Report On The
1992 Performance Monitoring
On The
DOWN VALLEY TAILINGS PROJECT
FARO MINE
VOLUME 1

Golder Associates

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March, 1993 **922-2406**

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31 March 1993

Ref. No. 922-2406

Curragh Resources Inc.
P.O. Box 1000
Faro, Yukon
Y0B 1K0

Attention: Mr. Bill Dunn

RE: 1992 ANNUAL GEOTECHNICAL AND PERFORMANCE EVALUATION DOWN VALLEY TAILINGS PROJECT

Dear Sir:

Bound herewith is Golder Associates Ltd.'s summary of the annual inspection and data review for the project. The inspection has also included the Fresh Water Supply Reservoir Dam and review of related instrumentation data.

The conclusion of our review of instrumentation data and visual inspection for both the Down Valley Project and the Fresh Water Supply Reservoir Dam is that they are both operating safety, but that continued observation of their performance is necessary.

Some items of maintenance are noted, including reiteration of the need to continue with the repair of damaged instrumentation installations, particularly the slope indicator installations. Attention to the maintenance items recommended in this report would remove concern related to project performance during a design runoff event.

We appreciate the assistance you have provided in collecting the data that has been required for this report, and also the continued involvement at Faro Mine.

Yours very truly,
GOLDER ASSOCIATES LTD.

PROFESSIONAL ENGINEER
YUKON TERRITORY
PETER J. WHEELER

P.J. Wheeler, P. Eng.

PJW:kk

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1.0 INTRODUCTION

The Curragh Resources' Faro Mine Down Valley Tailings Project comprises three major components, viz. the Diversion Canal, the Intermediate Dam and the Cross Valley Dam. An extensive geotechnical monitoring program was initiated in December, 1981, and is continuing on an ongoing basis. This report presents an assessment of the results of this program to December, 1992 and documents Golder Associates Ltd.'s inspection of the Fresh Water Supply Dam which is located on Rose Creek approximately 2.5 km upstream of the Down Valley Tailings Project. The monitoring data associated with this report is presented in Appendix I.

2.0 1992 MONITORING PROGRAM

A plan of the Down Valley Project layout and the monitoring locations is presented on Figures 1 and 2 of this report. The monitoring data is presented in Appendix I.

The 1992 monitoring program schedule set out by Golder Associates for the Down Valley Project facilities is presented in Figure 3. Actual observations consisted of the following:

Diversion Canal Backslope

- Slope indicator readings on the canal backslope at BS2, 5, 9 and 18 in September
- Observations of thermistors BS2, 5, 9, 10, 12, 17 and 18, in September.
- Observations of piezometers BS2, 5, 9, 10, 16 and 18 in September

Diversion Canal Dyke

- Observation of slope indicators 91-CD2, CD19, CD21, 88-6 and 88-10 in April, June and September and 91-CD1, CD10 and CD15 in September.
- Observation of piezometers CD19, CD21, 88-17 and 88-11 in April, June and September and CD4, 7, 9, 10, 13, 15, 26 and 29 in September
- Observations of thermistors CD4, 5, 10, 15, 17, 24, 25, 26 and 27 in September, CD19, 20, 21, 88-7 and 88-11 in April, June and September and 81-125 in April and June.

Cross Valley Dam

- Owner observation of thermistors 88-4 and 88-5 in the Cross Valley Dam monthly between January, June and September and CVDC1, 6 and 11 in September.
- Owner observation of Cross Valley Dam piezometers CVDC4, 6, 7 and 9 in June and September and CVDC1 and 11 in September.
- Owner observation of Cross Valley Dam piezometers CVDP 1, 3, 4, 6, 7 and 9 in September.

Spoil Piles

- Observation of thermistors SP2, SP3 and SP5 in September.

- Observation of slope indicators SP2 and SP5 in September.

Intermediate Dam

- Owner observation of Intermediate Dam piezometers ID4, 5, 6 and 7 in January, February, April, May, June and September and ID3 in February, May, June and September.

Fresh Water Supply Dam

- Owner observation of Fresh Water Supply Dam thermistor 85-5 in January, February, April, May, June and September.

- Owner observation of Fresh Water Supply Dam piezometers in 85-2, 85-3 and 85-6 in January, April and September, 85-4, 85-5 and 88-15 and 88-16 in April, June and September. Piezometer 85-1 was found to be buried in January.

All the readings taken in 1992 were in general accordance with the schedule presented on Figure 9 of our report entitled "1991 Performance Monitoring on the Down Valley Tailings Project, Faro Mine" with the exception of:

- Monthly readings of seepage and pond levels at the Intermediate Dam.

- Quarterly readings of pond levels and weirs at the Fresh Water Supply Dam.

- September readings of thermistors at the Intermediate Dam.

- Monthly readings of temperature at the recording station, CVD weir outflow, ID siphons and 2+100 tile flow.

- Monthly readings of flow in Rose Creek at the recording station location.

- December piezometer readings at the Fresh Water Supply Dam and Intermediate Dam.

- December readings of thermistors, piezometers and slope indicators on the Diversion Canal Dyke in the area of Stations 1+900 to 2+350.

- Canal dyke crest elevation survey.

While the absence of this data may not be critical to the project, incomplete data does make it more difficult to demonstrate the safe and acceptable performance of the project and thus Owner diligence in fulfilling the entire program is warranted.

Results of the monitoring program are discussed in the following sections in relation to inferred performance of the various facilities being monitored. In addition to the monitoring program discussed above a field inspection of the facility was conducted by Mr. P.J. Wheeler of Golder Associates Ltd. on September 8 and 9, 1992.

3.0 DIVERSION CANAL

3.1 Canal Dyke

3.1.1 Thermal Regime

The thermal regime observed in September, 1992 is summarized in Table 1. In late September 1992 in the area of stations 1+900 to 2+350 on the Canal Dyke, the thawed ground temperatures of the upper 1 m of the dyke were generally in the range of 0.8 to 3.7°C with frozen ground temperatures down to -0.3°C occurring at depth where permafrost is still present. The actual data for the observations is presented in Appendix I.

The September 1992 temperature readings indicate generally colder ground temperatures than for September 1991 to depths of 3 to 4 m. This may be because the 1992 readings were taken almost three weeks later than the 1991 readings. In support of this observation, Figure 4 presents the mean monthly temperatures recorded at Faro Airport which indicates that the mean temperature in September, 1992 was approximately 1.5°C compared to a September, 1991 temperature of approximately 7.7°C.

Thermal conditions at the locations of the thermistors were generally consistent with those in 1991 and 1990. At these locations, the depths to frozen ground in September were as follows:

CD 17	- approximately 9.5 m
88-7	- approximately 6 m
88-11	- approximately 6 m
CD 26	- approximately 8.5 m

It is interesting to note that CD 26 indicated frozen ground at 8.5 m. A 1990 reading (1991 readings were not taken) indicated the ground to be fully thawed to the depth of instrumentation (9.6 m).

3.1.2 Piezometers

The September 1992 pneumatic piezometer readings are discussed under three groups describing differing performance:

1. One piezometric performance pattern covers the upstream portion of the canal (Sta. 0+400 to 1+530; CD 4 to CD 15) where the thermistor readings have historically indicated fully thawed ground to the full depth of the instrumentation (10 metres).

   Along this reach of the canal the piezometric levels range between 2.0 metres higher and 0.4 metres lower than they were in September 1991. In all but one piezometer (CD 15) the piezometric levels were higher in 1992 than 1991 by an average of 1 metre. For reference, Table 2 presents a summary of the April to October precipitation records for 1983 to 1991 from the Faro Airport. Unfortunately, the higher water levels recorded at the piezometer locations cannot be corroborated by a comparison between the precipitation records for 1991 and 1992. They may be attributable to a higher water level in the tailings pond.

2. The second piezometric performance pattern is in the intermediate section of the canal. It extends from Sta. 1+900 (CD 19) to 2+160 (88-13) and it differs from the upstream reach in that the ground is still frozen below depths of 6 to 7 metres. In this reach piezometric levels ranged from 0.3 m to 1.5 m higher in 1992 compared with those for September, 1991. One piezometer indicated a 5.2 m increase in piezometric level but this reading is thought to be erroneous.

   As the ground in this reach is still frozen to an unknown depth below 6 to 7 metres, it is difficult to be certain if these changing piezometric levels are associated with thaw consolidation, general canal seepage, influence of the rising tailings pond level, or with freezing of the piezometer tip itself.

3. The third performance pattern is from Sta. 2+600 (CD 26) to 3+000 (CD 29) where the thermistors indicate thawed conditions to the depth of the instrumentation (10 metres).

   At the instrumentation locations the September, 1992 piezometric levels are generally 0.6 to 0.8 m higher than for September, 1991. The 1992 piezometer readings are lower than the peak values recorded in October 1986.

3.1.3 Ground Movements

Slope indicators at CD 19 (Sta. 1+900) and CD 21 (Sta. 2+100) have traditionally indicated movements in the upslope direction with the majority of the movement occurring within the top 5 metres of instrumented depth. Review of the readings at these locations over a one year period from

September 1991 to September 1992 indicated an upslope movement of 19.6 mm at instrumentation location CD 19 and a downslope movement of 115.2 mm at CD 21. The results of this monitoring and observation of the instrumentation by Curragh personnel during the September 1991 reading confirms that this instrumentation had been disturbed.

Slope indicators at BH 88-6 and 88-10 (Sta. 2+115 and 2+160) indicate an accelerated downslope movement, in the order of 119 to 196 mm over the period 1991 to 1992. These movements are significant, although it was difficult to recognize the effects of movement during the visual inspection. It should be noted that the downslope movements in the order of 33 and 34 mm at BH 88-6 and 88-10, respectively, were measured during the period September 1991 to June, 1992. This information indicates that the readings taken in September 1992 could be erroneous or that the instrumentation has been damaged.

Notwithstanding this however, it appears that the movements are continuing and it is recommended that the readings at these instrument locations be continued during 1993, particularly in view of the potential for accelerated movements.

3.1.4 Dyke Stability

The Canal Dyke at Sta. 2+100 has been closely monitored and some mitigative drainage and berm construction was installed in September 1989. While this construction has been of some benefit in reducing horizontal movements, movement does not appear to have ceased.

It is also important to note that a buttressing effect has probably been achieved due to the higher tailings level in this area. It is recommended that readings be continued on a semi-annual basis in April and September, 1993.

3.2 Canal Backslope

3.2.1 Thermal Regime

1992 readings at the thermistor locations indicated a generally comparable thermal regime at all instrumentation points except BS5 and BS9, which had been frozen at or below depths of 2 and 2.5 metres, respectively in 1991, but now appear to be fully thawed to the full depths of the instrumentation which is 9.5 metres.

3.2.2 Piezometers

Readings were taken at all piezometer locations in 1992. Piezometer readings in September 1992 were in the range of 0.28 to 2.44 metres lower than in October, 1990. This decrease in water level cannot be corroborated by comparison of precipitation records for the months of the readings or for the overall average precipitation, although the precipitation in the one month prior to the readings was higher in 1990. The lower water levels may be a function of general downward drainage of the area due to thawed ground.

3.2.3 Ground Movement

Readings were taken at five inclinometer locations in 1992. It appears that the movement trend of BS2 has reversed by 149.9 mm and at BS9 has accelerated by 137.8 mm. In both these cases the readings are considered erroneous, on review of the inclinometer plots. Movement at BS5 is considered negligible although it has appeared to reverse trend by 4 mm. Movement of the locations of BS10 and BS18 has increased by 27.7 and 17.2 respectively, in the downslope direction.

3.3 Spoil Piles

3.3.1 Thermal Regime

Readings were taken at all thermistor locations in 1992 with non-interpretable readings at SP2. The thermal regime at SP3 changed from fully frozen to the depth of instrumentation in 1990 to frozen below 6.5 m in 1992 whereas the thermal regime of SP5 changed from thawed in 1990 to frozen below 6.5 m in 1992.

3.3.2 Ground Movements

Slope indicator readings at the location of SP2 (Sta. 1+530) indicate that the general trend is consistent with that of the previous year but that the top 1 metre seems to have displaced in the upstream direction by 36.3 mm which is inconsistent with previous trends. This may indicate local surface disturbance or an erroneous reading.

In the period 1991 to 1992 an upslope movement of 15 mm was experienced at the location of slope indicator SP5 which is contrary to the downslope trend experienced over past years.

4.0 CROSS VALLEY DAM

4.1 Thermal Regime

A summary of the thermal regime at the Cross Valley Dam is presented in Table 3. Although thermistor readings were not taken at all of the instruments positioned to observe foundation temperature beneath the Cross Valley Dam, it is expected that fully thawed conditions still exist at the instrument locations, as indicated in the 1990 annual inspection report. Readings at two thermistor locations, viz. CVDC11 and CVDC6 during 1992 indicate conditions consistent with 1990 readings.

Thermistors 88-4 and 88-5, installed on the dam crest, indicate thawed conditions with temperatures between +6.3 and +3.5°C to depths of 4.2 m in September, 1992.

4.2 Piezometer Readings

The piezometric records for the Cross Valley Dam are presented in Table 4. Groundwater levels were higher in 1992 relative to 1991 in the range of 0.29 to 1.05 metres except piezometer CVDP7 and CVDP10 which exhibited lower levels by 2.03 and 0.98 metres, respectively. While data is not available, it is expected that pond levels upstream of the Cross Valley Dam have not varied significantly from an elevation of 1063.5 metres.

4.3 Seepage

Seepage through and beneath the Cross Valley Dam is collected by a granular toe drain which was constructed in 1991. Three tributary V-Notch weirs and a combined flow weir are located as shown on Figure 1.

During 1992 flows were measured at the north and south V-Notch weirs (X11 and X12, respectively) and the combined flow weir X13. The recorded monthly flows are presented on Table 5. Figure 5 presents the recorded seepage flows for Weir X13 and the old location of Weir 3 for the years 1986 to 1992, inclusive. Table 6 summarizes the minimum, maximum and average year flow at weir X13 (3) during the period 1983 to 1992. The summary graph presented in Figure 5 clearly demonstrates that there has been a steady decline in mean annual seepage rate. Table 5 indicates that the south abutment flow (x 12) is generally higher than the old Weir 6 flows taken in 1991, probably due to the collection of a larger tributary area of seepage.

During 1992 the average annual flow rate at Weir X13 was approximately 1084 igpm, with a minimum average monthly rate of 885 igpm in November and a maximum of 1439 igpm in May. From Table 6 it can be seen that the 1992 average flow was approximately 20 percent less than the flows in the period 1987 to 1991. This reduction in seepage is significant and considered to be a response to the ongoing accumulation of sedimented tailings fines on the pond bottom and the accumulation of tailings upstream of the Intermediate Dam. The reduction may also be attributable to the lower differential head between the upstream and downstream sides of the Cross Valley Dam due to the construction of the toe drain. It is expected that the reduction in differential head may be on the order of 5 to 10 percent.

5.0 INTERMEDIATE DAM

5.1 Thermal Regime

Readings were not taken at the thermistor locations in the south abutment of the Intermediate Dam since the thermistor had been destroyed, possibly during the startup of the second siphon sometime during 1992. Readings taken in 1988 to 1990 had indicated that the ground was thawed to the full depth of the instrumentation.

5.2 Piezometers

Many of the piezometers installed at the Intermediate Dam have been damaged, destroyed or abandoned due to various construction activities on the Intermediate Dam over the years. However, observation of the remaining piezometers generally show an increase in water level of between 0.22 and 1.34 metres from 1991 to 1992. The 1991 piezometer readings were taken during the construction period at which time the pond level upstream of the Intermediate Dam had been lowered by 1 to 1.5 metres to allow construction of the spillway and Intermediate Dam upgrade to proceed. It appears that piezometer 91-1D5 may be malfunctioning since it indicated water levels approximately 1 metre above the piezometer tip (a decrease of water level by 5.14 and 14.35 metres at the shallow and deep tip, respectively). The detailed data is provided in Appendix I.

6.0 FRESH WATER SUPPLY DAM

6.1 Thermal Regime

One thermistor string installed to a depth of 8.1 m from the crest of the Fresh Water Supply Dam (85-5) indicated temperatures between +0.2 and +5.0°C in September, 1992. Similar conditions existed in September, 1991 but with higher near-surface temperatures. This is probably a function of the differing ambient air temperatures between late September 1992 and early September 1991. This thermistor string was installed by Dome Petroleum in 1985.

6.2 Piezometers

Piezometric levels in the Fresh Water supply dam were generally 0.68 to 2.11 metres higher in 1992 than 1991 with piezometer 85-3 indicating a 0.02 m drop in water level. The locations and elevations of these piezometers are shown in Appendix I, Section 4.0, Fresh Water Supply Dam Piezometers.

7.0 FIELD INSPECTION BY GOLDER ASSOCIATES LTD.

Both the Down Valley Project and the Fresh Water Supply Dam were inspected by Mr. P.J. Wheeler of Golder Associates Ltd. during the period 8 to 9 September, 1992. While the Down Valley Project has been inspected annually beginning in 1983, annual inspection of the Fresh Water Supply Dam began in 1988.

The purpose of the 1992 site inspection was to examine the facilities in detail for evidence of deficient performance, to provide a basis for possible adjustment to the frequency of monitoring, to observe maintenance undertaken subsequent to the 1991 inspection and then to review points of immediate concern with the Owner.

At the conclusion of the inspection, brief discussions were held with Messrs. Bill Dunn and Gerrit Vos of Curragh Resources Inc. to review the results of the inspection. In addition, an interim report was presented in our letter dated October 8, 1992 outlining particular and important points of maintenance which merited Curragh's attention before the onset of winter.

7.1 Facilities Examination and Required Remedial Works

The Diversion Canal, Cross Valley Dam, Intermediate Dam, the North Valley Wall Interceptor Ditch and the Fresh Water Supply Dam were all inspected on foot.

7.1.1 Diversion Canal

The dyke section, backslope and thermal liner, and the shoreline area downslope of the canal were examined in detail. The dyke examination was conducted to review the state of visible cracking associated with settlement and to review toe-of-dyke seepage occurrences. The backslope examination was carried out to review the integrity of the thermal liner, especially with regard to safe routing of run-off from the slope above. The shoreline examination was conducted to review seepage occurrences at that elevation, and to review performance of the waste material slopes.

The crest of the diversion canal dyke had been regraded prior to the 1992 inspection. Therefore, the cracking that had been monitored over the last few years in the area of Sta. 1+750 to 2+400 had been essentially obliterated and the top of grade regraded.

In light of the history of the cracking in the reach between Sta. 1+750 and 1+950, it is considered prudent to continue monitoring this area in accordance with the schedule presented on Figure 6.

Inspection of the thermal liner on the backslope of the canal revealed that the erosion gulley repairs are continuing to be effective although some minor hand-shaped channels would serve to more effectively direct run-off to the armoured gulleys. Except in the area of about Sta. 1+900, top surface cracking is not readily apparent along the top of the thermal liner. Significant cracking in the area of Sta. 1+900 was encountered during the 1991 inspection and there has been further widening and movement since then. The cracking pattern tends to be arcuate in shape on the top surface of the thermal liner and extends over a distance of 50 metres. At the time of the inspection the local condition of the liner had deteriorated significantly, respecting its condition at the time of the 1991 inspection. Water from upslope is currently entering the cracks, probably to the detriment of local stability.

The 1991 and 1992 (see letter dated October 8, 1992) recommendation still applies to this area. This area should be repaired by removing the top 150 mm of thermal liner, placing a geomembrane over the area, and then replacing the removed soils over the geomembrane to hold it in place. This will encourage local drainage from upslope to run over the top surface of the thermal liner and down the slope to the Diversion Canal. Because the distress in this section of the thermal liner has accelerated, some regrading of the top of the liner may be required. This construction should be carefully supervised to ensure that the thermal liner and natural backslope cover are not disturbed during the work.

Although inspection of the rock weir cascade was hampered by a high stream flow, each of the weirs was dissipating head as intended.

The shoreline area downslope of the Diversion Canal was inspected from the 1981 Diversion Dam to just downstream of the Cross Valley Dam. Since the 1991 inspection both the tailings level and the pond water level upstream of the Intermediate Dam have risen due to the 1991 Intermediate Dam upgrade construction. At the time of the inspection, deposition of tailings in the Down Valley Area had been discontinued and the pond level was approximately 1 metre lower than the full supply level. The pond level downstream of the Intermediate Dam appeared to be at a level consistent with the operating level for this pond.

Ongoing shoreline sloughing upstream of the Intermediate Dam has ceased because much of the material from the shore edge spoil deposits was used early in 1991 for construction of baffles which extended across the tailings area (see Figure 1).

Inspection for continuing shoreline sloughing occurring elsewhere was difficult since the pond and tailings levels were much higher than in 1991. At the time of the inspection the water level was at an elevation of approximately 1081.20 m.

South abutment seepage is currently being handled by the toe drain which was constructed during the 1991 Intermediate Dam upgrade. Beyond the Intermediate Dam, the condition of the shoreline is unchanged from previous years, other than for ongoing local sloughing of the spoil pile faces.

Downstream of the Cross Valley Dam and beyond the immediate abutment area there was no evidence of seepage.

7.1.2 Cross Valley Dam

Inspection of the dam comprised examination of the spillway area, the crest area for evidence and status of cracking, and the downstream toe drain where foundation seepage is collected and directed into culverts and drainage ditches constructed as part of the toe drain.

The water level at the time of the inspection appeared to be consistent with the normal operating level for the pond.

The cracking along the crest of the dam appeared more pronounced than in 1991 but over the past year the location of the cracks are more or less consistent with locations observed in past years. Thus the behaviour appears to be generally typical, reflecting the sporadic reaction of the uppermost part of the core of the dam to annual freezing.

Observations along the toe of the dam indicated that the toe drain, culverts, drainage channels and weirs are operating as intended. Some ditch maintenance is required along the downstream side of the toe drain along the north end to improve the flow to the north culvert.

7.1.3 Intermediate Dam

The crest of the dam had been graded, recompacted and shaped prior to the September inspection. This had been done in response to a contract cleanup deficiency remaining from the 1991 construction. No cracking was apparent anywhere along the crest of the dam.

Evidence of seepage was not apparent along most of the downstream toe of the dam. However, minor seepage was encountered immediately south of piezometer 91-1D4 and seepage was occurring at the south end of the dam. This confirms that the granular toe drain constructed prior to the 1991 Intermediate Dam upgrade is effective in transferring seepage water to the downstream pond.

The downstream slope of the Intermediate Dam spillway dyke immediately downstream of the Intermediate Dam ranges from 1.25H:1V to 1.5H:1V. Based on our observation of this slope it is recommended that the slope be buttressed with fill which is currently available in the general vicinity. The fill should be dozed into place in 300 mm lifts and compacted to a minimum 95 percent standard Proctor density. Because of the equipment requirement for construction of this buttress the new slope should be constructed to a finished grade not steeper than 2H:1V.

7.1.4 North Valley Wall Interceptor Ditch

At the time of the 1992 inspection the maintenance requirements outlined in the previous annual reports had been undertaken in the area of Guardhouse Creek and in the eastern portion of Borrow Area 'F'.

There remains a need to armour the outfall at the west end of Borrow Area 'F', and to further improve the capacity of the culvert at the haul road crossing. Downstream of the culvert the North Valley interceptor trench had been designed previously to have a 6.1 metre bottom width and depth of 2.6 metres. The bottom width of the trench at the time of the inspection was much smaller than this (approximately 2 metres). To undertake no maintenance is to run the risk of having unwanted quantities of flow passing through the system. It may enter from somewhere above the Intermediate Dam, or between the two dams. In either case, the spillways will have to function to carry the flow and it is our understanding that this is undesirable from Curragh's mine operation perspective.

7.1.5 Fresh Water Supply Dam

This if the fifth consecutive year that the facility has been inspected by Golder Associates Ltd.

The principal components of the inspection have been to examine the spillway for evidence of adjacent seepage flow, to review the crest for cracking in relation to what has been seen previously, to examine the abutments of the dam for evidence of changed performance, and to examine the area downstream concerning seepage.

The condition of the spillway is unchanged from previous years and there was no evidence of leakage around the structure.

The crest of the dam still retains evidence of prior years' cracking and it appears that, all along the crest, the cracks are more open this year than in 1991.

The area behind the west abutment was dry at the time of the inspection and there was no water on the surface of the downstream side of the dam as had been the case in previous years. The interceptor trench constructed on the toe berm in 1991 was also dry during the inspection.

The flow emerging from around the valve house appeared to be slightly less than that observed in 1990 and 1991. This is supported by the dry conditions encountered along the west abutment area.

In view of the rate of flow from around the valve house, and while recognizing the possible impact of precipitation and foundation seepage, there may also be a component related to riparian outlet leakage. In this regard it is recommended that those facilities be inspected during 1993, a task that will require temporary blocking of the pipe at its upstream end, its dewatering, TV viewing, and probably ultrasonic work for evaluation of corrosion. While this work is underway, the valves should be checked and rehabilitated as necessary. Depending on the outcome of the inspection, other steps may be necessary to be assured of trouble-free service in the future. This inspection had been recommended as part of the 1991 Annual Inspection Report. Prior to such inspection it is also recommended that design and construction records be researched to determine the degree to which the pipe was protected against corrosion.

The weirs constructed to measure seepage flow from beneath most of the toe berm were improved prior to the 1991 inspection to prevent bypassing flow . The treatment has consisted of adding 75 to 100 mm sized rock to provide additional support and use of bentonite enriched soils to ensure an adequate seal. The seal is still generally providing the desired results with the seepage around the weir now insignificant compared with weir flow.

The general conclusion of the inspection is that the condition of the embankment and downstream area is good, but that some inspection of the low level outlet is warranted in light of flow emerging around the valve house.

7.2 Performance Monitoring and Annual Reviews

As has been noted in previous reports, the performance monitoring and annual inspections have served as a basis for adjusting the frequency of observation of instrumentation, for installing additional instrumentation, and for undertaking maintenance work. Notable in this regard is the condition of the Diversion Canal dyke and downslope area upstream of the Intermediate Dam. The database and inspection records also serve as a reference from which to judge current performance and through which to be forewarned of any trends towards potentially troublesome performance.

In keeping with the key importance and the nature of these facilities, and the ongoing value of a comprehensive performance history, it remains prudent to sustain the data acquisition, data review and the annual inspection aspects of the project surveillance program.

In addition to the basic monitoring schedule outlined in Figure 6, it is important that a responsible Curragh engineer also make regular visits to the key structures as follows:

1. To inspect the south abutment areas of all three dams discussed above and to observe performance of the new weighted filter drain at the Cross Valley Dam, as well as the canal dyke and lower slope area upstream of the Intermediate Dam.

2. To inspect the valve house area at the Fresh Water Supply Dam for evidence of seepage flow rate change.

Any change in condition that is noted as a consequence of these inspections should be brought to the attention of Golder Associates Ltd. so that it may be evaluated in light of the data base and prior performance history of the structures, and to determine if mitigative action is needed. With reference to (1) above, inspection of the dyke and slope area upstream of the Intermediate Dam also needs to be complemented with instrument readings as outlined on Figure 6 because they are mutually useful in maintaining watch over the area.

8.0 ACTIONS AND RECOMMENDATIONS

The frequency of readings of the instrumentation has been greatly reduced from the initial practice of quarterly observations because confidence in the performance of the project has been substantiated by accumulated data.

In 1992 monitoring was undertaken as part of the continued monitoring schedule regarding localized Diversion Canal dyke performance related to crest cracking, performance of the Intermediate Dam in relation to its raising, and performance of the Fresh Water Supply Dam.

In light of the data base and the results of the 1992 and previous inspections, the following recommendations are made concerning ongoing data acquisition, and concerning required maintenance. Data acquisition requirements are also presented in Figure 6.

8.1 Diversion Canal

The continued monitoring of the Diversion Canal is recommended with details as follows:

8.1.1 Instrumentation Observation

a) dyke top and spoil pile thermistors to be read annually in September;

b) the canal backslope thermistors are to be read every two years (next reading in 1994);

c) slope indicator locations 91-CD1, 91-CD2, CD 15, CD 19, CD 21, CD 29 in the canal dyke, BS 11 and BS 18 in the canal backslope and SP 3 and SP 5 in the spoil piles to be read annually in September;

d) all functioning dyke top piezometers to be read annually in September;

e) all canal backslope piezometers to be read every two years (next reading in 1994);

f) all survey monuments to be read every two years (next reading in 1993), since this was missed in 1992. It is recommended that survey information be obtained on the canal dyke and on the diversion canal backslope in the vicinity of Stations 1+900 to 2+900.

g) all instruments in the reach from approximately Sta.1+900 to 2+350 to be read in April and September, 1993.

Results of the 1993 monitoring should be forwarded to Golder Associates Ltd. for review after each set of readings is obtained so that a detailed assessment may be conducted in September of 1993 at the time of the annual inspection, or earlier, if monitoring results warrant immediate action.

8.1.2 Other Requirements

It is important that the crest of the dyke be dressed and recompacted each September to close and consolidate areas where cracks may have developed. The purpose of this treatment is to prevent ingress of dyke surface run-off that may be concentrated in the settled areas, perhaps to enter local cracks to the disadvantage of stability. A large peg-type vibratory drum packer should be used in conjunction with blading to accomplish this work. Care must be taken not to disturb the existing instrumentation which has been installed to monitor performance of the dyke.

The canal dyke crest elevation survey which was last carried out in 1990 should be conducted in 1993 (this survey was not conducted in 1992 as recommended) to record changes in the dyke surface associated with the 1991 and 1992 dyke recompaction and dressing. The locations of the spikes used for the profile survey, located between Sta. 1+900 and 2+750 should be re-established. The survey should extend to approximately Sta. 2+900 and be conducted in September.

8.2 Cross Valley Dam

Continuing surveillance is required; instrumentation observations, detailed on Figure 6 should consist of:

a) piezometers to be read annually in April and September;

b) thermistors to be read annually in September;

c) the downstream toe seepage flow weirs to be read monthly while also recording the Cross Valley Dam reservoir level.

8.3 Intermediate Dam

Continuing surveillance is required; instrumentation observations, detailed on Figure 6 should consist of:

a) the piezometers to be read semi-annually in April and September;

b) flow from the downstream toe drain to be noted monthly;

c) the tailings pond water level to be noted monthly.

8.4 Fresh Water Supply Dam

Continuing surveillance is required; instrumentation observations, detailed on Figure 6 should consist of:

a) the piezometers to be read semi-annually in April and September;

b) the reservoir water level and weir flows to be noted semi-annually in April and September.

8.5 Miscellaneous Requirements

Continued monitoring of the flow in Rose Creek at the automatic recording station is recommended. Likewise, the program of water temperature recording initiated in 1987 should be continued, although data was not recorded in 1992. The locations of interest are the automatic flow level recording station, the Intermediate and Cross Valley Dam outflows and Weir 3. Observations should be taken monthly.

Although some instrumentation repair work was done in October, 1990, an inventory of the instrumentation condition at that time indicates that much of the instrumentation remains in need of repair because potentially important data is not being obtained. Repairs deemed necessary as a result of 1990 instrumentation readings and annual inspection are outlined in letter report 902-2406, dated November 9, 1990. Some instrumentation had been installed subsequent to this and some repairs had been effected, however, the following work remains:

a) attempt to clear blockage from slope indicators BS 2, BS 10, BS 11, BS 16, BS 17 and SP 5;

b) replace slope indicator at 88-6;

c) replace destroyed slope indicator at 88-12;

d) install a slope indicator at Sta. 1+950 on the canal backslope and a slope indicator at the south abutment of the Intermediate Dam;

The proposed schedule for the 1993 monitoring program is shown on Figure 6. It incorporates the points discussed above.

8.6 Physical Works Maintenance Requirements Summary

As a summary of the observations presented in Section 7.0, Field Inspection, the items of maintenance and construction noted below are considered important. Some of these points were presented in our interim report dated October 8, 1992.

1. **Diversion Canal Dyke**
   No maintenance required.

2. **Canal Backslope**
   Placement of a flexible membrane liner over a section of the thermal liner approximately 50 m long at approximate Sta. 1+900 to ensure that upslope runoff is directed across the thermal liner and prevented from entering its surface in the area of arcuate cracking.

3. **Canal Channel**
   Remove large rocks from canal invert and repair the quarry crossing ramp.

4. **Spoil Piles**
   No maintenance required.

5. **Toe-of-Slope along the Diversion Channel**
   No maintenance required

6. **Cross Valley Dam**
   Regrading of the ditch on the downstream side of the toe drain at the north end. The ditch should be constructed approximately 1.5 metres deep at the culvert location and graded upwards to the north end of the drain.

7. **Intermediate Dam**
   Buttressing of the backslope on the Intermediate Dam spillway immediately downstream of the dam is required. A source of suitable material is available to the west approximately 40 metres downstream of the Intermediate Dam centreline. The fill should be dozed into place in 300 mm lifts and compacted to a minimum 95 percent Standard Proctor density. Because

of the equipment that will be needed to construct this new slope it is expected that the final configuration will be somewhat flatter than 2H:1V, this being the minimum requirement.

8. **North Valley Wall Interceptor Ditch**

a) At the outfall from Borrow Area "F" some dumped rock is needed to arrest the undercutting erosion. A load of mine waste could be dozed over the edge.

b) The culvert which crosses the haul road to Borrow Areas J and K is undersized from the perspective of the 1:500 year flood event.

c) Enlarge channel downstream of 'J' and 'K' road crossing consistent with previous design (6.1 metre bottom width and depth of 2.6 metres).

9. **Fresh Water Supply Dam**

a) During 1993, the riparian outlet conduit and associated valving should be inspected to determine if its condition is the reason for the observed seepage. This inspection should be conducted by persons experienced in such work.

TABLE 1 – DIVERSION CANAL THERMAL REGIMES

LOCATION	THERMAL REGIME (Depth in metres)									
No. Stn.	Sept. 27, 1983	Sept. 28, 1984	Oct. 05, 1985	Oct. 1986	Sept. 30, 1987	Oct. 01, 1988	Sept. 02, 1989	Oct. 03, 1990	Sept. 05, 1991	Sept. 22, 1992
CANAL DYKE										
CD4 0+400	Thawed	Thawed	Thawed	Thawed, warmer than 84 & 85	Thawed, colder than 86	Thawed, warmer than 87 & 86	Thawed	Thawed	–	Thawed
CD5 0+510	Frozen 4.8–5.2	–	Thawed	Thawed, warmer than 84 & 85	Thawed, colder than 86	Thawed, warmer than 87 & 86	Thawed	Thawed	–	Thawed
CD10 0+990	Thawed	Frozen 4.8–5.4	Thawed	Thawed, warmer than 84 & 85 except at 7.8 m	Thawed, colder than 86	Thawed, warmer than 87 & 86	Thawed	Thawed	–	Thawed
CD15 1+530	Thawed	Thawed	Thawed	Thawed and warmer	Thawed, colder than 86	Thawed, warmer than 87	Thawed	Thawed	–	Thawed
CD17 1+705	Thawed	Frozen 7.8–8.2	Frozen 1.5–2.4	Thawed to 4.4 m	Thawed, colder than 86	Thawed, warmer than 87 & 86	Thawed	Thawed to approx. 9.5 m	–	Thawed to approx. 9.5 m
CD19 1+900	Thawed to 4.5	Thawed to 3.8	Thawed to 4.2	Frozen 6.2–6.7	Thawed to 4.3 m; warmer than 86	Thawed to 4.7 m; warmer than 87 & 86; frozen at same temp.	Thawed to 4.8 m		Thawed except at 6 to 7 m –	Thawed Thawed
CD20 2+000	Thawed to 6.0	Thawed to 5.3	Frozen 5.3–8.9	Thawed to 4.4 m	Partially frozen 6.0–9.0 Colder than 86	Frozen 6.4–8.5; warmer than 87 & 86	Thawed	Thawed	Thawed to approx. 6.0 m	Thawed to approx. 7.0 m
CD21 2+100	Thawed to 4.3	Thawed to 6.0	Thawed to 4.8		Thawed to approx. 4.7 m similar to 86	Thawed to approx. 4.9 m colder than 87	Thawed to approx. 6.0 m	Thawed to approx. 4.0 m	Thawed to approx. 6.0 m	Thawed to approx. 6.0 m
88–7 2+115							Thawed to approx. 5.0 m	Thawed to approx. 6.0 m	Thawed to approx. 4.0 m	–
88–9 2+120							Thawed to approx. 3.0 m	Thawed to approx. 4.0 m	Thawed to approx. 6.0 m	
88–11 2+160							Thawed to 5.0 m	Thawed to approx. 6.0 m	Thawed to approx. 4.0 m	–
88–13 2+160							Thawed to approx. 3.0 m	Thawed to approx. 4.0 m		Thawed
CD24 2+365	Thawed	Thawed	Thawed	Thawed and slightly warmer	Thawed, warmer than 86	Thawed, warmer than 87 & 86	Thawed	Thawed		Thawed
CD25 2+460	Thawed	Thawed	Thawed	Thawed and warmer	Thawed, similar to 86	Thawed, warmer than 87 & 86	Thawed	Thawed		
CD26 2+600	Frozen 5.5–7.8	Frozen 4.5–7.7	Frozen 4.5–7.0	Thawed	Thawed, colder than 86	Thawed, warmer than 87 & 86	Thawed	Thawed		Thawed to approx. 8.5 m
CD27 2+765	Thawed	Thawed	Thawed	Thawed and warmer	Thawed, colder than 86	Thawed, warmer than 87 & 86	Thawed	Thawed except at 2.3 m		Thawed
CD28+900	Frozen 3.0–6.2	Frozen 3.3–5.4	Frozen 4.0–5.2	Thawed to 7.7 m	Thawed to approx. 7.7 m warmer than 86	CD28 destroyed, adjacent 81–96 indicates thawed, warmer than 87	Thawed except at 7.5 m (81–96)	Thawed (81–96)		81–96 destroyed
CD29 3+000	Thawed to 2.9	Thawed to 3.4	Thawed to 3.2	Frozen 4.2–6.2	Thawed, warmer than 86	Thawed, warmer than 87	Thawed	Thawed		destroyed
CD30 3+130	Thawed	Thawed	Thawed	Thawed	Thawed, warmer than 86	Thawed, slightly warmer than 87	Thawed	Thawed		destroyed

For location of instrumentation see Figure 1

TABLE 1 – DIVERSION CANAL THERMAL REGIMES

LOCATION	THERMAL REGIME (Depth in metres)									
No. Stn.	Sept. 27, 1983	Sept. 28, 1984	Oct. 05, 1985	Oct. 1986	Sept. 30, 1987	Oct. 01, 1988	Sept. 02, 1989	Oct. 03, 1990	Sept. 05, 1991	Sept. 22, 1992
CANAL BACKSLOPE										
BS2 0+400	Frozen 2.0–7.8	Frozen 1.5–6.5	Frozen to 7.9 m	Frozen full depth	No readings taken in 87	Frozen approx. from 5.3–6.7; warmer than 86	No readings taken in 1989	Thawed to approx. 5.0 m; warmer than 88	No readings taken in 1991	Thawed
BS4 0+710	–	–	–	–		Thawed, warmer than 86		No readings taken in 1991		No reading taken in 1992
BS5 0+960	Frozen 2.3–2.8	Thawed	Thawed to 5.5 m	Thawed full depth		Thawed, warmer than 86		Thawed to approx. 6.0 m; colder than 88		Thawed
BS9 1+530	Thawed	Thawed	Thawed	Thawed and slightly warmer		Thawed, warmer than 86		Thawed		Thawed
BS10 1+900	Thawed to 2.2 m	Thawed to 2.0 m	Thawed to 2.0 m	Thawed to 2.8 m		Thawed to 3.9 m; warmer than 86		Thawed to approx. 5.0 m warmer than 88		Thawed to approx. 6.0 m
BS11 2+100	Thawed to 0.5 m	Frozen	Frozen	Thawed to 1.0 m		Thawed to 1.6 m; warmer than 86		Thawed to 3.5 m; warmer than 88		No reading taken in 1992
BS12 2+260	Thawed	Thawed	Thawed	Thawed		Thawed, warmer than 86		Thawed, warmer than 88		Thawed
BS15 2+760	–	Thawed	Thawed	Thawed		Thawed, warmer than 86		Thawed, warmer than 88		Thawed
BS16 2+900	Thawed to 2.0 m	Thawed to 2.3 m	Thawed	Thawed to 3.2 m		Thawed to 4.6 m; warmer than 86		Thawed except at 8.5 m; warmer than 88		No reading taken in 1992
BS17 2+900	Thawed to 2.5 m	Thawed to 2.5 m	Frozen	Thawed to 3.3 m		Thawed to 4.1 m; warmer than 86		Thawed to 4.3 m; warmer than 88		Thawed to 8.0 m
BS18 3+100	Thawed to 3.4 m	Thawed to 2.8 m	Thawed to 3.1 m	Thawed to 4.1 m		Thawed to 5.9 m; warmer than 86		Thawed, warmer than 88		Thawed
SPOIL PILE										
SP2 1+530	Thawed to 3.8 m	Thawed to 3.0 m	N/D	Thawed to 3.3 m	Thawed to approx. 4.9 m warmer than 86	Only 2 out of 10 thermistor tips giving readings	Only 3 out of 10 thermistor tips giving readings	Only 7 out of 10 thermistor tips giving readings; thawed to approx. 6 m	No readings taken in 1991	Only 1 out of 10 thermistor tips giving readings.
SP3 1+900	Thawed to 2.6 m	Thawed to 2.6 m	N/D	Thawed to 4.3 m	Thawed to approx. 4.6 m warmer than 86	Thawed to 5.0 m; warmer than 8	Thawed to 6.5 m	Thawed to 6.0 m		Thawed to 6.0 m
SP5 2+950	Thawed to 3.1 m	Thawed to 4.7 m	Thawed to 3.4 m	Thawed to 4.4 m	Thawed to approx. 3.7 m colder than 86	Thawed to 4.9 m; warmer than 8	N/D	Thawed to 6.0 m		Thawed to 6.5 m

For location of instrumentation see Figure 1

TABLE 2

TOTAL PRECIPITATION - FARO AIRPORT

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
April	2.2	2.5	13.9	12.9	10.0	8.2	2.0	7.0	2.8	15.8
May	20.6	36.8	17.2	35.1	40.0	38.0	17.9	23.4	22.4	14.4
June	55.6	49.1	28.2	12.8	50.8	37.3	41.0	45.4	30.2	11.4
July	49.1	16.7	62.6	76.3	92.4	97.2	51.7	30.0	115.4	68.1
August	65.8	65.0	80.8	28.7	63.5	25.6	16.9	64.4	33.4	34.4
Sept.	21.2	5.5	46.3	44.4	30.2	43.3	30.8	66.2	47.4	47.8
Oct.	16.3	11.0	20.0	22.7	26.8	29.4	45.9	22.2	49.6	11.4
TOTAL	230.8	186.6	269.0	282.9	313.8	279.0	206.2	58.6	301.2	203.3

NOTE: All precipitation readings in mm.

TABLE 3

CROSS VALLEY DAM THERMAL REGIME

LOCATION		THERMAL REGIMES (Depth in metres)										
No.	Stn.	Sept./82	Sept./83	Sept./84	Oct./85	Oct./86	Sept./87	Oct./88	Sept./89	Oct./90	Sept./91	Sept. /92
CVDT4	0+630	Thawed 4.5-14.2	Thawed 2.5-8.5	-	Thawed to 8.4	Thawed to >11.4	Thawed to approx. 14m warmer than 1986.	Thawed, slightly warmer than 1987.	Thawed to approx. 12 m	Thawed to approx. 14 m	No Reading	No Reading
CVDC1	0+050	Frozen 4.8-5.8	Thawed	Thawed >15	Thawed >15	Thawed and warmer	Thawed, slightly cooler than 1986.	Thawed, warmer than 1987.	N/D	N/D	No Reading	Damaged
CVDC11	0+645	Thawed to 4.6	Thawed to 5.4	Thawed to 4.4 and 9.2-12.8	Thawed	Thawed and very warm	Thawed, slightly warmer in 1986.	Thawed, slightly colder than 1987.	Thawed	N/D	No Reading	Thawed
79-20 (north abut.)				Frozen 4.5-6.5	-	No change from 1984	Thawed from 2 to 12 m; slightly warmer than 1986	Thawed from 2 to 12 m; similar to 1987.	N/D	N/D	No Reading	No Reading
CVDC6	0+340	Thawed	Thawed	Thawed	-	Thawed	Thawed, colder than 1986.	Thawed, except at 21 m; warmer than 1987.	Thawed except at 21 m.	Thawed except at 21 m.	No Reading	Thawed except at 21 m

Note: For locations of instrumentation see Figure 1

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TABLE 4
CROSS VALLEY DAM
PIEZOMETRIC RECORDS (in metres, from August 1982)

LOCATION	CVDC1	CVDC2	C4-0+215		CVDC6	C7-0+450		CVDC9-0+565		CVDC11	81-126-P	CVDT1	CVDT2	CVDT3
	0+050	0+150	(shallow)	(deep)	0+340	(shallow)	(deep)	(shallow)	(deep)	0+645	Sth Abut.	0+210	0+450	0+570
Tip Elev.	1049.60	1048.00	1040.20	1032.00	1032.30	1040.10	1035.20	1040.00	1033.00	1050.80	1050.06	1040.20	1038.50	1040.10
DATE	PIEZOMETRIC ELEVATION (m)													
Aug'82	1052.40	1052.48	1050.53	1050.24	1052.11	1048.34	1051.39	1057.04	1056.91	1050.94		1049.68	048.64(?)	051.69(?)
Dec'82	1051.56	1052.06	1049.81	1049.79	destroyed	1047.90	1050.73	1054.80	1056.76	1051.44		1049.35	048.61(?)	-
Apr/May'83	1050.86	1051.36	1049.92	1049.66		1048.09	1050.59	1054.46	1055.95	052.06(?)		1049.38	1048.11	1050.88
Jun'83	<1049.60	1050.38	1049.09	1049.17		1047.86	1050.95	1053.26	1055.02	1054.93		1048.96	1048.03	1050.04
Aug/Sep'83	<1049.60	1049.62	1049.06	1048.98		1047.62	1049.59	1052.21	1053.86	051.99(?)		1048.96	1047.80	1049.87
Oct'83			1049.29	1049.2		1047.66	1049.82	1052.48	1054.63	-		1048.91	1047.70	1049.53
Dec'83	<1049.60	1050.17				-	-	-	-	1052.62		1048.94	1047.62	1049.35
Feb'84			1049.42	1049.28		1047.68	1049.91	1053.60	1055.09	-		1049.03	1047.71	1049.32
Mar'84	<1049.60	1050.03				-	-	-	-	1055.42		-	-	-
Apr'84			1048.88	1048.92		1047.51	1049.47	1052.97	1054.11	-		1048.70	1047.52	1049.20
Jun'84	<1049.60	1050.24	1049.23	1049.13		1047.70	1049.77	1055.09	1053.48	1053.53		1048.92	1047.80	1049.78
Aug'84			1049.13	1049.02		-	-	1053.43	1054.71	-		1048.78	1047.66	1049.68
Oct'84	<1049.60	1049.82				-	-	-	-	1051.85		1048.77	1047.50	1049.42
Jun'85			1050.13	1049.95		1048.05	1049.77	1055.04	1056.78	1059.34		1049.59	1048.06	1049.99
Oct'85	1050.44	1051.22	1049.63	1049.40		1047.72	1050.28	1054.39	1057.51	1058.22		1049.19	1047.91	1049.64
May'86	1051.14	1051.85	1050.05	1049.96		1047.78	1050.69	1056.19	1054.58	1059.27		1049.43	1047.84	1049.65
Oct'86	1051.07	1051.29	1050.64	1050.36		1048.57	1051.43	1055.33	1056.97	1059.34	1055.31	1049.45	1048.34	1049.90
Oct'87	1051.14	1051.99	1050.21	1049.05		1048.07	1050.98	1054.99	1056.66	1058.71	?	1049.54	1048.41	destroyed
Jun/Jul'88	1052.05	1052.41	-	1049.83		1048.03	1050.89	1056.20	1056.41	1059.16	1055.73	-	-	
Oct'88	1050.23	destroyed								1057.66	1054.05			
Sep'89	-	destroyed				1048.05	1050.96	1054.93	1056.76	1057.80	-	-	-	-
Jan'90	-	destroyed	dry?	1049.79								1049.71	1048.41	destroyed
Oct'90	1051.14	destroyed	dry?	1050.03		1048.25	1050.96	1055.40	1057.00	1056.34	1054.96			
Dec'90										1064.11				
May'91				1050.26		1048.04	1050.63	1055.15	1056.69	1063.55				
Sep'91				1050.11		1048.12	1050.85	1055.38	1057.08					
Jun'92				1051.25		1048.56	1051.51	1056.15	1057.91					
Sep'92				1050.94		1048.60	1051.33	1055.67	1057.54	1059.00				

Note: For location of instrumentation see Figure 1 and 1-1.

TABLE 4 (Cont'd)

CROSS VALLEY DAM

PIEZOMETRIC RECORDS (in metres, from August 1982)

LOCATION	CVDP-1	CVDP-2	CVDP-3	CVDP-4	CVDP-5	CVDP-6	CVDP-7	CVDP-8	CVDP-9	CVDP-10
	0+450	0+450	0+450	0+210	0+210	0+210	0+570	0+570	0+570	0+570
Tip Elev.	1046.81	1046.84	1047.01	1046.76	1046.58	1046.67	1047.53	1047.93	1048.18	1049.1
DATE	PIEZOMETRIC ELEVATION (m)									
Aug'82	1051.43	1051.67	1049.60	1055.09	1052.32	1050.59				
Dec'82	1051.19	1051.39	1049.53	1054.32	1052.53	1050.52				
Apr/May'83	1050.87	1050.97	1049.39	1053.62	1051.90	1050.17	1056.98	1057.87	1057.42	1052.11
Jun'83	1050.17	1050.55	1048.97	1052.22	1051.13	1050.66	1056.35	1055.70	1055.46	1051.34
Aug/Sep'83	1049.68	1050.20	1048.69	1051.24	1050.43	1049.40	1055.02	1054.79	1054.48	1051.97
Oct'83	-	-	-	-	-	-	-	-	-	-
Dec'83	1049.96	1050.34	1048.69	1049.35	1050.64	1049.54	1053.55	1055.70	1055.18	1051.62
Feb'84	-	-	-	-	-	-	-	-	-	0
Mar'84	1049.89	-	1048.90	1052.01	1050.64	1049.61	1056.35	1055.77	?	?
Apr'84	-	-	-	-	-	-	-	-	-	-
Jun'84	1049.96	1050.34	1048.62	1051.80	1050.64	1049.54	1056.21	1055.70	1055.46	1051.55
Aug'84	-	-	-	-	-	-	-	-	-	-
Oct'84	1049.89	1050.41	1048.69	1051.80	?	1049.61	-	1055.63	1055.32	-
Jun'85	-	-	-	-	-	-	-	-	-	-
Oct'85	-	-	-	-	-	-	-	-	-	-
May'86	1051.50	1051.25	1049.81	1053.90	?	1050.73	1059.57	1059.92	1058.54	1051.97
Oct'86	1051.64	1051.74	1049.81	1053.83	?	1050.87	1059.36	1059.57	1058.26	1051.34
Oct'87	1057.64	1051.18	1049.67	1053.69	?	1050.45	?	1058.99	1058.68	1051.06
Jun/Jul'88	-	-	-	047.74(?)	?	-	-	-	-	-
Oct'88	1051.08	1051.39	1049.46	rough line		1049.96	059.57(?)	1057.73	1057.56	049.45(?)
Sep'89	1051.15	1051.32	1049.32	1046.9	?	1050.17	1059.36	1058.43	1058.19	1049.94
Oct'90	1051.08	1050.62	1049.25	1053.52	-	1050.52	1059.08	1058.36	1058.05	-
May'91	1051.01	1048.94	1050.37				1059.43	1058.57	1058.05	1049.38
Sep'91	1051.22	1050.41	1049.32				1059.43	1058.64	1058.33	1050.29
Jun'92										
Sep'92	1051.85	1051.96	1047.29		1053.51	1051.29				1049.31

Note: For location of instrumentation see Figure 1 and 1-1.

TABLE 5

CROSS VALLEY DAM SEEPAGE FLOWS
Weir Flow (I.G.P.M.)

DATE	WEIR X11 (N. ABUT.)	WEIR X12 (S.ABUT.)	WEIR X13 (CENTRE)
January, 1992	290	55	1056
February, 1992	238	53	924
March, 1992	211	46	1129
April, 1992	172	79	1188
May, 1992	343	106	1439
June, 1992	330	231	1412
July, 1992	256	40	1162
August, 1992	383	44	-
September, 1992	-	-	911
October, 1992	251	7	924
November, 1992	370	40	885
December, 1992	330	17	898

NOTES:

1. For location of weirs see Figure 1.

Table 6
Cross Valley Dam
Weir 3 (X13) Average Yearly Flow

YEAR	MEAN POND ELEVATION (m)	MINIMUM FLOW (month) (igpm)	MAXIMUM FLOW (month) (igpm)	AVERAGE YEARLY FLOW (ipgm)
1982	1058.55	1203 (Sept)	4400 (Jun)	1828
1984	1059.85	1075 (Oct)	1345 (Dec)	1209
1985	1061.99	1330 (Sept-Dec)	1800 (Jul)	1477
1986	1063.2	1265 (May)	1795 (Sept)	1487
1987	≈ 1063.2	1220 (May)	1682 (Aug-Sept)	1497
1988	≈ 1063.5	1250 (June)	1750 (Aug)	1514
1989	≈ 1063.5	1146 (Mar)	1551 (Aug)	1358
1990	≈ 1063.5	1028 (Mar)	1631 (Sept)	1312
1991	≈ 1063.5	1056 (Oct)	1443 (Jun)	1293
1992	N/A	8852 (Nov)	1439 (May)	1084

NOTES:

1) For locations of weirs see Figure 1

2) Flows for 1983, 1984 and 1985 based on records for period June to December and flow for 1991 based on records for period January to November.

3) High flow through Weir 3 in June, 1982 due to siphon discharge above weir.

4) Weir 3 was replaced by X13 as a consequence of the seepage filter construction conducted in the summer of 1991.

Table 6
Cross Valley Dam
Weir 3 (X13) Average Yearly Flow

YEAR	MEAN POND ELEVATION (m)	MINIMUM FLOW (month) (igpm)	MAXIMUM FLOW (month) (igpm)	AVERAGE YEARLY FLOW (ipgm)
1982	1058.55	1203 (Sept)	4400 (Jun)	1828
1984	1059.85	1075 (Oct)	1345 (Dec)	1209
1985	1061.99	1330 (Sept-Dec)	1800 (Jul)	1477
1986	1063.2	1265 (May)	1795 (Sept)	1487
1987	≈ 1063.2	1220 (May)	1682 (Aug-Sept)	1497
1988	≈ 1063.5	1250 (June)	1750 (Aug)	1514
1989	≈ 1063.5	1146 (Mar)	1551 (Aug)	1358
1990	≈ 1063.5	1028 (Mar)	1631 (Sept)	1312
1991	≈ 1063.5	1056 (Oct)	1443 (Jun)	1293
1992	N/A	8852 (Nov)	1439 (May)	1084

NOTES:

1) For locations of weirs see Figure 1

2) Flows for 1983, 1984 and 1985 based on records for period June to December and flow for 1991 based on records for period January to November.

3) High flow through Weir 3 in June, 1982 due to siphon discharge above weir.

4) Weir 3 was replaced by X13 as a consequence of the seepage filter construction conducted in the summer of 1991.

SCHEDULED 1992 INSTRUMENTATION READINGS

Figure 3

1992 INSTRUMENTATION READINGS

	Jan '92	Feb '92	Mar '92	Apr '92	May '92	Jun '92	Jul '92	Aug '92	Sep '92	Oct '92	Nov '92	Dec '92
1. DIVERSION CANAL												
- Thermistors - Canal Dyke									X			
- Spoil Pile									X			
- Backslope									X			
- Slope Indicators - Canal Dyke									91-CD1,CD2;CD15,19,21,29			
- Spoil Pile									SP3,5			
- Backslope									BS11,18			
- Piezometers - Canal Dyke									X			
- Backslope									X			
- Survey Monuments									X			
- 1+900 to 2+350 - Thermistors			X			X			X			X
- Piezometers			X			X			X			X
- Slope Ind.			X			X			X			X
2. CROSS VALLEY DAM												
- Thermistors									X			
- Piezometers					X				X			
- Toe Weirs and pond level	X	X	X	X	X	X	X	X	X	X	X	X
3. INTERMEDIATE DAM												
- Thermistors									X			
- Piezometers			X			X			X			X
- Toe drain seepage, pond level	X	X	X	X	X	X	X	X	X	X	X	X
4. FRESH WATER SUPPLY DAM												
- Piezometers			X			X			X			X
- Weir flows and pond level			X			X			X			X
5. MISCELLANEOUS												
- Rose Creek Flow, Recording St.	monthly											
- Water Temp. - Flow Record. St.	monthly											
- CVD Weir Outflow	monthly											
- ID Siphons	monthly											
- 2+100 Tile Flow	monthly											

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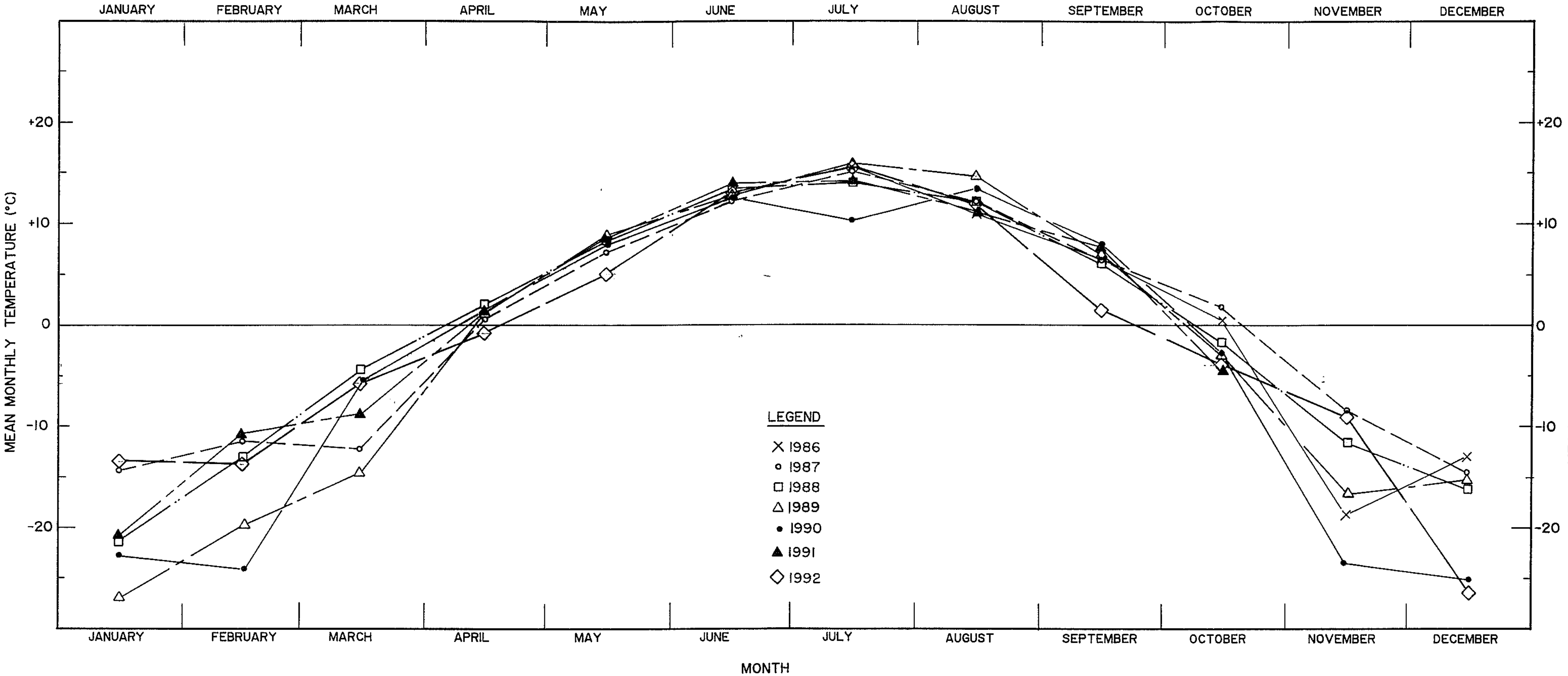
MEAN MONTHLY TEMPERATURES (°C)
FARO AIRPORT

Figure 4



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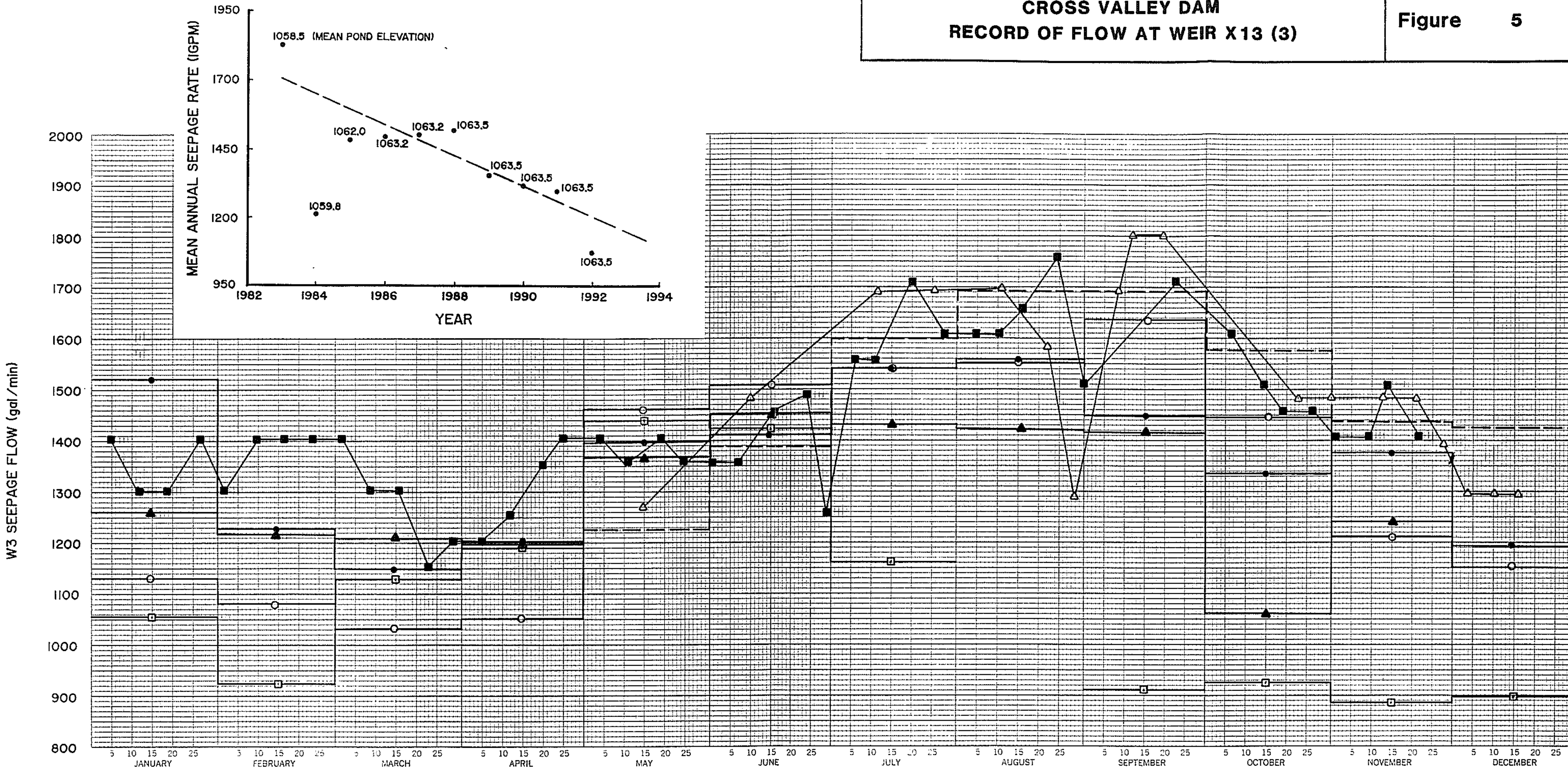
CROSS VALLEY DAM
RECORD OF FLOW AT WEIR X13 (3)

Figure 5



LEGEND

- 1986
- 1987 MONTHLY AVERAGE FLOW
- 1988
- 1989 MONTHLY AVERAGE FLOW
- 1990 MONTHLY AVERAGE FLOW
- 1991 MONTHLY AVERAGE FLOW
- 1992 MONTHLY AVERAGE FLOW

NOTE

1. 1983, 1984 and 1985 FLOWS NOT PLOTTED (SEE PREVIOUS GOLDER REPORT No. 882-2412 FOR 1983-1985 FLOWS).
2. A TOE-OF-SLOPE SEEPAGE FILTER WAS INSTALLED ON THE CROSS VALLEY DAM IN 1991.

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SCHEDULED 1993 INSTRUMENTATION READINGS | **Figure 6**

1993 INSTRUMENTATION READINGS

	Jan '93	Feb '93	Mar '93	Apr '93	May '93	Jun '93	Jul '93	Aug '93	Sep '93	Oct '93	Nov '93	Dec '93
1. DIVERSION CANAL												
- Thermistors - Canal Dyke									X			
- Spoil Pile									X			
- Backslope									X			
- Slope Indicators - Canal Dyke												
- Spoil Pile												
- Backslope												
- Piezometers - Canal Dyke									X			
- Backslope									X			
- Survey Monuments									X			
- 1+900 to 2+350 - Thermistors				X					X			
- Piezometers				X					X			
- Slope Ind.				X					X			
2. CROSS VALLEY DAM												
- Thermistors - BH88-4,5									X			
- Piezometers				X					X			
- Toe Weirs and pond level	X	X	X	X	X	X	X	X	X	X	X	X
3. INTERMEDIATE DAM												
- Thermistors									X			
- Piezometers				X					X			
- Toe drain seepage, pond level	X	X	X	X	X	X	X	X	X	X	X	X
4. FRESH WATER SUPPLY DAM												
- Piezometers				X					X			
- Weir flows and pond level				X					X			
5. MISCELLANEOUS												
- Rose Creek Flow, Recording St.												
- Water Temp. - Flow Record. St.												
- CVD Weir Outflow												
- ID Siphons												
- 2+100 Tile Flow												

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