GROUNDWATER RESOURCE AND LAKE CONSTRUCTION INVESTIGATION

CONWAY RANCH AT MONO LAKE, MONO COUNTY, CALIFORNIA

APPLIED GEOTECHNOLOGY INC. (1987)
A report prepared for
Conway Ranch
Post Office Box 179
June Lake, California  93529

GROUNDWATER RESOURCE AND
LAKE CONSTRUCTION INVESTIGATION
CONWAY RANCH AT MONO LAKE
MONO COUNTY, CALIFORNIA

AGI Project No. 15,248.001

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1.0 SUMMARY

We have investigated groundwater resources and near surface geologic conditions beneath the proposed lake on Conway Ranch. As part of the investigation, we:

- Reviewed available background information.
- Conducted a geologic and surface water reconnaissance.
- Installed a test well to a depth of 171 feet.
- Performed a pumping test using the existing domestic and fire pump wells.
- Excavated 17 test pits in the proposed lake area.

Results of the investigation are summarized below.

Geology: Conway Ranch is underlain by a variable thickness of unconsolidated sediments resting on metamorphic and granitic bedrock. Bedrock is close to the surface in the northeast quarter of the Ranch and across the southern edge of the Ranch. We suspect there is also a bedrock high trending north-south near the middle of the Ranch. This bedrock high separates a central basin from another basin in the southeast quarter of the Ranch.

The unconsolidated sediments overlying bedrock can be grouped into three major units. The uppermost unit is approximately 30 feet thick and consists of interbedded silt, silty sand, and silty clay. Underlying these sediments is approximately 40 to 100 feet of sand and gravel. The sands and gravels are underlain in turn by sandy clay in the central basin area and by clayey gravel in the southeastern basin.

Near surface sediments in the proposed lake area are complexly interbedded and do not lend themselves to a simple interpretation. However, the uppermost sediments tend to be organic rich, grading coarser with depth. Thus, near surface silty clays and clayey silts tend to grade downwards to silty sands and, in some areas, gravelly sands.

Groundwater Occurrence and Flow: Groundwater occurs under water table conditions in the unconsolidated sediments overlying bedrock ("Water Table Aquifer"). The sands and gravels are the chief water bearing deposits, although the overlying silts and sands also contain considerable water. The underlying sandy clays and clayey gravels impede groundwater flow and act as an aquitard.
The saturated thickness of the Water Table Aquifer was approximately 65 to 70 feet at the time of our investigations. Depth to the water table ranged from 5 to 6 feet in the central basin, to 68 feet in the extreme southeast corner of the Ranch. The high water levels in the central basin area appear to be maintained in part by the damming effect of the inferred bedrock high. Groundwater flow appears to be constrained by the bedrock configuration such that all off-site flow is through a narrow southeast trending channel.

**Water Balance:** A water balance was calculated for the Conway Ranch (the 870-acre parcel of property) assuming all inputs to the Ranch equal all outputs. Inputs are as follows:

- Direct precipitation onto the Ranch property.
- Surface water and groundwater runoff from the adjacent mountains.
- Artificial diversion of surface water onto the Ranch from Wilson Creek and Virginia Creek.

Outputs are as follows:

- Evapotranspiration (ET).
- Surface water runoff principally through Wilson Creek.
- Groundwater flow.

Values for these parameters are tabulated below as follows:

<table>
<thead>
<tr>
<th>Inputs (cfs)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Precipitation</td>
<td>1.79</td>
</tr>
<tr>
<td>Runoff from adjacent mountains: Area I</td>
<td>5.27</td>
</tr>
<tr>
<td>Area II</td>
<td>1.51</td>
</tr>
<tr>
<td>Area III</td>
<td>4.78</td>
</tr>
<tr>
<td>Wilson Creek diversion</td>
<td>19.00</td>
</tr>
<tr>
<td>Virginia Creek diversion</td>
<td>2.30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34.65</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs (cfs)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Evapotranspiration</td>
<td>3.80</td>
</tr>
<tr>
<td>Groundwater flow</td>
<td>2.40</td>
</tr>
<tr>
<td>Surface water runoff</td>
<td>28.45</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34.65</strong></td>
</tr>
</tbody>
</table>
Groundwater Safe Yield: Safe yield is defined as the volume of groundwater which can be withdrawn from the Water Table Aquifer with no overall reduction in storage (i.e., no groundwater mining). We calculate a safe yield of 2.4 cfs or approximately 1,100 gallons per minute assuming complete off-site export of all extracted groundwater. However, this assumption is unrealistic as extracted groundwater will be used to supplement stream flows and lake storage on the Ranch and will therefore reinfiltreate and thus recharge groundwater supplies. We believe 30% reinfiltiration is realistic and the safe yield would, therefore, be approximately 1,500 gallons per minute.

Groundwater Storage: Groundwater storage is defined as the volume of water held in the Water Table Aquifer which can be removed by pumping. We calculate the average annual storage as 4,900 acre feet assuming a specific yield of 30% and a saturated thickness of 60 feet in the central basin and 80 feet in the southeast quarter of the Ranch.

Lake Evaporation Losses: We calculate evaporation losses from the proposed 33-acre lake as 112.2 acre feet per year (.15 cfs) assuming an average annual evaporation rate of 40.8 inches/year. This evaporation rate is probably only slightly higher than the evapotranspiration rate from the existing land surface because of the high water table and thick vegetation growth in the proposed lake area.

Lake Construction: Because of the shallow water table and soft soils in the proposed lake area, it will be necessary to excavate the lake with a drag line or large hydraulic backhoe. The backhoe has several important advantages over a drag line, including the ability to excavate a smooth bottom and to deposit excavated soil directly into trucks for transport.

Lake Seepage Losses: There should be no seepage losses through the base of the lake because of the high groundwater table. However, water will flow out of the lake through the downstream side of the lake into the adjoining Water Table Aquifer. This outflow will be balanced in whole or part by groundwater inflow along the upstream side of the lake. We cannot quantify the outflow relative to inflow and therefore recommend that a liner be installed along the downstream edge of the lake. The simplest and least costly method to install a liner is to place a 2 to 3-foot thick layer of some of the clay-rich soils excavated from the lake.

Organic Soil Volume: We calculate the volume of organic-rich soil available from the proposed lake area is 2,100,000 cubic feet assuming an average thickness of 17.5 inches over 33 acres. The actual thickness is quite variable, ranging from essentially none to 84 inches.
2.0 INTRODUCTION

2.1 General

This report presents the results of our groundwater resource investigation and geotechnical evaluation of a proposed lake on Conway Ranch near Mono Lake, California. Conway Ranch is comprised of two parcels of property. A larger 870-acre parcel is located east of U.S. Highway 395 and north of California State Route 167, and a smaller 180-acre parcel is located west of the intersection between Highway 395 and SR 167. The location of the two parcels is shown on the Vicinity Map, Figure 1.

2.2 Project Description

We understand the 870-acre portion of Conway Ranch will be developed as a fly fishing resort. The resort will include a number of communal buildings, condominiums, and private residences, as well as access roadways. Two new streams, in addition to the existing Wilson Creek, will be constructed for fly fishing. In addition, a 33-acre artificial lake will be built near the center of the property. Water for the lake and for the streams will be supplied by surface water from Wilson Creek and the Virginia Creek diversion, and supplemented by groundwater from wells drilled on-site. We understand approximately 1500 gallons per minute of groundwater will be necessary to sustain the new streams and lake during times of extreme drought.

2.3 Purpose

The purpose of our investigation is to assess groundwater availability and adequacy to supply resort requirements, and to assess geotechnical aspects of creating the new lake. Since only the 870-acre parcel is being developed, our investigation was directed specifically to that portion of the Conway Ranch.

Goals for the groundwater availability aspect include:

- Determine aquifer geometry and water bearing characteristics.
- Determine sources and nature of groundwater recharge, specifically including snow melt and surface water from Wilson Creek and the Virginia Creek diversion.
- Check water balance calculations as reported in Beak’s 1987 Environmental Impact Review, particularly as they relate to evapotranspiration and groundwater recharge estimates.
- Determine aquifer storage, maximum safe yield, and the likelihood of sustaining 1500 gallons per minute withdrawal rate during periods of drought.
Vicinity Map
Conway Ranch at Mono Lake
Mono County, California

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Geotechnical Engineering
Geology & Hydrogeology

FIGURE 1

Scale In Feet
0 4000

U.S.G.S Bodie SW Quadrangle

Mono Lake

-5-
Goals for the geotechnical aspect include:

- Estimate water losses from the lake through evaporation and leakage through the lake bottom.
- Provide recommendations to minimize leakage, if necessary.
- Evaluate the extent and volume of organic soils available in the proposed lake area for use as topsoil.
- Evaluate construction and/or drainage problems relating to excavation of the lake bed.

Our scope of work to accomplish the goals described above is summarized in the following section.

2.4 Scope of Work

Our scope of work included data review, field investigations, and data analysis. Specifically, our scope included the following:

Evaluate Existing Data: Prior to beginning field investigations, we reviewed existing information and data concerning site hydrogeologic conditions, including studies by J.H. Kleinfelder and Associates (1983); Beak Consultants (1987); and Loeffler (1977). A list of references used in this investigation is included at the end of the report.

Site Geologic/Hydrologic Reconnaissance: We conducted a detailed site reconnaissance focusing on geologic structures as they might control groundwater movement and on microhydrologic conditions which govern surface water movement. As part of this task, site geology was mapped and surface water flows were measured in upgradient and downgradient locations in Wilson Creek. The surface water flows were determined by estimating water velocities and measuring the stream cross sectional area.

Test/Production Wells: We installed one test/production well (Test Well No. 3) near the middle of the Ranch at the location shown on the Site Plan, Plate 2. The purpose of the test well was primarily to obtain supplemental geologic and groundwater information in the central portion of the Ranch. The well boring was drilled to 171 feet and electric logs were run immediately following completion of the drilling. Based on the results from the electric logs and our observations during drilling, a well was installed to a total depth of 74 feet. The well was then developed for use as a possible water supply well. Well installation details and a geologic log are included in Appendix A.
Aquifer Pumping Test: We conducted a 16-hour pumping test using the existing domestic and fire water supply wells in the southeast corner of the site. The pumping test data were analyzed to determine aquifer hydraulic characteristics, including permeability, storage coefficient, and transmissivity. These parameters form the basis for assessing groundwater availability, storage, and maximum safe yield. The pumping test data and analysis are included in Appendix B.

Proposed Lake Geotechnical Investigation: We excavated 17 backhoe test pits to depths ranging from 8 to 13 feet to investigate geotechnical conditions in the proposed lake area. Test pit locations are shown on Figure 2, and logs of the test pits are included in Appendix E.
3.0 SITE CONDITIONS

3.1 Site Description

Conway Ranch lies at the foot of the Sierra Nevada Mountains in the extreme northwest corner of the Mono Lake Basin. This basin contains Mono Lake and extends some 20 to 30 miles south and east of the Ranch.

The Ranch topography slopes gently downwards from the north and west property lines towards a small basin in the central part of the property. South and east of the central basin, the land surface abruptly rises approximately 15 feet, and then slopes gently downwards to the southeast towards Mono Lake. Near the west and north property lines, the land surface rises steeply into the Sierra Nevada Mountains.

Much of the Ranch has been irrigated in the past for sheep or cattle pasture. Consequently, most of the central basin is covered with thick grass and a few scattered trees. The higher ground to the south and east is covered with native sage and high desert vegetation.

3.2 Surface Water

Surface water flow generally follows the land slope and is thus from the mountains downwards into the Ranch property. However, the natural flow regime has been extensively modified through excavation of numerous drainage ditches and the diversion of creek flows from other areas onto the Ranch. Wilson Creek, which passes through the Ranch, was created through diversion of water from Mill Creek. Surface water is also diverted from Virginia Creek and is carried onto the northeast corner of the Ranch through several ditches. Refer to Figure 1 for the location of Virginia Creek and Mill Creek. For a more detailed description of the diversion ditches and for historic flow rates in these ditches, refer to Beak (1987).

Wilson Creek enters the Ranch near the middle of the southern property line (see Figure 2, Site Plan). The creek meanders generally northeast and then abruptly turns and flows to the southeast after reaching the border of the central basin described previously. The stream gradient is nearly flat in the northeast trending portion where the stream is bordered by low banks less than 10 feet in height. In the southeast trending portion, however, the gradient steepens and the stream becomes deeply incised with bordering banks greater than 20 feet in height. A small dam with an adjustable spillway blocks Wilson Creek just east of the Ranch property. The dam was reportedly built to provide fish habitat.

3.3 Geology

Regional Setting: The Sierra Nevada Mountains surround Conway Ranch to the west and north. The mountains are composed of granitic bedrock of the Sierra Nevada Batholith and surrounding metamorphic bedrock. These rocks extend beneath unconsolidated sediments filling the Mono Basin.
Mono Basin is filled with a great thickness of unconsolidated sediment derived from erosion of the adjacent mountains. Considerable volcanic ash is interbedded with the sediment as a result of volcanic activity throughout the eastern Sierra Nevada. Much of the sediment was deposited in a prehistoric lake which filled most of the basin tens of thousands of years ago. The existing Mono Lake is a small remnant of the prehistoric lake.

**Site Geology:** Our geologic mapping indicates Conway Ranch is underlain by at least two types of bedrock - granitic and metamorphic. The metamorphic rock is a hornfels (a massive fine-grained metamorphosed mudstone or siltstone) which outcrops as a series of reddish, rubbly masses or platy fragments. The granitic outcrop as rounded whitish masses.

Depth to bedrock varies substantially across the Ranch with rock outcropping at the surface in some areas and bedrock greater than 200 feet deep in other areas. Figure 3, Geologic Map and Groundwater Flow Map, shows our interpretation of areas with near-surface bedrock occurrence. The bedrock is near the surface across the southern property line and in the northeastern portion of the Ranch. We suspect there is also a bedrock high extending north-south parallel to the eastern edge of the central basin. This feature is shown on Figure 3 as a queried bedrock high. Geologic Cross Sections A-A' and B-B' also show our interpretation of bedrock occurrence with depth across the central basin area. Observations from Test Well No. 3 and the well logs from the existing domestic and fire wells were used in developing the Cross Sections.

The bedrock configuration beneath Conway Ranch appears to have resulted in the formation of a small basin in the central part of the Ranch separated from the rest of the Ranch and Mono Basin. This central basin is reflected in the central topographic basin described previously. Basin depth is unknown although Test Well No. 3, located near the southwestern edge of the basin, was drilled to a depth of 171 feet without encountering bedrock.

Test Well No. 3 encountered an upper 30-foot of interbedded silts, sands, and silty clays, underlain by sandy gravels. The fine-grained silts, clays, and sands probably represent sediment deposited in alternating stream and lake environments. The underlying gravels which extend down to approximately 70 feet were likely deposited by high energy streams issuing from the Sierra Nevada. Periods of quiet water deposition are marked by silty clay layers near depths of 50 and 70 feet.

Underlying the sandy gravels is an approximately 20-foot thick layer of very tight mixed silt, sand, and gravel. This deposit appears to be a mudflow or glacial till deposit.

A fairly uniform sandy clay with varying proportions of fine gravel extends from 90 feet to the base of the boring (171 feet). We interpret this to be lake sediment deposited in a prehistoric lake. A detailed geologic log of Test Well 3, along with electric log results and well installation details, is included in Figure 6.
LEGEND

- Approximate Water Table or Wilson Creek Elevation, July, 1987
- Water Table Aquifer
- Silty clays and sands
- Sand and gravel
- Clay and gravel (right side of section)
- Sandy Clay (left side of section)
- Bedrock

Note: See Geologic and Groundwater Flow Map, Figure 3, for Cross Section Location.

Conceptual Cross Section B - B'
Conway Ranch at Mono Lake
Mono County, California

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FIGURE 5

JOB NUMBER: 15,248 001
DRAWN: SL
APPROVED: HAA
DATE: 29 July 87
REVISED DATE:
Geologic conditions appear to be somewhat similar on the east side of the bedrock high, based on the driller's logs for the domestic water supply and fire pump well. There are some differences, although it is difficult to tell whether these are true geologic differences or simply differences in interpretation. The sandy clay in Test Well No. 3 correlates with interbedded clay and gravelly clay in the well driller's logs. However, the top of the clayey sediments appears to begin at 115 to 120 feet below land surface, as compared to 70 feet in Test Well No. 3. Similarly, the sand and gravel encountered in Test Well 3 at 30 to 70 feet below land surface correlates with sand and gravel reported at 8 to 115 feet below land surface in the domestic well, and 25 to 120 feet in the fire pump well. Finer-grained silty clays and sands were logged as overlying the gravels in both the domestic and fire wells.

Proposed Lake Area Geology: Seventeen test pits were excavated in the proposed lake area to determine near-surface geologic conditions (test pit locations are shown on Figure 2, Site Plan). As anticipated, the near-surface deposits are comprised primarily of fine-grained silts, silty clays, and silty fine sands. Some organic rich silts and clays are also present as well as coarser-grained sands and gravels and a deposit of dense silty sandy gravel or gravelly sandy silt.

The dense silty sandy gravel deposit was encountered beneath the low ridge which trends north-south between Test Pits 3 and 7. It was also encountered south of Test Pit 7 in Test Pit 8 and north of Test Pit 3 in Test Pit 4. At Test Pit 8, this deposit was covered with approximately 2.5 feet of soft, saturated silty clay and silt. To the north, the deposit rises and was present at the surface in both Test Pits 7 and 3. Further north, the top of the deposit drops beneath overlying clayey silt. No further sign of this deposit was observed in either Test Pit 14 or 15 located north of Test Pit 4.

The silty sandy gravel thickness ranges from 2 feet (Test Pit 4) to greater than 7.5 feet (Test Pit 8). In all Test Pits (except Test Pit 8), the silty sandy gravel was underlain by much softer or looser sediments ranging from silty clay to sandy gravel. Test Pit 8 did not extend through the silty sandy gravel, so the underlying sediments were not reached.

The distribution and character of the silty sandy gravel suggests it is a mudflow deposit which originated in higher areas to the south and flowed out into the central basin. The mudflow deposit overlies older lake and stream sediment and is itself overlain by younger lake sediment.

The near surface sediments in areas away from the low ridge consist of complexly interbedded silts, clays, sands, and gravels. Because of this complexity, it is difficult to describe sediment distribution. However, the sediments observed in the test pits can be grouped into three basic units: uppermost sediments, massive silty clay, and underlying complexly interbedded sediments. In general, the uppermost sediments are the finest grained and grain size increases downward.
The uppermost sediments underlying the root mat (sod) generally consist of soft to hard, brown to dark brown silt, silty clay, or organic silt or clay. Roots from the overlying plants often penetrate this zone, and it is often organic rich. The uppermost sediments generally range between 6 and 24 inches in thickness, but an unusual organic rich black silty sand was encountered in Test Pit 16 extending to 7 feet below land surface.

The water table in the proposed lake area ranges from near land surface to 5 or 6 feet in depth. Consequently, the uppermost sediments range from dry to saturated depending on the water table depth. The sediments are typically hard when dry and soft when saturated.

Underlying the uppermost sediments is a fairly widespread 2 to 5-foot thick layer of massive gray silty clay or clayey silt. In many areas, the clay/silt is saturated and has the consistency of toothpaste. We interpret this deposit to be lake sediment deposited in a prehistoric lake.

Beneath the massive silty clay is a complex sequence of interbedded silty clay, silt, silty sand, and sand. The character of these sediments suggests deposition from alternating lake and stream environments. Some coarse grained sandy gravels were also encountered in Test Pits 3 and 4, possibly representing high energy glacial outwash deposits.

3.4 Groundwater

Occurrence and Flow: Most groundwater beneath Conway Ranch occurs in the sediments which overlie bedrock. Some groundwater likely occurs in fractures in the bedrock, but is volumetrically insignificant relative to groundwater occurring in the sediments.

Groundwater in the sediments generally occurs under water table conditions. Consequently, the saturated sediments are referred to in this report as the "Water Table Aquifer."

Cross Sections A-A' and B-B' show the inferred location of the Water Table Aquifer. The uppermost silty clays and sands, and the intermediate gravels comprise the Water Table Aquifer. The underlying clayey sediments are not included as they are likely to impede groundwater movement rather than contribute to it. In this report, these clay sediments are referred to as the Clay Aquitard.

The Water Table Aquifer is approximately 65 feet thick at Test Well 3 and 70 feet thick at the Domestic Well. Although the aquifer thicknesses are similar at these two locations, depth to water table is not. Cross Section B-B' shows the water table within 5 to 6 feet of the surface in the central basin area, and dropping to approximately 45 feet below land surface at the Domestic Well. In terms of absolute elevations, the water table elevation was at 6822.5 feet in Test Well 3 and 6761.7 feet in the Domestic Well in July, 1987, an elevation difference of nearly 61 feet. Groundwater elevations measured in the various wells on Conway Ranch are listed in Table 1.
These water elevation relationships and our geologic mapping suggest that groundwater beneath the central basin is separated in part from groundwater in the southeast corner of the Ranch by a bedrock high. In effect, there are two groundwater basins beneath the Ranch.

Groundwater flow beneath the Ranch is generally from the northwest towards the southeast paralleling Wilson Creek as shown on Figure 3. Groundwater entering the central basin is constricted by areas of near surface bedrock such that virtually all outflow from the basin is through a small channel leading towards the southeast corner of the Ranch. Virtually all off-site groundwater flow occurs through this same area.

**Recharge:** The Water Table Aquifer beneath Conway Ranch is recharged through surface water infiltration and through subsurface lateral flow from the mountainous areas to the north and west. Precipitation in the mountainous areas which does not evaporate either runs off as surface water or infiltrates and moves downslope in bedrock fractures or in loose weathered soil atop unweathered bedrock. Groundwater in the loose weathered soil will readily flow into and recharge the Water Table Aquifer. Groundwater in fractures may or may not reach the Water Table Aquifer, depending on fracture continuity and orientation.

Surface water from the Virginia Creek diversion and from Wilson Creek and its various diversion ditches also serves to recharge the Water Table Aquifer. In the central basin area, groundwater elevations apparently are maintained near land surface by the damming effect of the inferred bedrock high. Consequently, only minor recharge occurs from surface water in this area, as evidenced by the similarity of Wilson Creek and water table elevations. However, significant leakage from Wilson Creek and recharge to the Water Table Aquifer occurs along the southeast trending portion of the creek, where the water table is some distance below the base of the creek. Near the Domestic Well, for example, the water table is 25 to 30 feet below the creek.
TABLE 1: WELL AND GROUNDWATER ELEVATION DATA

<table>
<thead>
<tr>
<th>Well No.</th>
<th>Measuring Point</th>
<th>Measuring Point Elevation (feet)</th>
<th>Stickup (feet)</th>
<th>Land Surface Elevation (feet)</th>
<th>Date</th>
<th>Depth to Water (feet)</th>
<th>Water Table Elevation (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Well 3</td>
<td>Top of PVC casing</td>
<td>6829.62</td>
<td>1.3</td>
<td>6828.3</td>
<td>7/6/87</td>
<td>7.12</td>
<td>6822.5</td>
</tr>
<tr>
<td>Domestic Well</td>
<td>Top of sounding tube</td>
<td>6803.60</td>
<td>0.8</td>
<td>6802.8</td>
<td>7/6/87</td>
<td>41.90</td>
<td>6761.7</td>
</tr>
<tr>
<td>Fire Well</td>
<td>Top of sounding tube</td>
<td>6804.88</td>
<td>1.3</td>
<td>6803.6</td>
<td>7/6/87</td>
<td>44.31</td>
<td>6760.6</td>
</tr>
<tr>
<td>Monitoring Well</td>
<td>Top of PVC casing</td>
<td>6793.47</td>
<td>1.9</td>
<td>6791.6</td>
<td>7/6/87</td>
<td>67.92</td>
<td>6725.6</td>
</tr>
</tbody>
</table>

NOTES:

1) See Figure 2 for well locations.
2) Measuring point elevations based on survey by Triad Associates, assuming Measuring Point Elevation of 6829.62 at Test Well 3.
4.0 HYDROLOGIC ANALYSES

4.1 Water Balance

As part of this investigation, a water balance has been calculated for the 870-acre portion of the Conway Ranch to assess water flow and availability. The detailed water balance analysis is included in Appendix D. Following is a short discussion of the methodology and results.

The water balance was calculated by summing all inputs to the Ranch and balancing the total against all outputs.

Inputs to the Ranch are as follows:

- Direct precipitation (rain or snow) onto the Ranch property.
- Surface water and groundwater runoff from the adjacent mountains.
- Artificial diversion of surface water onto the Ranch from Wilson Creek and Virginia Creek.

All water entering the Ranch from one of the sources listed above then leaves the Ranch via one of the following routes:

- Evapotranspiration (ET) (combined evaporation and transpiration by plants).
- Surface water runoff principally through Wilson Creek.
- Groundwater flow.

Surface water and groundwater inputs were calculated by first defining three drainage basins in the surrounding mountains and summing the contribution from each basin. The three basins (Areas I, II, III) are slightly modified versions of those defined by Beak (1987). The Ranch property itself is defined as Area IV. Average annual precipitation values provided by Triad Engineering were used for the runoff calculations since the purpose of the analysis is to determine average conditions on the Ranch. Beak (1987) calculated runoff from the drainage basins using Thornthwaite’s method as described in Dunne and Leopold (1978). To check Beak’s calculations, we used a simplified method where total runoff was considered to be some percentage of average annual precipitation. The appropriate percentage was obtained from Boyle (1984) as reported in Beak (1987), and modified according to the specific conditions in each of the three drainage basins. Values for average annual inputs from the Wilson Creek diversion and the Virginia Creek diversion were also obtained from Beak (1987).
It was not possible to directly calculate surface water output from the Ranch. This is due in part to the fact that most runoff occurs during the spring from snow melt and spring storms, and in part to the lack of any stream discharge records. Without discharge records from a gaging station, it is virtually impossible to accurately calculate surface water output. Consequently, surface water output was determined by calculating and summing evapotranspiration and groundwater outflow and subtracting the sum from total inputs as follows:

\[
\text{Surface water output} = \text{total inputs to Ranch} - (\text{ET} + \text{Groundwater outflow})
\]

Evapotranspiration calculations are described in Appendix D.

Groundwater outflow was calculated using Darcy’s flow equation where the total discharge across a boundary \((Q)\) is equal to the hydraulic conductivity of the aquifer \((k)\) times the aquifer cross sectional area \((A)\) times the hydraulic gradient \((i)\), or:

\[
Q = kIA
\]

The cross sectional area thorough which discharge is occurring was determined from the drillers well logs and our geologic mapping. The hydraulic gradient was determined by interpolating water level elevations between the existing wells and the new well (Test Well 3). A value for \(K\) was obtained from the pumping test (see Appendix B for the pumping test data and analysis). Appendix C includes the groundwater discharge calculations.

Table 2 summarizes the water balance and compares our calculated values with Beak’s (1987). As can be seen, the average annual total inputs and outputs are similar although individual inputs and outputs vary.

4.2 Groundwater Safe Yield

Safe yield is traditionally defined as the volume of groundwater which can be withdrawn from an aquifer and exported from the area in question with no overall reduction in storage. Essentially, safe yield is equivalent to the average annual recharge, since groundwater withdrawals in excess of average annual recharge will result in groundwater "mining".

For the Conway Ranch it is difficult to directly calculate average annual recharge since the groundwater and surface water system (Wilson Creek) are in a state of dynamic balance. Recharge rates through seepage losses from the creek will be greater, for example, during periods of drought than during periods with above average precipitation. An additional difficulty concerns the aquifer configuration beneath the Ranch. As discussed previously, the central part of the Ranch appears to contain a groundwater basin separated to some extent from the larger Mono Basin.
TABLE 2: WATER BALANCE SUMMARY

<table>
<thead>
<tr>
<th>Inputs (cfs)</th>
<th>Beak (1987)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inputs</td>
</tr>
<tr>
<td>Area I Surface Water Runoff</td>
<td>5.27</td>
</tr>
<tr>
<td>Area II Surface Water and</td>
<td>&quot;Other drainages, Wilson diversions, Groundwater&quot;</td>
</tr>
<tr>
<td>Groundwater Runoff</td>
<td>1.51</td>
</tr>
<tr>
<td>Area III Surface Water and</td>
<td>&quot;Area IV Precipitation&quot;</td>
</tr>
<tr>
<td>Groundwater Runoff</td>
<td>4.78</td>
</tr>
<tr>
<td>Area IV (Conway Ranch) Direct</td>
<td>1.79</td>
</tr>
<tr>
<td>Precipitation</td>
<td>0</td>
</tr>
<tr>
<td>Wilson Creek Diversion</td>
<td>19.00</td>
</tr>
<tr>
<td>Virginia Creek Diversion</td>
<td>2.30</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>34.65</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Beak (1987)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outputs</td>
</tr>
<tr>
<td>Evapotranspiration</td>
<td>3.8</td>
</tr>
<tr>
<td>Groundwater Flow</td>
<td>2.4</td>
</tr>
<tr>
<td>Surface Water Runoff (Wilson Creek)</td>
<td>28.45</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>34.65</strong></td>
</tr>
</tbody>
</table>
Groundwater apparently fills this separate basin and the water level declines which would normally be expected during periods of drought do not occur in this basin. This results in part from the basin being continuously replenished through seepage from Wilson Creek and in part to the damming effect of the surrounding bedrock highs.

Groundwater flow out of the central basin appears to be constrained to a narrow southeast trending channel (see Figure 3, Geologic and Groundwater Flow Map) bordered by bedrock highs. Groundwater outflow in this channel is probably in a relatively steady-state condition as it appears to be controlled by discharge from the central basin which, as discussed previously, is itself continuously replenished from Wilson Creek. As a consequence, the best available estimate of average annual groundwater recharge is the average volume of off-site discharge through the bedrock channel.

Average annual groundwater discharge has already been calculated for the water balance as 2.4 cfs, or approximately 1100 gallons per minute (gpm). This value is essentially the traditional safe yield. However, for the Conway Ranch, this value is highly conservative since extracted groundwater will not be exported from the Ranch, but will be used to supplement flows in the streams and lake on the Ranch. Some percentage of the extracted groundwater will, therefore, reinfilt rate and recharge the groundwater. The longer the detention time in the lake and streams, the more water will reinfilt rate. Essentially, the Ranch could be considered a closed loop system with groundwater extraction at the lower edge of the property and reinjection in the upper part. Because of this situation, we believe a more realistic safe yield would be about 1500 gpm, assuming approximately 30% reinfilt rate of extracted groundwater.

4.3 Groundwater Storage

Groundwater storage is the total volume of groundwater held within the Conway Ranch boundaries which can be removed by pumping. Since groundwater only occupies the pore spaces between sediment grains, the total volume of groundwater is dependent on aquifer porosity. However, not all groundwater in pores can be removed by drainage or pumping from a well as some water will be held through molecular and surface tension forces. The volume percentage of water which can be removed is called the specific yield, and generally ranges between 10% and 35% for sands and gravels. Clays and other fine grained sediments typically yield much less, on the order of 3% to 5%.

Based on the pumping test data from the domestic water supply and fire pump wells, the aquifer acts as though it were, on average, a coarse sand. A coarse sand generally has a porosity of 35 to 40% and will yield about 30% (Todd, 1959, p.24).
To calculate storage, the aquifer thickness and areal extent are multiplied to determine aquifer volume. The aquifer volume is then multiplied by the percentage yield (specific yield) to obtain total storage. For the Conway Ranch, the aquifer geometry is not known with certainty. However, we made conservative assumptions about the areal aquifer extent and then calculated aquifer volume assuming a saturated thickness of 80 feet southeast of the bedrock high and 60 feet in the central basin. The resulting total volume is 700,000,000 cubic feet. With a specific yield of 30%, the total volume of groundwater storage equals 212,100,000 ft$^3$ (or about 4,900 acre feet). Groundwater storage calculations are described in more detail in Appendix C.

4.4 Lake Evaporation Losses

Loeffler (1977) reports studies by the Los Angeles Department of Water and Power indicating 39.6 inches/year evaporation from an on-land pan near Grant Lake and 42 inches/year from a floating pan on Grant Lake. Evaporation at Grant Lake can be considered similar to evaporation from the proposed Conway Ranch lake. Grant Lake is a freshwater lake and is about 600 feet higher in elevation than Mono Lake. Conway Ranch will also be freshwater and 400-500 feet higher than Mono Lake. Assuming an average evaporation rate of 40.8 inches/year, the total evaporation which can be expected from the proposed 33 acre lake is 112.2 acre feet/year or .15 cfs.

The 40.8 inches/year evaporation rate is almost identical to the 40.4 inches/year average annual potential evapotranspiration rate calculated by Beak (1987) for Conway Ranch. Under most conditions, actual evapotranspiration from land areas is considerably less than potential evapotranspiration because of insufficient soil moisture during the dry season to satisfy vegetation demand. The proposed lake area, however, currently stays wet throughout the entire year because of the shallow groundwater table and numerous irrigation ditches. Consequently, the actual evapotranspiration rate is likely close to the potential rate. Replacing the land with a lake should, therefore, result in only slightly greater evaporation losses.
5.0 PROPOSED LAKE CONSTRUCTION

5.1 Lake Excavation

Construction of the 33-acre lake to a depth of 10 to 15 feet below existing grade, as currently planned, will entail a fairly significant earth moving operation. Heavy equipment will be necessary to excavate the required volume of soil, and trucks and bulldozers will be necessary to move the excavated soils away from the lake and then grade it to some planned elevation.

Because of the shallow water table and the soft to extremely soft soils in the proposed lake area, normal excavation procedures using trucks and bulldozers will not be possible unless the excavation area is first dewatered. Dewatering might be accomplished through installation of shallow groundwater extraction wells around the proposed lake perimeter. However, we do not believe this would be feasible because of the large area involved. One way to compensate for the area limitation is to dewater and then excavate a series of smaller areas until the entire excavation was complete. However, this would be very costly as it would require the installation and removal of numerous wells.

Other excavation methods can be used below the water table. Below-water excavation can be accomplished with either a large hydraulic backhoe or a crane equipped with a drag line. The backhoe has several important advantages over the drag line including the ability to excavate a smooth, clean bottom and to deposit excavated soil directly into trucks for transport to the soil disposal area. Drag lines, by contrast, often leave a rough bottom, create more turbid conditions, and dump excavated soil onto the ground where it has to be picked up again for loading into trucks. Drag lines are also slower than backhoes, but they can reach further out into areas with difficult access. Backhoes with large 4 or 5 cubic yard buckets are available to expedite excavation work.

Whichever equipment is chosen, access onto the soft ground is likely to be a problem. Mud mats, wooden planks, or other support devices will almost assuredly be necessary.

5.2 Seepage Losses

Seepage losses through the bottom of the lake will be essentially nil because of the shallow groundwater conditions. However, water will flow through the downstream edge of the lake into the adjoining Water Table Aquifer. The rate of outflow will be balanced in whole or part by groundwater inflow along the upstream edge of the lake. It is not possible to calculate how much water will outflow laterally relative to lateral inflow without more information than is currently available. Consequently, we believe it would be prudent to provide some type of liner along the downstream edge of the lake to limit lateral seepage losses.
The simplest liner construction method would be to stockpile clay-rich soils during excavation of the lake area and then place these stockpiled soils as a 2 to 3-foot thick liner. Other commercial plastic liners or liner materials are available but would be costly.

5.3 Organic Soil Volume

The type and thickness of organic-rich sediment varies considerably across the proposed lake area. In some areas, there is essentially no topsoil or organic rich sediments (see logs from Test Pits 3, 4, and 7), and in others there is up to 84 inches of organic-rich sediment. Also, in some areas, the organic-rich material is at land surface and in others it is buried beneath 2 to 3 feet of non-organic soil. Because of this complexity, it is not possible to define distinct areas with uniform organic sediment thickness. Consequently, we have calculated the total volume of organic sediment by averaging thicknesses from all test pits and multiplying the resulting average by the proposed lake area (33 acres or 1,437,480 square feet). We believe this approach is relatively accurate since the test pits are spread fairly uniformly across the proposed lake area.

The average organic sediment thickness is 17.5 inches. This thickness over 33 acres results in a total volume of approximately 2,100,000 cubic feet.

The organic sediment varies from organic clay to silty sand, but generally is a brown silty clay or clayey silt with organic matter. Because it is typically clay rich, you might consider adding sand as an amendment before using it as topsoil in landscape or golf course areas.
REFERENCES


APPENDIX A

Test Well No. 3 Installation and Well Logs

Well Drilling Procedures

Test Well No. 3 was drilled with an Ingersoll Rand T4W drill rig equipped for fluid rotary operations. Drilling fluid composed of a water/bentonite powder mixture was continually flushed down the bore hole as drilling proceeded. Returning fluid carrying drill cuttings was discharged into a small ditch which emptied into a larger settling pit.

Drilling began on July 2, 1987, and was completed on the same day with the borehole at a total depth of 171 feet. Our geologist was on the drill site essentially full time during drilling and made a careful record of drilling operations and geologic conditions encountered in the boring.

Prior to beginning drilling, the uppermost aquifer was anticipated to be approximately 120 feet thick, as measured from land surface. However, during drilling it appeared permeable, water-bearing sediments (Water Table Aquifer) only extended downwards to about 70 feet and were underlain by a thick sequence of non-water bearing sandy clays. Drilling was halted after penetrating 100 feet of the non-water bearing clays, as it did not appear worthwhile to continue drilling for purely exploratory purposes.

Electrical Logging

Immediately following completion of the boring, downhole electrical logs were run to confirm and refine the geologic interpretations made during drilling. Results from the electrical logs confirmed our geologic interpretations and indicated two major water-bearing zones at approximately 30 to 45 feet and 52 to 69 feet below land surface. A well was then designed with screened sections in the two zones. Results from the electric logs as well as the geologic log are shown on Figure 6.

Well Installation

Well installation began and was completed on July 3, 1987. Construction details are shown on Figure 6.

Well Development

Immediately following well installation, well development began using air from a compressor mounted on the drill rig. Initially, approximately 50 gallons per minute was discharged from the well, but this increased to approximately 145 gpm by the end of development on July 6, 1987. During development, water conductivity and temperature were monitored as well as the volume of sand being discharged per liter of water. Initially, approximately 0.5 sf sand was being discharged. This reduced to approximately 0.02 ml by the end of development. A copy of our field well development record is included in this Appendix.
Pumping Tests

A crude water level recovery test was attempted after well development to evaluate aquifer parameters and well performance. The test consisted of monitoring water levels after shutting off the air lift. Unfortunately, the earliest water level measurement possible was 20 seconds after air lift shut-off and the water level rebounded to near static level within another 40 seconds. Consequently, no meaningful analysis could be performed, although the rapid water level rise does indicate fairly permeable conditions.

A second test was attempted using an electric submersible capable of discharging 30 gpm. This pump rate produced only 1.2 feet of drawdown.

Well Specific Capacity and Allowable Pumping Rate

Since the best available well capacity data is from the air lift recovery test, we have used it to calculate a specific capacity of 3.8 gpm/foot of drawdown. Assuming 25 feet of available drawdown to the top of the uppermost screen, the allowable pumping rate would be 100 gpm. However, during well development a flow of nearly 150 gpm was sustained for over an hour suggesting the allowable pumping rate is probably higher than 100 gpm. If the well is ever utilized as a water supply, a more accurate pumping test at a higher pumping rate would be advisable.

Following is Figure 2 showing well locations and Figure 6 showing Test Well 3 construction details and the geologic and electric logs. Also included following Figure 6 is a well development record and copies of the well drilling logs for the Domestic, Fire Pump, and Monitoring Wells.
LEGEND:

- Approximate location of groundwater monitoring or water supply well
- Approximate location and number of test pit
- 6825 - Elevation in feet

Reference: Undated topographic base map provided by Trifid Engineering, 1987

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Site Plan
Conway Ranch at Mono Lake
Mono County, California
**WATER WELL DRILLERS REPORT**

**No. 231278**

**OWNER:** General Delivery

**Location:** Buena Vista, Ca.

**WELL LOG:**
- Depth: 12 ft
- Location: 60 gravel

**LOCATION OF WELL**

- Owner's Well Number: 2
- Address: 66,373 W. 1/2
- Section: 6
- Township: 407
- Range: 15
- Section: 108
- Net of Elevation: 500,279 ft

**WELL LOCATION SKETCH**

**UPPER:**
- Reverse: No
- Air: No
- Bucket: No

**GRAVEL PACK:**
- Diameter of body: 6 in
- Packed from: 0 to 20 ft

**TYPE OF WORK:**
- New Well
- Deepening
- Reconditioning
- Horizontal Well
- Destructive (Describe destruction materials and procedures in item 12)

**PROPOSED USE:**
- Domestic
- Irrigation
- Industrial
- Test Well
- Snack
- Municipal
- Other

**WELL SEAL:**
- Surface sanitary seal provided: Yes
- If yes, to depth: 20 ft
- Transient seal against pollution: Yes
- Interval: 20 ft

**WATER LEVELS:**
- Depth of first water, if known: 20 ft
- Depth after well completion: 20 ft

**WELL TESTS:**
- Test made: Yes
- If yes, by whom: G. C. Trout

**WELL DRILLER'S STATEMENT:**
- Work started: 5-25
- Work completed: 5-20
- Address: 4165 16th St.
- City: San Juan
- Zip: 925-4

**LICENSED TO:**
- Name: Inoue Drilling & Pump Service
- License No: 41723
- Date of this report: 5-20-82
**Owner:** John Fredrickson  
**General Delivery**  
John Fredrickson Co.

**Location of Well:** Sec. 6, T23S, R12W, S.D.  
3 1/2 mile north  
3 1/4 mile east of highway 90  
NE 1/4, 1st Section of Township  
T23 S, W. of Wilson Creek

**Type of Work:**  
- New Well  
- Deepening

**Proposed Use:**  
- Domestic
- Irrigation
- Industrial
- Test Well
- Water Supply

**Gravel Pack:**  
- Diameter of bore: 3/8"  
- Depth: 50 ft to 204 ft

**Casing Installed:**  
- Material: Plastic
- Diameter: 10 in

**Perforations:**  
- Type of perforation or size of screen:  
- Size: 2 1/2 in

**Well Seal:**  
- Surface sanitary seal provided?: Yes  
- If yes, to depth: 50 ft

**Water Levels:**  
- Depth of first water, if known: 50 ft
- Standing level after well completion: 40 ft
- Usable: 10 ft

**Well Tests:**  
- Well test made?: Yes  
- If yes, by whom?:  
- Pump used: 2 3/4"  
- Air lift:  
- Depth to water at start of test: 6 ft  
- Water temperature: 41°F
- Discharge: 2.6 gallons per minute after 4 1/2 hours
- Chemical analysis made?: Yes  
- If yes, by whom?:  
- Electrical test made?: Yes  
- If yes, by whom?:

**Well Driller's Statement:**  
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.

**Signed:**  
[Signature]

**Name:** MARATHE Drilling, Inc.

**Address:** Rt. 4 Box 150

**City:** Bishop Co.

**License No.:** 417231  
**Date of this report:** 7-26-82

---

*IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM*
**WATER WELL DRILLERS REPORT**

**LOCATION OF WELL**
- Owner: John Frederickson
- Address: June Dale General Delivery, Ca. 93529

**WELL LOG**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Clay</td>
<td>35-45</td>
</tr>
<tr>
<td>1 1/2 mile</td>
<td>50-65</td>
</tr>
<tr>
<td>1 1/4 mile</td>
<td>65-80</td>
</tr>
<tr>
<td>1 1/2 mile</td>
<td>80-125</td>
</tr>
<tr>
<td>1 1/4 mile</td>
<td>125-145</td>
</tr>
<tr>
<td>1 1/2 mile</td>
<td>145-165</td>
</tr>
<tr>
<td>1 1/4 mile</td>
<td>165-190</td>
</tr>
</tbody>
</table>

**TYPE OF WORK**
- New Well
- Deepening
- Reconditioning
- Municipal Well

**PROPOSED USE**
- Domestic
- Irrigation
- Industrial
- Test Well
- Stock
- Municipal

**EQUIPMENT**
- Reverse
- Air
- Other

**GRAVEL PACK**
- No
- Size

**CASING INSTALLED**
- Plastic
- Complete

**PERFORATIONS**
- Type of perforation or size of screen

**WELL SEAL**
- Surface sanitary seal provided
- No
- Yes
- To depth

**WATER LEVELS**
- Depth of first water, if known
- Standing level after well completion

**WELL TESTS**
- As well test made?
- Yes
- No
- If yes, by whom
- If yes, by whom
- Depth to water at start of test
- Hours
- Water temperature
- Pump
- 40
- Boiler
- Air

**WELL DRILLER'S STATEMENT**
- This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

**SIGNED**
- (Well Driller)
APPENDIX B
Pumping Test Data and Analyses

Methodology

A pumping test was conducted on July 6 and 7, 1987, using the Fire Pump Well as a pumping well and the Domestic Well as a monitoring well. Depth to water was measured periodically in the other wells (Monitoring Well and Test Well No. 3); however, they showed no effect from the pumping.

The Fire Pump Well was pumped at a rate of approximately 250 gpm, according to an in-line gage at the pump house. This pump rate was not verified independently.

The Fire Pump Well was shut off after 16 hours because it appeared water levels had nearly stabilized in the Domestic Well. Total drawdown was approximately 20 feet in the pumped well and approximately 13 feet in the monitoring well. This data indicates a specific capacity of 12.5 gpm/foot of drawdown in the Fire Pump Well.

Data from the pumping was analyzed using several different methods including the This recovery, This drawdown, and Jacob straightline solutions. Results were fairly consistent with an average hydraulic conductivity of 0.017 feet/minute or 0.008 cm/sec.

Following is the pumping test data and analyses.
Hydraulic conductivity in feet/minute

Where:

- \( K \) = hydraulic conductivity
- \( D \) = Aquifer thickness in feet = 72
- \( Q \) = Pump discharge in ft³/min = \( \frac{250.94}{1337} \) = 0.19
- \( n \) = Drawdown in feet over one lag cycle = 3.0
- \( t_o \) = where \( t = 0 \) = 0.08 minutes (see P1)
- \( r \) = Distance in feet between observation well and pumped well = 59

\[
K = \frac{2.30 \times \frac{1}{2}}{(4)(3.14)(3.0 \text{ ft})(72 \text{ ft})} = 2.83 \times 10^{-2} \text{ ft/min}
\]

\[
S = \frac{2.25 \times 10^{-2}}{(99)(99)} \text{ ft}^2
\]

\[
S = 1.0000 \times 27 = 3.7 \times 10^{-3} \text{ ft}^2
\]
\[ T = \frac{2.64}{Q} \quad \text{or} \quad S = \frac{0.375}{T} \]

\[ T = \frac{2.64}{20} = 0.132 \text{ gpd/ft} \]

\[ Q = \text{discharge in gpm} = 250 \]

\[ L = \text{length in ft} = 3 \text{ ft} \]

**Storage Coefficient**

\[ T = \frac{2.64(2.5)}{3} = \frac{6.60}{3} = 2.2 \text{ gpd/ft} \]

\[ T = 120 = 27 \text{ gpd/ft} \]

\[ h = \frac{27,000 \text{ gpd/ft}}{72 \text{ ft}} = 385.6 \text{ gpd/ft}^2 \]

\[ (385.6 \text{ gpd/ft}^2 \times 0.00055 = 0.214 \text{ m/s} \]

\[ s = \frac{(385.6 \text{ gpd/ft}^2 \times 0.00055 \text{ day}}{0.00055 \text{ day}} = 1.5 \text{ m/s} \]

\[ V = 0.00055 \text{ day} \times 0.00055 \text{ day} = 0.000055 \text{ day} \]

\[ S = \left( \frac{1}{3} \right) \left( 27,000 \right) \left( \frac{77}{90} \right) = -0.54 \left( 3.74 \text{ x 10}^{-5} \right) \]

\[ S2 \quad T = 1.074 \text{ min/ft} \quad \text{or} \quad 2.83 \times 10^{-2} \text{ ft/min} \]
\[ \Delta = n - 4.5 \]

\[ K = \frac{(2.3)(33.4)}{1.1(8.14)(4.5)(7.2)} \approx 9.6 \times 10^{-3} \text{ c/s} \]
K0 = \frac{2.7 \times 2}{77 \times 0.5"}

K0 = \frac{2.7 \times 2}{2 \times 0.5"}

= \frac{7.38}{3 \times 2.7 \times 1728}

= \frac{7.38}{5.184}

= 1.414 \text{ ft/min}

= 7.5 \times 10^{-3} \text{ cm/min}

Comparing

Rec. w/ K = \frac{0.149}{4} \text{ ft/min}

Cur 1 w/ 1.5 ft of 4 in. pipe

Cur 2 w/ 2.0 ft of 4 in. pipe

Their drainage K = \frac{0.18}{4} \text{ ft/min}

Average

\frac{0.17}{4} \text{ ft/min}

= 0.02 \text{ ft/min}

= 0.02 \text{ cm/min}

\frac{0.17}{4} \text{ ft/min}

= 0.003 \text{ cm/min}
APPENDIX C

Groundwater Flow and Storage Analysis
Statement: G.W. flow will be measured at T1 using Darcy's Law:

\[ Q = k i \]

where:

\[ Q = \text{Discharge in CFS} \]
\[ k = \text{hydraulic conductivity as determined from field well pumping test} = 0.02 \text{ ft/min} \]
\[ i = \text{hydraulic gradient} = 0.36 \text{ (sec PZ)} \]
\[ a = \text{area through which groundwater discharges proportionate to flow (equivalent thickness times width)} = 200 \text{, 000 ft}^2 \]

\[ Q = 0.02 \text{ ft/min} \times 0.36 \times 200,000 \text{ ft}^2 = 2.4 \text{ CFS} \]
Aquifer Thickness

Domestic well: 60 ft. Depth @ surface = 350 ft
    Box of equip. (70 ft. fillers @ 7.5"
    Sheet 72

First well 60 ft. Depth ~ 43 ft. Sheet 77

Remittence well

The equip. was removed in July, 87 during a period of semi-drought. For three weeks, water levels were very low and probably slightly lower than normal.

Use 80 ft. as lower limit.
Discussion:
The calculation is of the total volume of water available from the ground water area.

Available water is defined as the specific yield or that portion available for use.

The specific yield of a porous soil is generally 45 to 80%. For Sands, the specific yield is generally 45 to 80% of the porosity.

The pumping test data from the borehole core indicates the aquifer is Sand. Therefore, an average porosity of 30% will be assumed.

Calculation:

\[ S_{\text{total}} = \left( \frac{\text{specific yield}}{1 \text{ unit}} \right) \]

\[ = \left( \frac{0.25}{1} \right) \times 10^8 \text{ ft}^2 \]

\[ = 1.75 \times 10^8 \text{ ft}^2 \]

\[ = 1.75 \times 0.000000004 \text{ ft}^2 \]

\[ = 0.0000000069 \text{ ft}^2 \]

\[ = 0.30 \times 7 \times 10^8 \text{ ft}^2 \]

\[ = 2.1 \times 10^8 \text{ ft}^2 \]
APPENDIX D

Water Balance Analysis
Area I

\[ \text{Area I} = \frac{1}{2} \times 574 \times 1.25 = 180 \text{ sq ft} \]

Area II

\[ \text{Area II} = 1.35 \text{ sq ft} \]

Area III

Break calculates 5.66 sq ft for Area III which includes part of Area IV as used in this analysis.

The calculated area is:

\[ \frac{1}{2} \times 574 \times 65 = 12512500 \text{ sq ft} - (1250 \times 1450) = 15412500 \text{ sq ft} - 5285 \text{ sq ft} - 5285^2 \times \frac{1}{2} = 5.66 \text{ sq ft} - 0.55 \text{ sq ft} = 5.11 \text{ sq ft} \]
<table>
<thead>
<tr>
<th>BR 1</th>
<th>No. 2</th>
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<tbody>
<tr>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>1.38</td>
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</tr>
<tr>
<td>5.66</td>
<td></td>
</tr>
<tr>
<td>1.43</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14.21</strong></td>
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</tbody>
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<table>
<thead>
<tr>
<th>No. 2</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>6.38</td>
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<td>1.25</td>
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<tr>
<td>5.11</td>
<td></td>
</tr>
<tr>
<td>1.35</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14.23</strong></td>
</tr>
</tbody>
</table>
FIGURE 1. MAP of STUDY AREA

BASE MAP PRODUCED BY
UNITED STATES GEOLOGICAL SURVEY
19XX
COUNTOUR INTERVAL 40 FEET

SCALE

LEGEND
PROPERTY LINE
DRAINAGE AREA
CREEK
DRAINAGE
follow is a schematic of the Conway area.

inputs

- area I surface water runoff
- area II surface water and groundwater runoff
- area III surface water and groundwater runoff
- area IV precipitation
- Wilson Creek discharge
- Virginia Creek diversion

outputs

- runoff from area IV
- surface water runoff (Wilson Creek)
- groundwater outflow

Note: Areas I, II, III, IV are BEAK drainage areas
(BEAK, 1987)

Calculations for each input and output are on
the following pages 2 through 8. A summary table showing inputs and outputs is on page 9.

Much of the data used in this analysis is from BEAK's report "DRAFT FIP SECTIONS - CONWAY RANCH AT MAWA LAKE."

Drainage area calculations are starting...
Area 2 inputs:

N.B. The only source of water to the area is from direct surface or groundwater flow from higher areas to the west. Precipitation from rains of runoff either runs off or infiltrates and moves towards groundwater, or evaporates. For this area, only surface water runoff inputs to Conway Retch. Evapotranspiration is lost to the atmosphere and groundwater flow is diverted away from Conway Retch by a bund wall high along the southern property line.

Runoff calculation: The clay soils method is not appropriate for this calculation, as most runoff occurs during storm events or as snow melting from snow packs. Consequently, we will use a factor x annual precipitation to arrive at a runoff volume. Boyle (1984)'s report in Beek (1987) reports that 60% of annual precip. discharge as runoff. We will use 50% and consider it includes groundwater flow (surface water infiltration).

So: \[ 25.0'' \times 0.50 = 12.5'' \text{ per year} \]
12.5 in/yr x (12.5 in/yr x 355 ft²/1000 in²) x (6.25 µm²)

\[ \times \left( \frac{2.79 \times 10^3 \text{ ft}^3}{\text{in}^3} \right) \div \left( 365 \text{ days/year} \right) = 27 \text{ ft}^3/\text{sec} \]

12.5 in/yr = 5.87 ft³/sec 

Runoff Alone
Area II Inputs

Narrative: All precipitation (snow + rain) in Area II eventually reaches Conway River through surface water runoff or groundwater flow, except that which evaporates. The input from this area is therefore precipitation minus evaporation, or surface water runoff plus groundwater flow. We assume no underflow from higher areas to the west.

Calculation: The runoff calculation is essentially the same as already described for Area I (Page 2) with the following modifications:

- The percentage runoff is increased to 60% of annual precipitation because of the steep slopes in Area II.
- An additional 10% of annual precipitation is taken as water which has infiltrated and is traveling downslope as groundwater. Therefore:

$\left(0.60 + 0.10\right) \times \left(20 \text{ in/year}\right) = 14 \text{ in/year}$

Assure Actual Resp. - Jim
oshnry, 1987

.42
14 in/yr. conv. \( 1.35 \text{ m}^3 = 1 \text{ ft}^3 \text{ conv.} \)

\[
\frac{14 \times \left( \frac{3.048 \text{ ft}}{\text{ m}} \right) \times \left( 1.35 \text{ m}^3 \right) \times \left( 2.97 \times 10^7 \text{ ft}^2 / \text{yr} \right)}{(365 \text{ days/yr}) \times (24 \text{ hr/day}) \times (60 \text{ min/hr}) \times (60 \text{ sec/min})} = 1.51 \text{ cfs} \quad \text{or} \quad 4.76 \times 10^7 \text{ ft}^3 / \text{yr} \text{ conv.} \]
Area III: Inputs

Narrative: The hydrology is defined in Area III essentially. The same as already described for Areas I - II with a 60% factor used including both surface water runoff and groundwater. This is probably conservative, as most water probably runs off in the spring and captures probably does not account for a full 40% of rainfall projection.

Therefore:

\[(0.60) \times (18 \frac{\text{in}}{\text{yr}}) = 10.80 \frac{\text{in}}{\text{yr}}\]

After: Ron E. 3/31/89

10.8 \frac{\text{in}}{\text{yr}} \text{ over } 5.11 \text{ mi}^2 = \left(10.8 \frac{\text{in}}{\text{yr}}\right) \times \left(1.083 \frac{\text{ft}^2}{\text{in}^2}\right) \times \left(5.11 \times 10^7 \frac{\text{ft}^3}{\text{mi}^2}\right) \div \left(3550 \frac{\text{cu ft}}{\text{yd}^3}\right) \div \left(24 \frac{\text{hr}}{\text{dy}}\right) \div \left(60 \frac{\text{mi}}{\text{hr}}\right) \div \left(60 \frac{\text{sec}}{\text{mi}}\right) = 4.32 \frac{\text{cf}}{\text{sq yd}}
The only input to this area is precipitation.

Average annual precip = 16 in/year (Jim Ogden, 1987)

\[ 16 \text{ in/year} \times 1.35 \text{ in}^2 = \left( 16 \frac{\text{in}}{\text{yr}} \right) \left( 0.0112 \text{ ft}^2 \right) \left( 2.97 \times 10^{-4} \text{ cfs/ft}^2 \right) \]

\[ \approx 6 \text{ cfs/yr} \times 6 = 36 \text{ cfs/yr} \]

\[ = 1.69 \text{ ft}^2/\text{sec} \text{ CFS} \checkmark \]

**WILSON CREEK INPUTS**

Narrative: Wilson Creek drains most of the water into a large lake-like reservoir and is thus mostly independent of runoff from the surrounding area. (Area I input is calculated separately on pages 2 and 3). According to AFEPA, 1987 figures, the average annual discharge to Wilson Creek from the powerhouse is 24.3 CFS. Since Canvey Ranch can only divert 19.0 CFS for its own use, we will use 19.0 CFS as the average annual usable discharge to the property. This is conservative as the excess over 19 CFS would also serve to recharge groundwater at Canvey Ranch after times of drought. Note that 19 CFS includes the...
For the purpose of this analysis, we are assuming no flow in the eastern section of the Army Base Reserve.

Thus, the Wilson Creek input = 19 cfs

**Virginia Creek Inflow Inputs**

According to Beck (1957), the average annual inflow from Virginia Creek is 2.3 cfs, most of which occurs between April and August.

**Inputs Summary**

<table>
<thead>
<tr>
<th>Area</th>
<th>Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area I</td>
<td>5.87</td>
</tr>
<tr>
<td>Area II</td>
<td>1.31</td>
</tr>
<tr>
<td>Area III</td>
<td>4.32</td>
</tr>
<tr>
<td>Area IV</td>
<td>1.69</td>
</tr>
<tr>
<td>Wilson Creek</td>
<td>19.00</td>
</tr>
<tr>
<td>Virginia Creek</td>
<td>2.30</td>
</tr>
</tbody>
</table>

Total average annual inflow to Conway Ranch = 34.69 cfs

Say 35 cfs
Evapotranspiration and Water Balance

Evaporation from the soil surface water reservoirs is a significant factor in the water budget for the area. The study area includes groundwater levels below the surface, which support various grasses. The other areas are dry, but some areas with deeper soils support sage brush. Most evaporation or transpiration occurs between April and September. The weather is cold during the remainder of the year.

ET Calculation: The Thornthwaite method for calculating actual ET is appropriate as in BEAK, 1987 (Appendix A; Attachment B). This method reduces potential ET to account for available soil moisture. BEAK, 1987 uses location ET from California isopleth maps supplied by Thorne for a total of 40.1 in/year total potential ET. We will use this figure as a most conservative value since it overestimates actual ET by some 20-70%.

For Jim O'Hara

36
Wilson Creek output

Method

Total input = ET + Gw outflow + Wilson Creek outflow

Therefore:

Wilson Creek out = Total Input - (ET + Gw outflow)

= 34.65 CFS - (42.1 CFS + 2.4 CFS)

= 34.65 - 6.63

= 28.02 CFS

Check

Is 28.02 CFS reasonable?

Stream flow measured in July, 1987 during reported drought.

Upstream Wilson Creek = 11.5 CFS

Upstream Wilson Creek = 9.0 CFS

11.5 + 28.4 doesn't seem too bad considering large percentage of runoff occurs during spring.
Inputs:

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lpc</td>
<td>5.27</td>
</tr>
<tr>
<td>Lci</td>
<td>1.51</td>
</tr>
<tr>
<td>Avic</td>
<td>4.78</td>
</tr>
<tr>
<td>Avic</td>
<td>1.79</td>
</tr>
<tr>
<td>Velic</td>
<td>19.0</td>
</tr>
<tr>
<td>Veloc</td>
<td>2.30</td>
</tr>
</tbody>
</table>

Total: 34.65 ft³/min

ET: 3.5 ft

Groundwater: 2.4 ft³/min

Outlet: 34.65 ft³/min

6.5 ft output = 5 x 6.5 = 2.4 ft³/min = 1077.19 gpm
= 1100 gpm
APPENDIX E

Test Pit Exploration and Logs

Methodology

Seventeen test pits were excavated to depths ranging from 6.5 to 13 feet in depth on July 2 and 3, 1967, with a Case 580E backhoe. The test pits were logged by our geologist who kept a careful record of soil and groundwater conditions.

In many test pits, the water table elevation was clearly apparent. Logs from these test pits show the water table elevation. In other test pits, the water table elevation was not clear, and the logs instead describe the depth and intensity of groundwater seepage.
# Coarse Grained Soils

**Major Divisions**

<table>
<thead>
<tr>
<th>Gravels</th>
<th>Typical Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW</td>
<td>Well-graded gravels, gravel-sand mixtures</td>
</tr>
<tr>
<td>GP</td>
<td>Poorly-graded gravels, gravel-sand mixtures</td>
</tr>
<tr>
<td>GM</td>
<td>Silty gravels, poorly graded gravel-sand - silt mixtures</td>
</tr>
<tr>
<td>GC</td>
<td>Clayey gravels, poorly graded gravel-sand - clay mixtures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sands</th>
<th>Typical Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>Well-graded sands, gravelly sands</td>
</tr>
<tr>
<td>SP</td>
<td>Poorly-graded sands, gravelly sands</td>
</tr>
<tr>
<td>SM</td>
<td>Silty sands, poorly graded sand - silt mixtures</td>
</tr>
<tr>
<td>SC</td>
<td>Clayey sands, poorly graded sand - clay mixtures</td>
</tr>
</tbody>
</table>

**Fine Grained Soils**

<table>
<thead>
<tr>
<th>Silts and Clays</th>
<th>Typical Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity</td>
</tr>
<tr>
<td>CL</td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays</td>
</tr>
<tr>
<td>OL</td>
<td>Organic clays and organic silty clays of low plasticity</td>
</tr>
<tr>
<td>MH</td>
<td>Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts</td>
</tr>
<tr>
<td>CH</td>
<td>Inorganic clays of high plasticity fat clays</td>
</tr>
<tr>
<td>OH</td>
<td>Organic clays of medium to high plasticity, organic silts</td>
</tr>
</tbody>
</table>

| Peat and Other Highly Organic Soils | |

---

**Legend**

- **Sample**
  - "Undisturbed"
  - Bulk
  - Not Recovered

- **Graphic Log**
  - Well Defined Change
  - Gradational Change
  - Obscure Change
  - End of Exploration

- **Bounces/foot**
  - Hammer is 140 pounds with 30 inch drop, unless otherwise noted
  - S - SPT Sampler (2.0 inch O.D.)
  - T - Thin Wall Sampler (2.6 inch Sample)
  - H - Split Barrel Sampler (2.4 Inch Sample)

- **Moisture Description**
  - Dry - Considerably less than optimum for compaction
  - Moist - Near optimum moisture content
  - Wet - Over optimum moisture content
  - Saturated - Below water table, in capillary zone, or in perched groundwater

---

**Soil Classification/Legend**

Conway Ranch at Mono Lake
Mono County, California

**Job Number** 15.248.001
**Drawn** SL
**Approved** MAA
**Date** 28 July 87

**Laboratory Tests**
- Consol - Consolidation
- LL - Liquid Limit
- PL - Plastic Limit
- Gs - Specific Gravity
- SA - Size Analysis
- Tx - Triaxial Shear
- DS - Direct Shear
- VS - Vane Shear
- Comp - Compaction
- UU - Unconsolidated - Undrained
- CU - Consolidated - Undrained
- CD - Consolidated - Drained

**Applied Geotechnology Inc.**
Geotechnical Engineering
Geology & Hydrogeology
**Test Pit Number 1**

Elevation 6825 feet Date 7/2/87

- Grass sod
- Dark brown topsoil with grass roots (OL)
- Gray clayey silt (MH) very soft, saturated; with trace of sand
- Mottled gray-orange silt (ML) soft, saturated
- Mottled gray-orange silt (ML) and silty sand (SM) soft, saturated; fine-grained sand
- Strong seepage below 7 feet from sand zones
- Sand size increases downwards to coarse at 9 feet
- Test pit terminated at 9 feet on 7/2/87.
- Sides caving.

**Test Pit Number 2**

Elevation 6822 feet Date 7/2/87

- Grass sod
- Brown clayey silt (MH) and silty clay (CL) soft to medium stiff, wet; with roots and organic pockets
- Gray clayey silt (MH) very soft, saturated; with trace fine to coarse sand
- Light seepage at 7 feet
- Mottled gray and orange silt (ML) soft to medium stiff, saturated
- Test pit terminated at 10 feet on 7/2/87.
- Sides caving.
Test Pit Number 3
Elevation 6824 feet Date 7/2/87

Approximate water table elevation

0
5
10
15

Sod
LIGHT GRAY-BROWN SANDY SILT (ML) hard, dry; with about 10% gravel

ORANGE-BROWN GRAVELLY SILTY SAND (SM) dense, dry; gravel angular to subrounded, ranging from fine gravel to coarse gravel

ORANGE-BROWN CLAYEY SILT (MH) medium stiff, moist; with some sand

ORANGE-BROWN GRAVELLY SAND (SW) medium dense, wet; with some silt

Seepage at 7.5 feet
ORANGE-BROWN SANDY GRAVEL (GW) medium dense, saturated; with some silt, gravel to 3 inches but generally to 1 inch

Test pit terminated at 9 feet on 7/2/87.
Sides caving below 7 feet.

Test Pit Number 4
Elevation 6822 feet Date 7/2/87

Approximate water table elevation

0
5
10
15

Sod
BROWN CLAYEY SILT (MH) hard, dry; with some fine sand
Medium stiff, moist at 1 foot

Soft, wet at 3 feet

GRAY-BROWN SILTY SANDY GRAVEL (GP/GM) medium dense, wet

BROWN SANDY GRAVEL (GP) medium dense, saturated; gravel is coated with orange oxide stain and generally ranges from fine gravel to 1-inch diameter

Test pit terminated at 8.5 feet on 7/2/87.
Sides caving below 6 feet.

Log of Test Pits 3 and 4
Conway Ranch at Mono Lake
Mono County, California

Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

PLATE

JOB NUMBER
15.248.001

DRAWN
SL

APPROVED
MAA

DATE
28 July 87

REVISED


Test Pit Number 5
Elevation 6820 feet  Date 7/2/87

Approximate water table elevation

Sod
LIGHT BROWN SILT (ML) soft, dry; with roots
LAMINATED DARK BROWN SILTY CLAY (CL) AND LIGHT BROWN SILT (ML) hard, moist; with orange-brown staining on some laminating
GRAY SANDY SILT (ML) hard, moist
GRAY-BROWN SILTY CLAY (CL) stiff, wet

Soft at 6 feet
INTERLAYERED GRAY FINE SAND (SP) BROWN SILTY CLAY (CL)
AND SILT (ML) loose, soft, saturated; sand layers less than 2 inches thick

Test pit terminated at 11.5 feet on 7/2/87.
Sides caving below 8 feet.

Test Pit Number 6
Elevation 6820 feet  Date 7/2/87

Sod
BROWN SANDY SILT (ML) soft, dry; stiff at 6 inches
DARK BROWN SILTY CLAY (CL) stiff, wet; laminated
GRAY SILTY CLAY (CL) medium stiff, saturated; massive
INTERLAYERED GRAY FINE SAND (SP) BROWN SILTY CLAY (CL)
AND ORANGE-BROWN FINE SANDY SILT (ML) loose, soft, saturated; sands and silts are water bearing, sand layers less than 2 inches thick

MOTTLED GRAY AND ORANGE SILT (ML) soft, saturated

Test pit terminated at 13 feet on 7/2/87.
**Test Pit Number 7**

**Elevation** 6822 feet  
**Date** 7/2/87

BROWN SILT (ML) soft, dry; with trace of sand and gravel and with roots

BROWN GRAVELLY SILTY SAND (SM) hard, moist

ORANGE-BROWN GRAVELLY SILTY SAND (SM) dense, moist

ORANGE-BROWN SANDY GRAVEL (GP) medium dense, wet

MOTTLED ORANGE AND GRAY SILT (ML) soft, saturated

Water bearing layers of gray medium to coarse sand at 5 to 7 feet

ORANGE-BROWN SILTY SAND (SM) AND SANDY SILT (ML) loose, soft, saturated

Test pit terminated at 10 feet on 7/2/87.

**Test Pit Number 8**

**Elevation** 6822 feet  
**Date** 7/2/87

Sod with dark brown organic silt (OL)

Light seepage from base of organic silt

MEDIUM BROWN SILTY CLAY (CL) soft, saturated; with organics

GRAY SILT (ML) soft, saturated

ORANGE-BROWN GRAVELLY SILTY SAND (SM) loose, saturated

Moderate seepage from 3.0 to 3.5 feet

BROWN SILTY SANDY GRAVEL (GM) loose, saturated

Test pit terminated at 10 feet on 7/2/87.

Sides caving below 6 feet.
Test Pit Number 9

Elevation 6819 feet Date 7/2/87

SOD WITH DARK BROWN ORGANIC SILT (OL)

MEDIUM BROWN SILTY CLAY (CL) (OL?) soft, saturated: with roots and organics

GRAY SILTY CLAY (CL) very soft, saturated; massive

Heavy seepage at 4 feet from silt or sand seams?

ORANGE AND BROWN SILTY SAND (SM) medium dense, saturated; with approximately 10% fine gravel

Test pit terminated at 9.5 feet on 7/2/87.

Sides caving below 4 feet.

-------------------------------

Test Pit Number 10

Elevation 6822 feet Date 7/2/87

SOD WITH DARK BROWN ORGANIC SILT (OL)

Seepage from base of sod

MEDIUM BROWN SILTY CLAY (CL) (OL?) soft, saturated; with some roots and organics

GRAY SILTY SAND (SM) loose, saturated; light seepage from this layer

GRAY SILTY CLAY (CL) very soft, saturated; massive

GRAY AND ORANGE SILTY CLAY (ML) AND SILTY CLAY (CL)
soft, saturated

ORANGE-BROWN SILTY SAND (SM) very loose, saturated

Test pit terminated at 6.5 feet on 7/2/87.

Sides caving below 1.5 feet.
Test Pit Number 11

Elevation 6825 feet  Date 7/3/87

SOD WITH DARK BROWN ORGANIC SILT (OL)
GRAY SANDY GRAVEL (GP) loose, wet; saturated at 18 inches; gravel ranges up to 1/2-inch diameter
GRAY SILTY CLAY (CL) very soft, saturated; with trace sand
Becomes mottled gray and orange below 6 feet
Heavy seepage at 8 feet
Some hard dessicated portions below 9 feet

Test pit terminated at 11 feet on 7/3/87.

Test Pit Number 12

Elevation 6820 feet  Date 7/3/87

Light sod
LIGHT BROWN SILTY SAND (SM) loose, moist; with roots
GRAY-BROWN FINE SANDY SILT (ML) medium stiff, wet
MEDIUM BROWN CLAY (CH) stiff, wet; with organics
GRAY SILTY CLAY (CL) very soft, saturated
INTERLAYERED GRAY-PINK SAND (SP) GRAY SILT (ML) AND
GRAY SILTY CLAY (CL) medium dense, medium stiff, saturated; silt predominates; moderate seepage from sand layers
MOTTLED GRAY-BROWN CLAYEY SILT (MH) soft, saturated

Test pit terminated at 12 feet on 7/3/87.
Test Pit Number 13
Elevation 6822 feet Date 7/3/87

Dark brown topsoil and sod
LIGHT BROWN SILT (ML) soft, dry
MEDIUM TO DARK BROWN ORGANIC SILTY CLAY (OH) stiff, wet
GRAY SILTY CLAY (CL) very soft, saturated
Soft at 4 feet with sandy zones

INTERBEDDED SILT (ML) GRAY-PINK FINE SAND (SP) AND
GRAY SILTY CLAY (CL) soft, loose, saturated
Seepage from sand zones
GRAY SILTY CLAY (CL) soft, saturated
Becomes mottled gray-brown and medium stiff at 10 feet
Test pit terminated at 11.5 feet on 7/3/87.

Test Pit Number 14
Elevation 6823 feet Date 7/3/87

Sod
LIGHT BROWN SILTY SAND (SM) very loose, dry; abundant
coarse-grained quartz grains
LIGHT BROWN SILTY SAND (SM) loose, dry; fine-grained
sand, abundant mica flakes
LIGHT BROWN AND ORANGE SANDY SILT (ML) medium stiff,
maintain
DARK BROWN ORGANIC CLAY (OH) stiff, wet
GRAY SILTY CLAY (CL) soft, wet to saturated
Medium stiff at 8 feet
Moderate seepage at 9 feet
Test pit terminated at 11 feet on 7/3/87.
Test Pit Number 15
Elevation 6827 feet Date 7/3/87

SOD WITH DARK BROWN ORGANIC SILT (OL)
MOTTLED BROWN AND ORANGE SILTY SAND (SM) loose, moist
GRAY SILTY CLAY (CL) soft, wet; numerous mica flakes
in thin layers

Saturated below 4.5 feet
Light to moderate seepage at 6.5 feet
GRAY SILTY SAND (SM) loose, saturated; fine-grained
with abundant mica
Contains contorted layers of laminated organic clay
and silt at 8 to 9 feet
Heavy seepage at 9 feet
Test pit terminated at 11 feet on 7/3/87.

Test Pit Number 16
Elevation 6827 feet Date 7/3/87

SILTY SAND (SM) with roots
MEDIUM BROWN SILTY SAND (SM) loose, moist
DARK BROWN SILTY ORGANIC CLAY (OH) medium stiff, wet

DARK GRAY-BLACK ORGANIC SILTY SAND (SM) loose, wet;
saturated at 3.5 feet, swamp odor
Heavy seepage at and below 3.5 feet
GRAY-GREEN AND ORANGE SILTY CLAY (CL) soft, saturated;
with thin layers of white granular volcanic ash (?)
Test pit terminated at 10 feet on 7/3/87.
Test Pit Number 17
Elevation 6825 feet  Date 7/3/87

SOD AND DARK BROWN ORGANIC CLAY (OH)
BROWN SILTY SAND (SM) loose, wet
GRAY SILTY CLAY (CL) soft, saturated
Seepage at 3.7 feet
Heavy seepage at 6 feet
Medium stiff mottled gray and orange at 7 feet and below

Test pit terminated at 11 feet on 7/3/87.
DISTRIBUTION

5 Copies

Triad Engineering
Post Office Box 1570
Mammoth Lakes, California 93546

Attention: Mr. James N. Ognisty

Quality Assurance and Technical Review by:

John E. Newby, P.E.
President

MAA/MS/tag