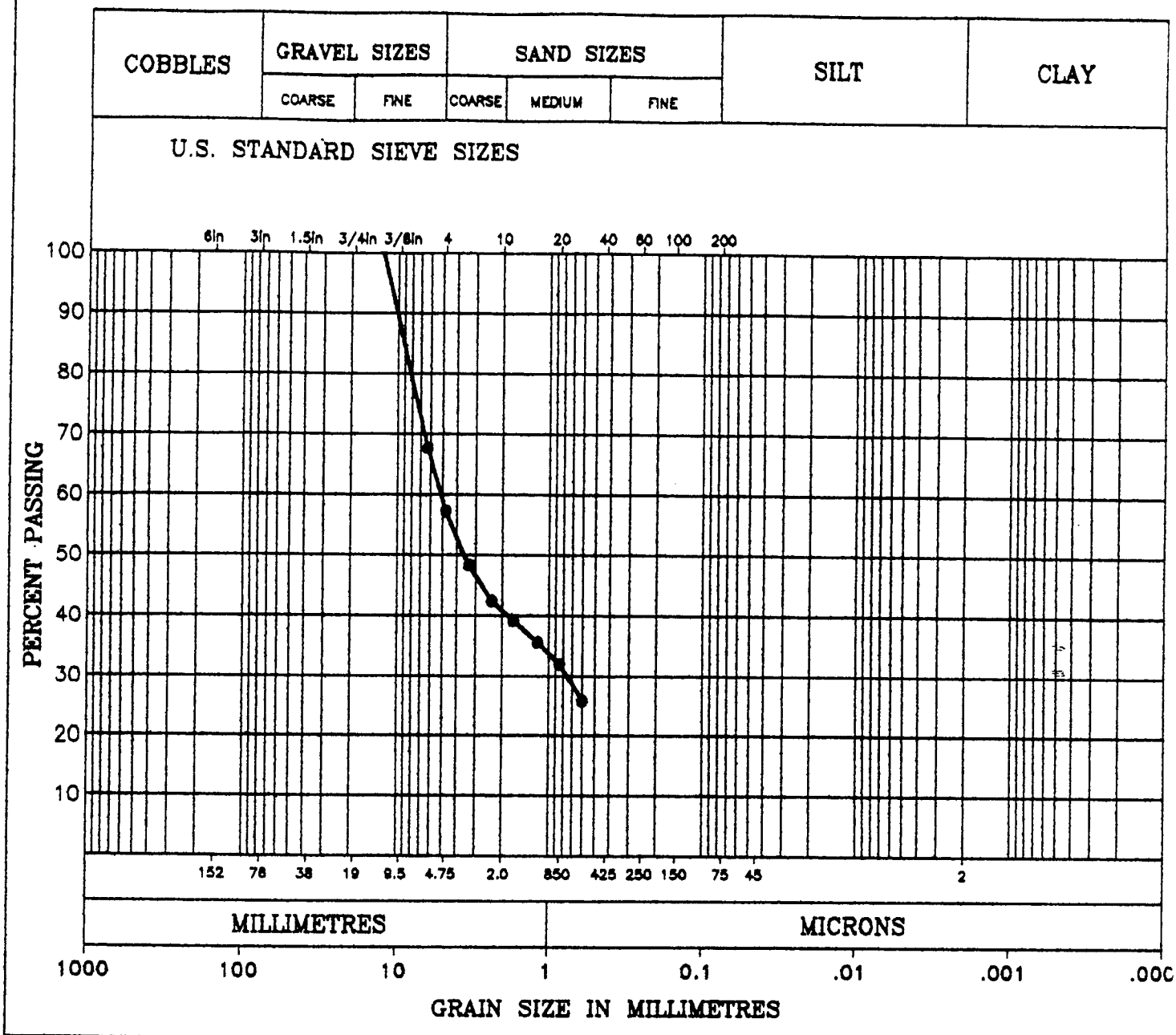


REMARKS:

SUMMARY			
D_{10} =	mm	GRAVEL	27. %
D_{30} =	mm	SAND	40. %
D_{60} = 2.6	mm	FINES	33. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna– Collet Road
HOLE: SAMPLE:
DEPTH: 32.8 m
TECHNICIAN: CW



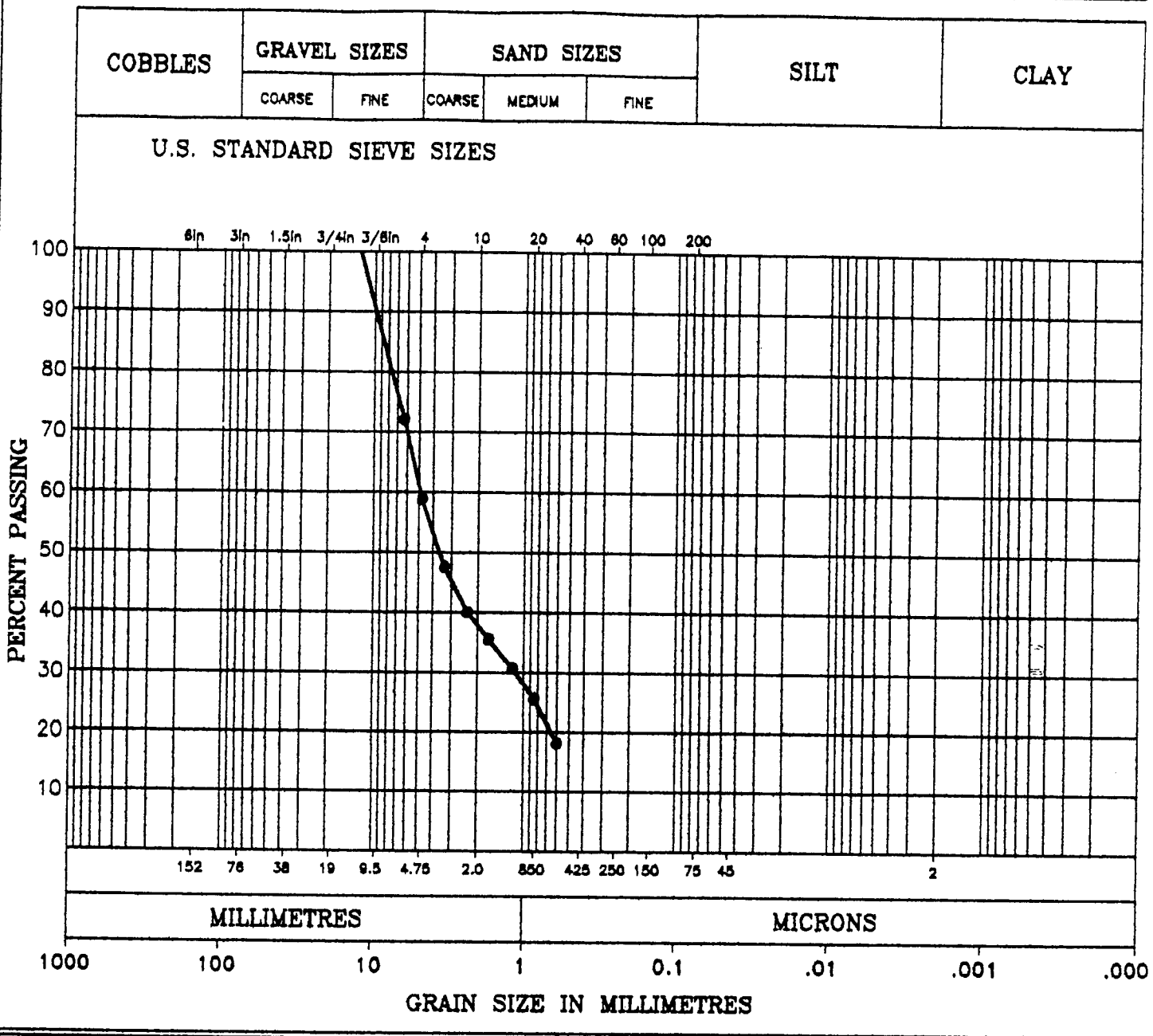
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	43. %
D_{30} = 0.77	mm	SAND	32. %
D_{60} = 5.2	mm	FINES	25. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna– Collet Road
HOLE: SAMPLE:
DEPTH: 36.0 m
TECHNICIAN: CW



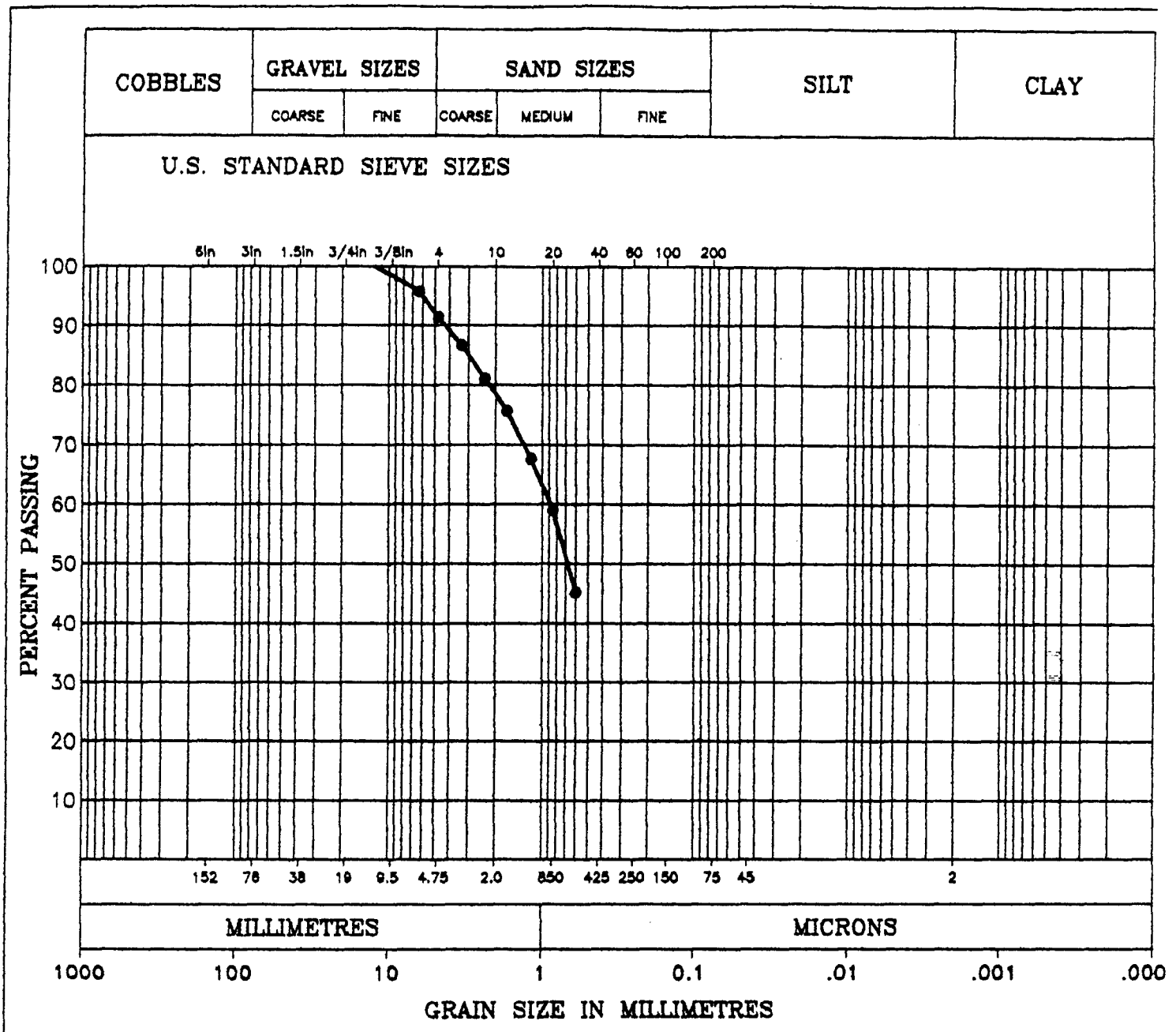
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	41. %
D_{30} = 1.1	mm	SAND	41. %
D_{60} = 4.9	mm	FINES	18. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna– Mayer Road
HOLE: SAMPLE:
DEPTH: 50.9 m
TECHNICIAN: CW



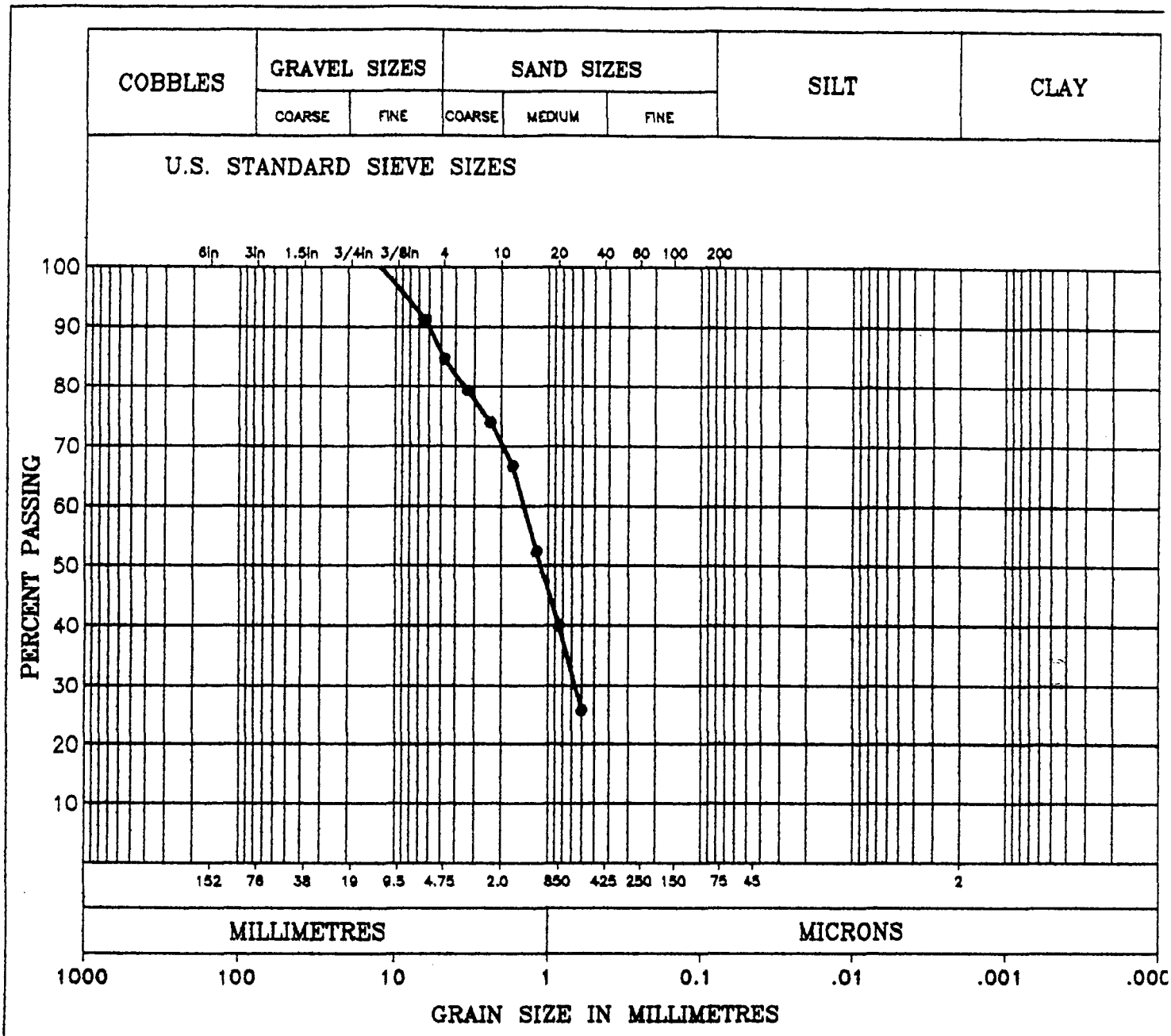
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	9. %
D_{30} =	mm	SAND	46. %
D_{60} = 0.89	mm	FINES	45. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Mayer Road
HOLE: SAMPLE:
DEPTH: 54.7 m
TECHNICIAN: CW



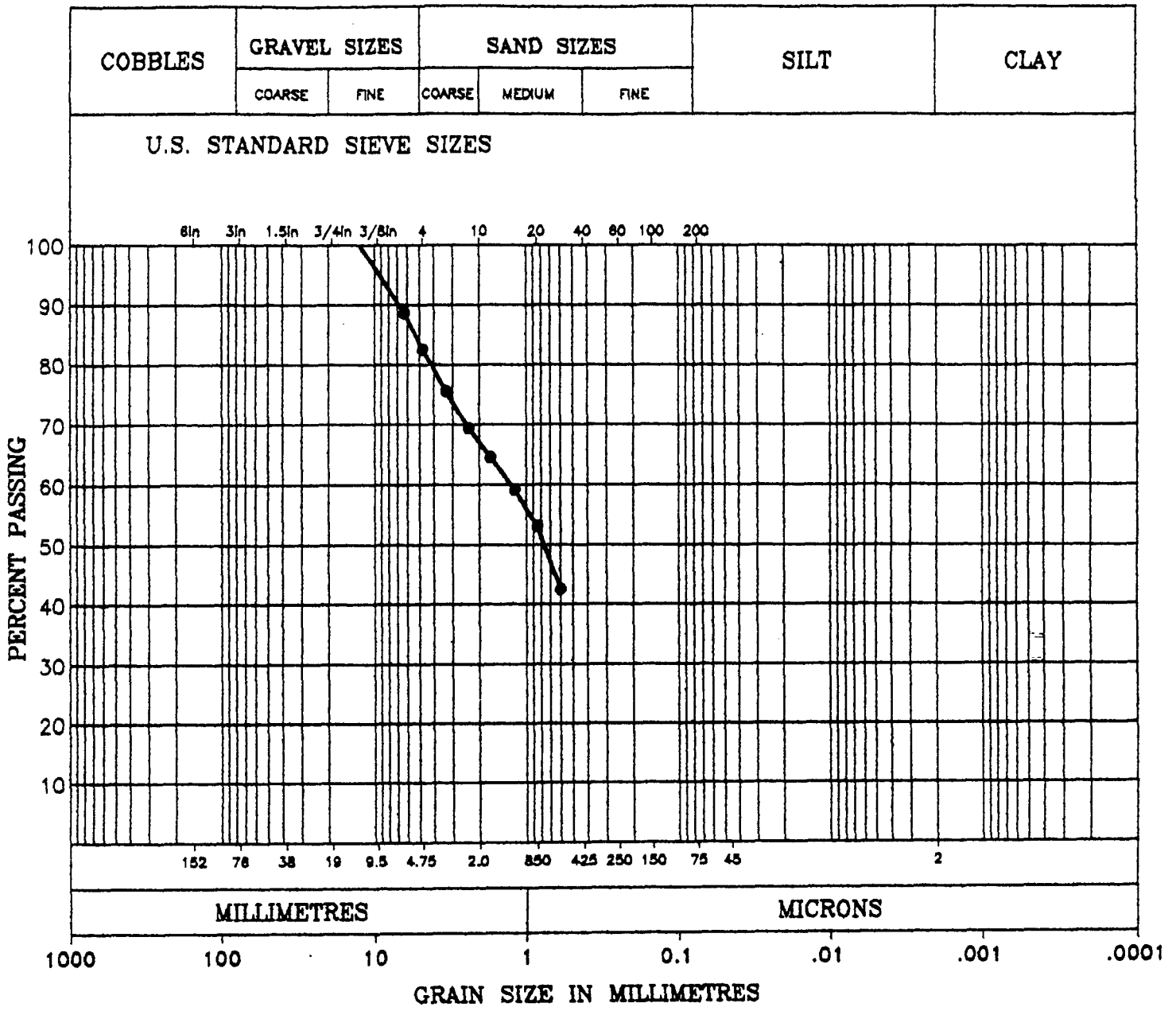
REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	15. %
D_{30} = 0.68	mm	SAND	59. %
D_{60} = 1.5	mm	FINES	26. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Mayer Road
HOLE: SAMPLE:
DEPTH: 64.0 m
TECHNICIAN: CW



REMARKS:

SUMMARY

D_{10} =	mm	GRAVEL	18. %
D_{30} =	mm	SAND	40. %
D_{60} = 1.3	mm	FINES	42. %
C_U =			
C_C =			

AGRA
Earth & Environmental
GRAIN SIZE DISTRIBUTION

PROJECT No: KX12138 DATE: 98.09.22
LOCATION: City of Kelowna- Mayer Road
HOLE: SAMPLE:
DEPTH: 70.5 m
TECHNICIAN: CW

NORWEST LABS
Surrey Ph (604) 514-3322 FAX (604) 514-3323
Edmonton Ph (403) 438-5522 FAX (403) 438-0396
Calgary Ph (403) 291-2022 FAX (403) 291-2021
Lethbridge Ph (403) 329-9288 FAX (403) 327-8527
Winnipeg Ph (204) 982-8630 FAX (204) 275-6019

Client Code: CITKET

Name: CITY OF KELOWNA TREATMENT PLT
Address: 951 RAYMER AVE

KELOWNA
BC V1Y 4Z7
Attn: Marianne Toms
Phone: (250) 862-5510
Fax: (250) 862-9276

Workorder: 38784
WO (Other)
PO Num:
Project:
Date Sampled: 28/09/98
Date Received: 29-Sep-98
Date Reported: 02-Oct-98

PRELIMINARY REPORT

Metal Analysis

			38784-2 ELDORADO PUMPSTATION TREATED WATER	38784-3 COOPER ROAD-TREATED WATER
Total Semi Trace Metals in Water				
Aluminum	0.01	mg/L	Not Detected	Not Detected
Antimony	0.02	mg/L	Not Detected	Not Detected
Arsenic	0.02	mg/L	Not Detected	Not Detected
Barium	0.0005	mg/L	0.0203	0.0199
Beryllium	0.0002	mg/L	Not Detected	Not Detected
Bismuth	0.02	mg/L	Not Detected	Not Detected
Cadmium	0.0005	mg/L	Not Detected	Not Detected
Calcium	0.01	mg/L	32.2	31.8
Chromium	0.001	mg/L	Not Detected	Not Detected
Cobalt	0.001	mg/L	Not Detected	Not Detected
Copper	0.002	mg/L	0.014	0.035
Iron	0.003	mg/L	0.01	0.01
Lead	0.005	mg/L	Not Detected	Not Detected
Lithium	0.002	mg/L	Not Detected	Not Detected
Magnesium	0.01	mg/L	8.59	8.36
Manganese	0.0005	mg/L	0.0027	0.0034
Molybdenum	0.005	mg/L	Not Detected	Not Detected
Nickel	0.002	mg/L	Not Detected	Not Detected
Phosphorus	0.06	mg/L	Not Detected	Not Detected
Potassium	0.2	mg/L	2.2	2.1
Selenium	0.02	mg/L	Not Detected	Not Detected
Silicon	0.05	mg/L	3.06	3.15
Silver	0.001	mg/L	Not Detected	Not Detected
Sodium	0.05	mg/L	10.4	10.2
Strontium	0.005	mg/L	0.258	0.256
Sulfur	0.1	mg/L	9.8	9.6
Thorium	0.005	mg/L	Not Detected	Not Detected
Tin	0.005	mg/L	Not Detected	Not Detected
Titanium	0.001	mg/L	Not Detected	Not Detected
Uranium	0.06	mg/L	Not Detected	Not Detected
Vanadium	0.002	mg/L	Not Detected	Not Detected
Zinc	0.001	mg/L	0.003	0.368
Zirconium	0.001	mg/L	Not Detected	Not Detected

Approved By: _____
John Davidson, Dipl. T C P H.I. (C)
Supervisor, Inorganics Lab

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Edmonton Ph (403) 438-5522 FAX (403) 438-0396
Calgary Ph (403) 291-2022 FAX (403) 291-2021
Lethbridge Ph (403) 329-9266 FAX (403) 327-8527
Winnipeg Ph (204) 982-8630 FAX (204) 275-5019

NORWEST LABS

Client Code: CITKET

Name: CITY OF KELOWNA TREATMENT PLT
Address: 951 RAYMER AVE.

KELOWNA
BC V1Y 4Z7
Attn: Marianne Toma
Phone: (250) 862-5510
Fax: (250) 862-9276

Workorder: 38784
WO (Other):
PO Num:
Project:
Date Sampled: 28/09/98
Date Received: 29-Sep-98
Date Reported: 02-Oct-98

PRELIMINARY REPORT

Metal Analysis

	Detection Limit	Units	38784-1 COLLETT RD - GROUND WATER
Dissolved Semi-Trace Metals Scan in Water			
Aluminum	0.01	mg/L	Not Detected
Antimony	0.02	mg/L	Not Detected
Arsenic	0.02	mg/L	Not Detected
Barium	0.0005	mg/L	0.0131
Beryllium	0.0002	mg/L	Not Detected
Bismuth	0.02	mg/L	Not Detected
Cadmium	0.0005	mg/L	Not Detected
Calcium	0.01	mg/L	24
Chromium	0.001	mg/L	Not Detected
Cobalt	0.001	mg/L	Not Detected
Copper	0.002	mg/L	0.013
Iron	0.003	mg/L	0.722
Lead	0.005	mg/L	Not Detected
Lithium	0.002	mg/L	Not Detected
Magnesium	0.01	mg/L	6.45
Manganese	0.0005	mg/L	0.0909
Molybdenum	0.005	mg/L	Not Detected
Nickel	0.002	mg/L	Not Detected
Phosphorus	0.06	mg/L	Not Detected
Potassium	0.2	mg/L	1.4
Selenium	0.02	mg/L	Not Detected
Silicon	0.05	mg/L	10.8
Silver	0.001	mg/L	Not Detected
Sodium	0.05	mg/L	8.77
Strontium	0.005	mg/L	0.144
Sulphur	0.1	mg/L	4.1
Thorium	0.005	mg/L	Not Detected
Tin	0.005	mg/L	Not Detected
Titanium	0.001	mg/L	Not Detected
Uranium	0.05	mg/L	Not Detected
Vanadium	0.002	mg/L	0.002
Zinc	0.001	mg/L	0.009
Zirconium	0.001	mg/L	Not Detected

4 mg/L

potability

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Lethbridge Ph (403) 328-9266 FAX (403) 327-8527
Winnipeg Ph (204) 982-8630 FAX (204) 275-6019

Client Code: CITKET

Name: CITY OF KELOWNA TREATMENT PLT
Address: 951 RAYMER AVE.

KELOWNA
BC V1Y 4Z7
Attn: Menanne Toma
Phone: (250) 862-5510
Fax: (250) 862-9276

Workorder: 38722
WO (Other):
PO Num:
Project:
Date Sampled: 24/09/98
Date Received: 25-Sep-98
Date Reported: 02-Oct-98

Metal Analysis

	Detection Limit	Units	38722-1 MAYER RD Q WATER
Dissolved Semi-Trace Metals Scan in Water			
Aluminum	0.01	mg/L	Not Detected
Antimony	0.02	mg/L	Not Detected
Arsenic	0.02	mg/L	Not Detected
Barium	0.0005	mg/L	0.0159
Beryllium	0.0002	mg/L	Not Detected
Bismuth	0.02	mg/L	Not Detected
Cadmium	0.0005	mg/L	Not Detected
Calcium	0.01	mg/L	41
Chromium	0.001	mg/L	Not Detected
Cobalt	0.001	mg/L	Not Detected
Copper	0.002	mg/L	0.023
Iron	0.003	mg/L	0.031
Lead	0.005	mg/L	Not Detected
Lithium	0.002	mg/L	Not Detected
Magnesium	0.01	mg/L	7.85
Manganese	0.0005	mg/L	0.247
Molybdenum	0.005	mg/L	Not Detected
Nickel	0.002	mg/L	Not Detected
Phosphorus	0.05	mg/L	0.31
Potassium	0.2	mg/L	2.8
Selenium	0.02	mg/L	Not Detected
Silicon	0.05	mg/L	8.49
Silver	0.001	mg/L	Not Detected
Sodium	0.05	mg/L	20.6
Strontium	0.005	mg/L	0.227
Sulphur	0.1	mg/L	10
Thorium	0.005	mg/L	Not Detected
Tin	0.005	mg/L	Not Detected
Titanium	0.001	mg/L	Not Detected
Uranium	0.05	mg/L	Not Detected
Vanadium	0.002	mg/L	0.005
Zinc	0.001	mg/L	0.008
Zirconium	0.001	mg/L	Not Detected

Approved By: _____
John Davidson, Dipl. C.P.H.I (C)
Supervisor, Inorganics Lab

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Calgary Ph (403) 291-2022 FAX (403) 291-2021
Lethbridge Ph (403) 329-9266 FAX (403) 327-8527
Winnipeg Ph (204) 982-8630 FAX (204) 275-8019

Client Code: CITKET

Name: CITY OF KELOWNA TREATMENT PLT
Address: 951 RAYMER AVE

KELOWNA
BC V1Y 4Z7
Attn: Marianne Toma
Phone: (250) 862-5510
Fax: (250) 862-9276

Workorder: 39018
WO (Other)
PO Num:
Project:
Date Sampled: 29/09/98
Date Received: 06-Oct-98
Date Reported: 08-Oct-98

Water Analysis

	Detection Limit	Units	39018-1 COLLETT ROAD	39018-2 ELDORADO	39018-3 COOPER ROAD
Alkalinity,total					
Total Alkalinity	5	mg CaCO3/L	86	115	111
Electrical Conductivity					
Electrical Conductivity	0.01	µS/cm	210	285	285
Hardness					
Hardness (CaCO3 equiv)	5	mg/L	na	117	108
Major Anions					
Chloride	0.1	mg/L	2.9	3.4	3.4
Fluoride	0.5	mg/L	Not Detected	Not Detected	Not Detected
Nitrate-N	0.05	mg/L	0.07	Not Detected	Not Detected
Nitrite-N	0.5	mg/L	Not Detected	Not Detected	Not Detected
Sulphate	0.1	mg/L	11.3	27.3	27.3
pH in Water					
pH	0.01	pH	7.58	7.99	7.76
Total Dissolved Solids					
Total Dissolved Solids	5	mg/L	139	185	176
Total Iron					
Iron	0.01	mg/L	0.722	na	na
Turbidity					
Turbidity	1	NTU	5	Not Detected	Not Detected

Approved By _____
John Davidson, Dipl. Chem. P.Ag. (C)
Supervisor, Inorganics Lab

NORWEST LABS

QA/QC for WO# 39018-1

input data

Al	0	CO3	0
Ca	24	HCO3	86
Fe	0.722	EC	210
Mg	6.45	TDS	139
Mn	0.0909	F	0
K	1.1	Cl	2.9
Si	10.8	NO2 N	0
Na	6.77	NO3-N	0.07
NH3-N	0	SO4	11.3

ionic balance

cation sum =	2.10			
anion sum =	2.04			
difference =	0.06	meq/L	1.50 %	
	difference (+/-)		if anion sum	
acceptable =	0.2	meq/L	0 - 3	PASS
acceptable =	2	%	3 - 10	
acceptable =	2.5	%	10 - 800	

100 x cation or anion sum = 0.9 to 1.1 X EC

csum x 100 =	210			PASS
asum x 100 =	204			PASS
acceptable =	189	to	231	

TDS/EC

TDS/EC =	0.66	PASS
acceptable =	0.55 - 0.7	

measured TDS / calc. TDS

calc TDS =	135	
mTDS/cTDS =	1.03	PASS
acceptable =	1 to 1.2	

NORWEST LABS

QA/QC for WO# 39018-2

input data

Al	0.04	CO3	0
Ca	32.6	HCO3	115
Fe	0	EC	285
Mg	8.57	TDS	185
Mn	0.0008	F	0
K	2.1	Cl	3.4
Si	2.93	NO2-N	0
Na	10.4	NO3 N	0
NH3-N	0	SO4	27.3

ionic balance

cation sum =	2.84			
anion sum =	2.96			
difference =	-0.12	meq/L or	2.10 %	
	difference (+/-)		if anion sum	
acceptable =	0.2	meq/l	0 - 3	PASS
acceptable =	2	%	3 - 10	
acceptable =	2.5	%	10 - 800	

100 x cation or anion sum = 0.9 to 1.1 X EC

csum x 100 =	284			PASS
asum x 100 =	296			PASS
acceptable =	257	to	314	

TDS/EC

TDS/EC =	0.65	PASS
acceptable =	0.55 - 0.7	

measured TDS / calc. TDS

calc TDS =	161	
mTDS/cTDS =	1.15	PASS
acceptable =	1 to 1.2	

NORWEST LABS

QA/QC for WO# 39018-3

input data

Al	0	CO3	0
Ca	30.3	HCO3	111
Fe	0	EC	285
Mg	7.74	TDS	176
Mn	0.0009	F	0
K	2	Cl	3.4
Si	2.85	NO2-N	0
Na	9.77	NO3 N	0
NH3-N	0	SO4	27.3

ionic balance

cation sum =	2.63			
anion sum =	2.88			
difference =	-0.26	meq/L or	4.70 %	
	difference (+/-)		of anion sum	
acceptable =	0.2	meq/L	0 - 3	PASS
acceptable =	2	%	3 - 10	
acceptable =	2.5	%	10 - 800	

100 x cation or anion sum = 0.9 to 1.1 X EC

csum x 100 =	263			PASS
asum x 100 =	288			PASS
acceptable =	257	to	314	

TDS/EC

TDS/EC =	0.62	PASS
acceptable =	0.55 - 0.7	

measured TDS / calc. TDS

calc TDS =	155	
mTDS/cTDS =	1.14	PASS
acceptable =	1 to 1.2	

NORWEST LABS
Edmonton Ph (403) 438-5522 FAX (403) 438-0396
Calgary Ph (403) 291-2022 FAX (403) 291-2021
Lethbridge Ph (403) 329-9266 FAX (403) 327-8527
Winnipeg Ph (204) 982-8630 FAX (204) 275-6019

Client Code: CITKET

Name: CITY OF KELOWNA TREATMENT
Address: 951 RAYMER AVE.

KELOWNA
BC V1Y 4Z7
Attn: Marianne Toma
Phone: (250) 862-5510
Fax: (250) 862-9276

Workorder: **39017**
W (Other):
PO Num:
Project:
Date Sampled: 25/09/98
Date Received: 06-Oct-98
Date Reported: 08-Oct-98

Water Analysis

	Detection Limit	Units	39017-1 MAYER RD Q. WATER
Alkalinity,total			
Total Alkalinity	5	mg CaCO3/L	159
Electrical Conductivity			
Electrical Conductivity	0.01	µS/cm	360
Hardness			
Hardness (CaCO3 equiv)	5	mg/L	102
Major Anions			
Chloride	0.1	mg/L	0.8
Fluoride	0.5	mg/L	Not Detected
Nitrate-N	0.05	mg/L	Not Detected
Nitrite-N	0.5	mg/L	Not Detected
Sulphate	0.1	mg/L	28
pH in Water			
pH	0.01	pH	8.03
Total Dissolved Solids			
Total Dissolved Solids	5	mg/L	230
Turbidity			
Turbidity	1	NTU	Not Detected

Approved By: _____
John Davidson, Dipl. [illegible] P.H.I. (C)
Supervisor, Inorganics Lab

NORWEST LABS

QA/QC for WO# 39017-1

input data

Al	0	CO3	0
Ca	41	HCO3	159
Fe	0.031	EC	360
Mg	7.65	TDS	230
Mn	0.24	F	0
K	3.5	Cl	0.8
Si	8.49	NO2 N	0
Na	20.6	NO3-N	0
NH3-N	0	SO4	29

ionic balance

cation sum =	3.8			
anion sum =	3.81			
difference =	-0.15	meq/L	1.99 %	
	difference (+/-)		of anion sum	
acceptable =	0.2	meq/l	0 - 3	
acceptable =	2	%	3 - 10	PASS
acceptable =	2.5	%	10 - 800	

100 x cation or anion sum = 0.9 to 1.1 X EC

csum x 100 =	366			PASS
asum x 100 =	381			PASS
acceptable =	324	to	396	

TDS/EC

TDS/EC =	0.64	PASS
acceptable =	0.55 - 0.7	

measured TDS / calc. TDS

calc TDS =	220	
mTDS/cTDS =	1.04	PASS
acceptable =	1 to 1.2	