AMARGOSA 1983

BY

ROBERT COACHE

COMPILED 3-84

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EXISTING PERMITTED WATER RIGHTS
AMARGOSA DESERT BASIN #230
(RED)

	PERMIT	NO.		PERMIT	NO.
	23057	1 U Cen. Nev. Util.		26610	21 U Cen Nev Util.
	25099	2 U "		26805	22 U "
	25423	3 U "	cert	27812	23 U I M V
	25554	4 U "		28062	24 U Embrey
	25557	5 U "	cert.	28777	25 U Oki Welch
	25558	6 U "	cert	28828	26 U Strickland
	25559	7 U "		28880	27 U Cen. Nev. Util
	25560	8 U "		29139	28 U. B.K.K. Co.
	25561	9 U "		29140	29 U. BKK Co.
	25562	10 U "		29341	30 U Fred Allen
	25580	11 U "	cert.	29451 [illegible]	31 U IMV
	25581	12 U "	cert.	29452	32 U IMV
	25582	13 U "		29649	33 U Wall et al
	25662	14 U "		29650	34 U Wall, et al
cert.	25742	15 U V.D. Hill		29741	35 U Cen. Nev. Util
cert.	25743	16 U V.D. Hill		30176	36 U Thorpe
cert.	25744	17 U V.D. Hill	cert.	30411 [illegible]	37 U Owens
	26197	18 Spr. Cen. Nev. Util	withdrawn	30884	38 U
	26427	19 U "		32279	39 U Ash Meadow Lodge
	26609	20 U "		33010	40 U Vassar

Suggest something like this:
Estimates of perennial yield for the Amargosa Desert area range from 24,000 acre-ft to as much as 117,000 acre-ft. An examination of the supporting data for these various yields and recent water-level measurements indicate that the perennial yield estimate of 24,000 acre-ft is the most realistic value.

— or something like that. This gets us away from a policy question and the use of references in the ABSTRACT.

ASSESSMENT OF ESTIMATES OF PERENNIAL YIELD OF WATER, AMARGOSA DESERT, SOUTHERN NEVADA

By J. P. Akers

ABSTRACT

The estimated perennial yield of the Amargosa Desert area, about 24,000 acre-feet, made by Walker and Eakin (1963) is considered the best estimate available, but the study by Pistrang and Kunkel (1964) suggests that the yield could be 4,000-5,000 acre-feet more. Unfortunately, an estimate made by James A. Goodrich (written communication, 1983) of 117,000 acre-feet was based, through no fault of his, on a depth-to-water map that is erroneous and therefore invalid. Additional pumping from the central Amargosa Desert would [? continue to] lower ground-water levels and could adversely impact some phreatophytic plants. The effect of such pumping on the water level in Devil's Hole with present data is conjectural and would depend principally upon the location, duration, and [volume] intensity of pumpage.

Location map?

INTRODUCTION

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Purpose and scope

Pressure has been mounting in recent years for housing and urban development in the Amargosa Desert area of southern Nevada. The development is contingent upon the availability of water supplies, of which virtually all would be from ground-water sources. Under present Nevada law, long-term "mining" of ground water is restricted; that is, the average annual withdrawal of water from a ground-water basin must not exceed the average annual natural recharge or discharge from that basin.

I don't see any reason to say this

The Amargosa Desert is underlain and mostly surrounded by sedimentary rock. The sedimentary rock at depth is predominantely carbonate rock which transmits water freely, and which probably is overlain by nearly continuous beds of volcanic tuff that tend to confine water in the underlying carbonate rock. The tuff, in turn, is overlain by valley fill which forms the valley floor and the main pumped aquifer in the valley.

The Amargosa Desert area is bisected by an inferred ground-water barrier which is subparallel to, and just west of, the line of springs in Ash Meadows (figure 1). The effectiveness of this barrier to impede water from moving at depth through the carbonate rock from east to west is not known.

Should this have a heading Hydrogeologic setting.

Questions recently have been raised concerning the adequacy of 3 two widely differing estimates of the "perennial yield" or "safe yield" of the Amargosa Desert, and in particular the most recent estimate of 117,000 acre-ft/yr. The first estimate of 24,000 acre-feet per year was made by Walker and Eakin (1963) and has been the basis upon which the Nevada State Engineer has approved or disapproved rights to appropriate ground water in the Amargosa Desert. The third second estimate of 117,000 acre-feet per year was made by James A. Goodrich in an unpublished affidavit (written communication, 1983). The second estimate by Pistrang and Kunkel (1964) ——

Abstract has 3 estimates

An assessment of the validity of the two estimates is the subject of this report. Also, briefly considered qualitatively, is the impact resulting from increased pumping from the central Amargosa Desert. The study was made in cooperation with the U.S. National Park Service.

ESTIMATE BY WALKER AND EAKIN (1963)

The estimate made by Walker and Eakin (1963) is based on a recognized method, described by Mann (1967) as follows:

> Average annual outflow and evapotranspirative waste. In relatively undeveloped basins, the safe yield can be estimated if it is assumed that all the rising water outflow, underflow out, and phreatophyte waste can be salvaged. A further component (difficult to measure) is the capture of formerly rejected recharge. All these components, adjusted for recirculation, become the safe yield.

This method assumes that before any significant pumping has occurred in a particular ground-water basin, the long-term average annual discharge (as rising ground water and as underflow) plus all losses to evapotranspiration, is equal to recharge to the ground-water system. Thus, if recharge is known, the discharge is known. Walker and Eakin (1963, page 29) state, "The physical conditions in Amargosa Desert suggest that the estimate of discharge is the better basis on which to estimate perennial yield in the light of present information." This method does not require an estimate of recharge to the ground-water system. Walker and Eakin's estimate of long-term average annual natural discharge is 24,000 acre-feet. Any additional quantity of water that might be captured from formerly rejected recharge in the Amargosa Desert area would be very small.

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Walker and Eakin do not hesitate to state that their estimates of evaporation, transpiration, and ground-water outflow are crude. They estimate that, collectively, the discharge from the carbonate rock as spring discharge and ground-water outflow is more than 17,000 acre-feet per year, and may exceed 20,000 acre-feet; and that about 7,000 acre-feet enters the valley fill from the northwestern part of the desert. This 7,000 acre-feet discharges as evapotranspiration and outflow at the southern end of the basin. They have used no unreasonable assumptions in their estimate and have overlooked no obvious elements in their determination of outflow.

One element, not so obvious but which was mentioned by Walker and Eakin (1963 page 27), is southwestward ground-water outflow along a possible transverse fault zone in the Funeral Mountains which could supply water to springs on the east side of Death Valley. As Walker and Eakin point out, water-level contours, shown in figure 1 (plate 3 of their report), do not indicate any such outflow. However, the data points used in constructing their contours may not be adequate to reflect such outflow. Any such outflow could be on the order of 4,000 to 5,000 acre-feet annually, which is equal to the estimated combined discharge of the springs (Pistrang and Kunkel, 1964; and Hunt and others, 1966). This additional outflow would raise the estimated total discharge from Amargosa Desert to 28,000 or 29,000 acre-feet, annually.

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ESTIMATE BY JAMES A. GOODRICH

James A. Goodrich's estimate (unpublished affidavit submitted to Nevada District Court, February 14, 1983) of ground-water welling up from the carbonate rock into the Amargosa Desert basin is based on a valid method and on depth-to-water data shown in figure 2 (from figure 1167-300-4, U.S. Bureau of Reclamation, 1975). Goodrich points out that the depth-to-water contours in this figure indicate a "ground-water mound." This "mound" is also apparent in the water-level contours shown in figure 3 (from figure 1167-300-5, U.S. Bureau of Reclamation, 1975).

No data points are shown on either map in the area of the "mound." The original water-level contour map, from which figure 1167-300-5 was made, was examined in the U.S. Bureau of Reclamation office in Boulder City, Nev., on November 15, 1983. Two data points were indicated on the original map in Sec. 1, T. 16 S., R. 48 E. The wells indicated at these points were labeled 1ad[1] and 1cd, and had indicated water levels of 52 feet and 44 feet below the land surface, respectively. No records of these wells could be found in the U.S. Bureau of Reclamation files or in the files or computer storage of the U.S. Geological Survey. Further, an intensive search in the field at these sites made by the author and Rodney L. Carson, U.S. Geological Survey, on November 14, 1983, revealed no wells.

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[1] In Nevada, locations of wells are designated within the section according to quarter sections which are labeled a, b, c, and d in a counter-clockwise direction beginning at the northeastern quarter section. Thus, a site designated 1a is in the northeast quarter of Section 1. Each 1/16 section is designated in a like manner within the quarter section.

David L. Brandstetter (U.S. Bureau of Reclamation, oral communication, November 15, 1983), a geologist who worked on the Amargosa project report, believes that the two well sites, shown only on the work copy of U.S. Bureau of Reclamation figure 1167-300-5, were misplotted and are actually for well sites known to be present in Sec. 1, T. 17 S., R. 48 E., rather than Sec. 1, T. 16 S., R. 48 E. The actual wells in Sec. 1, T. 17 S., R. 48 E. (listed in Walker and Eakin, 1963, table 3, and in U.S. Geological Survey files and computer storage) have the same location within the 160-acre tracts, 1a and 1c, and have water levels (rounded off) of 52 and 45 feet below land surface, respectively.

A well was found during the field search November 15, 1983, at a location that plots in T. 16 S., R. 48 E., 1ab (figure 1, almost at the crest of the "mound" (shown in figure 3). It had a measured water level of 150.6 feet below the land surface on November 14, 1983. Also, the measured water level in a well in T. 16 S., R. 48 E., 2d, which is on the southwestern flank of the "mound," was 130.6 feet below the land surface on November 4, 1983. These water levels are approximately 100 and 60 feet, respectively, lower than those shown in figure 3, and prove conclusively that no "mound" exists and hence no upwelling water occurs in the area shown. These water levels have altitudes of about 2,280 feet above sea level, which fit the contours shown on figure 1 (also see figure 3) by Walker and Eakin (1963, page 13).

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we need to introduce this section with an explanation of the Darcy equation and show the calculations.

Two other points should be made concerning Goodrich's calculation: (1) The water-level gradient along flow-line one indicated in the water-level contour map (figure 3) in the vicinity of well AM-101 is 0.002 rather than 0.007 as used by Goodrich. It is even less, 0.0015 (average of flow lines 2, 3, and 4, figure 3) in the area of highest permeability south of the "mound" in the middle of T. 16 N., R. 48 and 49 E. This area of high permeability is indicated by widely spaced contour lines; and (2) the transmissivity used by Goodrich is, in his own words, ". . . extremely high . . ." (page 20 of the affidavit). Koehler and Mallory (1981, page 16), in a study of the middle Amargosa Desert for sources of water for power-plant cooling, state, "Transmissivity was estimated to be 6,800 ft^2/d [about 51,000 gal/day/ft][1], based on pumping tests." Also, David L. Branstetter, (U.S. Bureau of Reclamation, oral communication, November 15, 1983), states that the transmissivity indicated by a pumping test of well AM-101 made by the Bureau was about one-tenth the figure of 300,000 gal/day/ft used by Goodrich. This gives a figure of about 30,000 gal/day/ft, which accords well with the estimate of Koehler and Mallory (1981).

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Thus, if the <u>formula</u> used by Goodrich is applied to the recomputed gradient of 0.0015, the revised transmissivity of 51,000 gal/day/ft, and a width of 55,400 feet (width as indicated in the area of high transmissivity at cross section A-A' in figure 3, a revised figure of nearly 4,800 acre-feet of water per year, instead of 117,000, is derived for the amount moving through the valley fill from the northwestern to the middle part of the Amargosa Desert. This quantity is in reasonable agreement with the statement by Walker and Eakin (1963, page 38):

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[1] Bracketed material added by author.

Thus, pumping from the valley fill might be limited to the somewhat less than 7,000 acre-feet supplied by underflow from the northwestern part of Amargosa Desert, from Fortynine Canyon area, and by upward leakage from the carbonate rocks south of Lathrop Wells.

No reason to have it on a page by itself

If this quote is to remain on a page by itself, seems like it should have quotation marks, as its indention is not noticeable.

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DISCUSSION OF OTHER POINTS MADE BY GOODRICH

Goodrich (page 16) indicated that the area of flow systems that contributes to the discharge of the Ash Meadows spring and to the Amargosa Desert area is possibly larger than that considered by Walker and Eakin (1963). This hypothesis may be valid. However, regardless of the area and the number of flow systems involved, Walker and Eakin's estimate is based on summarizing all elements of natural discharge which is equated to the "perennial yield." Thus, the size and number of contributing systems need not be considered, except as a check.

The inference made by Goodrich (page 20 of his affidavit)--from his quote from Winograd and Thordarson (1975, page 87)--that if Devil's Hole is directly connected with the alluvial aquifer, the limestone rocks exposed in the central part of the valley should have spring discharge, is not necessarily valid. The quote is simply saying that water does not flow through the confined carbonate aquifer from northwestern Jackass Flat and northwestern Amargosa Desert through the central Amargosa Desert to the Ash Meadows spring area as indicated below:

> Because water levels in the valley-fill and welded-tuff aquifers of northwestern Jackass Flats and northwestern Amargosa Desert are higher than the water level in Devils Hole (alt 2,359 ft), it may still be argued that water can move from these areas toward Ash Meadows (pl. 1). Such postulated flow might occur not through the Cenozoic aquifers, which appear to contain no areally extensive aquitards to maintain the head needed, but rather through the lower carbonate aquifer, which could maintain the necessary head due to regional confinement by the tuff aquitard. Unfortunately, this

> argument fails to explain the absence of spring discharge from several outcrops of the lower carbonate aquifer in the central Amargosa Desert; these outcrops (location given previously in the section "Character and Geologic Control of Spring Discharge") are lower than the water level in Devils Hole and should discharge some water if the source of the Ash Meadows discharge is north or northwest of the spring line.

This does not preclude westward movement of an unknown amount of ground water at depth from the spring area through the ground-water barrier (fault) west of the spring line and through the carbonate rock and confining tuff beds into the alluvial aquifer. If such movement is taking place, any reduction in head in the alluvial aquifer due to pumping east of the barrier would include more water to move from the spring area where reduction in head would occur, the amount depending on the proximity and intensity of pumping.

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The additional studies suggested by Goodrich (pages 22 and 23), and by others who have considered the water resources of the Amargosa Desert would certainly enhance our understanding of the ground-water hydrology, although they would be time consuming and expensive. However, until such studies are made, Walker and Eakin's (1963) estimates, crude as they may be, are still the most reasonable available.

The concluding remarks by Goodrich (page 20 of his affidavit), that the spring flow at Ash Meadows is only a fraction of the ground water entering Amargosa Desert is true; but, the recomputation of underflow in the vicinity of the "mound" indicates that spring flow is the most significant fraction. Devil's Hole may not be directly connected with the alluvial or limestone aquifers in the central Amargosa Desert west of the ground-water barrier, but it may be indirectly connected by leakage through or around the barrier. Until the relationship is clarified, a conservative stance on increasing the pumpage in the central Amargosa Desert is suggested.

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IMPACT OF PUMPING OR DIVERTING SPRING FLOW

If all, or a significantly greater part of, the 24,000 acre-feet of water were diverted by pumping for development, the present ecology of the desert area would be adversely affected. That part of the ecosystem dependent on the spring flow would suffer. Pumping at a greater rate from the central Amargosa Desert would lower ground-water levels and intercept flow that in part sustains the shallow ground-water table in the lower reaches of the basin, and could cause phreatophytes, such as mesquite, salt grass, and willow, to die. The hydrographs in Walker and Eakin (1963, figure 2) show that ground-water levels began declining in the Amargosa Desert in about 1957 in response to the pumping rate prevailing at that time. The average decline between 1957 and 1962, principally in the eastern tier of sections in T. 16 N., R. 15 E., and western tier in T. 16 N., R. 49 E., was about 0.7 foot per year. The maximum decline for that 5-year period was 6.1 feet. Any increase in pumping would commensurately accelerate the water-level decline.

The effect of pumping and attendant water-level decline in the central Amargosa Desert on the water level in Devil's Hole cannot be predicted with present data. Dudley and Larson (1976, page 51) state:

> There is no evidence at the present time that withdrawals of ground water to the west of the spring line would produce drawdown in the Paleozoic carbonate rocks nor diminish the flow of the major springs.

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However, Winograd and Thordarson (1975, page 50) state:

> In the southern Amargosa Desert . . . ground water in the Cenozoic rocks [which include the valley fill][1] is derived through upward leakage from the underlying lower carbonate aquifer. In these areas, water in the lower carbonate aquifer has higher head than that in the Cenozoic rocks.

Also, on page 82, they state:

> . . . some ground water in the lower carbonate aquifer (northwest of Longstreet Spring) might move directly into the central Amargosa Desert without being forced upward into the Quaternary and Tertiary fill.

On page 85 they state:

> . . . some ground water probably also moves southwestward across the Ash Meadows discharge area through the lower carbonate aquifer.

They further state (page 25):

> The magnitude of the hypothesized underflow across the spring line into the central Amargosa Desert cannot be approximated despite the availability of crude estimates of discharge from central and southern Amargosa Desert.

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[1] Bracketed material added by Author.

If westward underflow occurs through the carbonate rocks beyond the spring line, and if upward movement of water occurs from the carbonate rocks into the valley fill, any reduction in head in the valley fill by pumping would induce more water to move westward resulting in a decline in water levels along and east of the spring line. However, until definitive data are obtained, the effect of pumping ground water from the Amargosa Desert west of the spring line and east of the barrier on water levels and spring flow, east of the spring line cannot be assessed quantitatively.

WATER LEVELS IN JANUARY 1984 AND WATER-LEVEL CHANGE, 1963-84

Water bulk for 32 wells for which comparative data are available were measured January 18-20, 1984, by the Geological Survey (table 1). These data, when compared with data obtained by Walker and Eakin (1963, table 3) in 1962 indicate that water levels have declined an average of 12.2 feet in the central part of the Amargosa Desert in the last 22 years. The range in decline is from zero in flowing well 29dl, T. 17 S., R. 50 E., to 34 feet in well 14dl, T. 16 S., R. 48 E.

REFERENCES CITED

Dudley, W. W., and Larson, J. D., 1976, Effect of irrigation pumping on pupfish habitats in Ash Meadows, Nye County, Nevada: U.S. Geological Survey Professional Paper 927, 52 p.

Hunt, C. B., Robinson, T. W., Bowles, W. A., and Washburn, A. L., 1966, Hydrologic basin, Death Valley, California: U.S. Geological Survey Professional Paper 494-B, 138 p.

Koehler, J. H., and Mallory, M. J., 1981, Addendum to: Sources of power-plant cooling water in the desert area of southern California--Reconnaissance study: U.S. Geological Survey Open-File Report 81-527, ? p.

Mann, J. F., Jr., 1967, Safe yield and overdraft: Methods of evaluation, in Program IV, Ground-water basin management, Water Resources Engineering Series, University of California, Berkeley, p. 5-1 to 5-3.

Pistrang, M. A., and Kunkel, Fred, 1964, A brief geologic and hydrologic reconnaissance of the Furnace Creek Wash area, Death Valley National Monument, California: U.S. Geological Survey Water-Supply Paper 1779-Y, 35 p.

U.S. Bureau of Reclamation, 1975, California-Nevada Amargosa Project, concluding report: U.S. Bureau of Reclamation, 65 p.

Walker, G. E., and Eakin, T. E., 1963, Geology and ground water of Amargosa Desert, Nevada-California: Nevada Department of Conservation and Natural Resources, Ground-water Resources-Reconnaissance Series Report 14, 45 p.

Winograd, I. J., and Thordarson, William, 1975, Hydrogeologic and hydrochemical framework, south-central Great Basin, Nevada-California, with special reference to the Nevada Test Site: U.S. Geological Survey Professional Paper 712-C, 126 p.

TABLE 1.--Depth to water and water-level change, 1962-84. Water levels for 1962 from Walker and Eakin (1963, table 3); 1984 water levels measured by the U.S. Geological Survey. All water levels below land-surface datum.

Well no.	Nevada: Water level 1962	Nevada: Water level 1984	Change
16S/48E-2b1	135.9	142.6	-6.7
-2d1	124.3	131.4	-7.1
-3a1	127.4	143.7	-16.3
-5b1	127.6	142.5	-14.9
-9b1	105.2	116.0	-10.8
-10b1	116.6	131.3	-14.7
-13a1	116.8	121.9	-5.1
-14b1	102.7	109.5	-6.8
-14d1	92.0	126.0	-34.0
-17a1	100.6	109.0	-8.4
-18b1	90.0	117.4	-27.4
-26a1	75.7	100.3	-24.6
-27d1	58.8	64.0	-5.2
-36a1	67.5	82.7	-15.2
16S/49E-19b1	106.0	113.7	-7.7
-20a1	118.4	129.8	-11.4
-22b1	131.1	138.8	-7.7

TABLE 1.--Depth to water and water-level change, 1962-84. Water levels for 1962 from Walker and Eakin (1963, table 3); 1984 water levels measured by the U.S. Geological Survey. All water levels below land-surface datum.--Continued

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Well no.	1962	Water level 1984	Change
	Nevada		
16S/49E-22d1	112.1	132.3	-20.2
-23a1	105.9	107.3	-1.4
-26d2	106.8	135.5	-28.7
-28c1	92.0	111.9	-19.9
17S/48E-1d4	43.8	55.9	-12.1
17S/49E-4a1	80.7	86.8	-6.1
-4b1	--	92.0	--
-6a1	59	DRY	-16.5
-6b1	50.1	66.6	-9.9
-8d1	48.1	58.0	-5.6
-11b2	59.4	65.0	-5.6
-15b1	52.0	61.2	-9.2
17S/50E-29d1	0.00	00.0	00.0
18S/49E-2c1	71.6	77.1	-5.5
	California		
27N/4E-25b1	20.7	27.0[a]	-6.3

[a] "Scranton" well, dry at bottom at 23 feet in 1984: Water level is given for adjacent test hole.

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ASSESSMENT OF THE ESTIMATED PERENNIAL WATER YIELD, AMARGOSA DESERT, NYE COUNTY, SOUTHERN NEVADA

U.S. GEOLOGICAL SURVEY

Open-File Report 80-1216

Prepared in cooperation with the

U.S. NATIONAL PARK SERVICE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ASSESSMENT OF THE ESTIMATED PERENNIAL WATER YIELD, AMARGOSA DESERT, NYE COUNTY, SOUTHERN NEVADA

By J. P. Akers

Open-File Report 80-1216

DRAFT

Prepared in cooperation with the
U.S. NATIONAL PARK SERVICE

Carson City, Nevada
1981

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CONVERSION FACTORS AND ABBREVIATIONS

Only the inch-pound system is used in this report. Abbreviations and conversion factors from inch-pound to metric units are listed below.

Multiply	By	To obtain
Acre-feet (acre-ft)	0.001233	Cubic hectometers (hm^3)
Acre-feet per year (acre-ft/yr)	0.001233	Cubic hectometers per year (hm^3/yr)
Feet (ft)	0.3048	Meters (m)
Feet squared per day (f^2/d)	0.0920	Meters squared per day (m^2/d)
Gallons per day per foot (gal/day/ft)	??????	

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ALTITUDE DATUM

The term "National Geodetic Vertical Datum of 1929" (abbreviation, NGVD of 1929) replaces the formerly used term "mean sea level" to describe the datum for altitude measurements. The NGVD of 1929 is derived from a general adjustment of the first-order leveling networks of both the United States and Canada. For convenience in this report, the datum also is referred to as "sea level."

ILLUSTRATIONS

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TABLES

PART I

RULING DENYING 117 APPLICATIONS IN AMARGOSA

PART II

GROUNDWATER PUMPAGE INVENTORY AMARGOSA 1983

Groundwater Pumpage Inventory Amargosa 1983

Irrigation	5893.0 Ac-Ft	
Irrigation No Permits or Certificates	3212.0 Ac-Ft	
Industrial	125.0 Ac-Ft	850.00
Commercial	20.0 Ac-Ft	
Quasi-Domestic	250.0 Ac-Ft	ADJ → 200.00
TOTAL	~~9500.0 Ac-Ft~~	10,175.0

AMARGOSA 1983

Existing certificated rights for irrigation	26,320 Ac-Ft
Estimated amount of water pumped for irrigation under certificated rights	5,893 Ac-Ft
Estimated amount of water pumped for irrigation with no permit or certificate	3,212 Ac-Ft
Percentage of existing water rights used	22.4%

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
15881	CERT.	WILLIAM MONROE	SW	NW	10	16	48	10	0		
			NE	NW	10	16	48	40	40		
			SE	NW	10	16	48	40	40		
								90	80	400	
36584	CERT.	RALPH ALLISON	NW	NW	15	16	48	5.0	5.0	20	
26152	CERT.	BLUE DIAMOND ENTER.	SE	SE	8	16	48	12.0	12.0	60.0	
16178	CERT.	CHARLES DEFIR	NE	NW	8	16	48	40	30	150	
17417	CERT.	J. HOMER OVERHOLSER	NE	NE	17	16	48	8.02	5.0		
			NW	NE	17	16	48	32.02	20.0		
			SE	NE	17	16	48	1.0	0		
			SW	NE	17	16	48	4.78	0		
									25.0	75.0	

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
18772	CERT.	HARRISON & HOLTZ	NW	NW	20	16	48	40	20		
			SW	NW	20	16	48	39	0		
			NW	SW	20	16	48	40	20		
			SE	NE	19	16	48	40	20		
			LOT 4		19	16	48	40	0		
								199	60	300	
30411	CERT.	JAMES OWEN	NW	SE	23	16	48	31	31.25		
			NE	SE	23	16	48	40	31.25		
			SW	SE	23	16	48	40	31.25		CIRCLE SPRINKLER
			SE	SE	23	16	48	40	31.25		
								151	125	625	

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
15893	CERT.	JAMES OWEN	NW	NE	23	16	48	40	31.25		
			NE	NE	23	16	48	40	31.25		
			SW	NE	23	16	48	40	31.25		CIRCLE SPRINKLERS
			SE	NE	23	16	48	40	31.25		
								160	125	625	
17404	CERT.	MORRIS DE LEE	NW	SW	25	16	48	40	31.25		
			NE	SW	25	16	48	40	31.25		
			SW	SW	25	16	48	40	31.25		
			SE	SW	25	16	48	40	31.25		
								160	125	625	

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
38127	CERT.	MACK C. VASSAR	NW	NW	26	16	48	29.2	29.2		
			NE	NW	26	16	48	29.2	29.2		
			SW	NW	26	16	48	29.2	29.2		CIRCLE SPRINKLERS
			SE	NW	26	16	48	29.2	29.2		
								116.8	116.8	584	
38363	CERT.	MACK C. VASSAR	NE	NE	26	16	48	29.2	29.2		
			SE	NE	26	16	48	29.2	29.2		
			NW	NE	26	16	48	29.2	29.2		
			SW	NE	26	16	48	29.2	29.2		CIRCLE SPRINKLERS
								116.8	116.8	584	

AMARGOSA INVENTORY 1983

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
31204	CERT.	EVELYN STRUNK	NW	NE	8	16	49	4.556	4.556	22.8	
24763	CERT.	WILLIAM ELLIS	NE	NE	8	16	49	19.69	19.69	98.5	? AC. OF ORIGINAL IS UNDER #'S 26718 & 29069
31727	CERT.	KENNETH GAREY	SE	SW	9	16	49	5.0	5.0	25.0	
29521	CERT.	KENNETH GAREY	SE	SW	9	16	49	5.0	5.0	25.0	
24585	CERT.	KENNETH GAREY	SE	SW	9	16	49	23.75	23.75	118.8	
16047	CERT.	THEO SELBACH	NE	SW	9	16	49	40.0	1		
			NW	SW	9	16	49	20.0	.0		
									1	5.0	CORN PLANTED
16545	CERT.	MILTON WICHNER	NE	NE	28	16	49	21.98	21.98		100 AC-FT NO PERMIT
			NE	NE	28	16	49	0	20		
									41.98	210.0	
										-100.0	
										110.0	

AMARGOSA INVENTORY 1983

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
27813	CERT.	INDUSTRIAL MINERAL VENTURES	NW	SW	1	17	48	31.4	0		
			NE	SW	1	17	48	31.4	25		
			SW	SW	1	17	48	31.4	0		
			SE	SW	1	17	48	31.4	25		
									50	250	
14054	CERT	ALEXANDER BETTLES	NE	NE	12	17	48	16.7			
			SE	NE	12	17	48	8.7			
								25.4	5.0	25.0	PASTURE

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
20352	CERT.	HELEN WATSON	NW	NW	1	17	49	40	31.25		
			NE	NW	1	17	49	40	31.25		
			SW	NW	1	17	49	40	31.25		
			SE	NW	1	17	49	40	31.25		
			LOT	9	36	16	48	26	0		
			LOT	10	36	16	48	21.9	0		
			LOT	11	36	16	48	26	0		
								233.9	125	625	
29451	CERT.	INDUSTRIAL MINERAL	SW	NW	28	17	49	INDUSTRIAL			
29452	CERT.	VENTURES	SE	NE	29	17	49	USE		5.0	

AMARGOSA INVENTORY 1983

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
36762	DENIED	JAMES OWEN	NW	NW	23	16	48	40	31.25		
			NE	NW	23	16	48	40	31.25		NO PERMIT
			SW	NW	23	16	48	40	31.25		
			SE	NW	23	16	48	40	31.25		
								160	125	625	
36764	DENIED	JAMES OWEN	NE	NW	25	16	48	40	31.25		
			NW	NW	25	16	48	40	31.25		NO PERMIT
			SE	NW	25	16	48	40	31.25		
			SW	NW	25	16	48	40	31.25		
								160	125	625	
			NW	SW	7	17	49		31.25		
			NE	SW	7	17	49		31.25		NO PERMIT
									62.5	312.5	

AMARGOSA INVENTORY 1983

NUMBER	STATUS	OWNER OF RECORD	PLACE OF USE ¼	¼	S	T	R	ACRES	NUMBER OF ACRES IRRIGATED	AMOUNT OF WATER USED (ACRE-FEET)	REMARKS
			NW	SE	7	17	49		31.25		
			NE	SE	7	17	49		31.25		
			SW	SE	7	17	49		31.25		NO PERMIT
			SE	SE	7	17	49		31.25		
									125	625	
42568	DENIED	BILLIE BETTLES	NW	SE	1	17	48		31.25		
			NE	SE	1	17	48		31.25		
			SW	SE	1	17	48		31.25		NO PERMIT
			SE	SE	1	17	48		31.25		
									125	625	
44652	DENIED	DAVID RAU	SE	NW	12	17	48		40		NO PERMIT
		PORTION UNKNOWN	NE	NW	12	17	48		20		
									60	300	
					28	16	49		20	100	NO PERMIT FROM PAGE 5 IN CONJUNCTION WITH PERMIT # 16545

PART III

STATIC WATER LEVEL MEASUREMENT DATA AND HYDROGRAPHS

GORDON W. BETTLES
SE¼ SE¼ Sec. 36, T16S, R48E, MDB&M
FIELD #6, PERMIT NO. 14048

3/4/64	54.4	3/8/72	54.8
6/18/64	54.4	11/8/72	55.8
8/2/64	55.9	3/13/73	54.9
11/4/64	55.1	8/23/73	56.4
2/12/65	55.0	2/26/74	54.3
5/12/65	56.2	11/14/74	56.8
11/23/65	55.7	4/30/75	56.9
3/15/66	55.7	9/26/75	58.0
6/16/66	56.9	8/16/78	60.5
9/22/66	56.3	12/28/78	59.4
1/31/67	54.9	4/1/80	61.7
3/21/67	55.4	7/18/80	64.4
6/15/67	56.1	9/12/80	66.1
9/25/67	56.7	12/18/80	65.1
1/10/68	54.5	9/1/81	69.4
4/16/68	54.7	12/9/81	67.7
9/24/68	56.0	3/17/83	67.6
1/14/69	55.4	6/22/83	71.1
6/9/70	53.9	9/20/83	73.8
10/30/70	52.3	3/1/84	69.1
10/12/71	57.0		

H. H. RECORDS
NE¼ SE¼ Sec. 19, T16S, R49E, MDB&M
FIELD #9, PERMIT NO. 19915

3/4/64	99.6	11/8/72	105.0
6/18/64	100.0	3/13/73	103.5
9/2/64	99.7	8/23/73	102.5
11/4/64	99.2	2/26/74	102.4
2/12/65	98.9	11/14/74	100.9
5/20/65	98.7	4/30/75	101.3
8/17/65	99.0	9/26/75	102.2
11/23/65	98.5	7/20/76	117.0 (Well 75' away pumping)
3/15/66	98.5	7/28/78	116.7
6/16/66	100.2	12/28/78	105.7
9/22/66	No Measuring Hole	12/20/79	107.0
1/31/67	No Measuring Hole	4/1/80	119.2
3/21/67	Pumping	7/18/80	124.5
6/15/67	109.5 (Well 75' away pumping)	9/12/80	121.5
9/29/67	100.8	12/18/80	118.3
1/10/68	100.4	9/3/81	109.4
4/16/68	99.8	12/9/81	104.5
9/24/68	102.0	3/17/83	106.9
1/14/69	100.8	6/22/83	107.2
6/9/70	99.7	9/20/83	109.9
10/12/71	Pumping	3/1/84	105.8
3/7/72	Pumping		

CHARLES DE FIR

NE¼ NW¼ Sec. 8, T16S, R48E, MDB&M

FIELD #17, PERMIT NO. 14790

3/4/64	114.0	10/12/71	114.0	
7/9/64	114.1	3/8/72	113.7	
9/2/64	114.1	11/8/72	113.5	
10/29/64	113.0	3/13/73	114.2	(Pumping next door)
2/12/65	113.0	8/23/73	114.7	
5/20/65	113.0	2/26/74	115.8	
8/17/65	113.1	11/14/74	115.5	
11/23/65	113.0	4/30/75	115.8	
3/15/66	113.1	9/26/75	117.0	
6/16/66	113.9	7/20/76	119.2	
9/22/66	113.3	7/28/78	120.1	
1/31/67	113.3	12/28/78	118.3	
3/21/67	113.1	12/20/79	119.4	
6/15/67	113.4	4/1/80	126.2	
9/29/67	113.4	7/18/80	127.4	
1/10/86	113.6	9/12/80	125.0	
4/16/68	113.3	12/18/80	120.0	
9/24/68	113.4	9/3/81	124.7	
1/14/69	113.6	12/9/81	132.9	(Pumping next door)
6/9/70	113.7	3/17/83		(Something dead floating on top)
10/30/70	113.7			

TOM GALLAGHER
NE¼ NW¼ Sec. 14, T16S, R48E, MDB&M
FIELD #18, PERMIT NO. 14079

3/4/64	102.3	3/8/72	102.5
7/9/64	102.7	11/8/72	102.7
9/2/64	103.1	3/13/73	102.8
10/29/64	103.0	8/23/73	103.0
2/12/65	101.5	2/26/74	103.7
5/20/65	102.6	11/14/74	102.9
8/17/65	102.8	4/30/75	103.8
11/23/65	101.8	9/26/75	104.3
3/15/66	102.1	7/20/76	106.0
6/16/66	102.7	7/28/78	105.6
9/22/66	102.4	12/28/78	105.8
1/31/67	102.1	12/20/79	106.8
3/21/67	101.9	4/1/80	106.7
6/15/67	101.9	7/18/80	107.6
9/29/67	102.7	9/12/80	107.9
1/10/68	102.5	12/18/80	107.8
4/16/68	102.1	9/3/81	109.4
9/24/68	102.7	12/9/81	108.9
1/14/69	102.1	3/17/83	109.5
6/9/70	102.2	6/22/83	110.4
10/30/70	102.4	9/20/83	110.8
10/12/71	101.4	3/1/84	110.3

DAVID HOLLOWELL
NW¼ NE¼ SEC. 1, T17S, R48E, MDB&M
FIELD #19, PERMIT NO. 20880

3/4/64	50.8	3/8/72	50.9
7/9/64	50.9	11/8/72	52.4
9/2/64	50.5	3/13/73	51.5
10/29/64	51.3	8/23/73	52.6
2/12/65	50.9	2/26/74	52.7
5/20/65	51.3	11/14/74	52.9
8/17/65	52.8	4/30/75	53.2
11/23/65	51.6	9/26/75	53.6
3/15/66	52.5	8/16/78	57.5
6/16/66	53.0	12/28/78	59.7
9/22/66	53.4	4/1/80	59.3
1/31/67	51.3	7/18/80	61.5
3/21/67	52.8	9/12/80	63.3
6/15/67	53.1	12/18/80	62.0
9/29/67	53.5	9/1/81	67.0
1/10/68	51.7	12/9/81	64.3
4/16/68	51.4	3/17/83	64.2
9/24/68	52.9	6/22/83	68.9
1/14/69	52.5	9/20/83	70.7
6/9/70	52.6	3/1/84	65.4
10/12/71	53.6		

WILLARD JOHNS
NW¼ NW¼ SEC. 14, T16S, R49E, MDB&M
FIELD #20, PERMIT #19072

3/5/64	158.7		11/7/72	160.4
6/18/64	158.7		3/13/73	158.5
9/2/64	159.2		8/23/73	159.2
10/29/64	159.1		2/26/74	158.8
2/12/65	159.0		11/14/74	158.1
5/20/65	159.1		4/30/75	159.0
8/17/65	159.2		9/26/75	159.9
11/23/65	158.5		7/20/76	160.2
3/15/66	158.8		6/27/78	162.0
6/16/66	159.1		12/28/78	165.6
9/22/66	158.8		12/20/79	169.3
1/31/67	158.7		4/1/80	162.7
3/21/67	163.5	(Had been pumping)	7/18/80	162.9
6/15/67	157.6		9/12/80	163.1
9/29/67	157.9		12/18/80	163.0
1/10/68	157.8		9/3/81	163.4
4/16/68	157.7		12/9/81	163.5
9/24/68	158.5		3/17/83	163.7
1/14/69	157.7		6/22/83	164.1
6/9/70	158.2		9/20/83	164.2
10/12/71	160.0		3/1/84	164.1
3/8/72	159.9			

KATHRYN DALTON
NE¼ NW¼ SEC. 22, T16S, R49E, MDB&M
FIELD #22, PERMIT #18064

3/5/64	124.2	6/9/70	126.0
6/18/64	124.1	8/23/73	127.0
9/2/64	124.6	2/26/74	126.8
10/26/64	124.1	11/14/74	127.7
2/12/65	123.9	4/30/75	128.3
5/20/65	124.6	9/26/75	129.1
8/17/65	124.6	6/27/78	135.8
11/23/65	124.7	12/28/78	135.9
3/15/66	124.7	12/20/79	136.2
6/16/66	124.9	4/1/80	136.3
9/22/66	124.8	7/18/80	136.4
1/31/67	124.7	9/12/80	136.5
3/21/67	124.8	12/18/80	136.6
6/15/67	125.0	9/3/81	138.1
9/29/67	125.0	12/9/81	137.3
1/10/68	125.3	3/17/83	137.9
4/16/68	124.9	6/22/83	138.2
9/24/68	125.7	9/20/83	138.0
1/14/69	125.9	3/1/84	138.6

BUDDINGTON R. CLAIRE
NW¼ NW¼ SEC. 27, T16S, R49E, MDB&M
FIELD #23, PERMIT #20631

3/5/64	107.8
6/18/64	107.9
9/2/64	108.2
11/4/64	107.5
2/12/65	107.4
5/20/65	107.7
8/17/65	107.9
11/23/65	108.2
3/15/66	108.2
6/16/66	108.7
9/22/66	108.5
1/31/67	107.9
3/21/67	108.3
6/15/67	108.3
9/29/67	108.5
1/10/68	109.0
4/16/68	108.4
9/24/68	109.4
1/14/69	109.1
6/9/70	109.6
10/29/70	110.0
10/12/71	108.1
3/8/72	110.1
11/7/72	110.1
3/13/73	109.0
8/23/73	110.3
2/26/74	110.7
11/14/74	108.9
4/30/75	109.4
9/26/75	110.1
6/27/78	111.8
12/28/78	112.0
12/20/79	112.2
4/1/80	110.0
7/18/80	112.4
9/12/80	112.5
12/18/80	113.0
9/3/81	115.5
12/9/81	114.0
3/17/83	114.6
6/22/83	115.8
9/20/83	114.8
3/1/84	115.2

E. L. PARSONS
NE¼ NE¼ SEC. 4, T17S, R49E, MDB&M
FIELD #26, PERMIT #20701

3/5/64	80.7	3/9/72	82.1
6/18/64	81.4	11/8/72	82.9
9/2/64	82.1	3/13/73	82.6
11/4/64	81.7	8/23/73	82.8
2/12/65	81.6	2/26/74	82.5
5/20/65	81.7	11/14/74	81.5
8/17/65	81.6	4/30/75	81.8
11/23/65	81.9	9/26/75	82.1
3/15/66	81.8	8/16/78	82.7
6/16/66	82.0	12/28/78	86.2
9/22/66	82.4	12/20/79	83.2
1/31/67	81.4	4/1/80	83.9
3/21/67	82.1	7/18/80	85.5
6/15/67	81.9	9/12/80	86.4
9/29/67	81.9	12/18/80	86.7
1/10/68	82.1	9/1/81	88.8
4/16/68	82.1	12/9/81	88.7
9/24/68	82.7	3/17/83	88.0
1/14/69	82.2	6/22/83	86.7
6/9/70	82.1	9/20/83	88.1
10/29/70	82.2	3/1/84	86.8

STEELMAN
NW¼ NW¼ SEC. 15, T17S, R49E
FIELD #28, PERMIT #17694

3/5/64	54.4	10/29/70	65.2
6/18/64	54.8	3/9/72	64.7
9/2/64	55.3	11/8/72	64.9
11/4/64	54.8	3/13/73	64.8
2/12/65	54.7	8/23/73	64.3
5/20/65	56.7 (Well pumping 100' away)	2/26/74	64.1
8/17/65	56.8 (Well pumping 100' away)	11/14/74	No measurement
11/23/65	56.6	8/16/78	62.6
3/15/66	56.7 (Well pumping 100' away)	12/28/78	62.5
6/16/66	56.8 (Well pumping 100' away)	12/20/79	73.1
9/22/66	57.8 (Well was off 4 hours)	4/1/80	66.6
1/31/67	56.0	7/18/80	77.9
3/21/67	56.9	9/12/80	75.3
6/15/67	Pumping	9/1/81	82.1
9/29/67	56.4	12/9/81	69.6
1/10/68	55.9	3/17/83	66.9
4/16/68	56.2	6/22/83	66.8
9/24/68	54.9	9/20/83	68.4
1/9/69	55.8	3/1/84	66.4
6/9/70	61.5		

PART IV

INDEX AND MAP SHOWING POINT OF DIVERSION OF APPLICATIONS DENIED, CERTIFICATED WATER RIGHTS, AND PERMITTED WATER RIGHTS

APPLICATIONS DENIED BY STATE ENGINEER'S RULING
ON AMARGOSA DESERT BASIN #230
DATED DECEMBER 15, 1982
(BLUE)

APPLICATION	NO.
34760	1
35388	2
35389	3
36585	4
36586	5
36587	6 - 30
36761	7 P
36762	8 P
36763	9 P
36764	10 P
36765	11 P
36766	12 P
36767	13 P
36768	14 P
36769	15 P
36770	16 P
36771	17 P
36772	18 P
36773	19 P
36774	20 P
36775	21 P
36776	22 P
36784	23
36785	24
36786	25
36787	26
36854	27
36875	28
36877	29
36878	6 - 30
36879	31
37080	32
37081	33
37082	34
37133	35
37134	36
37135	37
37136	38 - 56
37233	39
37234	40
37235	41
37260	42
37281	43
37282	44
37283	45
37284	46
37306	47
37307	48
37308	49
37309	50
37312	51
37324	52
37325	53
37326	54
37327	55
37352	38 - 56
37353	57
37354	58
37387	59
37392	60
37393	61
37394	62
37396	63
37404	64
37405	65
37408	66
37409	67
37410	68
37412	69
37413	70 - 114
37559	71
37575	72
37592	73
37593	74
37594	75
37595	76
37601	77
37602	78
37603	79
37604	80
37605	81
37634	82
37650	83
37764	84
37765	85
37767	86
37771	87
37772	88
37779	89
37780	90
37781	91
38079	92
38207	93
38208	94
38336	95
38411	96
38466	97
38467	98
39026	99
39137	100
39293	101
39309	102
39398	103
40537	104
40538	104 - 106
40539	105 - 106
41139	107
41215	108
41754	109
41755	110
42568	111
42757	112
42925	113
42926	70 - 114
44612	115
44652	116
45090	117

EXISTING CERTIFICATED WATER RIGHTS
AMARGOSA DESERT BASIN #230
(ORANGE)

PERMIT	NO.	PERMIT	NO.
13574	1	19448	40
14054	2	19916	41
14055	3	19917	42
14059	4	20162	43
14078	5	20352	44
15410	6	20355	45
14702	7	20411	46
15819	8	21584	47
15881	9	21593	48
15893	10	21952	49
16047	11	22140	50
16178	12	22141	51
16399	13	22233	52
16544	14	22581	53
16545	15	22582	54
16586	16	22746	55
17137	17	22761	56
17181	18	22941	57
17241	19	23426	58
17340	20	23797	59
17348	21	24369	60
17404	22	24585	61
17417	23	24725	62
17657	24	24729	63
17694	25	24763	64
17790	26	25552	65
17835	27	25555	66
17853	28	25565	67
17854	29	25566	68
17951	30	25636	69
18222	31	26152	70
18267	32	26283	71
18375	33	26442	72
18376	34	26673	73
18528	35	26718	74
18764	36	27813	75
18772	37	29069	76
19034	38	29521	77
19197	39	31204	78

EXISTING PERMITTED WATER RIGHTS
AMARGOSA DESERT BASIN #230
(RED)

PERMIT	NO.	PERMIT	NO.
23057	1	26610	21
25099	2	26805	22
25423	3	27812	23
25554	4	28062	24
25557	5	28777	25
25558	6	28828	26
25559	7	28880	27
25560	8	29139	28
25561	9	29140	29
25562	10	29341	30
25580	11	29451	31
25581	12	29452	32
25582	13	29649	33
25662	14	29650	34
25742	15	29741	35
25743	16	30176	36
25744	17	30411	37
26197	18	30884	38
26427	19	32279	39
26609	20	33010	40