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QA: QA

**Civilian Radioactive Waste Management System  
Management & Operating Contractor**

**Data Qualification Report: Precipitation Chloride Data  
for Use on the Yucca Mountain Project**

**TDR-NBS-GS-000015 REV 00**

**September 2000**

Prepared for:

U.S. Department of Energy  
Yucca Mountain Site Characterization Office  
P.O. Box 30307  
North Las Vegas, Nevada 89036-0307

Prepared by:

TRW Environmental Safety Systems Inc.  
1211 Town Center Drive  
Las Vegas, Nevada 89144

Under Contract Number  
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**September 2000**

Prepared by:

  
\_\_\_\_\_  
Charles Wilson, Chairperson

9/28/00  
Date

  
\_\_\_\_\_  
Terry L. Steinborn, Technical Representative

9/28/00  
Date

  
\_\_\_\_\_  
Robert Wemheuer, Responsible Manager

09/30/00  
Date

## EXECUTIVE SUMMARY

This data qualification report uses technical assessment and corroborating data methods according to Attachment 2 of AP-SIII.2Q, Rev. 0, ICN 2, *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data*, to qualify U.S. Geological Survey (USGS) hydrochemical data sets used in Analysis/Model Report (AMR) S0040, *Geochemical and Isotopic Constraints on Groundwater Flow Directions, Mixing and Recharge at Yucca Mountain* (ANL-NBS-HS-000021) and AMR U0085, *Analysis of Geochemical Data for the Unsaturated Zone* (ANL-NBS-HS-000017). Data obtained prior to approval of the USGS Yucca Mountain Project Quality Assurance Program Plan in May 1989 are unqualified. The unqualified data sets considered in this report are identified in Data Tracking Number (DTN) GS930108315214.003, "Chemical Analysis of Surface-Water, Spring and Precipitation Samples Collected from Kawich and Stewart Creek Basins from September, 1984, to April, 1989". Only the chloride data in these data sets were used in the aforementioned AMRs and are considered in this report.

The corroborating data method of qualification was chosen to compare unqualified data sets to qualified data sets. This was done to show that the data sets provide consistent characteristics of the precipitation at areas that were chosen as natural analogs to Yucca Mountain.

The unqualified chloride data were separated from DTN GS930108315214.003 and three new DTNs containing the qualified data were generated. The status of the new DTNs cited below should be changed to qualified.

| DTN                | Title   |
|--------------------|---|
| MO0005CL3SPRGS.000 | Dissolved Chlorides in mg/L in Samples Taken Over Time from 3 Springs Basin Near Warm Springs, NV, Precipitation Water Quality, Water Years October 1984 to September 1991                        |
| MO0005CLESTWRT.000 | Dissolved Chlorides in mg/L in Samples Taken Over Time from East Stewart Basin, East Stewart Creek Near Ione, Nye County, Precipitation Water Quality, Water Years October 1984 to September 1991 |
| MO0005CLKAWICH.000 | Dissolved Chlorides in mg/L in Samples Taken Over Time from Kawich Peak, 3 Springs Basin, Warm Springs, Nye County, Precipitation Water Quality, Water Years October 1984 to September 1991       |

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## ACRONYMS AND ABBREVIATIONS

|      |  |
|------|--|
| ACC  | Accession Number                             |
| AMR  | Analysis/Model Report                        |
| ATDT | Automatic Technical Data Tracking            |
| CMB  | Chloride Mass Balance                        |
| DOE  | U.S. Department of Energy                    |
| DTN  | Data Tracking Number                         |
| HP   | Hydrologic Procedure                         |
| PMR  | Process Modeling Report                      |
| QAPP | Quality Assurance Program Plan               |
| SNL  | Sandia National Laboratory                   |
| TWRI | Techniques of Water Resources Investigations |
| USGS | U.S. Geological Survey                       |
| WIPP | Waste Isolation Pilot Plant                  |
| YMP  | Yucca Mountain Project                       |

# 1. INTRODUCTION

## 1.1 PURPOSE

The data covered by this qualification report have been cited in analysis/model reports (AMRs) to support the Site Recommendation in determining the suitability of Yucca Mountain as a repository for high level nuclear waste. Those analyses cited both qualified and unqualified hydrochemical data. This report evaluates unqualified precipitation chloride data based on the pedigree of the data and within the context of supporting analyses on the Yucca Mountain Project (YMP). The following AMRs use the unqualified chloride data considered in this report:

- AMR S0040, *Geochemical and Isotopic Constraints on Groundwater Flow Directions, Mixing and Recharge at Yucca Mountain* (ANL-NBS-HS-000021) (Kwicklis 2000) - an analysis of groundwater recharge rates, flow directions and velocities, and mixing proportions of water from different source areas based on groundwater geochemical and isotopic data.
- AMR U0085, *Analysis of Geochemical Data for the Unsaturated Zone* (ANL-NBS-HS-000017) (Fabryka-Martin 2000) - identifies fluid geochemical parameters for the unsaturated zone, local precipitation, and surface water; discusses the occurrence and origins of fracture minerals; and presents a thermal history of the unsaturated zone.

These data are being evaluated for inclusion in technical products to include AMRs and Process Modeling Reports (PMRs) that support the Site Recommendation and that may also be used to support the License Application. A finding that the precipitation chloride data are qualified means that the data are adequate for generalized use and can be appropriately used in a wide variety of applications, so long as consideration is given to limitations on the accuracy, precision and representativeness of the data for an intended use in a technical product. These data were reviewed in accordance with Attachment 6 of procedure AP-3.15Q Rev 1, *Managing Technical Product Inputs*, and found to not be used in the direct calculation of Principal Factors for postclosure safety or disruptive events.

## 1.2 SCOPE

This report evaluates a subset of the data identified in Data Qualification Plan TDP-NBS-GS-000031, Rev 2. The data qualification plan identifies data tracking numbers (DTNs) containing acquired and developed ground water, surface water and precipitation data measured by the U.S. Geological Survey (USGS) or other sources cited in USGS literature. The DTNs cited in the plan include the following hydrochemical data:

- Major ions
- Carbon Isotopes
- Deuterium

- Oxygen Isotopes
- Tritium
- Total Uranium and Uranium Isotopes

These data sets contain a wide variety of hydrochemical data required by general water chemistry sampling and analytical protocols or sampling plans developed for the activities at the time of data acquisition (e.g. temperature, chemistry and volume of surface water and spring discharge). These data are not explicitly within the scope of this qualification activity.

This qualification report considers only the chloride data sets selected to support the hydrochemical analyses in AMRs S0040 and U0085. To the extent that only subsets of data within a specific DTN are used in the analyses, only those data were evaluated for qualification.

This report evaluates the precipitation chloride data using the methodology and evaluation criteria described in the qualification plan. Other qualification reports prepared to Data Qualification Plan TDP-NBS-GS-000031, Rev 2 address major ion and isotopic hydrochemical data.

The following DTN contains the precipitation chloride data considered in this report.

| DTN                | Title  |
|--------------------|--|
| GS930108315214.003 | Chemical Analysis of Surface-Water, Spring and Precipitation Samples Collected from Kawich and Stewart Creek Basins from September, 1984, to April, 1989 |

### 1.3 DATA QUALIFICATION TEAM

The Responsible Manager for this data qualification task is Robert Wemheuer.

The Chairperson for this data qualification team is Charles Wilson. Dr. Wilson has a Ph.D. (1970) in civil engineering with emphasis in groundwater hydrology. He has 20 years of experience in site characterization for nuclear facilities and served on the data qualification independent Peer Review Panel for the U.S. Department of Energy's (DOE's) Waste Isolation Pilot Plant (WIPP) site license application. Dr. Wilson has had no involvement with the collection or processing of any YMP data.

Terry Steinborn is a data qualification team member. Dr. Steinborn has a BA (1968) in chemistry with emphasis on inorganic and radiochemistry and an MS (1972) and PhD (1976) in geology with emphasis on geochemistry and volcanology, and is a Professional Hydrogeologist, certified by the American Institute of Hydrology. He has 24 years of experience, most of it in activities related to nuclear and hazardous waste environmental issues. He served on the DOE-HQ Independent Review Team for WIPP, and worked with Sandia National Laboratories (SNL) on WIPP, the Greater



Confinement Disposal Program, and SNL Site Environmental Restoration. He has had no involvement with the collection or processing of any YMP data

Gary Patterson was listed as an additional data qualification team member in the Data Qualification Plan (TDP-NBS-GS-00031, Rev 2) for this activity. However, because of other USGS project commitments, he was unable to participate in this project and provided no input regarding qualification of the data considered in this report.

## 1.4 BACKGROUND

The data considered in this report were collected from 1984 to 1992. The chloride data in the cited DTN are unqualified because they were collected prior to implementation of the YMP-approved USGS Quality Assurance Program Plan (QAPP). In general, data collected by the USGS after May 3, 1989 are considered qualified. After May 3, 1989, USGS Hydrologic Procedures (HPs) became the approved implementation procedures for USGS data collection activities. The USGS began developing and implementing these procedures as early as 1983 but they were not formally adopted by the Survey until 1986. In particular, Hydrologic Procedures USGS HP-167, *Precipitation Measurement Using a Belfort Weighing Rain Gage* (ACC: HQX.19890419.0113), and USGS HP-184, *Collection and Preservation of Atmospheric Precipitation Samples for Chemical Analysis* (ACC: HQX.19891002.0092), are applicable to the instruments used to collect the data considered in this report. These procedures were finalized on June 9, 1988, and February 7, 1989, respectively, and document protocols of the USGS for collecting precipitation data during the 1980s. Both procedures were approved for use under the USGS QAPP and after May 3, 1989, were used to collect qualified data.

## 2. QUALIFICATION METHODS

Qualification methods of *technical assessment* and *corroboration* are used. Technical assessment is applied to determine the appropriateness of data acquisition and analysis methodologies and their application (i.e. technical review of procedures and protocols). The corroborating data method is used in making cross comparisons to evaluate the internal consistency of independently acquired data within the hydrochemical database. Other technical assessment methods are used where needed to further support the data qualification process.

**Technical Assessment.** Technical assessment of the unqualified precipitation chloride data from the Kawich and Stewart Creek Basins is based on the appropriateness of precipitation sampling and analysis methods, the completeness and traceability of records, and the continuity of methodology between periods of acquisition of unqualified and qualified data.

**Corroborating Data.** As stated in procedure AP-SIII.2Q Attachment 2, the corroborating data approach may include comparisons of unqualified to unqualified data as well as unqualified to qualified data. Corroborating data methods are used to show that the chloride data set provides internally consistent information.

## 2.1 EVALUATION CRITERIA

The criteria considered in evaluating the qualification status of the precipitation chloride data are identified below. These criteria were selected to incorporate the considerations in procedure AP-SIII.2Q Attachment 2 and the applicable qualification process attributes listed in procedure AP-SIII.2Q Attachment 3.

1. Are data collection and analysis methods comparable to those used under the YMP-approved USGS QAPP, or are the data collection and analytical methods reasonable in view of standard measurement and instrumentation practice at the time the data were collected?
2. Are the data the best available?
3. Are these data or similarly collected data generally accepted by the technical community for use in non-project applications?
4. Does analysis of comparable qualified and unqualified data sets suggest the same conclusions regarding the saturated zone flow conceptual model?

## 2.2 RECOMMENDATION CRITERIA

The following recommendation criteria are considered in determining whether the status of the data should be changed to *qualified*.

1. The data collection methods, documentation, and results were reasonable and appropriate in view of standard practice at the time the data were collected.
2. The data were required for the analysis and the best available data were used.
3. These data or similarly collected data are generally accepted by the technical community for use in non-project applications.
4. The extent and quality of the corroborating data are sufficient and no additional data sources were identified that should have been considered.

Although precise definition of the accuracy and precision of a data point is often not possible, particularly with older data, the data qualification team recognizes that even qualified hydrologic and hydrochemical data have an inherent variability. This variability can result from natural fluctuations in the field as well as from minor changes in sampling and analysis techniques and should be expected. A generalized use of data is therefore a use wherein conclusions are not based on the precise value of a single data point or on minor differences among a small number of data points but are rather based on the cumulative evidence of many corroborating data points. Such use tends to be self-correcting, it simplifies identification of significant errors and outliers, and it focuses on general trends and ranges of values. A generalized use of data is therefore most appropriate for data points with mixed origin and pedigree.

### 3. EVALUATION RESULTS

Precipitation chloride data were collected in the Kawich and Stewart Creek Basins in southern Nevada, along with surface water, spring flow, and other precipitation chemistry data. These basins are considered as approximate natural analogs to the Yucca Mountain site. The precipitation chloride data from this data set are used in chloride mass balance (CMB) calculations in Section 6.5.6 of AMR S0040 (Kwicklis 2000) and in Section 6.9 of AMR U0085 (Fabryka-Martin 2000). These data provide a range of chloride content in precipitation whose adjusted end members Kwicklis uses to calculate regional infiltration rates ranging from 7 mm/yr to 14 mm/yr (AMR S0040, Table 10). Fabryka-Martin uses a low-weighted average precipitation chloride content to calculate infiltration rates at selected sites at Yucca Mountain (AMR U0085, Tables 26 and 27). Her estimated rates of recharge (1 to 20 mm/yr) are comparable to the estimates of Kwicklis. The partly independent estimates of recharge rates in AMRs S0040 and U0085 show that the use of combined qualified (24 months) observations and unqualified (55 months) observations of precipitation chloride content lead to overlapping estimates of recharge rates at Yucca Mountain. It is clearly demonstrated by the comparison of infiltration rates calculated from these data and supported by lines of evidence based on other chemical species ( $^{36}\text{Cl}$ , major ions, etc. in Section 6 of U0085) that any unrepresented uncertainty contained in the unqualified precipitation chloride data in DTN GS930108315214.003 has no impact on the calculation of recharge rates as used in AMRs S0040 and U0085.

The unqualified data in DTN GS930108315214.003 were acquired between September 1984 and April 1989 (55 months). The data from 1986 through 1991 for Kawich and 3 Springs Basins are tabulated and listed in DTN GS910908315214.003 (McKinley and Oliver 1994). The data in this tabulation are characterized as preliminary. The qualified data in DTN GS930108315214.003 were collected between February and September 1992 and between May 1989 and September 1991 (24 months). All periods of observation at the two sites contain breaks in observational continuity due to battery failure, equipment breakdown and equipment changeout. At certain times snow samples were collected manually. Gaps in data were in some cases filled by records from nearby stations. These conditions are relatively evenly distributed over the entire data population, and have no more discernable effect on the qualified periods of data than on the unqualified periods (McKinley and Oliver 1994 and 1995). The data are characteristic of the short term variability of the climate in southern Nevada. Comparison of monthly average dissolved chloride contents, and actual and projected yearly precipitation rates (Tables 1 and 2), show a pattern of relatively consistent monthly averages of chloride content with annual rainfall averages that vary by more than a factor of two in some cases. This results from great variability in rainfall events with long and very irregular periods between storms.

The average yearly magnitude of precipitation in this region is most probably related to the altitude of the sample area. A plot of average rainfall per year shows this irregular climatic pattern in both study areas and illustrates that the periods of qualified and unqualified data have similar variability (Figures 1 and 2). Plots of monthly averages of chloride content in precipitation are also similar over periods of qualified and unqualified

data for both areas (Figures 3 and 4). The general consistency in data collection methods during the periods of collection of both the qualified and unqualified data at both sites, and the absence of any systematic differences in the data between the data sets, imply that there is no hidden uncertainty in the unqualified parts of the data.

The Kawich and Stewart Creek Basins are at different elevations than Yucca Mountain and are wetter. Kwicklis (S0040) chose precipitation rates estimated for Yucca Mountain based on statistical analysis by Hevesi et al. (1992). Fabryka-Martin used a precipitation rate selected on the basis of professional judgement. The chloride content of precipitation is a more regional aspect of climate than precipitation volume and is not as subject to variation caused by sampling altitude nor as vulnerable to bias introduced by sample collection method or handling. Kwicklis' use of CMB calculations was to help identify trends in site subsurface groundwater flowpaths (S0040). Fabryka-Martin used the CMB calculations to estimate the rates and variation of recharge in relation to topographic and geomorphic characteristics of the site to support  $^{36}\text{Cl}$  studies and unsaturated zone vertical flow character (U0085). Although related, these uses of CMB calculations have different sensitivities to the data. The comparability of the results of both applications shows that the precipitation chloride data contained in this DTN are consistent in quality. Original sample records are intact in their original form and are tabulated and discussed in McKinley and Oliver (1994 and 1995).

#### 4. EVALUATION CONCLUSIONS

The data meet each of the evaluation criteria as follows:

1. The data collection and analysis methods are comparable throughout the data acquisition period which includes pre- and post-QAPP time periods.
2. The data are the best available. A comparison of the data with other data available in the region is extensively discussed in Section 6.3 of AMR U0085.
3. The data are part of a wide category of similar data collected by several governmental agencies and generally accepted by the technical community.
4. The chloride data sets from this DTN support consistent conceptual models in AMRs S0040 and U0085 (Figures 1, 2, 3 and 4). In addition, the conclusions supported by these data are consistent with the conclusions about saturated zone flow presented in AMR S0045, *Calibration of the Site Scale Saturated Zone Flow Model* (MDL-NBS-HS-000011).

#### 5. RECOMMENDATIONS

The chloride data meet each of the recommendation criteria as follows:

1. The data collection methods, documentation and results as used in AMRs S0040 and U0085 were reasonable and appropriate.

2. The data were required for the analysis and are the best available.
3. The data are generally accepted by the technical community for use in non-YMP applications.
4. The extent and quality of corroborative data are sufficient and no other suitable data sources were identified. In addition, the data are corroborated by comparison of data sets collected at the same sites in a continuous program, before and after the adoption of USGS QAPP. Conclusions reached are supported by both qualified and unqualified subsets of the data and are consistent with conclusions reached based on independent hydrological data sources as discussed extensively in Section 6 of AMR S0045.

As a result of this analysis, the precipitation chloride data presented in DTN GS930108315214.003 are qualified. The qualified chloride data were separated from DTN GS930108315214.003 and three new DTNs containing those data were generated. These new qualified DTNs are cited below.

| DTN                | Title   |
|--------------------|---|
| MO0005CL3SPRGS.000 | Dissolved Chlorides in mg/L in Samples Taken Over Time from 3 Springs Basin Near Warm Springs, NV, Precipitation Water Quality, Water Years October 1984 to September 1991                        |
| MO0005CLESTWRT.000 | Dissolved Chlorides in mg/L in Samples Taken Over Time from East Stewart Basin, East Stewart Creek Near Ione, Nye County, Precipitation Water Quality, Water Years October 1984 to September 1991 |
| MO0005CLKAWICH.000 | Dissolved Chlorides in mg/L in Samples Taken Over Time from Kawich Peak, 3 Springs Basin, Warm Springs, Nye County, Precipitation Water Quality, Water Years October 1984 to September 1991       |

## 6. REFERENCES

Fabryka-Martin, J. 2000. *Analysis of Geochemical Data for the Unsaturated Zone*. Document Identifier ANL-NBS-HS-000017. AMR U0085.

(Fabryka-Martin 2000)

Hevesi, J.A.; Flint, A.L.; and Istok, J.D. 1992. "Precipitation Estimation in Mountainous Terrain Using Multivariate Geostatistics: Part II: Isohyetal Maps." *Journal of Applied Meteorology*, 31, 667-688. TIC: 225248. ACC: NNA.19930427.0167.

(Hevesi et al. 1992)

Kwicklis, E. 2000. *Goechemical and Isotopic Constraints on Groundwater Flow Directions, Mixing and Recharge at Yucca Mountain, Nevada*. Document Identifier ANL-NBS-HS-000021. AMR S0040.

(Kwicklis 2000)

McKinley, P.W., and Oliver, T.A. 1994. *Meteorological , Stream-Discharge, and Water Quality Data for 1986-1991 from Two Small Basins in Central Nevada*. U.S. Geological Survey Open File Report 93-651. Denver, Colorado. TIC: 210498. ACC: NNA.19940114.0099.

(McKinley and Oliver 1994)

McKinley, P.W., and Oliver, T.A. 1995. *Meteorological , Stream-Discharge, and Water Quality Data for Water Year 1992 from Two Basins in Central Nevada*. U.S. Geological Survey Open File Report 94-456. Denver, Colorado. TIC: 215235. ACC: MOL.19950124.0284.

(McKinley and Oliver 1995)

**TABLE 1**  
**EAST STEWART CREEK**

| SEPT. 1984 - APR. 1989<br>(SURFACE WATER QUALITY)<br><br>OCT. 1985 - APR. 1989<br>(PRECIPITATION)<br><br>DTN GS930108315214.003<br>(UNQUALIFIED) |  | MAY 1989 - SEPT. 1991<br><br>DTN GS930108315214.004<br>(QUALIFIED) |                                       | FEB. 1992 - SEPT. 1992<br><br>DTN GS930908315214.030<br>(QUALIFIED) |                                       |
|--|--|--|---------------------------------------|---|---------------------------------------|
| SURFACE WATER QUALITY  | PRECIPITATION (MILLIMETERS)                | SURFACE WATER QUALITY  | PRECIPITATION (MILLIMETERS)           | SURFACE WATER QUALITY   | PRECIPITATION (MILLIMETERS)           |
| DISSOLVED CHLORIDES (MG/L AS CL)   |  | DISSOLVED CHLORIDES (MG/L AS CL)                                   |                                       | DISSOLVED CHLORIDES (MG/L AS CL)                                    |                                       |
| MONTHLY AVE:<br>0.80 MG/L  | MONTHLY AVE:<br>38.1 MM                    | MONTHLY AVE:<br>0.85 MG/L  | MONTHLY AVE:<br>41.1 MM               | MONTHLY AVE:<br>0.43 MG/L   | MONTHLY AVE:<br>34.3 MM               |
|  | TOTAL FOR TIME PERIOD:<br>1641.3 MM        |  | TOTAL FOR TIME PERIOD:<br>1192.3 MM   |   | TOTAL FOR TIME PERIOD:<br>274.1 MM    |
| PROJECTED MONTHLY AVE.<br>FOR 1984:<br>0.99 MG/L   | PROJECTED TOTAL FOR 1984:<br>NOT AVAILABLE | PROJECTED MONTHLY AVE.<br>FOR 1989:<br>0.83 MG/L                   | ACTUAL TOTAL FOR 1989:<br>302.3 MM    | PROJECTED MONTHLY AVE.<br>FOR 1992:<br>0.43 MG/L                    | PROJECTED TOTAL FOR 1992:<br>411.6 MM |
| PROJECTED MONTHLY AVE.<br>FOR 1985:<br>0.71 MG/L   | PROJECTED TOTAL FOR 1985:<br>635.0 MM      | PROJECTED MONTHLY AVE.<br>FOR 1990:<br>0.93 MG/L                   | ACTUAL TOTAL FOR 1990:<br>511.8 MM    |   |                                       |
| PROJECTED MONTHLY AVE.<br>FOR 1986:<br>0.78 MG/L   | ACTUAL TOTAL FOR 1986:<br>252.7 MM         | PROJECTED MONTHLY AVE.<br>FOR 1991:<br>0.79 MG/L                   | PROJECTED TOTAL FOR 1991:<br>629.9 MM |   |                                       |
| PROJECTED MONTHLY AVE.<br>FOR 1987:<br>0.86 MG/L   | ACTUAL TOTAL FOR 1987:<br>602.0 MM         |  |                                       |   |                                       |
| PROJECTED MONTHLY AVE.<br>FOR 1988:<br>0.80 MG/L   | ACTUAL TOTAL FOR 1988:<br>573.3 MM         |  |                                       |   |                                       |
| PROJECTED MONTHLY AVE.<br>FOR 1989:<br>0.83 MG/L   | ACTUAL TOTAL FOR 1989:<br>302.3 MM         |  |                                       |   |                                       |

**CONVERSION FACTORS:**

1. INCHES WERE MULTIPLIED BY 25.4 TO OBTAIN MM.

**TABLE 2**  
**KAWICH PEAK**

| FEB. 1989 - APR. 1989                               |                                       | MAY 1989 - SEPT. 1991                               |  | FEB. 1992 - SEPT. 1992                              |  |
|---|---------------------------------------|---|--|---|--|
| DTN GS930108315214.003<br>(UNQUALIFIED)             |                                       | DTN GS930108315214.004<br>(QUALIFIED)               |  | DTN GS930908315214.030<br>(QUALIFIED)               |  |
| SURFACE WATER<br>QUALITY                            | PRECIPITATION<br>(MILLIMETERS)        | SURFACE WATER<br>QUALITY                            | PRECIPITATION<br>(MILLIMETERS)           | SURFACE WATER<br>QUALITY                            | PRECIPITATION<br>(MILLIMETERS)           |
| DISSOLVED<br>CHLORIDES<br>(MG/L AS CL)              |                                       | DISSOLVED<br>CHLORIDES<br>(MG/L AS CL)              |  | DISSOLVED<br>CHLORIDES<br>(MG/L AS CL)              |  |
| MONTHLY AVE:<br>1.18 MG/L                           | MONTHLY AVE:<br>23.4 MM               | MONTHLY AVE:<br>0.39 MG/L                           | MONTHLY AVE:<br>31.8 MM                  | MONTHLY AVE:<br>0.47 MG/L                           | MONTHLY AVE:<br>35.6 MM                  |
|   | TOTAL FOR<br>TIME PERIOD:<br>70.4 MM  |   | TOTAL FOR<br>TIME PERIOD:<br>922.5 MM    |   | TOTAL FOR<br>TIME PERIOD:<br>284.0 MM    |
| PROJECTED<br>MONTHLY AVE.<br>FOR 1989:<br>0.53 MG/L | ACTUAL<br>TOTAL FOR 1989:<br>253.2 MM | PROJECTED<br>MONTHLY AVE.<br>FOR 1989:<br>0.53 MG/L | ACTUAL<br>TOTAL FOR 1989:<br>253.2 MM    | PROJECTED<br>MONTHLY AVE.<br>FOR 1992:<br>0.47 MG/L | PROJECTED<br>TOTAL FOR 1992:<br>427.2 MM |
|   |                                       | PROJECTED<br>MONTHLY AVE.<br>FOR 1990:<br>0.25 MG/L | ACTUAL<br>TOTAL FOR 1990:<br>363.5 MM    |   |  |
|   |                                       | PROJECTED<br>MONTHLY AVE.<br>FOR 1991:<br>0.59 MG/L | PROJECTED<br>TOTAL FOR 1991:<br>204.4 MM |   |  |

**CONVERSION FACTORS:**

1. INCHES WERE MULTIPLIED BY 25.4 TO OBTAIN MM.



FIGURE 1  
EAST STEWART CREEK

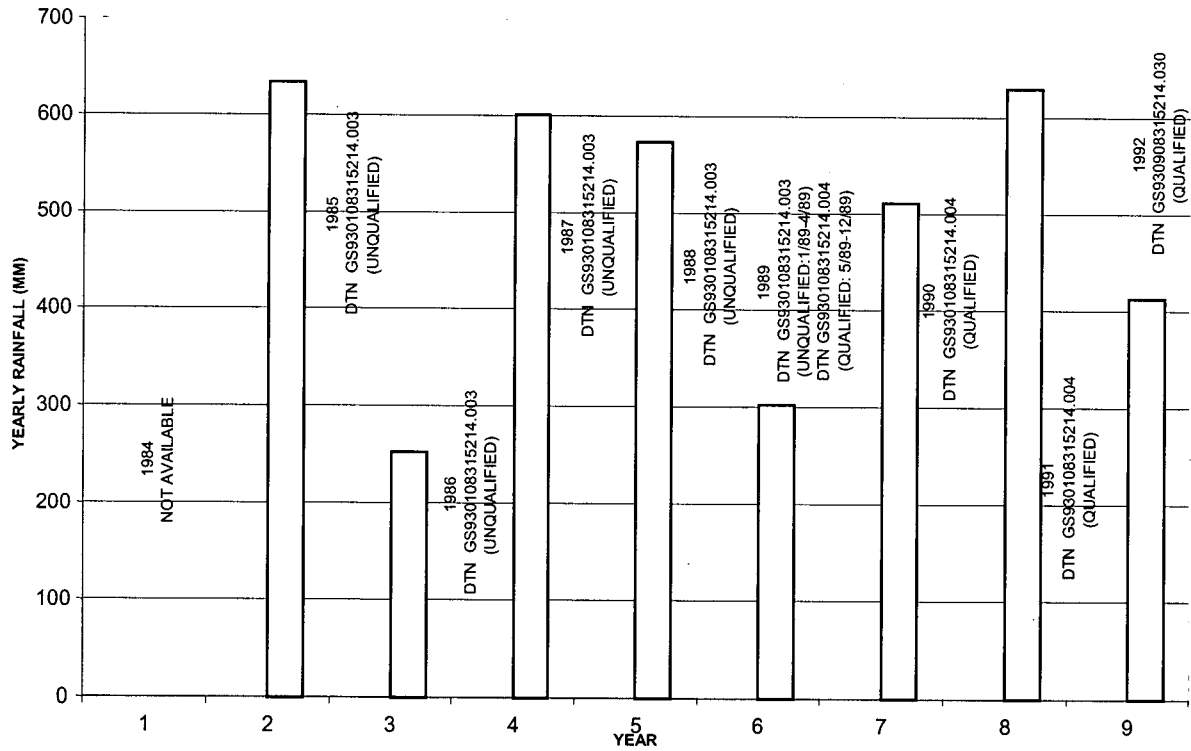
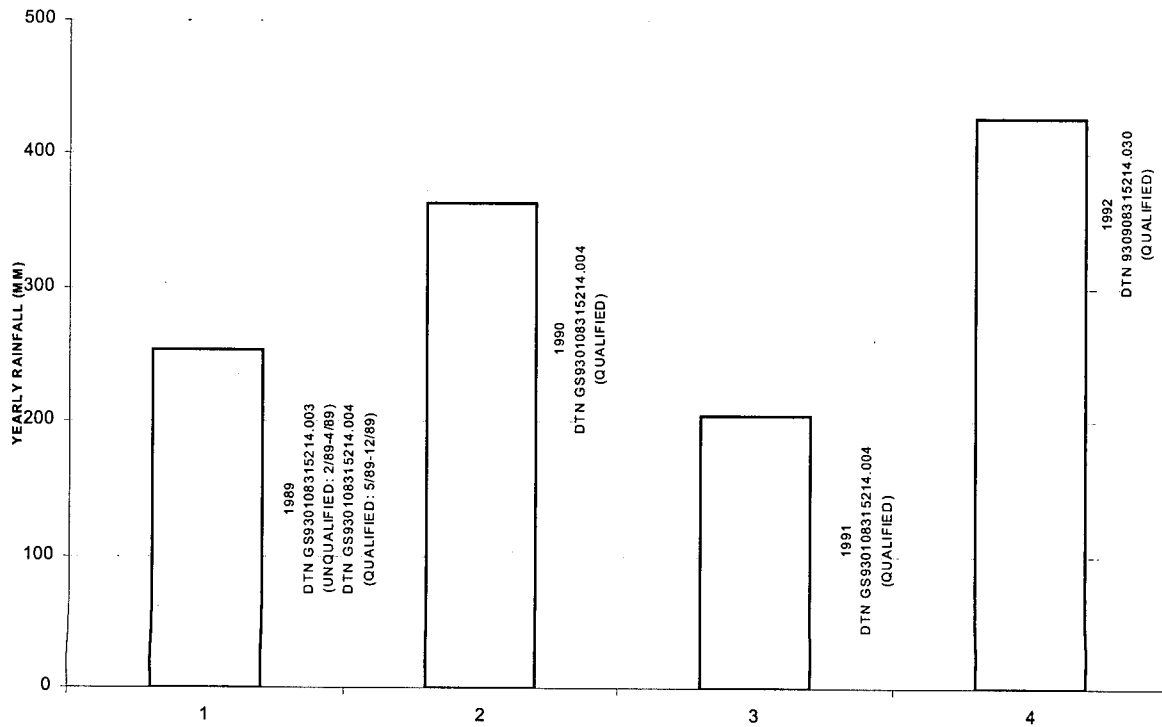
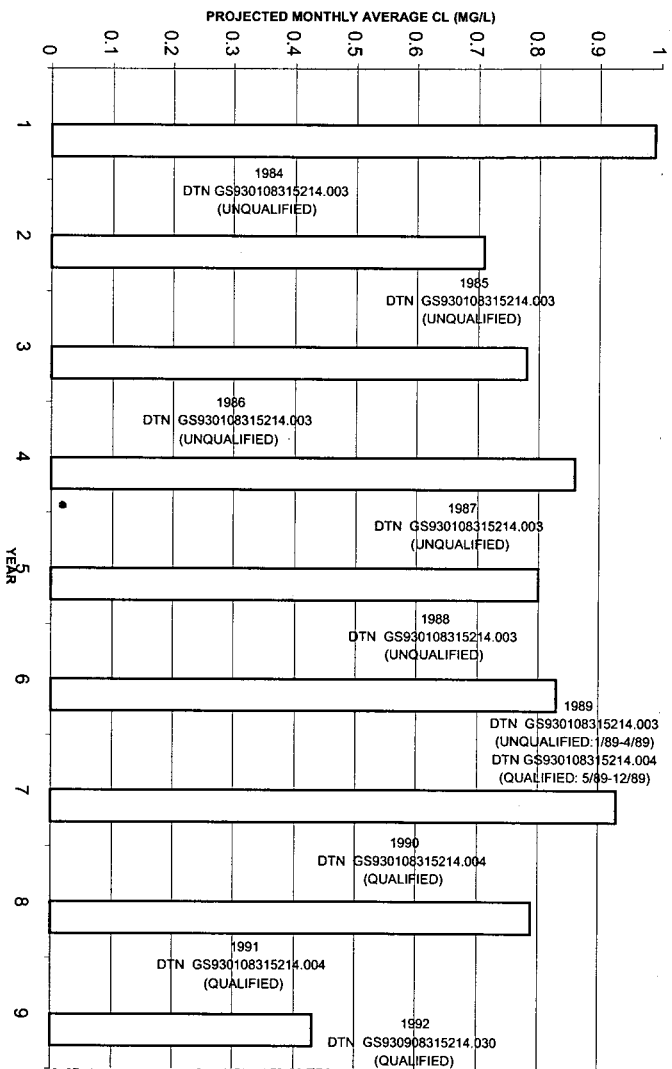


FIGURE 2  
KAWICH PEAK



**FIGURE 3**  
**EAST STEWART CREEK**



**FIGURE 4**  
**KAWICH PEAK**

