JOHN ANDERSON
AQUA IRRIGATION

Ministry of Works and Development

ALEXANDRA RESIDENCY.

FALLS DAM SITE VISIT REPORT

Inspection 24 April 1985

Alexandra Files
15/41 & 15/15/3
7 June 1985.

Author: D.W. Richards

R. 85/53

Ministry of Works and Development

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Inquiries to Q McCarthy | Date 27 June 1985 | Our ref 15/15/3 | Your ref 15/41

The District Commissioner of Works
Ministry of Works and Development
Private Bag
DUNEDIN

ATTENTION DWASO
DCE

FALLS DAM SPILLWAY REPAIRS

Your 15/43 of 7 June 1985 refers.

Your comments and conclusions on the condition of the concrete lining of the spillway of Falls Dam have been read with interest, however due to the onset of winter and high water levels (it is anticipated water will be flowing down the spillway in the next week or two) repairs have been postponed until early summer - October/November 1985.

Your clauses for the specification have been noted and will be included in the contract documents.

Q McCarthy
for Manager
Alexandra Residency

Ministry of Works and Development

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Inquiries to

Date 12 June 1985

Our ref 15/43

Your ref

The Manager
Alexandra Residency
Ministry of Works and Development
Box 273
ALEXANDRA

ATTENTION Mr B D Patterson

FALLS DAM SPILLWAY IMMEDIATE REPAIRS
SPECIFICATION CLAUSES

Your 15/15/3 of 22 May 1985 refers.

The following material comprises clauses which should appear in the specification section of the contract documents for the immediate repairs to the Falls Dam spillway.

REPAIR PREPARATION

Repairs are to be limited to those areas identified in this specification. These are:

a Damage to the top two panels and connecting circumferential joint running through the middle of the flow guide vanes in the two bays closest to the left abutment of the dam.

b Damage to the circumferential joint below the toe of the guide vanes over an approximately 4 m length below the panel closest to the old quarry face cutting.

c Damage to, and replacement of plaster in, the complete length of the second circumferential joint below the toe of the guide vanes.

All broken and poor quality concrete shall be broken out. Where steel is exposed the concrete shall be broken out at least 75 mm below the back of the rebar. Where rock is exposed the concrete shall be removed back to the rock. Care shall be taken to ensure that no steel is damaged.

The edges of the concrete shall be cut to provide a dovetail key for the repair concrete. The excavated depth at those edges shall be at least 50 mm and locally to depths as elsewhere is required in this specification.

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Where the repair is along existing concrete joints the excavation shall be keyed as specified above. Old concrete surfaces shall be scabbled to provide the equivalent of a type B concrete joint as described in CD 101.

At any significant source of water leakage from behind the spillway lining a local excavation is to be formed in the rock. This local excavation shall be filled with 9 mm crushed aggregate held in place with expanded metal sheeting cut to shape. A length of 25 mm black polythene pipe shall be inserted to drain the leakage water to the surface of the lining concrete. Where the leakage occurs along a construction joint a length of 25 mm diam black polythene pipe with drilled perforations is to be installed to lead the water to the drainage points.

The surface of all broken out concrete and rock shall be thoroughly cleaned of loose or deleterious material using high pressure water jetting. Deleterious material shall also be removed from the concrete surfaces both above and around the repair areas sufficient to prevent further contamination of the exposed surfaces prior to concrete placing.

All exposed reinforcement shall have any remaining adhering concrete carefully chipped off and shall be thoroughly cleaned off by wire brushing. All loose rust must be removed.

Prior to concrete placement the receiving concrete surfaces shall be thoroughly dampened, but with no surplus free water remaining.

CONCRETE MATERIALS

The concrete strength at 28 days shall be 20 MPa.

The concrete mix design shall be submitted for approval but shall incorporate the following features:

a Maximum aggregate size is 19 mm.

b 4-5% air entrainment for frost resistance.

c Aggregates shall be graded toward the coarser material (ie less sand) for greater durability.

d The W/C ratio shall not exceed 0.4 to provide greater strength and durability and to minimise shrinkage.

A plasticiser such as Daracem-FL or equivalent may be used for concrete laid in the top two panels to provide added workability while maintaining low W/C ratio.

Concrete shall be well tamped into position using hand held pneumatic equipment.

All concrete surfaces shall be finished to Class U2 as specified in NZS 3114:1980. Templates for checking the vertical profile shall be cut on site to fit the vertical profiles of adjacent sound concrete areas. The profile of the finished surface shall be regular and deviations shall not exceed 5 mm over a 3 m length from the template.

Repaired areas shall be damp cured for a period of not less than three days in accordance with CD 101.

Suitable protection against frost shall be provided for the period that the concrete is curing.

D W Richards
for District Commissioner of Works

Ministry of Works and Development

District Office

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[redacted] Private Bag, DUNEDIN

Telephone 771 480. Telex NZ 5728

Inquiries to

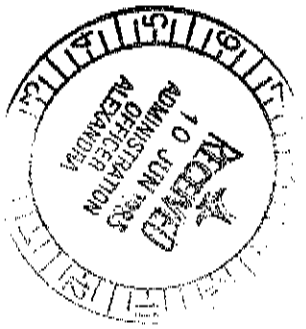
Date 7 June 1985

Our ref 15/43

Your ref 15/41 ←

~~Copy of Letter 15/15/3~~ SI

The Manager
Alexandra Residency
Ministry of Works and Development
Box 273
ALEXANDRA



ATTENTION Mr P M Gallant
Mr B D Patterson

FALLS DAM SITE VISIT REPORT

... Please find enclosed a copy of the report on the recent site visit to inspect the spillway of Falls Dam. The report is essentially an inventory of the problems that exist with the concrete lining of the spillway.

While comment is also made on the diversion valves and the dam membrane, it has been done on the basis of only a cursory inspection and these items will need to be examined in more detail at some future date. Replacement of the nosing cone of the needle valve is urgent and enquiries are being made by this office at present to expedite this matter.

... Attached to the report is a complete photographic record of the features which the report addresses.

D.W. Richards

D W Richards
for District Commissioner of Works

Encl

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FALLS DAM

REPORT ON SITE VISIT OF 24 APRIL 1985

OBJECTIVES

The inspection of Falls Dam was principally to inspect the spillway as this had been reported to be under some distress and inspection had not been possible over the last two years because of the high lake levels and continuous spilling of water throughout that period. A full photographic record of the spillway glory hole as far as the throat was taken in order to compare with photographs of the February 1981 inspection. Numerous photographs of features further down the tunnel were also taken to record particular or typical features.

Time did not allow for a detailed investigation of the valves and dam membrane. Brief notes are included however and a number of photographs were taken.

PARTICIPANTS

District Office : I G Walsh
D W Richards
G L Elliot
W R Aitken

Residency : P M Gallant
I Kenning
T H Highsted
M Blair

DIVERSION VALVES

Introduction

The inspection of the spillway required that the diversion valves be closed. This offered the opportunity to check how well they operated and to inspect them externally.

Gate Valve

It is understood from T Highsted that this valve had not been operated for approximately seventeen years. The old grease evident at the gate's greasing points had a hard surface, indicating that it had not been serviced in some years also. Despite its apparent neglect it operated very smoothly.

Externally the paint system used has large areas which have been lost because of corrosion. This is superficial and no cause for concern. The valve's travel indicator is missing.

The seat into which it sits is still in place on the screw thread and it would be a simple matter to replace the indicator. Closing the valve is quite a lengthy job because of the internal gearing (it took a little over 3000 revolutions to close) and this may be the reason why it is seldom used.

It is recommended that the travel indicator be reinstated and that the gate valve be serviced and its operation checked regularly, at least bi-annually.

Photo 1 : Gate Valve

Pipework

The pipework showed the signs of age but is clearly quite sound with no seepage evident and all bolts in good order.

It is recommended that the pipe be inspected on say a bi-annual basis to check for leaks. An ultrasonic thickness testing might also be made at some future date.

Needle Valve

The needle valve operated smoothly. It generally appears to be in good order from what is seen in the valve chamber.

An inspection was made of the nosing cone where the needle valve discharges into the spillway tunnel and extensive cavitation damage was seen. It is probable that the nosing cone could be lost in the relatively near future. The remainder of the working parts that could be seen looked to be in good order.

It is recommended that a search be made to find the pattern and that a new nosing cone be ordered immediately. This could be installed after the 1985/86 season.

Photo 2 : Needle valve casing and gears.
Photo 3 : Needle valve nosing cone damage.
Photo 4 : Close up of cavitation damage on the needle valve nosing cone.

SPILLWAY CONCRETE CONDITION

Introduction

The spillway was inspected beginning from the outlet end. The notes made are made on the basis of the panels (approx 4 m long each) which the concrete lining was placed in. Sketches of the spillway and panel joint locations are appended to this report.

Abbreviations Used in the Notes

I/W jt	Invert to wall construction joint where wall begins to curve upward.
Jt mm/nn	Joint between panels m and n
Hor jt	Horizontal construction joint
u/s	Upstream
d/s	Downstream
TL	True Left
TR	True Right

Panel 1

General Good all round, some lime leaching at crown.

Panel 2

Invert	Some erosion, no steel exposed. Make up invert 75 mm deep over area 600 mm by 3 m long.
Walls	Good
Crown	Some lime staining but no deterioration

Panel 3

Invert	Erosion, no steel exposed. Make up slab required full width (2.5 m) to 75 mm depth.
Walls	Good
Crown	Good, some lime staining

Panel 4

Invert	Progressively more erosion, no steel exposed. Full width treatment, not urgent.
Walls	Slight boneyness at I/W jts both sides
Crown	Good

Photo 5 : Jt 4/5 TR

Panel 5

Invert	No steel exposed. Full width cover required.
Walls	Erosion at I/W jts, otherwise good
Crown	Good, some lime leaching

Photo 6 : Jt 5/6 TL

Panel 6

Invert No steel exposed. Full width slab required.
Walls Significant erosion at I/W jts, no steel exposed
Crown Good, some lime staining

Photo 7 : Typical of invert, 27 inches of tape showing
Photo 8 : I/W jt TR. TL similar but not as severe

Panel 7

Invert No steel exposed, erosion getting progressively worse, generally less than 100 mm but up to 120 mm max locally.
Walls Severe local erosion at I/W jts, otherwise good
Crown Good

Photo 9 : I/W jt TL
Photo 10: I/W jt TR, erosion 130 mm deep, 200 mm wide, 1.1 m long

Panel 8

Invert Similar to panel 7.
Walls Small scale I/W jt erosion not as bad as panel 7, otherwise good.
Crown Good, some lime staining

Panel 9

Invert Increased erosion in floor, 100 mm plus for more than a third of panel length.
Wall TL Good, including I/W jt
Wall TR Localised erosion of I/W jt beside Jt 9/10

Photo 11: I/W jt TR next to Jt 9/10, erosion 150 mm deep and 300 mm long

Panel 10

Invert Erosion not as severe as panel 9, approx 75 mm, no steel exposed.
Walls I/W jts good, walls good
Crown Good
Jt 10/11 Possible movement between panels 10 and 11. Jt closed at crown, open at invert up to 5 mm. Not recent, not serious, patching only required.

Panel 11

Invert	Severe erosion 100 mm, no steel exposed. Localised erosion TL up to 1 m wide and 50 mm deep, requires patching.
Walls	Good, except I/W jt TL eroded 40-50 mm deep requires patching
Crown	Good
JT 11/12	Closed at crown, open up to 5 mm at invert. Not recent nor serious.
General	Tide mark quite distinct 2.5 m above invert.

Panel 12

Invert	Erosion more general, 100 mm.
Walls	Erosion 50 mm I/W jts both sides, hor jt 1.5 m above invert TL eroded 60 mm deep, walls otherwise good.
Crown	Good, more lime leeching evident.
Jt 12/13	No movement evident.

Photo 12: Hor jt 1.5 m above invert TL

Panel 13

Invert	Similar to panel 12.
Walls	I/W jts better than panel 12, walls good except hor jt 1.5 m above invert noted in panel 12 continues full length of panel 13.
Crown	Significant increase in lime build up (extent is from middle of panel 12 to end of panel 15) indicating more cracking. Not recent. Not considered serious.
Jt 13/14	Joint open at invert, historical seepage 1.0-1.5 m above invert up to crown with significant lime build up.

Photo 13: Hor jt 1.5 m above invert TL full length, boney, 200 mm high and 80 mm deep.

Panel 14

Invert	Erosion working up walls (300 mm above invert level), 75 mm cover required.
Walls	I/W jts good. Patch required TL for hor jt 1.5 m up, 30 mm x 100 mm x 500 mm. Crack (construction joint?) 3 m above invert, not serious.
Jt 14/15	Tight at invert, open at I/W jts both sides with TL worst of the two with a hole more than 100 mm deep, 30 mm wide and 400 mm long. Seepage evident at these points. Drainage hole required?

Panel 15

Invert	No steel exposed, erosion 100 mm deep, full width, 300-400 mm up wall.
Walls	I/W jts eroded both sides 50 mm, no large pockets. Walls good.
Crown	Good
Jt 15/16	Invert tight, I/W jt region eroded 50 mm plus.

Panel 16

Invert	No steel exposed, extensive erosion approx 100 mm but no holes.
Wall TL	Good, I/W jt good, minor erosion. Hor jt 1.5 m above invert 2/3 panel length requires patching.
Wall TR	Wall generally good, I/W jt 50 mm erosion full length.
Crown	Good

Photo 14: Typical open joint (Jt 16/17) between panels
Photo 15: Typical of tunnel viewed u/s

Panel 17

Invert	General erosion approx 100 mm but no holes.
Walls	TL good. TR not good with seepage and local erosion 100 mm deep and 600 mm long requiring patching.
Jt 17/18	Water flowing both sides, existing 20 mm dia drain TL. Joint erosion OK in walls, below 1.5 m open, undercut and repair.

Panel 18

Invert	Extensive erosion, no deep holes, 100 mm plus.
Wall TL	Good, I/W jt has cavities extending some distance underneath, boney at hor jt 1.5 m up and patch required, significant increase in patching evident between 150 mm to 1.5 m above invert.
Wall TR	Good, I/W jt erosion 75 mm.
Crown	Good
JT 18/19	Open up to 1.5 m both sides typically less than 25 mm, local hole 75 mm deep, 150 mm high and 250 mm long at 400 m above invert, 2.5 m up on TL joint in poor condition with cavities up to 150-200 mm deep.

Photo 16: Cavity under wall TL I/W jt

Panel 19

Invert	Old patching 1.5 m wide nearly full length is cracked at jt 19/20. Remove as it will be very difficult to tie on to.
Wall TL	I/W jt has several local pockets 50-100 mm deep, patching required of erosion between 300 mm and 1.2 m above invert.
Wall TR	Erosion general away from patched area 75 mm deep, I/W jt good.
Crown	Good
Jt 19/20	Invert plaster (50 mm) cracked. Joint in poor condition TL from invert to 2 m, holes extensive with 100 mm gap at surface. From 2 m to 3 m TL holes variable but extending 150-200 mm deep and shaped like 60° notches. Does not look good. Joint on TR better but holes evident, 50 mm max width, up to 2 m above invert level, holes dry.

Panel 20

Invert	Patched 30%, 50 mm thick, will need to be removed.
Wall TL	I/W jt requires patching of erosion up to 100 mm deep. Patch for hor jt 0.9 m above invert 1 m long. Repair old patch of hor jt 1.8 m above invert full panel length and 300 mm wide.
Wall TR	I/W jt eroded 50 mm full length. Hor jt 1.5 m full length of panel, 75 mm deep and 250 mm wide needs patching, seepage from this construction joint. Hor jt 3 m above invert is OK.
Crown	Good
Jt 20/21	Tight at invert, open in wall up to 2.5 m TL and similar TR. TL localised spalling over 30% of height 100 mm deep and 75 mm wide. TR better with no significant spalling.
General	Overall this panel is very poor up to 2.5 m above invert level.

Photo 17: TL hor jt 1.8 m above invert with old patching failing, showing also general lining condition.

Panel 21

Invert	50 mm thick concrete patch still covers 85% of invert.
Wall TL	Severe erosion from invert up to 1.2 m above. Probably because of effect of valve outlet only 5 panels further up on opposite side.
Wall TR	Better, surface erosion 50 mm up to 900 mm above invert with no deep holes.
Crown	Good

Jt 21/22 Joint tight at invert, severe erosion TL extending from joint d/s and up to 1.5 m above invert, TR joint seeping with general erosion but no local holes and minor patching only required.

Photo 18: Wall TL severe erosion up to 1.2 m above invert.

Panel 22

Invert Erosion greater than 100 mm up to 750 mm above invert level, no prior patching remaining, no steel exposed.
Wall TL I/W jt eroded 50 mm half panel length, rework required on existing patching 1.8-2.5 m above invert.
Wall TR I/W jt eroded 50 mm full panel length, local areas of surface erosion up to 1.5 m above invert not severe but need patching, remainder of wall good.
Crown Good
JT 22/23 Open at invert 2-3 mm. TL open up to 2.5 m above invert with erosion 75 mm generally but local spots typically between 150 mm and 250 mm wide. TR open up to 2 m, 5 mm gap, evidence of prior patching, very localised erosion only up to 75 mm max width.

Panel 23

Invert Erosion generally 100 mm, scattered remnants of patching summing to 1.0-1.5 m^2, no steel exposed.
Wall TL General erosion up to 900 mm above invert, I/W jt eroded 75-150 mm deep locally and up to 200 mm wide, rest of wall good.
Wall TR General erosion up to 900 mm above invert, I/W jt better with only local patching over erosion of 50 mm required.
Crown Good
Jt 23/24 Open 1-2 mm at invert. Open TL up to 3 m above invert, local erosion 100 mm deep and 50 mm wide. Open TR up to 3 m above invert and 3 mm wide, erosion not severe, prior patching evident.

Panel 24

Invert 75% patched.
Wall TL Irregular erosion 100 mm deep away from the invert patching and up to 750-900 mm above invert level. Wall good.
Wall TR As for TL but erosion depth only 50 mm, remainder of wall good.
Crown Good
Jt 24/25 Erosion of joint across full width of invert to 100 mm depth plus a crack in the patching concrete remote from the joint but associated with it.

Joint open TL locally 100 mm wide and 50 mm deep as far as 3 m above invert. TR open as far as 2.5 m up, erosion up to 75 mm deep is local only.

Panel 25

Invert	100% patched with gaps.
Wall TL	I/W jt not bad with localised 50 mm erosion. Minor patching 500 mm above invert 50 mm deep. Very localised general erosion but better than panel 24. Hor jt 2.5 m above invert has eroded up to 150 mm deep and full panel length, needs patch.
Wall TR	I/W jt 50 mm erosion, local erosion up to 600 mm above invert, remainder OK.
Crown	Good
Jt 25/26	Invert cracked. Open TL 3 mm up to 2.5 m above invert with local erosion 150-200 mm deep, patch required. TR is tight but with minor seepage 2 m above invert level and a hole 2.4 m up.

Photo 19: Hor jt 2.5 m above invert TL.

Panel 26

General	Panel 26 encompasses the downstream end of the valve bay at end of diversion tunnel.
Invert	75% patching, in poor condition and requires replacement.
Wall TL	I/W jt poor, erosion 75-100 mm deep. Patching required for 2 holes above 1.3 m over invert along construction jt 1.2 m long, 75 mm wide, 75 mm deep. Hor jt 2.5 m above invert poor over 80% of panel length with holes 150-200 mm deep, requires patching.
Wall TR	I/W jt requires 50 mm patching. Change in wall angle (into diversion tunnel) patch required up to 3 m above invert for 25 mm wide and 50 mm deep gap. On TR there is also an intermediate panel jt at outlet of diversion tunnel which has erosion the full 3 m height requiring patching, 50 mm wide and 25 mm deep.
Jt 26/27	Joint is in the middle of the valve chamber bay. Invert is patched but tight. Jt open TL up to 3 m above invert with erosion up 1.2 m, severe at 1.2 m above invert and coincides with hor jt of panel 27. Crack TR 2 mm wide but no erosion.

Photo 20: Hor jt 1.3 m above invert TL
Photo 21: Needle valve jet (at low head) and valve chamber bay TR showing vertical construction joints (composite of 2)

Panel 27

General	Panel 27 at needle valve position.
Invert	Poor, old patching has failed, needs replacement surface protection, no steel exposed except at the intermediate transverse joint at half panel position there is a 2 inch steel pipe in the floor (old grout hole or seepage hole?).
Wall TL	I/W jt eroded at u/s end 75 mm deep and 150 mm wide, 2 m long patch required. Hor jt 1.2 m above invert eroded at d/s end 155 mm deep, 200 mm wide and 1.2 m long with steel exposed.
Jt 27/28	Invert not visible because of silt. Joint at TL open to 2 m height with erosion 75 mm deep, 50 mm wide over 50% of joint length. TR offset toward valve. Jt good at crown.

Panel 28

Invert	Covered with silt, patching has failed, requires relining, steel is exposed.
Wall TL	Hor jt 2.5 m above invert in poor condition, requires patching 150 mm deep, 250 mm wide and 1.5 m long.
Wall TR	Local small patching required on wall and up to 100 mm above invert.
Jt 28/29	Joint not seen in walls between invert and construction jt 2.5 m above invert but seen over crown.

Panel 29

Invert	Relining required.
Wall TL	Erosion up to 100 mm above invert, remainder good except for hor jt 2.5 m above invert is bad with water seeping.
Wall TR	Good
Jt 29/30	Open at invert and up both sides to 3 m height, requires patching, erosion locally 50 mm deep generally but up to 75 mm deep with some 150 mm wide.

Panel 30

General	Not in bad condition generally.
Invert	Eroded but patching not needed.
Wall TL	I/W jt eroded 100 mm deep, up to 200 mm wide and 1.5 m long. Hor jt 2.5 m above invert in poor condition (similar to panels 28 and 29) requires patching. Remainder good.
Wall TR	Local erosion I/W jt 100 mm deep by 200 mm wide by 1 m long. Wall generall good except crack at hor jt 1.6 m height but erosion minimal.
Crown	Good. Note two spall marks side by side about 200 mm dia.

Jt 30/31 Invert eroded. TL open 3 mm up to 2.5 m height needing minor patching. TR more severe erosion up to 2.5 m height, requires patching 50 mm by 50 mm up to 2 m level.

Photo 22: I/W jt hole TR just u/s of jt 29/30.
Photo 23: Panel 30 invert looking u/s.

Panel 31

General Last full panel section before bend.
Invert Erosion evident but sound generally, erosion regular and even and no serious distress.
Wall TL I/W jt eroded 50 mm deep and 50 mm wide, requires patch. At 1.5-1.6 m height minor surface patching. Hor jt 2.5 m above invert requires patching but significantly less than previous panels.
Wall TR I/W jt OK. Minor surface patching needed at hor jt 2.0 m above invert, minor seepage at u/s end of this feature.
Crown Good, lime build up.
Jt 31/32 Joint in poor condition with exposed steel in invert and crown requiring cover protection, seepage TL.

Photo 24: Jt 31/32 at invert viewed d/s.

Panel 32

General Start of bend. Erosion is generally severe but particularly at invert and up to half height of sides where main impact of spilling water is taken, steel is exposed in places.
Invert Severely eroded.
Sides TL and TR eroded to half height, erosion particularly at mid-height construction jt.
Crown Some spalling, lime staining.
Jt 32/33 Erosion of jont up to 150 mm locally almost total circumference.

Photo 25: Invert of panel 32 in immediate foregound (Jt 32/33 difficult to see, topmost joint visible is Jt 35/36).
Photo 26: Crown of panel 32 showing steel exposure at Jt 31/32 at bottom.

Panel 33

Invert Substantial erosion up to 150 mm deep in places.
Sides Erosion severe up to approx 3/4 height of panel and adjacent to construction jt, especially TL.
Crown Good, old drainage pipe (19 mm) limed up.
Jt 33/34 Severely eroded at invert.

Photo 27: Close up of TL mid-height construction jt.
Photo 28: TL mid-height construction jt.
Photo 29: As for photo 28.
Photo 30: View up to throat of spillway showing TL mid-height construction jt butting up to jt 33/34 at extreme right of photo. Floor of lifting cage at jt 35/36.
Photo 31: Crown of panel 33, old 19 mm weep hole pipe.
Photo 32: Jt 33/34 at invert severely eroded.

Panel 34

General Centre panel of the bend, invert length 2.6 m (cf other four panels of bend 4 m length of invert). Exposed aggregate shows concrete mix used washed quartz river gravels as fine aggregate up to 12 mm and crushed greywacke up to 75 mm for coarse aggregate. Concrete matrix looks very limey and can be scratched relatively easily with knife. It appears this panel was poured as a complete ring.
Invert Severe erosion, mainly on bottom third of circumference.
Crown Good except for very minor spalling.

Photo 33: View up to throat of spillway (at top, jt 36/37). G Elliot standing on invert of panel 34.
Photo 34: Jt 34/35 invert (u/s)
Photo 35: Jt 34/35 TL
Photo 36: Jt 34/35 TR
Photo 37: Jt 34/35 crown (d/s)

Panel 35

Invert No steel exposed at joints, severity of erosion diminishes up the invert, erosion around bottom third of circumference.
Crown Good, old grout pipe (see photo 37).

Photo 38: Jt 35/36 invert (u/s)
Photo 39: Jt 35/36 TL
Photo 40: Jt 35/36 crown (d/s), exposed steel, gap 75 mm deep, 150 mm wide and 3 m long, old plaster not adhering well on this side where it has been applied.
Photo 41: Jt 35/36 TR, steel exposed.

Panel 36

General Last panel of bend.
Invert Erosion significantly less than panels 34 and 35, total of 1-2 m^2 patching required.
Sides Both sound.
Crown Bad local erosion with exposed steel, 125 mm deep,

300 mm wide by 500 mm long.
Jt 36/37 Erosion 100 mm by 100 mm max, 75% of total joint has eroded.

Photo 42: View of invert (u/s) from below showing local damage on panel 36.
Photo 43: Jt 36/37 invert (u/s) (composite of 2)
Photo 44: Jt 36/37 crown (d/s)
Photo 45: Jt 36/37 TL
Photo 46: Jt 36/37 TR

Panel 37

General Bottom most of intake rings, jt 36/37 marks the throat position. Generally good condition, plastered surface. Apparently these panels were constructed as the spillway was excavated down into the rock, hence the construction joint sloping down and into the rock face to allow room for concrete to be placed behind the forms of the next panel down. This technique resulted in a gap remaining at the top of the new panel which was later plastered. The orientation of the construction joint is such that any opening of the joint allows water to force this plaster out.
Side u/s Local erosion 500 mm by 500 mm by 150 mm (shows up better on photo 42 rather than flash assisted photo 47).
Side TL Good
Side TR Extensive erosion related to joint
Side d/s Good
Jt 37/38 Severe erosion complete circumference 75-150 mm max deep, 150 mm wide, steel exposed, old plaster coming away (old repairs?). Cover to steel is typically 65 mm.

Photo 47: Jt 37/38 u/s
Photo 48: Jt 37/38 d/s
Photo 49: Jt 37/38 TL, note steel
Photo 50: Jt 37/38 TR

Panel 38

General Good, minor erosion of plaster only all around. No work required.

Photo 51: Jt 38/39 u/s, good
Photo 52: Jt 38/39 d/s, plaster could need replacement
Photo 53: Jt 38/39 TL, minor attention required
Photo 54: Jt 38/39 TR, some spalling of plaster, no steel exposed.

Panel 39

Side u/s Good
Side d/s Major spalling of plaster, no steel exposed, some concrete spalling
Side TL Minor plaster spalling
Side TR Medium spalling, not as severe as d/s
General Minor plastering to panel, superficial epoxy repair?

Photo 55: Jt 39/40 u/s, good joint, minor opening of joint 25 mm max. Minor patching, no undercutting.
Photo 56: Jt 39/40 d/s, more significant spalling, no
Photo 57: Jt 39/40 TL, good, minor erosion below jt 1.5 m long, patch with minor undercut.
Photo 58: Jt 39/40 TR, minor spalling, surface patching.

Panel 40

General Spillway flares out significantly, overall condition of panels good generally except for defect TR.
Side TR Possible construction jt (or concrete gone off too much when placed?), 1.5 m long, 100 mm wide and 150 mm deep, patch required.

Photo 59: Panel 40 TR defect
Photo 60: Jt 40/41 u/s, good, minor local spalling 300 mm long
Photo 61: Jt 40/41 d/s, open 12-15 mm, spalling very minor
Photo 62: Jt 40/41 TL, spalling 75 mm, no steel exposed, patching required. Note falsework keys above in panel 41 need filling
Photo 63: Jt 40/41 TR, joint eroded 350 mm deep, 100 mm wide and 4 m long. Steel exposed, 450 mm centres, 50-100 mm cover generally

Panel 41

General Second panel down from toe of guide vanes. Constructed as a continuous ring, cf panels above have vertical construction jts. Poor concrete and spalling plaster evident at mid panel height, probably resulting from poor technique, this being the first complete ring poured as spillway was excavated down.
Side u/s Spalling of plaster, generally good, falsework block out requires repair.
Side TL Block outs again to repair, spalling plaster, poor mid heigh construction jt requires patching, less than 1 m long, 300 mm deep.
Side d/s Poor intermediate construction jt about 6 m long,

no steel exposed.
Side TR Similar to TL, minor spalling, evidence of construction jt.
Jt 41/42 Generally in very poor condition.

Photo 64: Jt 41/42 u/s, infill plaster lost.
Photo 65: Jt 41/42 d/s, horizontal steel exposed, 600 mm wide, 4 m long and full panel depth. Urgent repair.
Photo 66: Jt 41/42 TL, severe erosion, steel exposed, bedrock exposed. Urgent repair. Vertical steel half inch at 450 mm centres, horizontal steel 3/4 inch. Steel anchorages of one inch bar. Slab thickness 150 mm, max aggregate size 75 mm. Joint infill wedge very loose.
Photo 67: Jt 41/42 TR, erosion 150 mm deep, 200 mm wide, 3 m long.
Photo 68: View from above showing damage at jt 41/42 u/s and TL (photos 64 and 66) and at jt 42/43 u/s (photo 72).

Panel 42

General Panel below toe of guide vanes, built in 12 sections with vertical joints between.
Side u/s Generally good, local erosion totalling 1 m^2, no steel exposed.
Side TL Aggregate exposed 75% of panel area, erosion 100-120 mm, no steel exposed.
Side d/s Obscured by moss, similar to TL
Side TR Obscured by moss, similar to TL

Photo 69: Jt 42/43 TL, eroded 50 mm wide, 100-150 mm deep
Photo 70: Jt 42/43 d/s, eroded 200 mm wide, 100-150 mm deep, possible steel exposed
Photo 71: Jt 42/43 TR, good, minor local erosion 50 mm wide and 75 mm deep
Photo 72: Jt 42/43 u/s, erosion 300 mm wide, 150-200 mm deep and 3 m long, steel exposed, patching required.

Panel 43

General Lower vane section. Photos of complete bays numbered clockwise from u/s vane.

Photo 73: Bay 1, aggregate exposed 70% area, no steel exposed in panel.
Photo 74: Bay 2, similar to bay 1.
Photo 75: Bay 3, more severe erosion, especially down from Jt 43/44. Urgent repair of jt.
Photo 76: Bay 4, substantial deterioration of central section. Urgent repair.

Photo 77: Close up of damage at jt 43/44 bay 4.
Photo 78: Bay 5, minor spalling vertical construction jt, generally good.
Photo 79: Bay 6, minor spalling, worse than bay 5, not severe, minor patching only.

Panel 44

General Upper vane section.

Photo 80: Bay 1
Photo 81: Bay 2
Photo 82: Bay 3, repair poor construction jts mid panel.
Photo 83: Bay 4
Photo 84: Bay 5
Photo 85: Bay 6

Spillway Intake Foundation

The spillway intake is generally cut into solid rock but it does appear that the outer lip of the spillway at one point has had to be built up. The slope away from the spillway into the reservoir is strewn with loose rock, most of which is probably excess cuttings from the excavations. The rock outcrops, where they could be seen, appear to be sound and there is no evidence that the spillway is in danger.

A new farmer's access track has at some time recently been installed between the spillway and the rock cutting face. This track has been constructed by building up the surface of the cutting area with granular material. It is recommended that the level of this track where is passes the spillway and for at least 10 m on either side, be lowered to at least that of the intake wall and preferably down to platform level so that water can be taken in from all sides evenly and not be restricted as it presently is. The present situations could promote serious damage to the spillway in high flood conditions because of the assymetrical inflow pattern inducing dynamic effects.

Photo 86: View up to foundation at Bay 5, rock at centre of photo mostly in situ
Photo 87: Loose rock slope below Bay 5, in situ rock top left and top right
Photo 88: Access track passed spillway

General Assessment and Recommendations

The general impression of the condition of the spillway's concrete lining is that it has performed very well and that only patching and surface treatment is required on the whole. Only those items noted as needing urgent repair will need to be done prior to the onset of winter. All other repairs could safely be left until after the winter.

The most urgent repairs are those noted for panel 43 and joints 43/44 and 41/42. It is recommended that these joints be cleaned, broken back to provide a concrete key and be filled with a stiff mortar.

The general repairs to joints and resurfacing of the invert can be undertaken after the irrigation season has ceased and may have to be programmed over two or three years.

The area of most surface degradation is at the bend immediately below the throat of the spillway. It is estimated that as much as 150 mm of this concrete has been lost and this should be reinstated with an abrasion resistant mortar properly keyed in and held back on to the existing surface.

DAM MEMBRANE

Introduction

The dam membrane was not formally appraised. The following notes however are offered.

General Condition

The overall condition of the membrane concrete appears to be sound. The surface of the concrete below normal water level shows signs of general deterioration with only the occasional exposure of the 75 mm size coarse aggregates (see photo 92). The damage at the waterline is more significant. This should be excavated out to sound concrete and filled back with mortar such as Expocrete TG.

Panel 2 has a crack running the full width above the first horizontal joint. Some erosion from this crack has also occurred and clearly this must be rectified. Cutting a vee notch and filling with epoxy mortar would be appropriate.

The joints appear to be working satisfactorily and no significant perishing of the rubber was seen. While it is true that the system needs to be reviewed this job is not an urgent one in the medium term.

Photo 89: Dam membrane
Photo 90: Dam membrane viewed from above
Photo 91: Close up of surface damage at normal water level between first and second panels
Photo 92: Concrete surface damage near the abutment midway down second horizontal panel row (composite of 3)
Photo 93: Second of top panels now showing damage at normal water level and horizontal crack above first horizontal joint

Photo 94: As for photo 93 (composite of 3)
Photo 95: End of second horizontal joint where it comes into the TL abutment showing how the rubber strips are held down
Photo 96: Vertical joint between the second and third panels (composite of 2)

Recommendations

The membrane appears to be in a relatively sound condition but should be separately inspected. This could be safely left until the spillway tunnel repairs are being undertaken. Meanwhile cracks and pitting visible on the surface of the concrete slab should be cleaned out and filled with Expocrete TG or similar.

D W Richards
Senior Engineer

17 May 1985

Ministry of Works and Development

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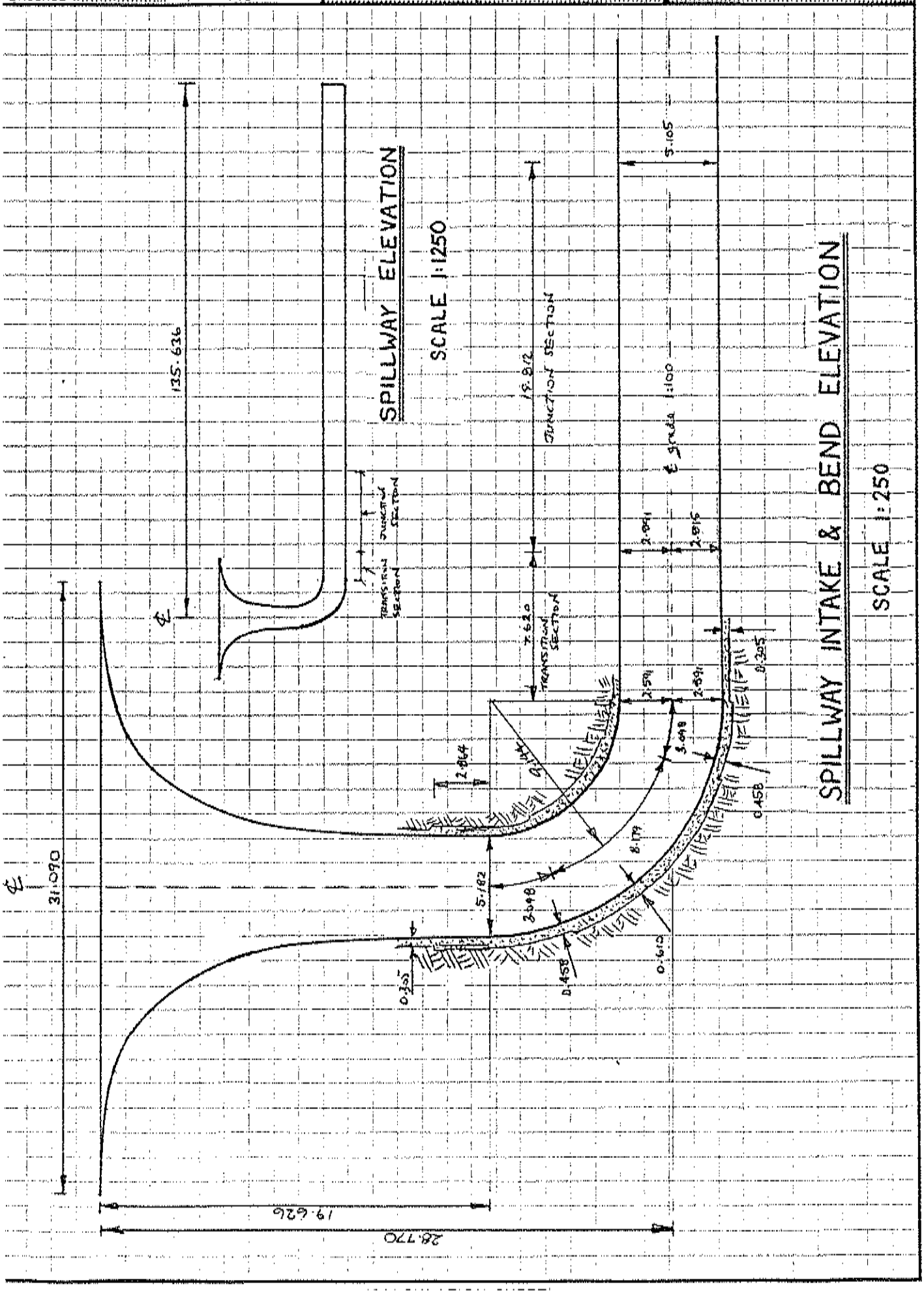

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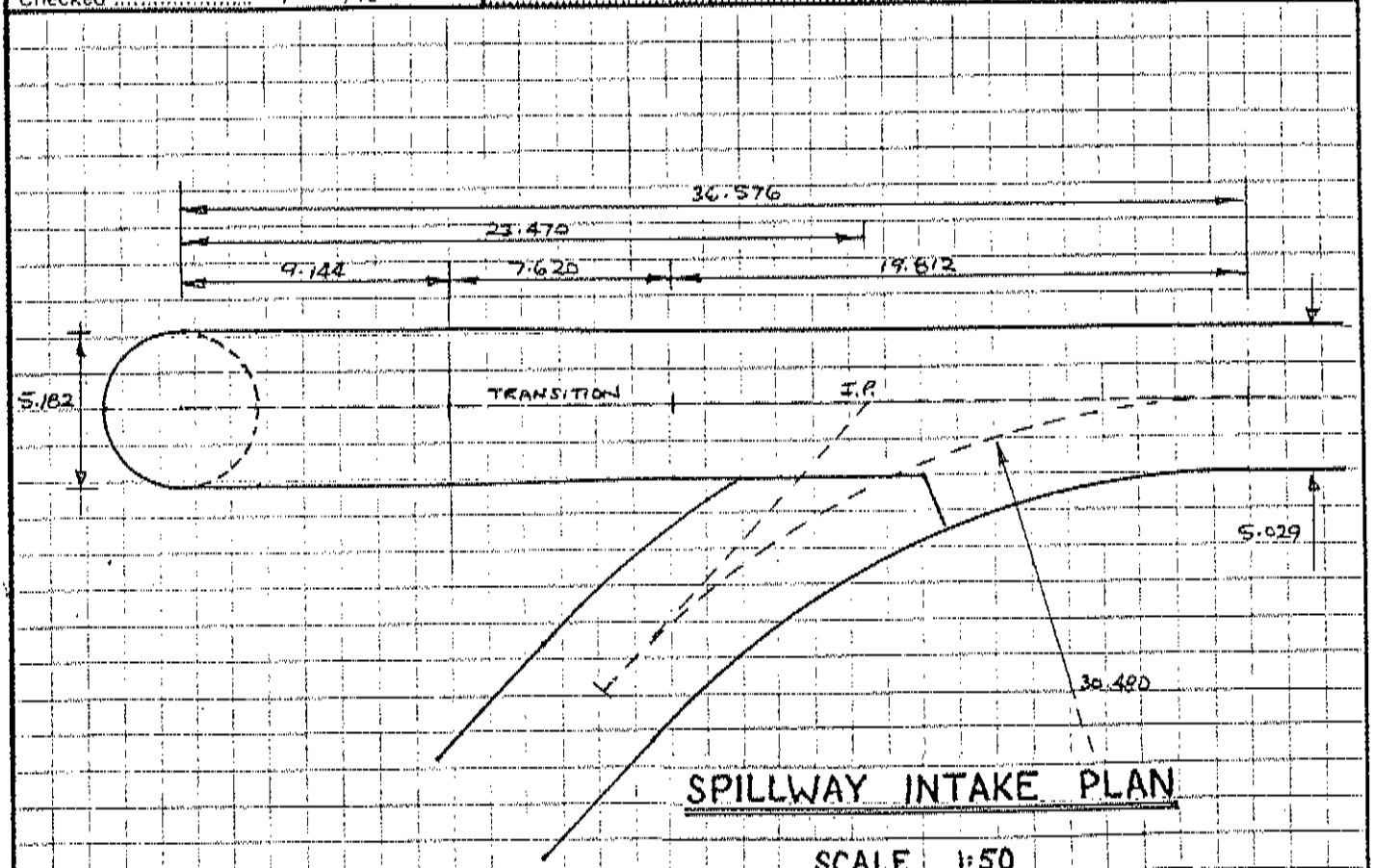

SPILLWAY INTAKE PLAN

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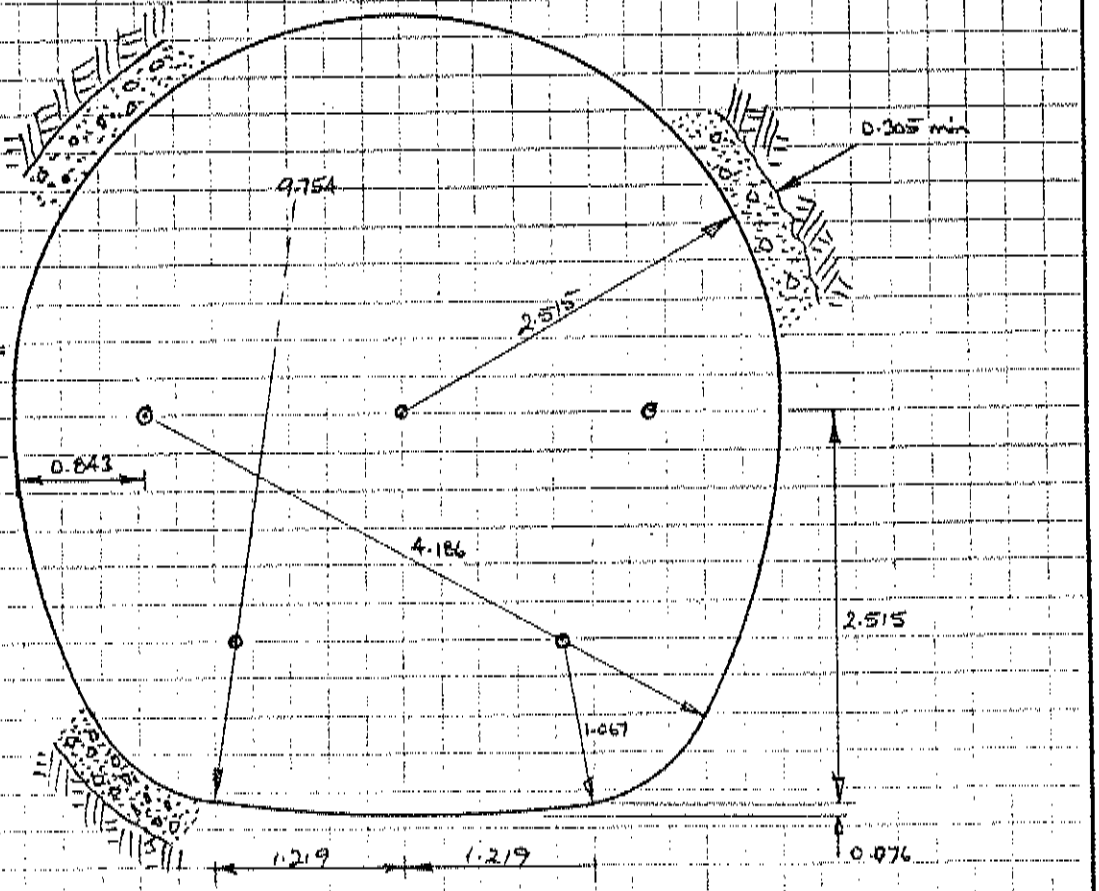

SPILLWAY TUNNEL TYPICAL SECTION

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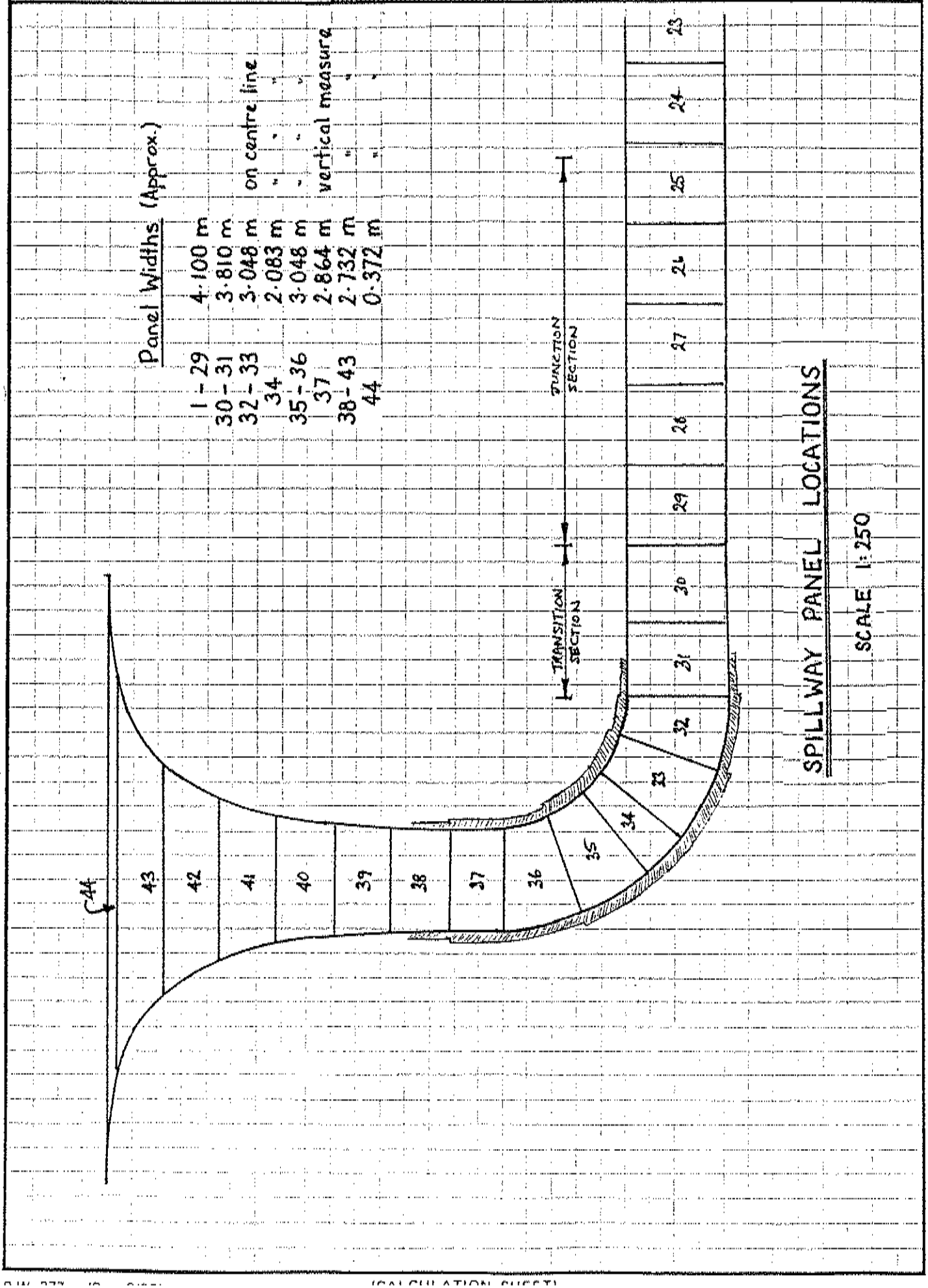


1127/5A

1. GATE VALVE

1127/6A

2. NEEDLE VALVE CASING & GEARS


13 4'95


13 4'95

1124/10

3. NEEDLE VALVE NOSING CONE DAMAGE

1127/9A

4. CLOSE UP OF CAVITATION DAMAGE ON THE NEEDLE VALVE NOSING CONE

1124/12

5. JT 4/5 TR

1124/13

6. JT 5/6 TL

1124/14

7. TYPICAL OF INVERT, 27" OF TAPE SHOWING

1124/15

8. I/W jt TR. TL SIMILAR BUT NOT AS SEVERE

1124/16

9. I/W jt TL

1124/17

10. I/W jt TR, EROSIAN 130mm DEEP, 200mm WIDE 1·1m LONG

1124/18

11. I/W jt TR NEXT TO JT 9/10. EROSION 150mm DEEP, 300m LONG

1124/19

12. HOR jt 1·5m ABOVE INVERT TL

1124/20

13. HOR jt 1·5m ABOVE INVERT TL FULL LENGTH PONEY 200mm HIGH x 80mm DEEP

1124/21

14. TYPICAL OPEN JOINT (Jt 16/17) BETWEEN PANELS

1124/11

15.
TYPICAL OF TUNNEL VEIWED U/S

1124/22

16. CAVITY UNDER WALL TL I/W jt

1124/23

17. TL HOR jt 1·8m ABOVE INVERT WITH OLD PATCHING FAILING, SHOWING ALSO GENERAL LINING CONDITION

1124/24

18. WALL TL SEVERE EROSION UP TO 1·2m ABOVE INVERT

1124/25

19. HOR jt 2·5m ABOVE INVERT TL

1124/5

20. HOR jt 1·3m ABOVE INVERT TL

1127/23A

1127/24A

21. NEEDLE VALVE JET (AT LOW HEAD) AND VALVE CHAMBER BAY TR SHOWING VERTICAL CONSTRUCTION JOINTS

1124/7

22. I/W jt HOLE TR JUST U/S OF JT 29/30

1124/6

23.
PANEL 30 INVERT LOOKING U/S

1124/4

24. JT 31/32 AT INVERT VEIWED D/S

1124/3

25.
INVERT OF PANEL 32 IN IMMEDIATE FOREGROUND (JT 32/33 DIFFICULT TO SEE, TOPMOST JOINT VISIBLE IS JT 35/36)

1124/8

26. CROWN OF PANEL 32 SHOWING STEEL EXPOSURE AT Jt 31/32 AT BOTTOM

1123/1

27. CLOSE UP OF TL MID-HEIGHT CONSTRUCTION jt

1124/9

28.
TL MID-HEIGHT CONSTRUCTION
jt

1123/0

29.
TL MID-HEIGHT CONSTRUCTION
jt

1124/2

30. VEIW UP TO THROAT OF SPILLWAY SHOWING TL MID-HEIGHT CONSTRUCTION JT BUTTING UP TO JT 33/34 AT EXTREME RIGHT OF PHOTO

1124/1

31. CROWN OF PANEL 33, OID 19mm WEEP HOLE PIPE

1123/2

32. jt 33/34 AT INVERT SEVERELY ERODED

1127/8A

33. VIEW UP TO THROAT OF SPILLWAY (AT TOP jt 36/37). G ELLIOT STANDING ON INVERT OF PANEL 34

1123/3

34. Jt 34/35 INVERT (U/S)

1123/4

35. Jt 34/35 TL

1123/5

36. Jt 34/35 TR

1123/6

37. Jt 34/35 CROWN (D/S)

1123/7

38. Jt 35/36 INVERT (U/S)

1123/8

39. Jt 35/36 TL

1123/9

40. Jt 35/36 CROWN (D/S), EXPOSED STEEL, GAP 75mm DEEP, 150mm WIDE + 3m LONG, OLD PLASTER NOT ADHERING WELL ON THIS SIDE WHERE IT HAS BEEN APPLIED

1123/10

41. Jt 35/36 TR, STEEL EXPOSED

1127/7A

42. VIEW OF INVERT (U/S) FROM BELOW SHOWING LOCAL DAMAGE ON PANEL

1123/11

1123/15

43. Jt 36/37 INVERT (U/S)

1123/12

44. Jt 36/37 CROWN (D/S)

1123/13

45. Jt 36/37 TL

1123/14

46. Jt 36/37 TR

1122/1

47. JT 37/38 U/S

1122/2

48. Jt 37/38 D/S

1122/3

49. Jt 37/38 TL, NOTE STEEL

1122/4

50. Jt 37/38 TR

1122/5

51. Jt 38/39 U/S ; GOOD

1122/6

52. J+ 38/39 D/S, PLASTER COULD NEED REPLACEMENT

1122/7

53. J+ 38/39 TL, MINOR ATTENTION REQUIRED

1122/8

54. J+ 38/39 TR. SOME SPALLING OF PLASTER, NO STEEL EXPOSED

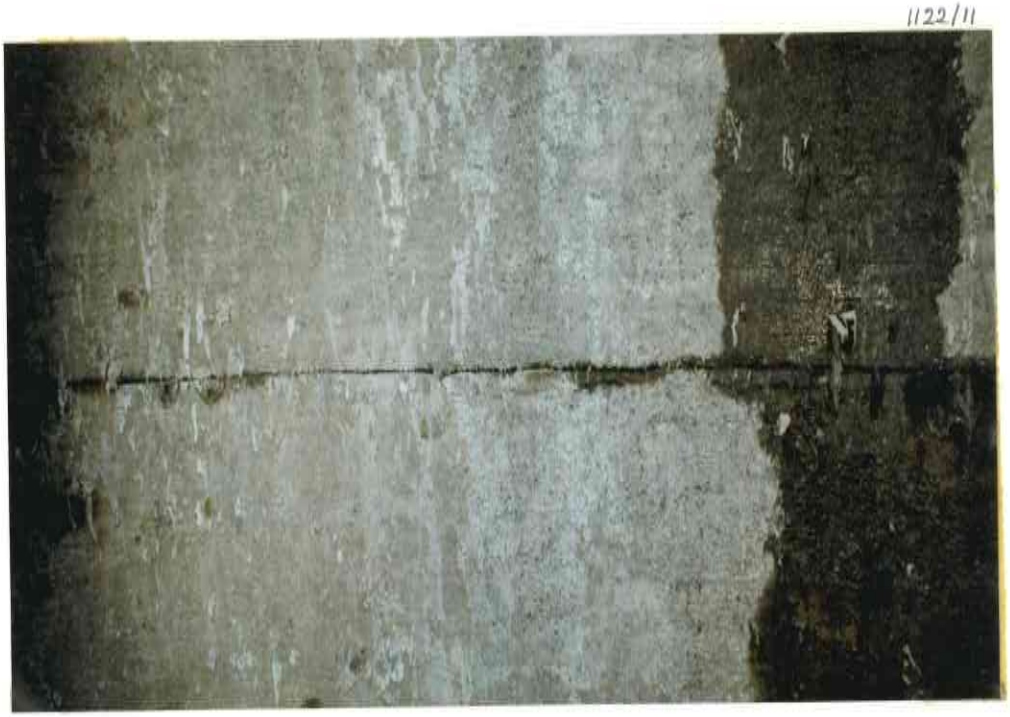
1122/9

55. J+ 39/40 U/S. GOOD JOINT, MINOR OPENING OF JOINT 25mm MAX. MINOR PATCHING, NO UNDERCUTTING

1122/10

56. Jt 39/40 D/S, MORE SIGNIFICANT SPALLING, NO

1122/11



57. Jt 39/40 T/L, GOOD, MINOR EROSIAN BELOW
Jt 1·6m LONG, PATCH WITH MINOR UNDERCUT

1122/12

58. J+ 39/40 TR. MINOR SPALLING, SURFACE PATCHING

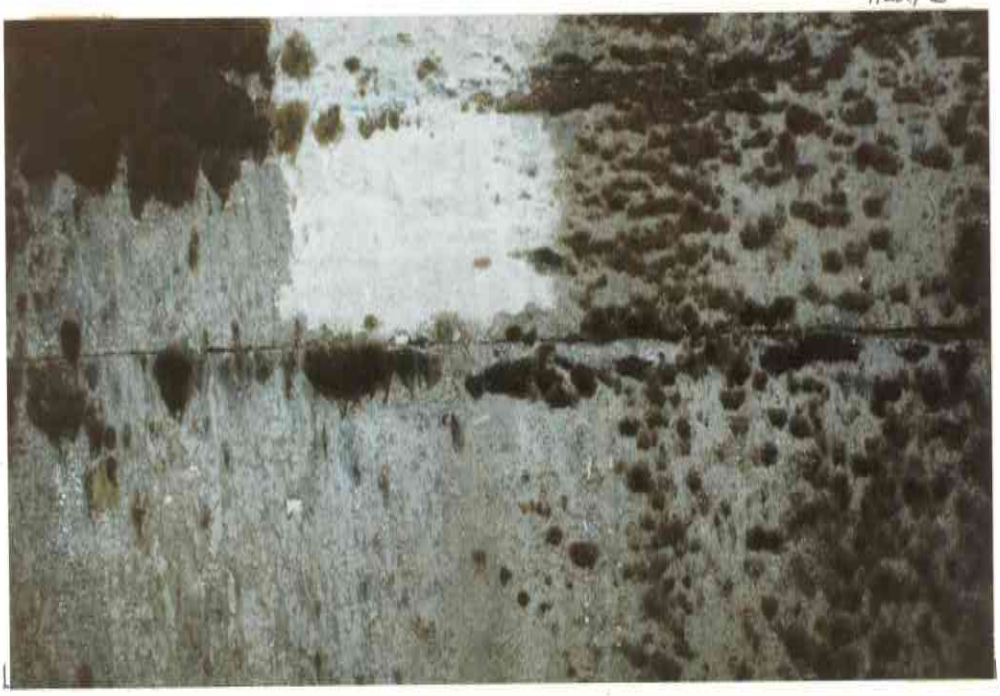
1122/13

59. PANEL 40 TR DEFECT

1122/14

60. J+ 40/41 U/S, GOOD, MINOR LOCAL SPALLING 300mm LONG

1122/15



61 J+ 40/41 D/S, OPEN 12-15mm SPALLING VERY MINOR

1122/16

62. J+ 40/41 TL, SPALLING 75mm, NO STEEL EXPOSED, PATCHING REQUIRED. NOTE FALSE WORK KEYS ABOVE IN PANEL 41 NEED FILLING

1122/17

63. J+ 40/41 TR, JOINT ERODED 350mm DEEP, 100mm WIDE + 4m LONG, STEEL EXPOSED, 450mm CENTRES, 50-100mm COVER GENERALLY

1122/18

64. J+ 41/42 U/S, INFILL PLASTER LOST

1122/19

65. J+ 41/42 D/S, HORIZONTAL STEEL EXPOSED, 600m WIDE, 4m LONG + FULL PANEL DEPTH. URGENT REPAIR

1122/20

66. J+ 41/42 TL. SEVERE EROSION, STEEL EXPOSED, BEDROCK EXPOSED. URGENT REPAIR. VERTICAL STEEL HALF INCH AT 450mm CENTRES. HORIZONTAL STEEL 3/4 INCH. STEEL ANCHORAGES OF ONE INCH BAR. SLAB THICKNESS 150mm. MAX AGGREGATE SIZE 75mm JOINT INFILL WEDGE VERY LOOSE

1122/21

67. J+ 41/42 TR, EROSION 150mm DEEP, 200mm WIDE 300mm LONG

1135/18

68. VIEW FROM ABOVE SHOWING DAMAGE AT Jt 41/42 U/S AND TL AND AT Jt 42/43 U/S

1122/22

69. Jt 42/43 TL, ERODED 50mm WIDE, 100-150mm DEEP

1122/24

70. Jt 42/43 D/S, ERRODED 200mm WIDE, 100-150mm DEEP, POSSIBLE STEEL EXPOSED

1122/23

71. Jt 42/43 TR, GOOD, MINOR LOCAL EROSION 50mm WIDE AND 75mm DEEP

1122/25

72. Jt 42/43 U/S, ERROSION 300mm WIDE, 150-200mm DEEP AND 3m LONG, STEEL EXPOSED, PATCHING REQUIRED

1126/2

73. BAY 1, AGGREGATE EXPOSED 70% AREA NO STEEL EXPOSED IN PANEL

1126/3

74. BAY 2 SIMILAR TO BAY 1

1126/4

75. BAY 3 MORE SEVERE EROSION, ESPECIALLY DOWN FROM J7 43/44 URGENT REPAIR OF IT

1126/5

76. BAY 4 SUBSTANTIAL DETERIORATION OF CENTRAL SECTION. URGENT REPAIR

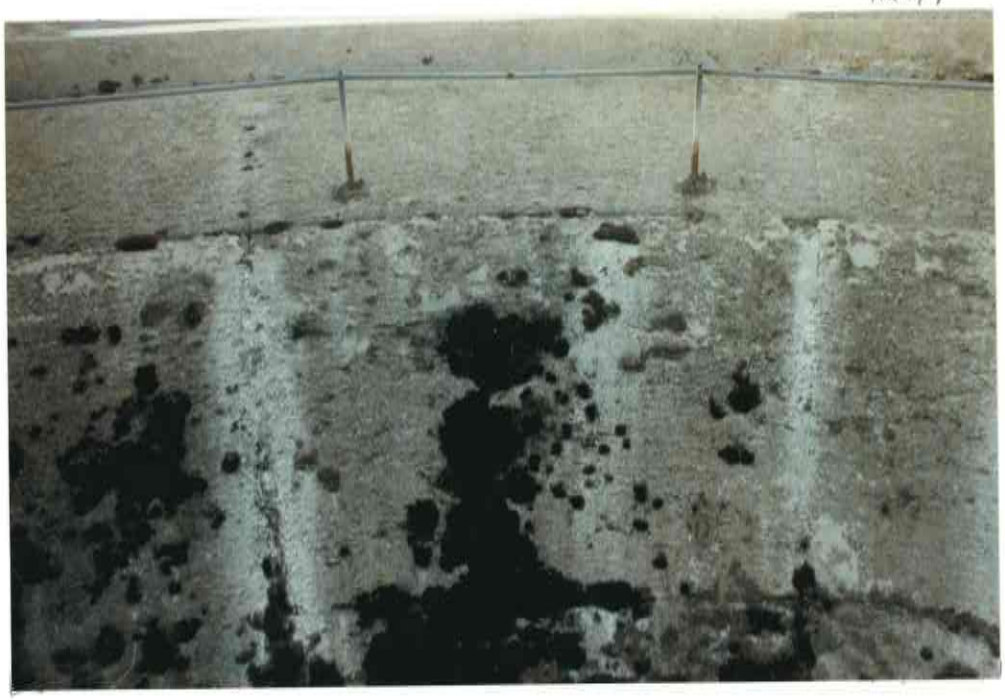
1125/19

77. CLOSE UP OF DAMAGE AT Jt 43/44 BAY 4

1126/6

78. BAY 5, MINOR SPALLING VERTICAL CONSTRUCTION jt. GENERALLY GOOD

1126/7



79. BAY 6, MINOR SPALLING, WORSE THAN BAY 5, NOT SEVERE, MINOR PATCHING ONLY

1126/8

80. BAY 1

1126/9

81. BAY 2

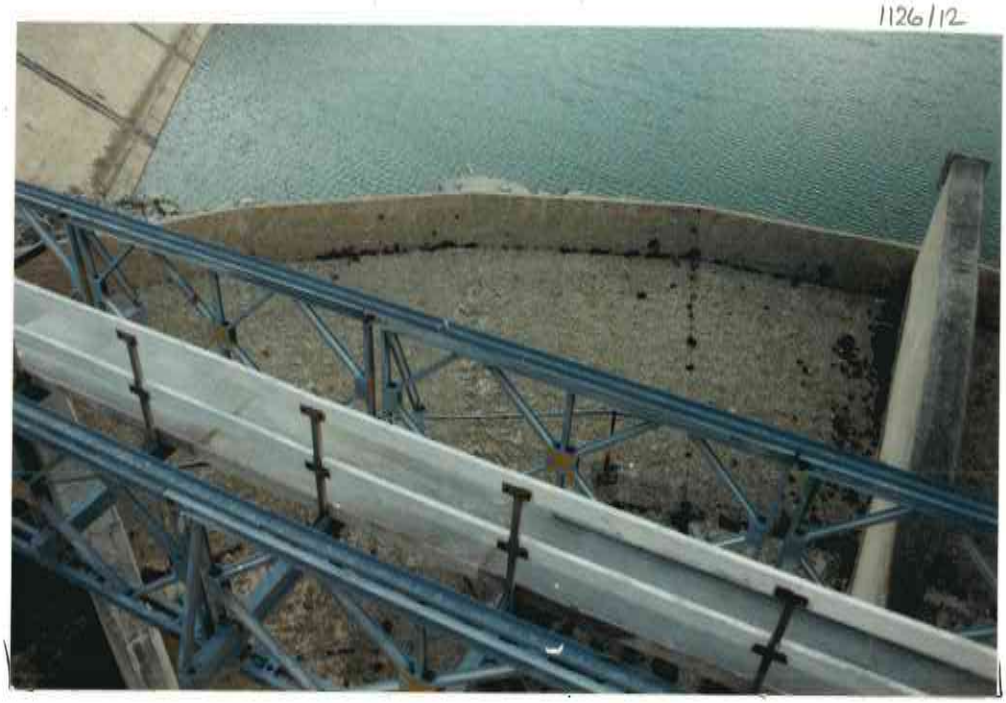
1126/10

82. BAY 3, REPAIR POOR CONSTRUCTION j/s MID PANEL

1126/11

83. BAY 4

1126/12



84. BAY 5

1126/13

85. BAY 6

1127/11A

86. VIEW UP TO FOUNDATION AT BAY 5, ROCK AT CENTRE OF PHOTO MOSTLY IN SITU

1127/12A

87. LOOSE ROCK SLOPE BELOW BAY 5, IN SITU ROCK TOP LEFT + TOP RIGHT

1127/10A

88. ACCESS TRACK PASSED SPILLWAY

1127/13A

89. DAM MEMBRANE

1126/14

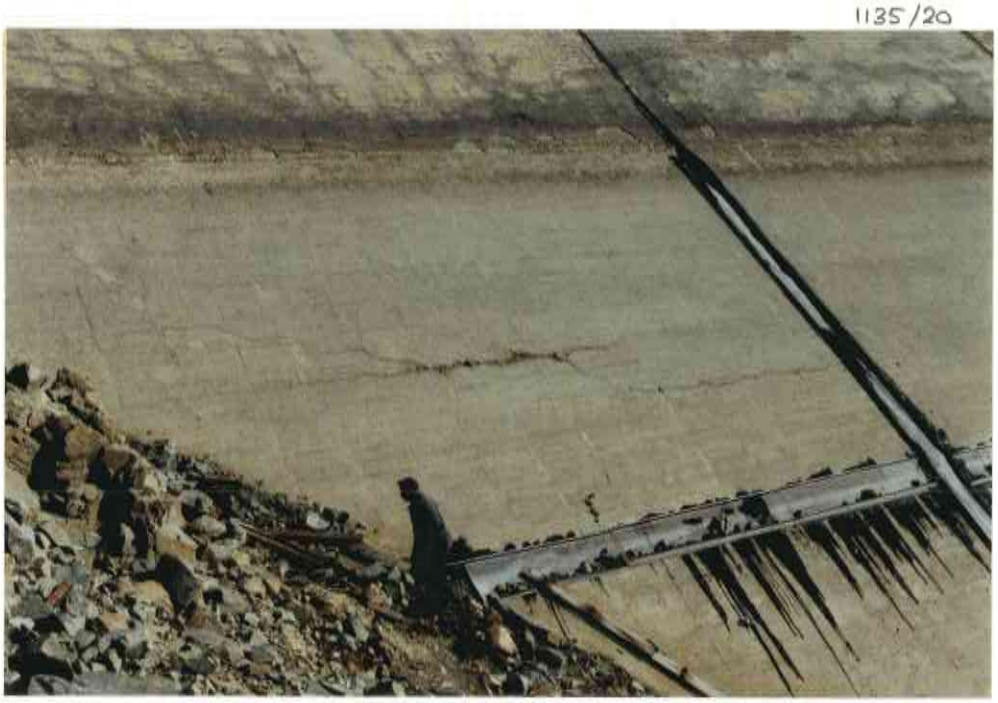
90. DAM MEMBRANE VIEWED FROM ABOVE

1135/21

91. CLOSE UP OF SURFACE DAMAGE AT NORMAL WATER LEVEL BETWEEN FIRST + SECOND PANELS

92. CONCRETE SURFACE DAMAGE NEAR THE ABUTMENT MIDWAY DOWN SECOND HORIZONTAL PANEL ROW

1135/20



93. SECOND OF TOP PANELS NOW SHOWING DAMAGE AT NORMAL WATER LEVEL & HORIZONTAL CRACK ABOVE FIRST HORIZONTAL JOINT

94. SECOND OF TOP PANELS NOW SHOWING DAMAGE AT NORMAL WATER LEVEL + HORIZONTAL CRACK ABOVE FIRST HORIZONTAL JOINT

1127/14A

95. END OF SECOND HORIZONTAL JOINT WHERE IT COMES INTO THE TL ABUTMENT SHOWING HOW THE RUBBER STRIPS ARE HELD DOWN

1127/16A

1127/15A

96. VERTICAL JOINT BETWEEN THE SECOND AND THIRD PANELS