April 27, 1990

MEMORANDUM

TO: Robert L. Morgan, State Engineer

FROM: Gerald W. Stoker, Area Engineer
Kerry E. Carpenter, Asst. Area Engineer

SUBJECT: UP&L Power Canal, Santa Clara System

I. BACKGROUND

Utah Power & Light Co. owns and maintains a water conduit consisting in various parts of earthen canal, concrete-lined canal, and steel pipe (30" to 48" Ø). This conduit originates in a water diversion on the Santa Clara River above Baker Reservoir and transmits water thence in a generally southwesterly direction to the Veyo generating station, then continuing to the Upper Sand Cove reservoir, the Lower Sand Cove reservoir, through the Lower Sand Cove generating station and to the Gunlock generating station. The discharge from the Gunlock station re-enters the Santa Clara River channel.

II. FIELD INVESTIGATIONS

Downstream users of the Santa Clara River water had expressed concern through River Commissioner Rod Leavitt that a significant portion of the water being diverted into the UP&L conduit was being lost to leakage. Pursuant to instructions from the Office of the State Engineer, a thorough investigation of the conduit was conducted on 23 April 1990 by Gerald Stoker, Area Engineer for the Division of Water Rights, Kerry Carpenter, Area Assistant Engineer, and Gary Nigbur, Area Manager for UP&L. During this investigation, nearly every section of the subject conduit was traversed and closely observed. As far as possible, visible leaks were identified and estimates were made of the quantity of water being lost.

On 26 April 1990, Mr. Stoker and Mr. Carpenter returned to the area with current metering equipment and took measurements to attempt to quantify flows in the upper portion of the conduit above Baker Reservoir and thus quantify the losses occurring in this reach of canal. Readings were taken at the initial point of diversion and at a spillway approximately $^{1}/_{4}$-mile downstream from this point. Two Parshall flumes were also re-read for comparison to readings taken during the earlier visit to the site.

Following are summarized and expanded field notes taken during these investigations. The "Point Numbers" associated with the notes are indicative of the sequence in which the observations were made. The observations have been re-ordered to run sequentially from the initial point of diversion to the final point of discharge and the accompanying map sheets (6) indicate the approximate locations of the observed points.
Numbers in parentheses represent aerial photographs used during the investigation and in the possession of the Cedar City Area Office of the Division of Water Rights.

POINT NO.	OBSERVATIONS
33	(Photo 477 15-2) Point of diversion: an antiquated headgate structure in rectangular concrete "box" section. Observed a small amount of water going over spillway to continue flowing in Santa Clara River; with the remainder diverted into earthen canal running parallel to and west of river. There is no flow-metering apparatus available at this point. (Gary Nigbur reports that base flow of 0.5 CFS is to remain in the river to support fish habitat.) 26 April 1990: Using a Type "AA" current meter, a flow of 14.84 CFS was measured as being diverted at this location.
33A	Approximately 350' below the initial diversion, a 1,000-foot piped section (36") has been installed. There are no apparent leaks in this section except that a significant amount of flow is leaking around the pipe headwall and re-entering the river. The grate over the pipe opening was observed to be partially obstructed with debris and water was pooling upstream and passing over a spillway and into the river. Mr. Carpenter and Mr. Nigbur removed the debris and the flow increased sufficiently that the pool subsided and the spilling was eliminated. Mr. Nigbur indicated that the leakage around the headwall was not considered especially problematic because this flow goes toward providing the required 0.5 CFS base flow in the river.
32	(477 15-2) Diversion structure allowing re-diversion of the canal flow into the river. The canal flow crosses a 9.67' wide spillway approximating a broad-crested wier; flow depth over the crest was measured at 0.36' (left) and 0.40 (right) with a drawdown of approximately 0.05', yielding an average head (H) of 0.43'; the breadth of the spillway is approximately 0.67'.

POINT NO.	OBSERVATIONS
32 (Cont'd)	Flow is estimated as $Q=CLH^{2/3}$, where C is a constant varying with H and the slope of the crest. For a level crest and H=0.43, a value of C= 2.77 is assumed. $Q = (2.77)\ (9.67)\ (0.43)^{2/3}$ Q = <u>7.55 CFS</u> 26 April 1990: An attempt was made to measure flow at this location using a "Pygmy" current meter to measure the flow over the spillway crest. However, the calculated results were obviously incorrect and so the attempt was abandoned.
32-31	(477 15-2) Canal section approximately 4,600 feet in length; primarily concrete lined. Some 21 leaks of various sizes identified, but all are unquantifiable due to terrain. It appears that most of the water lost will re-enter the Baker Reservoir.
31	(477 15-2) Measurement taken at 3-foot Parshall flume (location is at approximate NW extension of Baker Dam centerline): H = 0.70' (right), 0.69' (left), average of 0.69'; Q = 6.71 CFS. Mr. Stoker advised Mr. Nigbur that flume accuracy could possibly be improved by removing some embankment and growth at left side of flume inlet. 26 April 1990: Re-read Parshall flume. The staff gauge reads 0.92', measured 0.89' (left) and 0.87' (right); using average of 0.893' yields a Q of 10.05 CFS. This flow represents an increase of 49% over the previously measured flow, probably due to substantial precipitation received during the intervening period.
31A	(477 15-2) Observed flow in river below Baker Dam due to seepage around discharge structure. Very minor flow evident.
--	(477 13-1) Drove to area of "Brookside" subdivision and along Santa Clara River to area of spring collection for Veyo/Brookside culinary water systems. Leaks in the canal above this area typically appear as "falls" along the ledges on the west side of the river. No falls were observed although locations of previously existing are evident. Flow in the river was observed to be somewhat greater than below Baker Dam, apparently due to intervening spring flows.

POINT NO.	OBSERVATIONS
--	(477 31-1) Drove down "Canal Drive" to observe portion of canal above the Veyo generating station penstock. No leaks were evident in this area.
1A	(477 31-1) Measured flow through 3-foot Parshall flume below the Veyo generating station: H = 0.70, Q = 6.86 CFS. This flume measures the discharge from the Veyo station plus the flow in the Santa Clara River to this point. Therefore the slight increase over the previously metered point represents a balance of seepage losses from the canal and gained flows in the river. The measurement was taken at approximately 10:40 AM.
1	(477 13-3) Observed large water loss estimated at approximately 1 CFS between piped sections (42" and 36" welded steel). The lost flow crosses a small meadow area and re-enters the Santa Clara River. No estimate is made of the amount lost to infiltration prior to entering the river.
2	(477 13-3) Observed 3-4 smaller leaks in concrete lined section of canal which approximately 100' below the end of the 36" pipe section noted at Point No. 1. The majority of the seepage is infiltrating the hillside with a small amount re-entering the river. These seeps are not quantifiable.
3	(477 13-3) Observed 5-10 GPM leak in concrete lining located 50-75' above irrigation diversion for Veyo town. No water was being diverted for irrigation at this time.
4	(477 13-3) Observed split weld joint in steel pipe (36") section just across Santa Clara River. The loss is estimated at 5-10 GPM.
6	(477 13-3) Observed small amount of seepage at headwall of 36" steel pipe discharge to earthen canal. Wet ground, but no running water evident.
5	(477 13-3) Observed metal headgate leaking 2-5 GPM between gate and frame with water running to pasture. There no apparent leakage around the gate structure itself.
7	(477 13-3) Observed two small leaks with total loss of approximately 4 GPM.

POINT NO.	OBSERVATIONS
8	(477 13-3) Observed minor leakage beneath concrete headgate structure; estimated at 1-2 GPM.
9	(477 13-3) Irrigator is diverting approximately 1 CFS (unmetered) through concrete headgate structure. A large amount of underflow was observed to be bypassing the structure.
10	(477 13-3) Observed drainage crossing constructed of trestled "half-rounds" of 48" metal pipe with concrete headwalls. There is significant underflow escaping around the upstream headwall despite evidence of recent repair efforts. Mr. Nigbur was advised that it may be necessary to import clay soil material to effect a seal.
10-11	(477 13-3) Most of this section was observed using field glasses from the vehicle. The canal runs around the point of a hillside and significant leaks would be evidenced by increased vegetation and wet ground. No such indications were observed.
11	(477 13-3) Measured flow at 3-foot Parshall flume at 12:33 PM: H = 0.56', Q = 4.84 CFS. This represents a total loss of 2.02 CFS from the measurement at the Veyo generating station. The majority of this loss is obviously from the points identified above as Point No's 1 and 9. 26 April 1990: Measured flow at this flume again at approximately 1:30 PM: H = 0.64', Q = 5.97 CFS. This represents a net loss of approximately 4 CFS between this point and the flume near Baker Dam. The intervening canal/pipeline was not observed on this date to evaluate losses.
11-11A	(477 13-3, 477 11-3) Observed section of earthen canal approximately 10,000 feet in length by walking length of canal. A few areas of minor seepage were noted along this relatively flat reach, but most represented routine maintenance items and did not appear to present significant losses of water.
11A	(477 11-3) Observed Upper Sand Cove Reservoir. The water level is considerably lower that evidence of historic levels. Discharge leaves the reservoir in welded steel pipe (mostly 30" with a short section of battered 42" just below the reservoir).

POINT NO.	OBSERVATIONS
12	(477 11-3) Observed a "spurter" leak at a broken weld in a fabricated transition piece of welded steel pipe between the 36" and 42" sections. The estimated loss is less than 1 GPM.
13	(477 11-3) Observed minor seep in steel pipeline; not quantifiable.
14	(477 11-3) Observed two small seeps in pipeline at location of previous repair; unable to quantify.
15	(477 11-3) Observed $^1/_2$" tap into steel pipeline. This is possibly an unauthorized tap. The tap is valved and the valve was closed at this time.
16	(477 11-3) Observed 4" drain valve (UP&L installation) and 1" valved tap approximately 20' upstream. This is possibly an unauthorized tap. The valve was closed at this time.
17	(477 11-3) Observed small leak (approximately 0.5 GPM) at expansion joint in spiral-weld steel pipeline.
18	(477 11-3) Observed small leak (approximately 1 GPM) at point of previous repair in steel pipeline.
19	(477 11-3) Observed small leak (approximately 1 GPM) at expansion joint in steel pipeline.
20	(477 34-1) Observed small leak (approximately 1 GPM) at expansion joint in steel pipeline.
21	(477 34-1) Observed small leak (approximately 1 GPM) in vertical "surge pipe" at head of penstock for Lower Sand Cove generating station.
22,23,24	(477 34-1) Observed small leaks (approximately 1 GPM) in expansion joints in steel pipe penstock. Also observed 2-3 smaller seeps in this area - too small to quantify.
24-24A	(477 34-1) Observed earthen canal from vehicle between Lower Sand Cove generating station and Lower Sand Cove Reservoir. No evidence of leaks was observed.
25	(477 34-1) Observed spraying leak (approximately 1 GPM) at west support pillar over major drainage crossing.

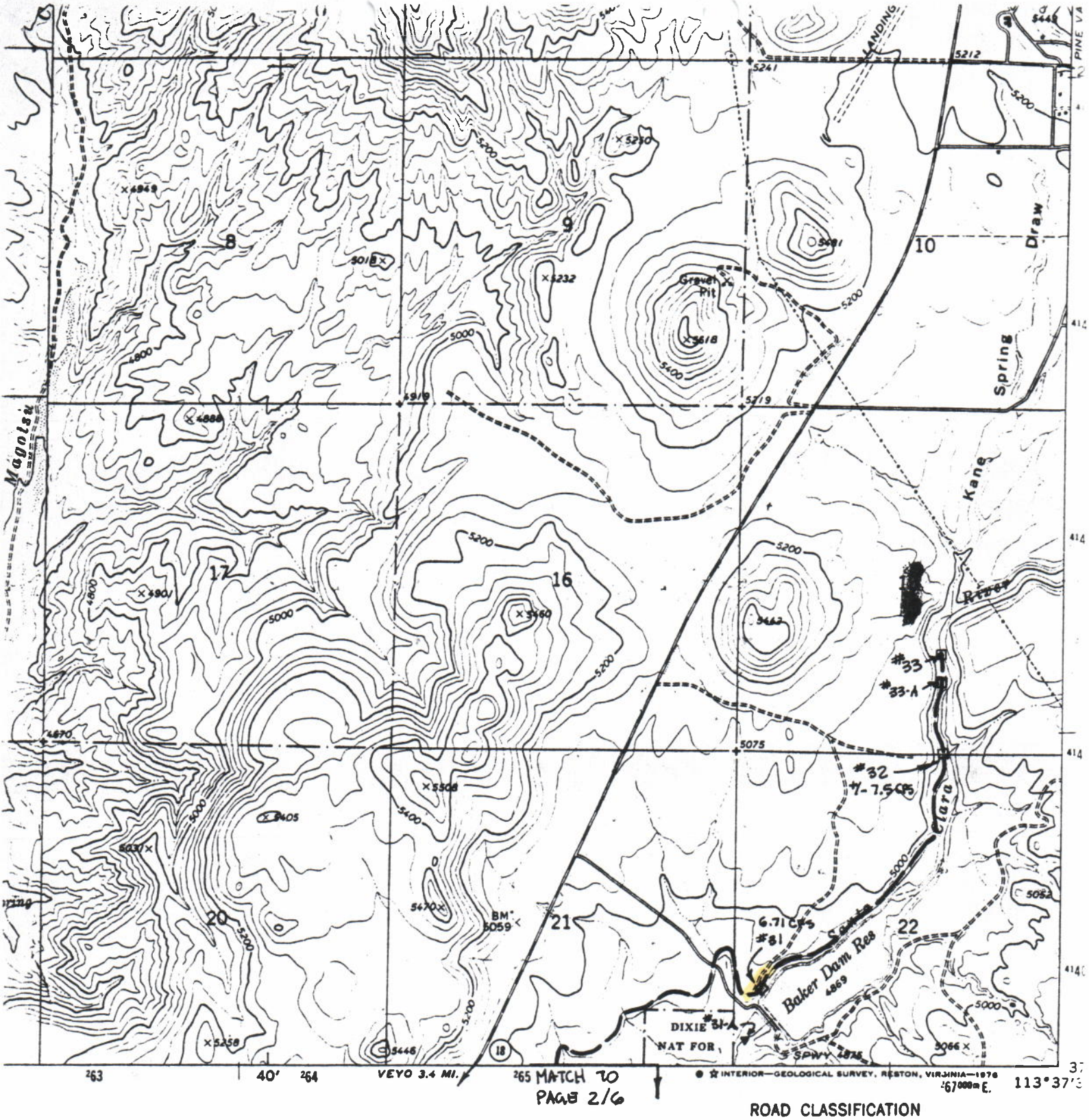
POINT NO.	OBSERVATIONS
26	(477 34-1) Observed spraying leak (approximately 1 GPM) at support pillar. It appears that a sharp rock point in the pillar has penetrated the pipe. Mr. Nigbur stated that draining this section of line for repairs is an extensive undertaking, so maintenance is usually delayed until several areas are in need of work before proceeding.
27	(477 34-1) Observed small seep; unable to quantify.
28	(477 34-1) Observed 4 small leaks (approximately 1 GPM each) in upper portion of vertical "surge pipe" above the Gunlock generating station. Also observed a leak of similar size in an expansion joint just below the surge pipe.
29	(477 34-1) Observed spraying leak (approximately 1 GPM) in steep portion of penstock above Gunlock generating station.
30	(477 34-1) Measured discharge from Gunlock station at 3-foot Parshall flume: H = 0.44', Q = 3.32 CFS. The direct reading staff gauge indicated a flow of approximately 3.75 CFS. The measurement was taken at 3:10 PM. The discrepancy of approximately 1.5 CFS between this reading and the flow measured at the flume near Veyo (Point No. 11) is not readily explained since the two intervening reservoirs may be taking an unknown amount for filling purposes. The leaks identified in the intervening canal and pipeline certainly do not appear to be of sufficient magnitude to account for a differential of this size.

III. CONCLUSIONS

Pursuant to the field investigation detailed in the foregoing, it concluded that there are a few points of leakage in the subject conduit that should receive maintenance attention. The principal points of significant loss are along the section of canal above the Baker Reservoir wherein approximately 4 CFS of flow is lost and just below the Veyo generating station where approximately 1 CFS is lost. However, it should be noted that the loss into the Baker Reservoir is possibly recoverable to the downstream users through a metered discharge from the reservoir. Also, the bulk of the water escaping below the Veyo station appears to re-enter the river and is thus usable downstream.

A question that Mr. Nigbur felt ought to be addressed is the responsibility of maintenance of irrigation diversions along the canal. While only one such diversion was noted to be capable of allowing the loss of a significant amount of water, others were observed to be creating minor losses that could develop into major problems if routine maintenance is not scheduled.

Finally, it might be noted that the observations made during the detailed investigation represent only those conditions evident at the flow conditions extant at that time. At higher rates of flow, other significant leakages may become evident. It is concluded that the leakage losses observed at this time represent more clearly an economic loss to UP&L than a loss of usable water to downstream users on the Santa Clara River.



ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

Interstate Route

U. S. Route

State Route

1 MILE

6000 7000 FEET

1 KILOMETRE

1929

QUADRANGLE LOCATION

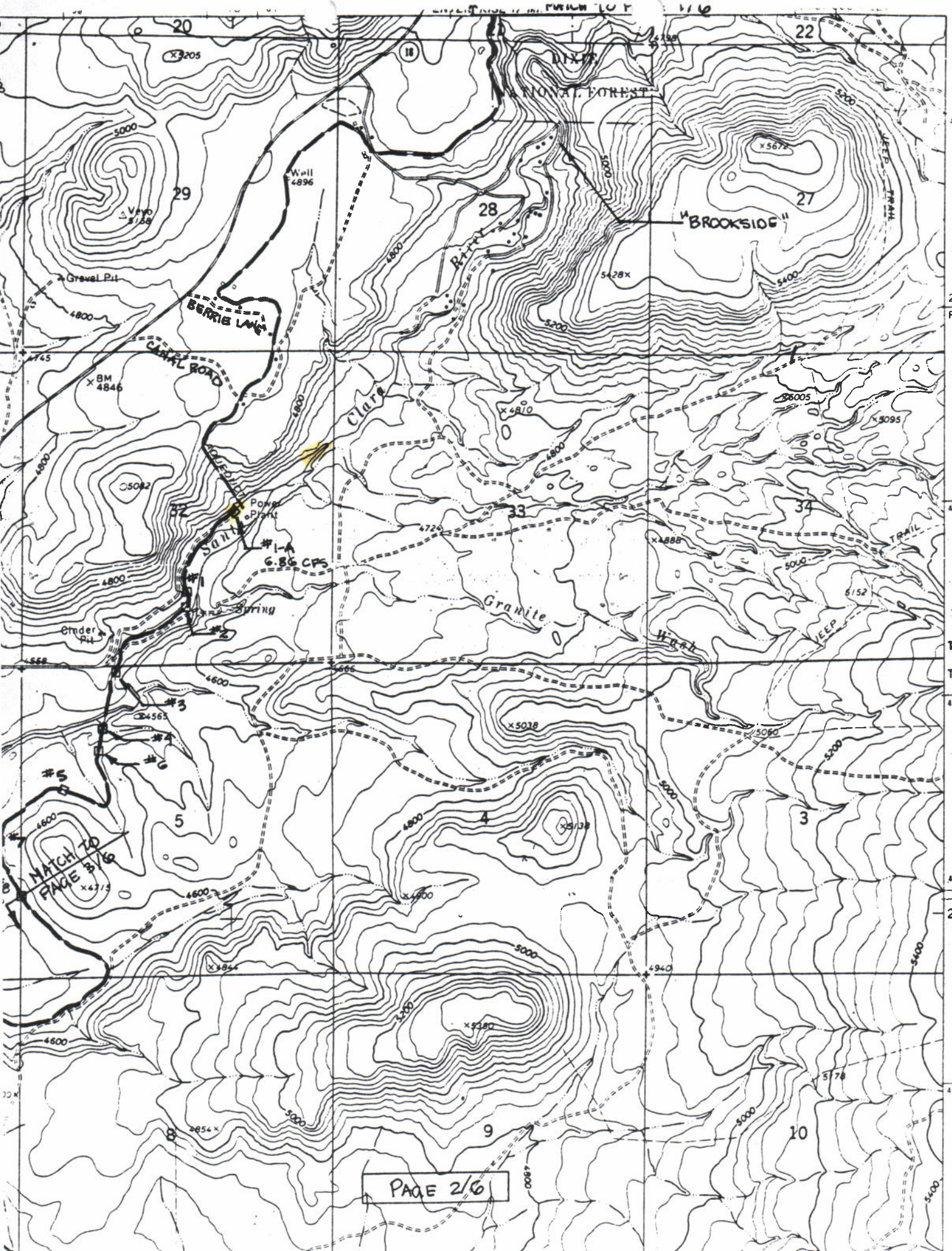
ACY STANDARDS
25, OR RESTON, VIRGINIA 22092
AVAILABLE ON REQUEST

PAGE 1/6

CENTRAL WEST, UTAH

N3722.5—W11337.5/7.5

1972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NATIONAL FOREST
"BROOKSIDE"
BERRIE LANE
CANAL ROAD
Gravel Pit
Well
4896
Vevo
5158
BM
4846
Clara
River
Power
Plant
#1-A
6.86 CFS
#1
#2
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#4
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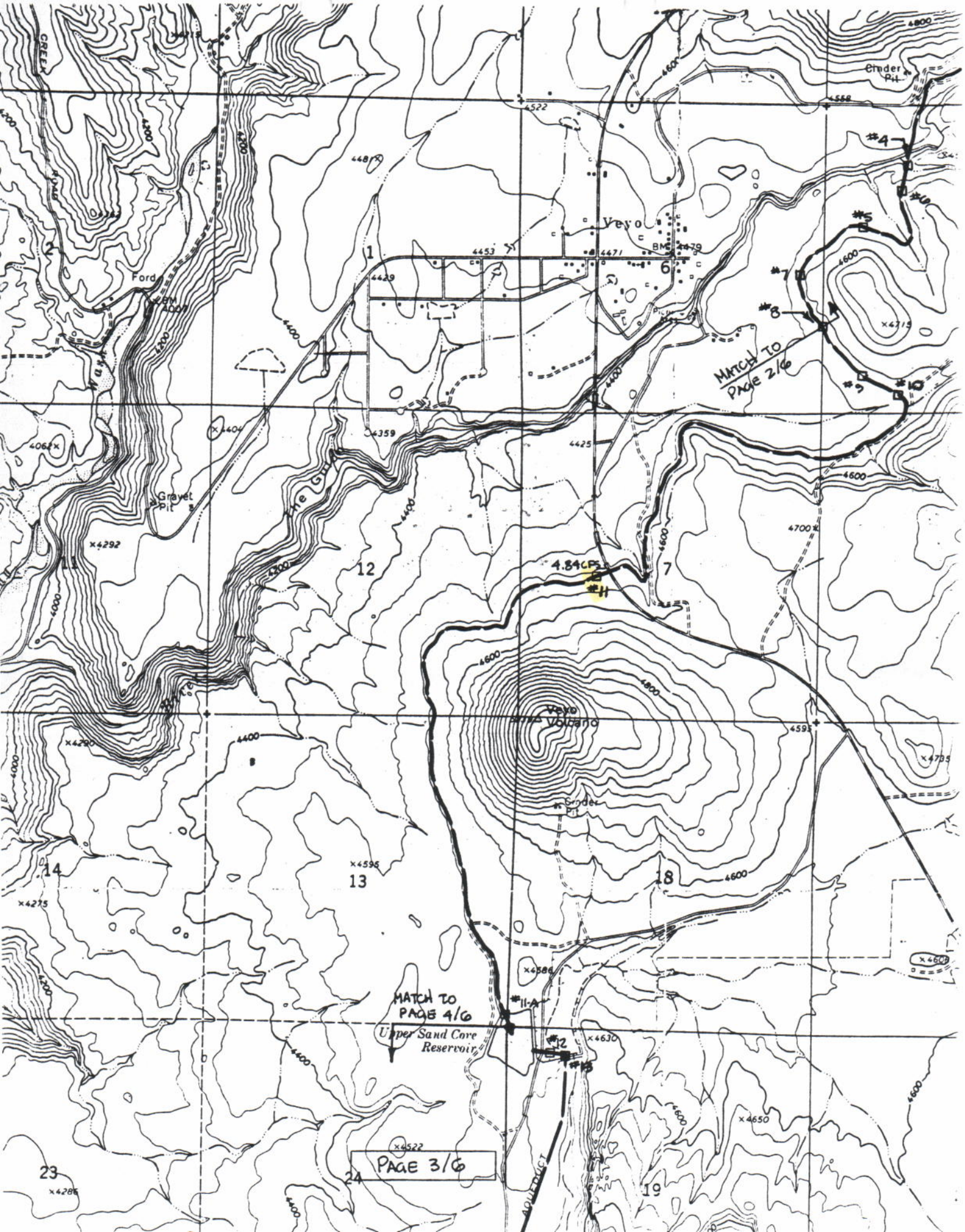

Cinder Pit
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4558
4481
Ford
BM 4007
Gravel Pit
The Gulch
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4425
4062
4292
4700
4.84CFS
#11
Veyo Volcano
Cinder Pit
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4290
4275
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4586
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Upper Sand Cove Reservoir
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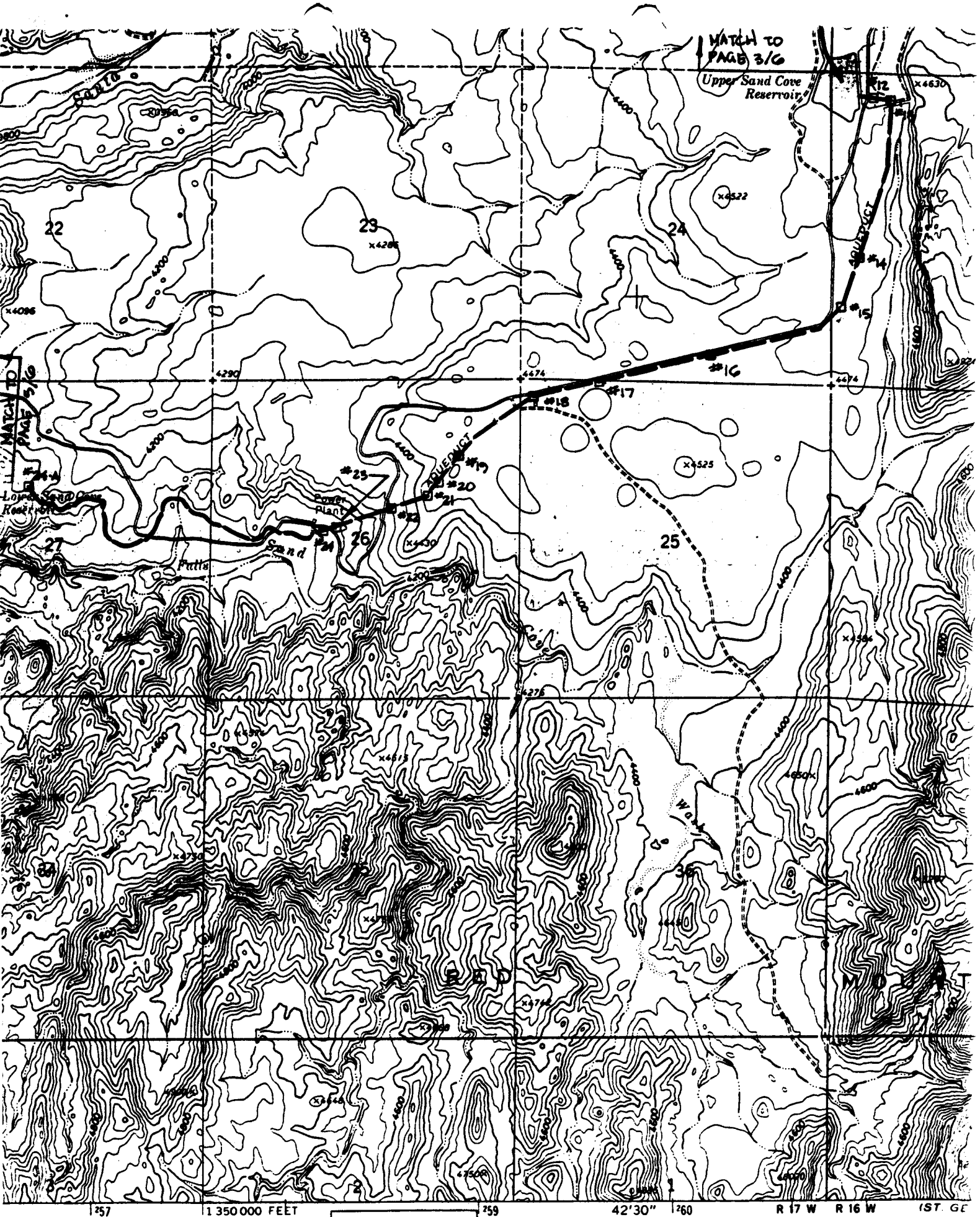
AQUEDUCT
PAGE 3/6



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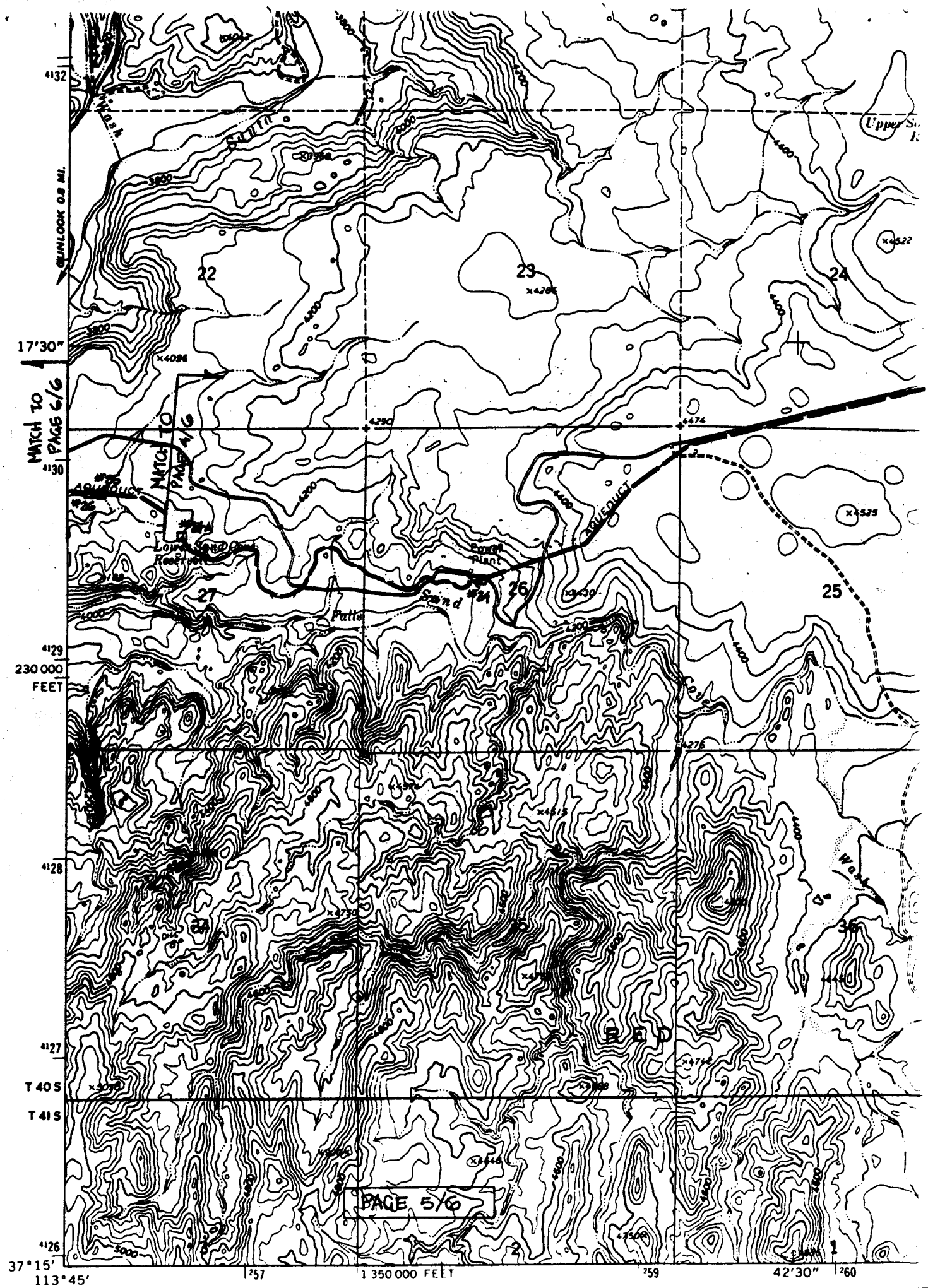
GS and NOS/NOAA

SCA



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AQUEDUCT
Lower Sand Cove Reservoir
Power Plant
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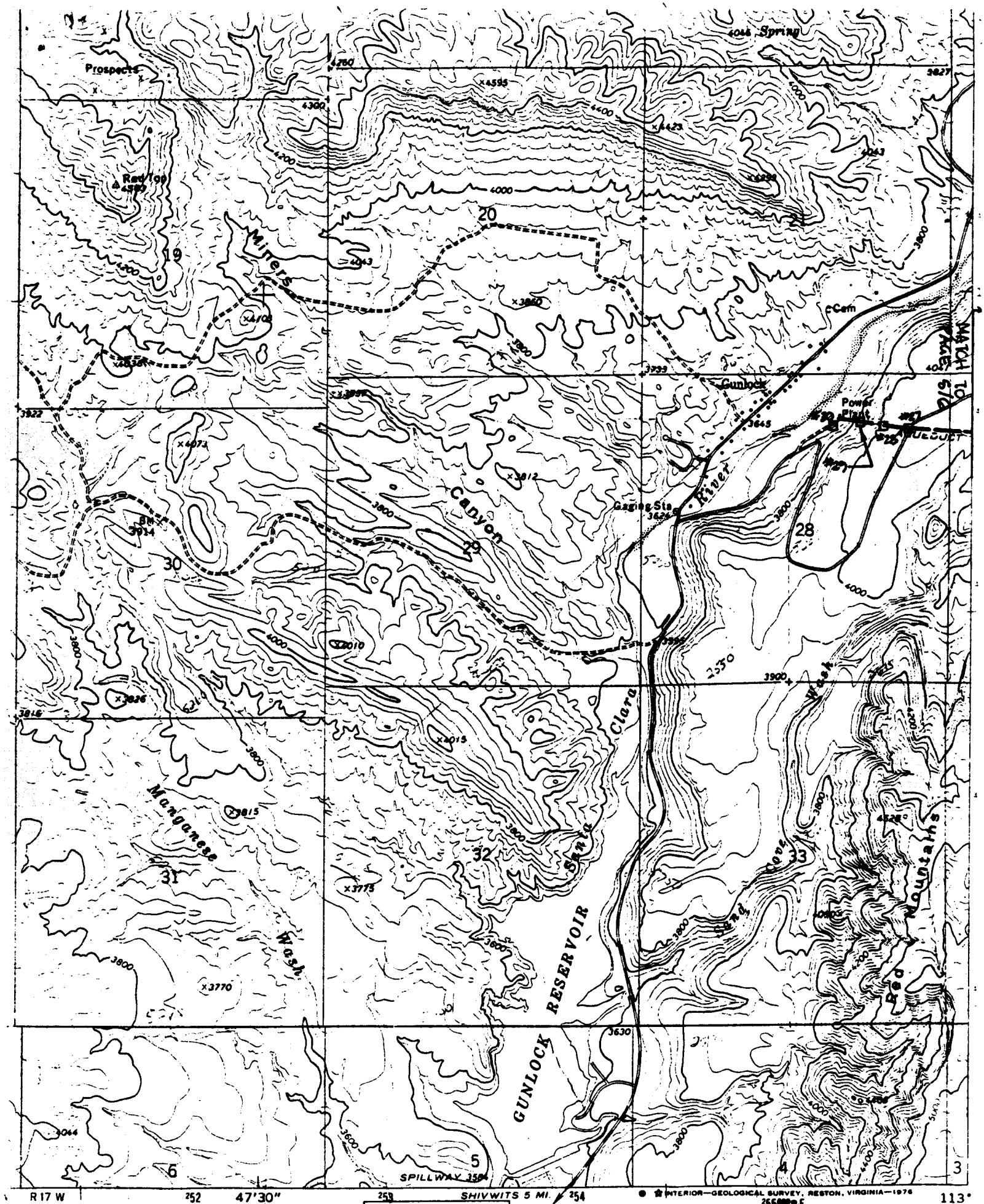

PAGE 6/6

ROAD CLASSIFICATION