DRAFT

WASHOE COUNTY

REGIONAL FLOOD CONTROL MASTER PLAN FRAMEWORK

Regional Water Planning Commission

Prepared By:

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July 2005

WRC FILE 2140/3096

WRC ENGINEERING, INC.

July 18, 2005

Ms. Jeanne Ruefer, Planning Manager
Washoe County Water Resources
4930 Energy Way
Reno, Nevada 89502

WRC File: 2140/3096

RE: Washoe County Regional Flood Control Master Plan Framework

Dear Ms. Ruefer:

Enclosed herein is the Washoe County Regional Flood Control Master Plan Framework. This report documents the regional flood control master plan frame work process. This report presents a synopsis of the project history, description of the study area, an overview of hydrologic and hydraulic analyses, special planning areas, master planning framework, and a summary of existing watershed specific flood control master plans.

We appreciate the opportunity to prepare this Regional Flood Control Master Plan Framework for Washoe County and look forward to being of service to you in the future.

Respectfully Submitted,

WRC Engineering, Inc.

Alan J. Leak, P.E.
Project Manager

COMMENTS JAC 11/07

1) PROPOSED FACILITY SIZES/FLOWS

2) NO PARCEL INFO SHOWN (EASEMENTS REQ'D?)

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ACKNOWLEDGEMENTS

WRC Engineering, Inc. would like to recognize, credit, and thank those individuals for their involvement and contributions to the development of this Regional Flood Control Master Plan (RFCMP) for Washoe County, Nevada. The Washoe County RFCMP, together with Regional Floodplain Management Plan, represents the community's commitment and effort to reduce the future flood damages and to promote public safety while allowing orderly development of the region.

Through out the project, project team meetings were held with the sponsoring agencies and participating stakeholders to discuss various aspects of the project, resolve differences, and share information among the participants. The following list of individuals and respective affiliations encompasses those that have actively participated in the preparation, authoring, and subsequent review of the report.

Regional Water Planning Commission	Mr. Michael J. Demartini
Washoe County	Ms. Jeanne Ruefer, Planning Manager
	Mr. Paul Urban, P.E
	Mr. Jim Smitherman
	Ms. Kristine Klein, P.E.
	Mr. Warren Call, P.E.
	Ms. Gail Prockish
	Ms. June Davis
City of Reno	Mr. Glen Daily, P.E.
	Terri Svetich, P.E.
City of Sparks	Mr. Shawn Gooch, P.E.
Nevada Department of Transportation	Mr. Amir Soltani, P.E.
Nevada Division of Water Resources	Mr. Robert Martinez, P.E
	Mr. Michael Anderson, P.E.
	Ms. Kim Groenewold

<u>Project's Consultant</u>

WRC Engineering, Inc.	Mr. Alan J. Leak, P.E. - Project Principal
	Mr. Aiguo Xu, Ph.D., P.E.
	Mr. Bach V. McClure, P.E.
	Mr. Patrick A. Harvey - AutoCAD Support
	Mr. Mark A. Stacks - AutoCAD Support
	Ms. Evelyn L. Loar -Document Production

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Washoe County Regional Water Planning Commission (RWPC), in cooperation with local sponsoring agencies, has selected WRC Engineering, Inc. to prepare an update to the 1991 Conceptual Washoe County Regional Flood Control Master Plan (RFCMP) for Washoe County, Nevada. The Washoe County RFCMP, together with Regional Floodplain Management Plan (RFMP), represents the community's commitment and effort to reduce the future flood damages and to promote public safety while allowing orderly development of the region. Many significant changes have occurred within the region since the development of the 1991 concept level master plan. The current Washoe County RFCMP has been prepared in accordance with the current policies of the RWPC and the RFMP. Throughout the project, project team meetings were held with the sponsoring agencies and participating stakeholders to discuss various aspects of the project, resolve differences, and share information among the participants. The purpose of this updated RFCMP is to evaluate the existing and projected drainage and flooding conditions and to recommend regional drainage facilities that can effectively reduce future flood damages within the region. The study area encompasses the entire area in Washoe County. Specifically, the RFCMP addresses the following items:

- Identify alternative and recommended regional drainage improvements needed to reduce existing and projected flooding and drainage problems
- Identify improvements needed to maintain the protection level of the ongoing Truckee River Flood Management Project
- Establish standards for development of hydrologic and hydraulic analyses and watershed specific flood control/drainage master plans
- Provide placeholders so that future watershed specific drainage master plans can be easily incorporated into the RFCMP.

The goals and policies of the RWPC on the region's water, wastewater, and flood control issues are documented in the Regional Water Plan (latest version dated 1/18/2005).

Several watershed-wide drainage master plans have been prepared and adopted by the local jurisdictions for some of the developing watersheds within Washoe County (Figure 1). However, there are many other watersheds within the County that are experiencing new developments without adequate drainage master plans to guide orderly development of the watersheds. For these watersheds, it is important to prepare and adopt watershed-wide drainage master plans to identify existing and future drainage and flooding problems and to develop solutions that can be implemented prior to or during development of these watersheds.

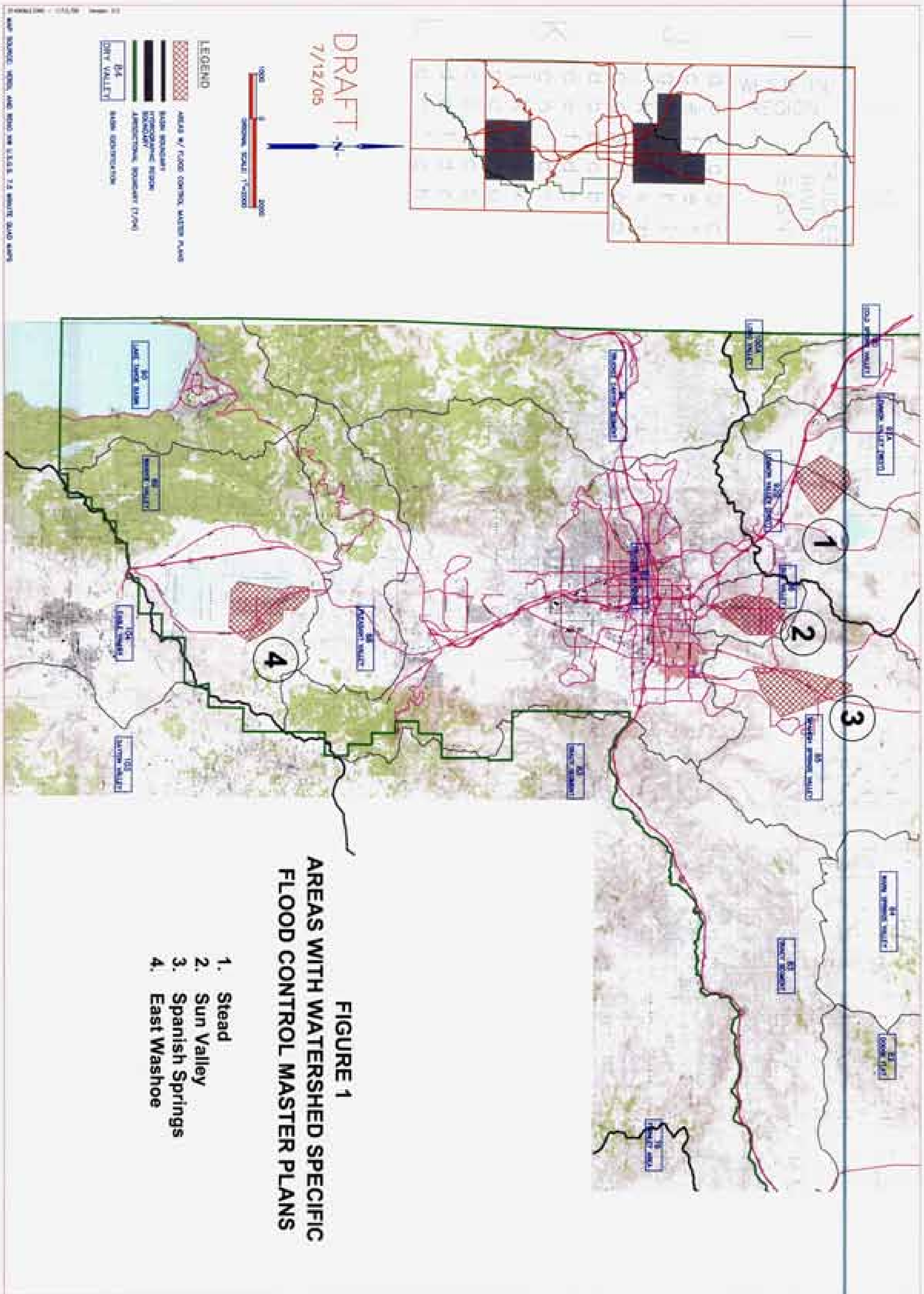
In order to promote consistency and completeness of future watershed drainage master plans, general master planning process guidelines should be adopted. All future drainage master plans should be prepared in accordance with the guidelines provided herein unless site-specific conditions necessitate different planning approaches.

Watershed specific drainage/flood control master plans have been prepared and adopted for some of the developing watersheds within the southern part of Washoe County. These watershed-wide master plans have been prepared to identify the regional drainage facilities that are necessary to reduce the existing and future drainage/flooding problems within the study watersheds. Brief summaries of the adopted existing master plans are provided in this report.

It is envisioned that for the watersheds that are currently without adopted master plans, separate watershed specific master plans would be prepared in the future for all development affected streams, drainage ways, and watersheds. All future master plans should be prepared in accordance with the guidelines provided in Chapter 5.

Adopted drainage master plans for individual developments have not been included in this document. The drainage facilities that are proposed and/or constructed for land development projects are usually constructed to mitigate the adverse impacts created by the respective developments, not for the benefit of the region/watershed.

Appendices A and B document the locations of existing flood control facilities and currently proposed improvements and their costs estimates.



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

Fig 1

I. INTRODUCTION

A. GENERAL

As a component of the region's overall flood damage reduction planning efforts, the Regional Water Planning Commission (RWPC) retained WRC Engineering, Inc. (WRC) to prepare an update to the Conceptual Washoe County Flood Control Master Plan prepared in 1991 (KJC, 1991). Subsequent to publication of the 1991 concept level master plan, significant changes have occurred within the region as summarized below:

- Regional governance issues have been addressed — How?
- Significant changes in the area development plans
- Several regional drainage studies have been prepared
- Significant advancements in the engineering technologies (modeling tools, drainage design manual, etc.)
- Changes in focus due to the 1997 flood event
- Some Regional Flood Control facilities have been planned and/ or constructed.

The Washoe County Regional Flood Control Master Plan (RFCMP) has been prepared in accordance with the policies of the RWPC and the Regional Floodplain Management Plan (RFMP). The RFMP provides guidelines and strategies on the floodplain management policy issues. The RFCMP provides specifics on recommended flood control measures and development of watershed specific hydrologic and hydraulic models.

B. PURPOSE AND SCOPE

The purpose of the Washoe County RFCMP is to evaluate the existing and projected drainage and flooding conditions and to recommend regional drainage facilities that can effectively reduce future flood damages within the region. The Washoe County RFCMP study area encompasses the entire area of Washoe County. Specifically, the RFCMP will address the following items:

- Identify alternative and recommended regional drainage improvements needed to reduce existing and projected flooding and drainage problems
- Identify improvements needed to maintain the protection level of the ongoing Truckee River Flood Management Project
- Establish standards for development of hydrologic and hydraulic analyses and watershed specific flood control/drainage master plans
- Provide placeholders so that future watershed specific drainage master plans can be easily incorporated into the RFCMP.

C. JURISDICTION

The Regional Flood Control Master Plan should be used as a guideline for all areas within Washoe County except the area within the Lake Tahoe Basin, which is governed by the Tahoe Regional Planning Agency.

D. RWPC POLICIES

The goals and policies of the RWPC on the region's water, wastewater, and flood control issues are documented in the Regional Water Plan, dated January 18, 2005. The following RWPC policies are applicable to the Washoe County Regional Flood Control Master Plan:

Policy 1.3.b: Protection and Enhancement of Groundwater Recharge

Policy 3.1.a: Regional Floodplain Management Plan and Regional Flood Control Master Plan

Policy 3.1.b: Floodplain Storage within the Truckee River Watershed

Policy 3.1.c: Floodplain Storage outside of the Truckee River Watershed

Policy 3.1.d: Truckee River Restoration

Policy 3.1.e: Watershed Protection

Policy 3.1.g: Management Strategies for Slopes Greater than 15 Percent

Policy 3.1.i: Floodplain Management/Flood Control Projects Subject to RWPC Review

Policy 4.1.a: Facility Plans and Infrastructure Studies-Conformance with Regional Water Plan

Policy 4.1.b: Timing and Sizing of Facilities

Policy 4.1.c: RWPC Programs and Policies to Reinforce Goals of Regional Plan

Policy 4.1.d: Inclusion of Non-Economic Criteria in Evaluation of Alternatives

Policy 4.1.e: Economic Decision-making Criteria

Policy 4.1.f: Facilities Excluded from Conformance Review

Policy 4.1.g: Examination of Long-Term Impact on Availability of Water Resources

Policy 4.2.a: Involvement of RWPC in Water Related Issues

In accordance with the RWPC Policy 3.1.a, the Regional Water Planning Commission recommends that Washoe County, City of Reno, and City of Sparks review and adopt the contents of this RFCMP and jointly implement the findings of the plan.

E. INFORMATION SOURCES

During the process of this study, WRC staff contacted several agencies, organizations, and individuals to obtain data and historical information regarding storm drainage and flooding of the study area. A summary list of the information gathered and used by WRC for the project is provided in Table 1.

Table 1. A summary list of the information gathered and used by WRC for the project

	Information Description
1	Spanish Springs Valley Flood Control Master Plan, Washoe County, Nevada, Harding ESE, January 2001
2	Washoe County Flood Control Master Plan Concept Level Report – Volume 1, Kennedy/Jenks/Chilton, January 1991
3	Drainage Master Plan for Sun Valley, Washoe County Nevada, SEA, Inc., April 1997; Addendum: Drainage Master Plan for the Spanish Springs Valley, Washoe County Nevada, SEA, Inc., April 1996
4	ReTrac Drainage Report, Reno Nevada, Volume 1, Stantec Consulting, Inc., June 2003; Drainage Master Plan, Stead, Nevada, Volume 1, Stantec Consulting, Inc., August 2000; Storm Drain Master Plan, East Washoe Valley, Washoe County, Nevada, Stantec Consulting, Inc., June1996.
5	GIS data including, jurisdictional boundaries, aerial photos, topographic maps from Washoe County GIS Program

F. PROJECT ADVISORY COMMITTEE

The Washoe County RFCMP study was sponsored by Regional Water Planning Commission (RWPC). The Project Advisory Committee, consisting of the following sponsor representatives, was formed to guide and support WRC in development of the master plan.

AGENCY	REPRESENTATIVE
Washoe County	Jeanne Ruefer, Water Resource Planning Manager
	Paul Urban, P.E., Flood Control Manager
	Jim Smitherman, Water Resources Program Manager
	Kristine Klein, P.E., Public Works
	Warren Call, P.E., Regional Transportation Commission
City of Reno	Glen B. Daily, P.E., Public Works
	Terri Svetich, P.E., Public Works
City of Sparks	Shawn Gooch, P.E., Flood Control Manager
Nevada Division of Water Resources	Robert Martinez, P.E., Engineering and Dam Safety
	Michael Anderson, P.E., Engineering and Dam Safety
	Kim Groenewold, Floodplain Management
Nevada Department of Transportation	Amir Soltani, P.E., Chief Hydraulic Engineer

A total of five project team meetings were held during the study with the Project Advisory Committee to discuss various aspects of the project, to obtain information and guidance, and to present results at various stages of the study.

II. HYDROGRAPHIC REGIONS AND WATERSHED BASIN DELINEATION

A. HYDROGRAPHIC REGIONS

The USGS and the Nevada Division of Water Resources, Department of Conservation and Natural Resources, have divided the state into discrete hydrologic units for water planning and management purposes. These have been identified as Hydrographic Areas, which are delineated as part of larger Hydrographic Regions or Basins. The State of Nevada contains fourteen (14) major Hydrographic Regions (basins) with a total of 256 hydrographic areas within the major hydrographic regions. Washoe County spans four Hydrographic Regions/Basins. The Northwest Region basin covers approximately 3,052 square miles of northern Washoe and Humboldt counties. The Black Rock Desert Region covers 8,632 square miles of parts of Washoe, Humboldt, and Pershing counties. The Truckee River Basin encompasses 2,300 square miles and contains parts of Washoe, Pershing, Churchill, Lyon, Douglas, Carson City, and Storey counties. The fourth basin is the Western Region and covers approximately 602 square miles located entirely within Washoe County.

B. BASE MAPPING AND WATERSHED BASIN DELINEATIONS

Topographic base maps for Washoe County were used as the framework to arrange various different data themes/layers and establish the fundamental accuracy needed by all regional data developers in order to facilitate the sharing of information and portability of datasets. USGS topographic maps prepared for the entire Washoe County area for hydrographic and watershed basin delineation and stream system indexing were scaled at 1" = 10,000' for areas outside of the RWPC jurisdiction. For areas located within the RWPC, maps were scaled at 1" = 5,000'. These base maps can be found in Appendix A.

The watershed basin delineations (as shown on maps in Appendix A) for Washoe County were based on the USGS 7.5' quadrangle maps.

III. HYDROLOGIC AND HYDRAULIC ANALYSIS OVERVIEW

7

A. ANALYSIS CRITERIA

All drainage plans, reports, construction drawings and specifications shall be reviewed in accordance with the provisions set forth in the current edition of the Washoe County Hydrologic Criteria and Drainage Design Manual, originally published in December 1996. Washoe County developed this Manual for use by Adopting Entities and consulting engineers. Facilities that have been designed and constructed for overall Master Drainage Plans that have been approved at the time of initial Manual adoption shall be analyzed using flow rates and volumes calculated per the requirements set forth in the edition of the Washoe County Hydrologic Criteria and Drainage Design Manual. Facilities planned but not under construction at the time of initial Manual adoption shall also be analyzed to ensure they meet adequate capacity requirements. If a facility does not have adequate capacity, including freeboard, the facility should be redesigned accordingly.

B. MODEL ADOPTION

Review and acceptance of drainage plans, studies, models, and any other drawings or specifications by Washoe County are required to obtain a final drainage system which is consistent and integrated in analysis, design, and level of protection. The degree of review depends on the complexity of the drainage improvement under consideration. The policy of Washoe County is to require that all drainage plans, studies, and documents be submitted for review and acceptance by the Public Works Department and be consistent with an applicable basin management plan and regional master plan. State agencies shall consider and, when applicable, comply with Washoe County's Master Plan when planning and designing their flood control facilities. Table 2 lists currently adopted effective models.

Table 2 Adopted Watershed Models

Model Identification	Notes

[Table contents will be added, when available]

C. SOILS DATA

Soil surveys used for analysis and planning in the Washoe County region have been prepared by the Natural Resources Conservation Service (NRCS). In addition, many libraries keep published soil surveys on file for reference. Also, soil conservation district offices and county agricultural extension offices have copies of local soil surveys that can be used for reference. Soil surveys are being completed and published on a continuing schedule. Therefore, it is important to contact the state or local official to determine the latest publication available. More detailed information on areas not listed can be obtained by contacting the State Conservationist.

Hydrologic data related to the mapped soils is used in determining the amount and rate of runoff occurring during storm events. This data is organized into four (4) hydrologic soil groups labeled A, B, C, and D. Soils in Hydrologic Soil Group A are highly permeable which results in lower amounts of runoff as compared to the other soil groups. Soils in Hydrologic Group B are moderately permeable which results in moderate amounts of runoff. Soils in Hydrologic Soil Group C have low permeability and a fairly high runoff potential. Soils in Hydrologic Soil Group D have the lowest permeability and the highest runoff potential. Soils coverage data is available from Washoe County GIS program.

D. VEGETATION DATA

Vegetation type and density are important in open channel design and storm runoff modeling. Vegetation characteristics are used in determining the Manning's roughness coefficient and parameters for runoff estimates. Vegetation coverage dada is available from Washoe County's GIS Program. Projects located within the limits of the vegetation coverage should use this data for analysis purposes. For areas out of the mapped vegetation area, the Washoe County Hydrologic Criteria and Drainage Design Manual should be used for guidance.

E. WATERSHED IMPERVIOUS AREA

Determining impervious areas within each watershed is important for computing storm water runoff rates and volumes. Based on Washoe County Hydrologic Criteria and Drainage Design Manual, the SCS Unit Hydrograph method should be used to calculate precipitation losses, such as interception and depression storage. Local depressions can occur in cracks and crevices in parking lots or roofs, or in a surface area where water is not free to move as overland flow.

Impervious areas are also important in determining the total time of concentration for each sub-watershed. For urban areas, the time of concentration consists of an inlet time or overland flow time plus the time of travel in the storm sewer, paved gutter, roadside drainage ditch or drainage channel. Overland flow in urbanized basins can occur from the back of the lot to the street, in parking lots, in greenbelt areas, or within park areas.

F. DRAINAGEWAYS

Technical and design standards for the hydraulic evaluation and design of open channels are provided in the Washoe County Hydrologic Criteria and Drainage Design Manual and should be used as a guide in designing drainageways. The minimum standards for various channel linings and design sections are presented in the Manual. Washoe County may require submittal of additional design and analysis information for any of the proposed channel sections and linings in order to assess the adequacy of a design for the proposed application. Therefore, it is recommended that the designer contact Washoe County prior to the design of drainageways to discuss additional requirements (if any) for the selected channel. Other drainageway design parameters include longitudinal channel slopes, which affect the maximum allowable velocity, vegetation type and density, used in determining the Manning's Roughness coefficient, and low flow channels, which are important because continuous low flows may destroy grass stands and cause channel degradation.

G. CLOSED BASINS

Until the Regional Flood Plain Management Plan and Regional Flood Control Master Plan are fully implemented, local flood management staff will use the best technical information available when working with a proposed project or land use change in a closed basin to determine the appropriate level of analysis required in order to evaluate and mitigate the impacts to 100-year flood peaks and floodplain storage volumes. On an annual basis, all three local flood management agencies, Reno, Sparks, and Washoe County, shall jointly adopt an agreeable "best technical information" available for use in implementation of the Regional Water Plan policies relating to flooding. The local flood management staff would be responsible for coordinating with the other appropriate local government agencies.

IV. SPECIAL PLANNING AREAS

A. TRUCKEE MEADOWS

1. TRUCKEE RIVER FLOODPLAIN MANAGEMENT PROJECT

Control of floods on the Truckee River and associated floodplains remains one of the Region's most significant water management challenges. To protect the Region's most valuable natural resources, residents of Sparks, Reno, and Washoe County implemented a flood management program that restores the health and vitality of the Truckee River while protecting communities along the river. Much of the natural floodplain for the Truckee River in the Truckee Meadows area has been developed and the natural process of flooding is almost nonexistent. In order to develop a consensus for a flood management plan with public input, Reno, Sparks and Washoe County created a community-based group known as the Community Coalition for Truckee River Flood Management, which works in cooperation with the U.S. Army Corps of Engineers. Diverse members of the community has come together since April 2000 to develop flood management alternatives for Reno, Sparks and neighboring residents on the Truckee River.

Since the 1997 flood in the Truckee Meadows from the Truckee River and its tributaries, in order to reduce and prevent flood damages, many steps have been taken by the local governments to move forward with the Truckee River Floodplain Management Project. The following lists some of the progresses on the project.

- Passage of the 1/8 cent sales tax by the Board of County Commissioners
- Development of an early warning system with river and precipitation gauges
- Ordinances have been enacted by the City of Reno and Washoe County pertaining to the development in Zone 1 of the floodplain.
- The community and the U.S. Army Corps of Engineers have developed hydrology/hydraulic models for various scenarios
- The Flood Coordinating Committee, consisting primarily of local elected officials, has been appointed

2. FLOODPLAIN VOLUME STORAGE MITIGATION AREA

The local flood management staff shall evaluate impacts using qualitative or quantitative analysis and the evaluation may be straightforward and brief. If a more in-depth analysis is appropriate, a "tiered" approach and criteria should be used. The current ordinance requires that a project not increase the 100-year peak flow at the boundary of a property. If the project can also demonstrate no increase in volume of 100-year runoff at the boundary of the property, the analysis is complete. If there is an increase in 100-year volume of runoff at the boundary of the property, the project must demonstrate either the increase will have no adverse impacts to downstream properties and no adverse impact to hydrologically connected properties or that the increase in volume of runoff will be mitigated in a regional flood control facility without adverse impacts. Impacts of a proposed project will be evaluated by comparing existing conditions with the proposed project conditions. Impacts of a proposed land use change will be evaluated by referencing conditions without the proposed land use change. Figure 2 shows the floodplain storage policy zones in the Truckee Meadows.

B. TRPA

The Tahoe Regional Planning Agency (TRPA) is charged with protecting Lake Tahoe from environmental degradation for the benefit of current and future generations. TRPA adopted nine thresholds in 1982 for air quality, water quality, soil conservation, vegetation, fisheries, wildlife, scenic resources, noise, and recreation. TRPA reports threshold performances in three ways. First, the overall picture of threshold attainment is reported. Secondly, TRPA examines the performance trend (positive, negative or neutral) of each threshold indicator. In general, indicator trends are positive or stable. Third, TRPA examines the thresholds with scientific evidence and technical information to determine if they are in need of amendment. According to the Regional Plan's Goals and Policies, beginning in 1991 and every five years thereafter, TRPA conducts a comprehensive evaluation of whether each threshold is being achieved and/or maintained, specific recommendations to address problem areas, and directs general planning efforts for the next five-year period. TRPA uses its five-year review to determine whether allocation of new development should continue apace as contemplated in the 1987 Regional Plan and accompanying Environmental Impact Statement.

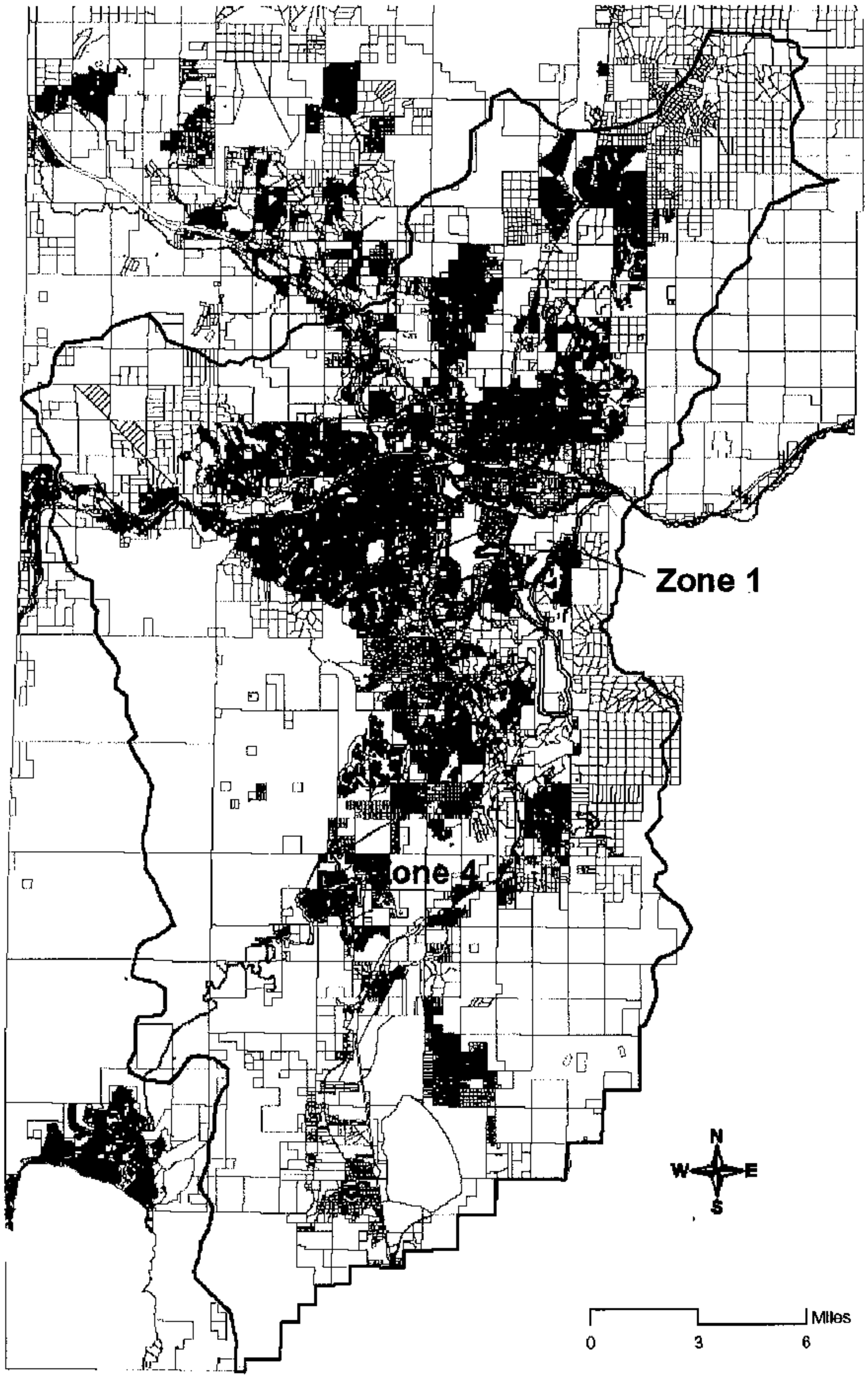


Figure 2 Floodplain Storage Policy Zone Map (Regional Water Planning Commission)

The planning for the part of Washoe County which falls within the Lake Tahoe Basin is not under the jurisdiction of Washoe County Regional Water Planning. The TRPA is the responsible agency.

C. REGULATED DRAINAGEWAYS

The design of all channels in Washoe County shall be based on maximum permissible velocities. This method of design assumes that the given channel section will remain stable up to the stated maximum permissible velocity provided that the channel is designed in accordance with the provisions of the Washoe County Hydrologic Criteria and Drainage Design Manual. If a higher velocity is desired, the design engineer must demonstrate to the satisfaction of the local entity and/or Washoe County that a higher velocity would not endanger the health or safety of the public and would not increase maintenance of the channel section. For natural and improved unlined channels, a geotechnical report shall be submitted in order to determine existing or proposed soil material classification. The maximum permissible velocities are based on flow studies conducted by various governmental agencies and private individuals.

D. OTHER AREAS

The Regional Water Planning Commission (RWPC) become involved in water-related matters when a regional problem exists or when the proposed solution to the situation is expected to create a regional impact. Regional guidelines for storm water hydrologic criteria and drainage design should be pursued when applicable to address inconsistencies between local governments' existing criteria and design standards. The RWPC and local governments provide ongoing planning for the community's water, wastewater, and storm water and flood control needs. Identification and review of potential impacts to existing or planned infrastructure, and needs for new or improved facilities, should provide for integrated planning and management of the region's water resources and cost-effective infrastructure development and improvements. The RWPC recognizes that not all facilities required to implement the Regional Water Plan are listed due to unforeseeable circumstances and/or the frequent necessity to alter facilities once final design and construction proceed. Consequently the RWPC will review facilities that are not in the current edition of the Regional Water Plan if such facilities are of such a kind or size that affect the Regional Water Plan.

Washoe County Development Code Article 418 regulates development activities within and adjacent to perennial streams within southern Washoe County. City of Reno Code Section 18.06.806 establishes standards for the review of development proposals within major drainageways (which drain a land of 100 acres or more). Therefore, any planning of flood control improvements within major drainageways in City of Reno, or within and adjacent to perennial streams within southern Washoe County need to meet the requirements specified in the respective regulations.

V. MASTER PLANNING PROCESS FRAMEWORK

A. INTRODUCTION

Several watershed-wide drainage master plans have been prepared and adopted by the local jurisdictions for some of the developing watersheds within the County. The contents of the existing adopted drainage master plans are summarized in Section VI of this report. However, as shown on Figure 1, there are many other watersheds within the County that are experiencing new developments without adequate drainage master plans to guide orderly development of the watersheds. For these watersheds, it is important to prepare and adopt watershed-wide drainage master plans to identify existing and future drainage and flooding problems and to develop solutions that can be implemented.

In order to promote consistency and completeness of the future watershed drainage master plans, general master planning process guidelines are provided in this section. All future drainage master plans should be prepared in accordance with the guidelines provided herein unless site-specific conditions necessitate different planning approaches.

B. GENERAL SCOPE

Detailed scope of each watershed drainage master plan should be prepared to address the unique drainage conditions that exist in each watershed. However, the general scope for the watershed-wide drainage master plans should be as follows:

1. Gather and assemble available relevant information on the existing drainage facilities, previous master plans, land use plans, zoning maps, flood hazard area delineations, and other applicable information.

2. Determine the hydrologic aspects of the study watershed including runoff rates and volumes under existing and fully developed scenarios for various return periods of storm events. The minimum design requires both the 5- and 100-year storm frequency events should be analyzed for both existing and full development conditions.

3. Identify existing and potential future drainage and flooding problems associated with the limited channel flow conveyance capacities, crossing capacities, stability of the channel banks and thalweg, etc.

4. Identify stormwater quality improvement needs and provide stormwater quality impact mitigation plans and/or structural controls for compliance with NPDES requirements

5. Solicit input regarding various drainage problems and alternative solutions to said problems from the project sponsors, stakeholders, and interested public.

6. Develop alternative plans for addressing the identified drainage problems including structural and non-structural solutions as well as the "do nothing" option.

7. Evaluate said alternatives using factors such as cost, public acceptance, cost effectiveness, applicability, public health and safety, stormwater quality, environmental impacts/benefits, etc., to formulate a specific recommendation for further actions and/or improvements.

8. Coordinate with the project sponsors to select the "best" alternative plan and prepare conceptual level design of the selected plan improvements.

9. Present in a written report the study's analysis, discussions, results, and recommendations regarding actions and/or improvements needed to address the identified drainage problems.

C. STAKEHOLDER AND PUBLIC PARTICIPATION

Obtaining the stakeholder and public support on the selected plan is vital for successful implementation of the plan. Therefore, it is important to get the stakeholders and the interested public informed and involved in the master planning process. The following summarizes the most frequently used methods to promote participation by the public and stakeholders:

- Public meetings at key project milestones
- Project website
- Regular project team meetings
- Project update news letters/pamphlets

- County, City, Home Owner's Association, and other community newspapers
- Mail notifications

At the beginning of the master planning project, the project team (consultants, project sponsors, etc.) should decide what public notification and participation methods are best suited for the project area. It is recommended that at least two public meetings be held during the master planning process to educate the public, present the project findings and recommendations, obtain comments, and to address public concerns. The first meeting should address alternative development scenarios and the second meeting should be held prior to the selection of the "best" plan.

D. DATA GATHERING

All available existing hydrologic and hydraulic studies, drainage facility design plans, FEMA floodplain studies, drainage master plans, and other relevant data should be gathered and reviewed with the help of sponsoring agencies. When appropriate, previously approved hydrologic and hydraulic studies should be used so that work by federal, state, or local agencies is not duplicated.

E. SPECIAL PLANNING AREA CONSIDERATIONS

Watershed drainage master plans should be prepared to meet the applicable federal, state, and local agency guidelines. WRC has prepared additional schematic improvement maps at 1" = 2,000' scale. Proposed master planned improvements have been schematically shown and referenced on these maps. These maps include locations where improvements are currently identified, proposed, or built. Placeholders will be used to accommodate the inclusion of additional maps as needed in future updates. These maps were prepared to reflect current improvement planning and constructed improvements. If a study area is located within the special planning areas (wholly or in part) as identified in Section IV, the master planning elements should be developed to conform to the adopted criteria specific for the applicable special planning areas. Detailed discussions on the special planning areas are provided in Section IV.

F. HYDROLOGIC AND HYDRAULIC ANALYSIS

Hydrologic and Hydraulic analyses for the subject watersheds and drainageways should be prepared in accordance with the analysis criteria provided in the Washoe County Hydrologic Criteria and Drainage Design Manual and Section V of this report.

G. PROBLEM AREA IDENTIFICATION

Problem area identification is a process by which the existing and estimated future conditions of the drainage systems are compared against a set of "desired" drainage system conditions. The drainage system conditions (whether existing or future) that do not meet or exceed the "desired" conditions are considered as "problem areas" for which alternatives are identified, evaluated, and selected to resolve or improve upon the identified problems. Normally, the "desired" conditions of the drainage systems should be same as the drainage facility design criteria specified in the Washoe County Hydrologic Criteria and Drainage Design Manual. However, there may be situations where site-specific limitations necessitate the "desired" condition to be lower or higher priority than those set forth in the Washoe County Hydrologic Criteria and Drainage Design Manual.

Determination of "problem areas" for a given watershed can be initiated by first identifying and categorizing the various types of problems that are encountered and/or expected to occur throughout the life of the master plan. A master plan may encompass both urbanized and non-urbanized drainage areas and channels. Therefore, the problem categorization process may include problems that could be identified by comparison to design standard criteria (i.e. allowable street overtopping) as well as problems for which subjective evaluation is needed (i.e. equilibrium channel slopes). This problem categorization process may also be aided by review of "indicator" data to establish the likelihood of certain problems occurring in the future.

Categorization of drainage problem types can be accomplished through visual observations of accessible channels and culverts, the floodplain delineation study results, hydraulic modeling results, and discussions with the project sponsors and other project participants. Common types of problems that may occur within Washoe County include:

1. Channel Capacity - This problem category is used to identify locations where the 100-year storm event runoff is not contained within a natural or manmade "identifiable" channel section. This lack of containment may be caused by many factors including man-induced activities that removed or destroyed the channel containment features (i.e. removal of the upper portion of a channel bank) or deposition of sediment that constricts the channel capacity. The problem associated with an inadequate channel section is the potential for floodwaters that exceed the channel capacity to divert away from the main channel and follow routes that could cause damage to public facilities and private property.

2. Channel Stability- This problem category is used to identify channel reaches where channel degradation has occurred or is expected to occur as a result of existing and/or future upstream developments. Although channel erosion/degradation is part of a natural process, urbanization of watersheds results in additional continuous base flows as well as increased quantity and frequency of minor storm runoff. These two factors tend to increase the instability of the channel bed and speed up the process of channel erosion/degradation (both bed and bank erosion). The amount of channel degradation is dependent upon the channel material, the location of bedrock or other erosion resistant layers, the amount of vegetative growth that can reduce minor storm velocities and stabilize channel banks, and the degree to which upstream development increases the quantity and frequency of storm flows.

3. Culvert/Bridge Capacity – This problem category identifies the existing drainage structures that do not have adequate flow conveyance capacity to convey the 100-year flows beneath the roadways. The potential problems associated with the significantly deficient crossings include a) increased upstream flood depth and width caused by the backwater b) increased risk of injury and/or death to pedestrians or persons in vehicles caught in the crossing overflows; c) increased risk of damage to or failure of the crossing structure; and d) restriction or elimination of access across said crossings for emergency response vehicles.

4. "At-Risk" Public/Private Improvements - This problem category identifies problems for which 100-year flood events may damage and/or destroy public and private improvements (i.e. houses, buildings, etc.) excluding bridges and culverts previously discussed.

In addition to the above four common problem categories, the following other problems maybe encountered:

- Sediment and debris deposition in channel and crossing structures
- Levees that do not meet the adopted design standards or are not maintained
- Canal storm water conveyance and embankment overtopping
- Horizontal migration of Channels
- Alluvial fan/mud flow flooding
- Loss of ground cover/vegetation due to fire
- Inadvertent detention basins (i.e., railroad embankment)
- High ground water table

H. ALTERNATIVES IDENTIFICATION AND DEVELOPMENT

The identification and development of alternatives to solve the identified drainage problems consist of a sequence of identifiable steps. The first step is to establish the project objectives by which the alternatives will be formulated (i.e. solve drainage problem, enhance water quality, etc.). Next, a preliminary list of all possible solutions that are available to solve the various types of drainage system problems is prepared. Since not all solutions are feasible for solving all problems, final alternative solutions are selected from the preliminary list and are developed specific to the individual drainage system reaches.

The main objective of a flood control/drainage master plan is to solve existing and anticipated future drainage problems. However, there are other important underlying issues that should be examined and resolved, to the extent feasible, as part of the drainage/flood control solutions. This follows the desire of the community, as demonstrated with the Truckee River Flood Management Project, to engage multi-objective planning to the extent feasible as part of this project. Some of these multi-objective goals are as follows:

1. Riparian Habitat- Maintain and possibly enhance the riparian habitat along the subject drainageways. Based upon past experience, development within a watershed tends to destabilize the natural riparian habitat in drainageways through the increased rate and duration of runoff from frequent storm events. These increases lead to increased bank failure, head cutting, and erosion of the riparian areas.
2. Storm Water Quality- Maintain and if possible, enhance storm water quality. Past studies have shown runoff from urban development to degrade the quality of water in downstream drainageways. This occurs through increases in nutrient loadings (e.g. nitrogen, phosphorus), additions of oils and chemicals, and increased sediment loads.
3. Recreation – Maintain the recreational use of the drainageways. If possible, the proposed structural improvements should be designed to be pedestrian and bike friendly.

All alternatives should be developed to safely handle, to the extent feasible, the projected "built-out" conditions flow rates and volumes. In addition, the potential adverse impacts due to future developments (i.e. increase in peak flow and volume) within the study watershed should be identified and the alternative plans should include necessary measures (i.e. regional detention basins) to mitigate the impacts. Previous studies have concluded that regional detention basins are more effective and easier to maintain than multiple small onsite detention basins. The locations and sizes of regional detention basins should be determined and included in the master plan alternatives. If regional detention basins cannot be incorporated into the watershed-wide master plan, then the master plan should clearly state that onsite detention basins should be provided by future developments to mitigate the increase in flows and volumes caused by their own developments.

The subject drainageways and tributaries within the study watershed should be divided into multiple design reaches. The design reach limits should be determined considering jurisdictional boundaries, major roadways, tributaries, confluences, railroads, regional detention basins, etc. A preliminary list of potential alternatives for all of the design reaches should be formulated and presented to the project sponsors for initial screening and discussions. The identified alternative plans should include both non-structural (i.e., purchase of flood-prone structures) and structural solutions varying from a "do-nothing" option to a "full structural solution" to minimize the drainage problems during a 100-year storm event. At a minimum, the following four alternatives should be considered for all of the design reaches and areas:

Alternative 1 - Do nothing (Existing conditions to remain unchanged)

Alternative 2 – Low Flow Channel Stabilization/Stream bank Stabilization

For design reaches where channel degradation or stream bank erosion is occurring or expected to occur, Alternative 2 consists of a construction of a low flow channel with a capacity to handle a volume of water approximately equal to the 2-year storm event. In locations where low flow channel grades exceed 0.5%, low flow check structures should also be included. For areas of severe stream bank erosion, Alternative 2 should include flattening channel side-slopes to 3:1 or flatter and lining the outside banks of curves with soil riprap or adding bioengineering elements such as live willow staking, live willow fascines or brush layering.

Alternative 3 – 100-Year Structural Solution

Structural improvements necessary for the drainageway systems to confine and convey the estimated 100-year flows are identified and proposed for this alternative. This alternative should also include the improvements proposed in Alternative 2 where needed to stabilize the low flow channels and stream banks.

Alternative 4 – 5-Year Structural Solution

This alternative should be developed when it is determined that the construction of the 100-year improvements will likely be difficult due to physical and/or financial constraints. Structural improvements (channels, culvert and bridges, etc.) necessary for the drainageway systems to safely confine and convey the estimated five-year flows are identified and proposed for this alternative. This alternative should also include the improvements proposed in Alternative 2 where needed to stabilize the low flow channels and stream banks.

For some watersheds/drainageways, there may be multiple solutions for the above Alternatives 2, 3, and 4 that can satisfy the project goals. Alternative channel types and alignments, detention basin alternatives, etc. should be considered in developing the stabilization, 5-year, and 100-year solutions. All feasible and implemental alternative solutions should be developed and evaluated.

I. ALTERNATIVES EVALUATION AND SELECTION

The identified drainage solution alternatives should be evaluated based upon various factors related to the established project objectives. The selection of a recommended alternative for each design reach should be made based upon a thorough understanding of the available options, benefits, and risks associated with its selection. As a minimum, the identified alternative solutions should be evaluated and compared against each other using the following criteria:

- Cost of construction
- Structural damage reduction
- Level of protection and public safety
- Number of directly benefited or adversely impacted structures
- Public acceptability
- Failure probability of the structural measures
- Emergency accessibility during major flood events
- Aesthetics and environmental impacts

An evaluation matrix table should be developed and presented to the project sponsors to help aid in the selection of the recommended alternative plan. Depending on the site-specific constraints, it may be necessary to select different alternatives for different design reaches.

1. Cost Estimates

A table of unit costs utilized to develop conceptual cost estimates for the alternative plans should be prepared. Since detailed investigations of each and every drainage problem site for all construction constraints are not practical at the alternatives evaluation stage, the improvement cost estimates should be conceptual in nature and should be used mainly for comparison with other alternatives for the sites identified. A more detailed cost estimate should be prepared for the selected alternative plan during the conceptual design phase of master planning. All total cost estimates should include a 25 percent construction cost contingency, a 15 percent engineering and materials testing services, and a 5 percent legal and administrative cost. The cost estimations should be divided into design reaches and jurisdictions, if applicable.

2. Structural Damage Reduction

If the proposed solutions result in direct damage reduction benefits to exiting structures (including the building contents), the projected damage reduction benefits should be estimated for alternatives comparison purposes. Damage reduction for the directly benefited structures may be estimated based on the estimated flow depths around the structures and the estimated or assessed values of the structures for various storm events. For the alternatives evaluation purposes, the value of the contents of each structure may be assumed to be equal to forty percent (40%) of the estimated or assessed value of the structure. Flow depths around the structures can be estimated based on the computed water surface elevations where available (i.e. FEMA FIRM). If not, the flow depths can be estimated using normal depth computations. The damage reduction estimates should be divided into design reaches. The potential damage reduction benefits to other facilities including roadways, vehicles, drainage facilities, etc. should not be included in the estimates.

The damage reduction estimates should be computed for the 5 and 100-year storm frequencies. The annual average damage reduction should be computed. Then, the annual average reduction estimate should be converted to "present worth" based on a 50-year return period and a rate of inflation expected over the 50-year period. Generally, a rate of 3 to 4 percent is used for this level of study and analysis.

J. CONCEPTUAL DESIGN OF SELECTED IMPROVEMENTS

Once the recommended alternative plan has been selected (Selected Plan) by the sponsoring agencies, conceptual design of the selected plan should be prepared to develop additional details of the selected improvements and to make necessary refinements to the plan. The conceptual design plan and profile drawings, details, and cost estimates should be prepared in sufficient detail to help guide the local jurisdictions in planning future developments, roadways, drainage crossings, regional drainage facilities, and other improvements. A detailed cost estimate for the selected plan should be prepared based on the conceptual design information. The total cost estimate should be divided into design reaches, jurisdictional limits, and the plan and profile sheets.

The plan and profile drawings should be prepared using 1"=200' horizontal and 1"=20' vertical scales on 11" x 17" sheets. Typical details of the proposed improvements should be provided either on the plan and profile sheets or separate details sheets. Descriptions and itemized cost estimates of the improvements shown on each plan and profile sheet should be provided on the pages facing the plan and profile drawings.

Hydrologic and hydraulic analysis of the selected plan should be performed in sufficient details to ensure that the plan elements can adequately provide the desired protections.

K. IMPLEMENTATION AND PRIORITIZATION

The drainage master plan should identify the potential implementation obstacles and issues for the selected plan. Also, the plan should provide prioritization of the improvements.

1. LAND USE CHANGES

Significant land-use changes within the contributing watershed will affect the identified flood hazard limits, the transportation of sediment, and the quality and quantity of storm water entering the drainageways. Therefore, the land-use changes should be monitored closely by the local entities. Whenever the land-use changes result in increased imperviousness ratios that exceed those identified in the watershed master plan, the jurisdictions should require that the hydrologic effects of these increases be mitigated through the construction of on-site or regional facilities and implementation of Best Management Practices (BMP's).

2. INTER-JURISDICTIONAL COORPERATION

As demonstrated by previous flood events including the 1997 Truckee River flood event, floodwater does not respect jurisdictional limits and boundaries. Therefore, coordination and cooperation among local jurisdictions are vital for successful planning and implementation of regional flood control plans. Developments within the watersheds that include more than one jurisdiction should be allowed only when the developments do not adversely impact the receiving downstream entity.

L. DRAINAGE MASTER PLAN REPORT

The individual watershed-wide drainage master planning process from initiation through conceptual design of the Selected Plan should be documented in a written report. Specifically, a synopsis of the project history, description of the study area and field inventory, summary of hydrologic and hydraulic analyses, identification of problem areas, evaluation of alternative drainage solutions and recommendations, selection of the "best" alternative plan, and preparation of conceptual design plans for the selected alternative plan should be presented in the report.

The master plan report should be prepared in accordance with the guidelines provided in the Washoe County Hydrologic Criteria and Drainage Design Manual. The format of the final report should be a bound 8½" x 11" or 11" x 17" report with foldout pages or map pockets, if deemed necessary. An executive summary should be prepared for each watershed master plan for inclusion into Section VI of the Washoe County Regional Flood Control Master Plan (RFCMP). Also, technical backup documentations (i.e., calculations, technical backup data, correspondences, and other pertinent information related to the project) should be provided in a separate bound report.

VI. REFERENCES

1. Washoe County Flood Control Master Plan, Concept Level Report, Volumes 1, Kennedy/Jenks/Chilton, January 1991.

2. Drainage Master Plan, Stead, Nevada, Volume 1, Stantec Consulting, Inc., August 2000

3. Spanish Springs Valley Flood Control Master Plan, Washoe County, Nevada, Harding ESE, January 2001

4. Drainage Master Plan for Sun Valley, Washoe County Nevada, SEA, Inc., April 1997

5. ReTrac Drainage Report, Reno Nevada, Volume 1, Stantec Consulting, Inc., June 2003

6. Addendum: Drainage Master Plan for the Spanish Springs Valley, Washoe County Nevada, SEA, Inc., April 1996

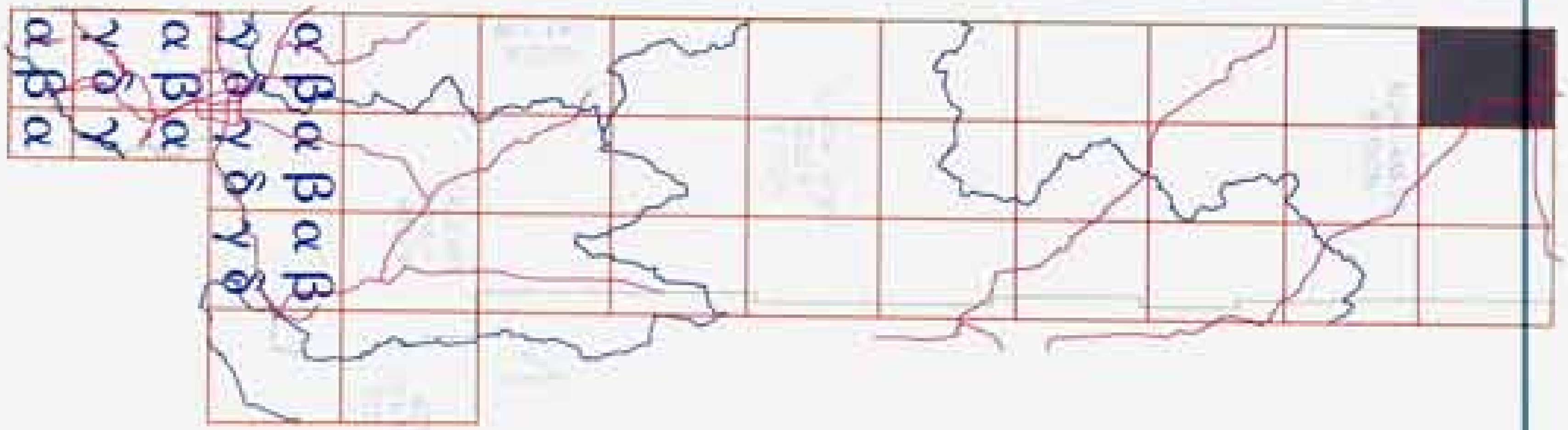
7. Storm Drain Master Plan, East Washoe Valley, Washoe County, Nevada, Stantec Consulting, Inc., June 1998

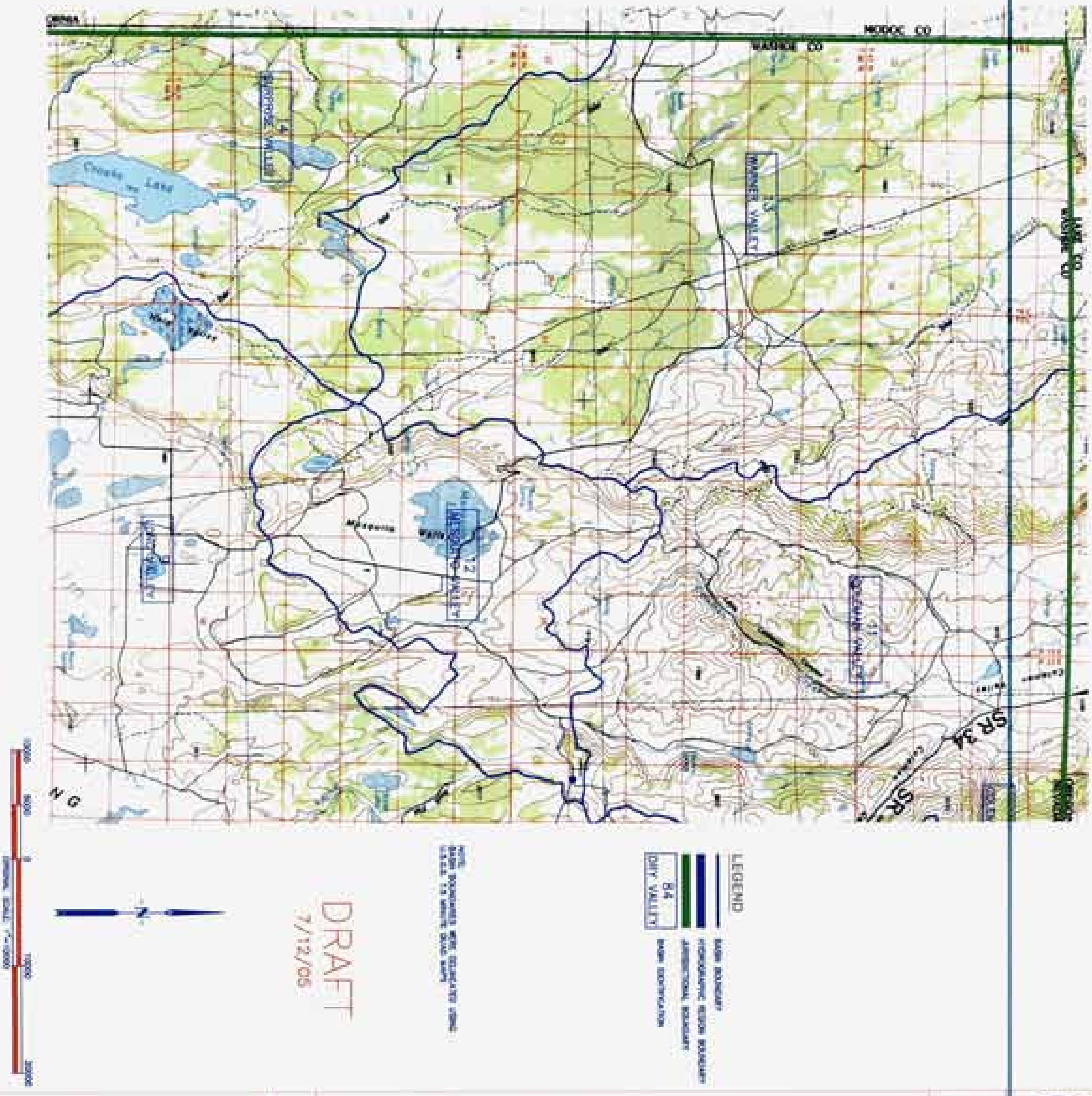
8. City of Sparks, Nevada Drainage Master Plan, Parsons, May 2002

9. Kiley Ranch Flood Control Master Plan, Spanish Springs Valley, Nevada, Nimbus Engineers, February 2001

APPENDIX A

MAPS SHOWING LOCATIONS OF FLOOD CONTROL FACILITIES





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REGIONAL FLOOD CONTROL MASTER PLAN

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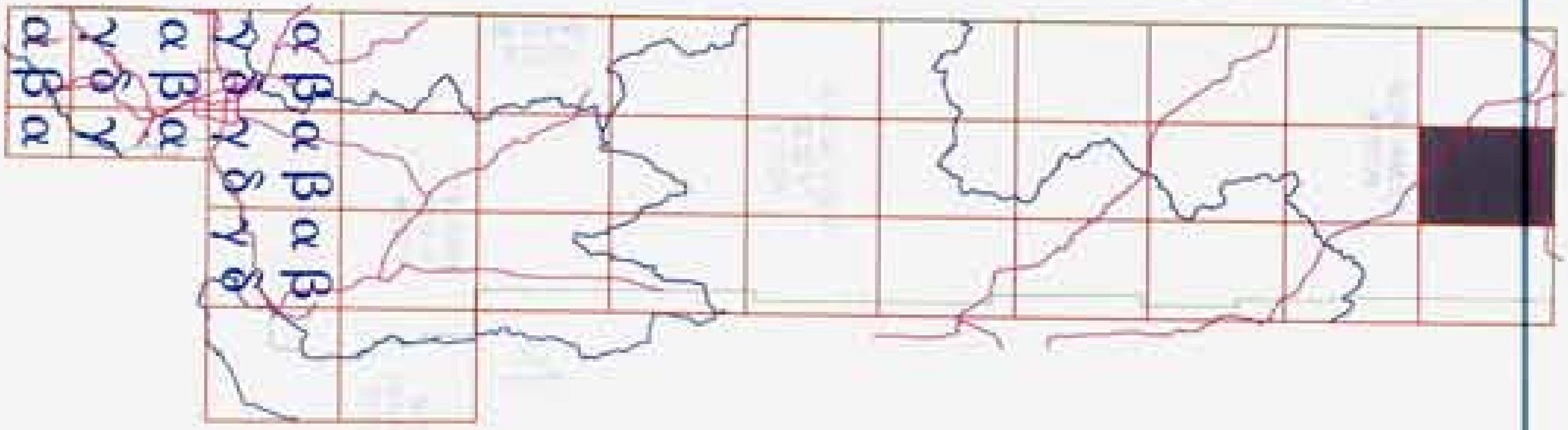

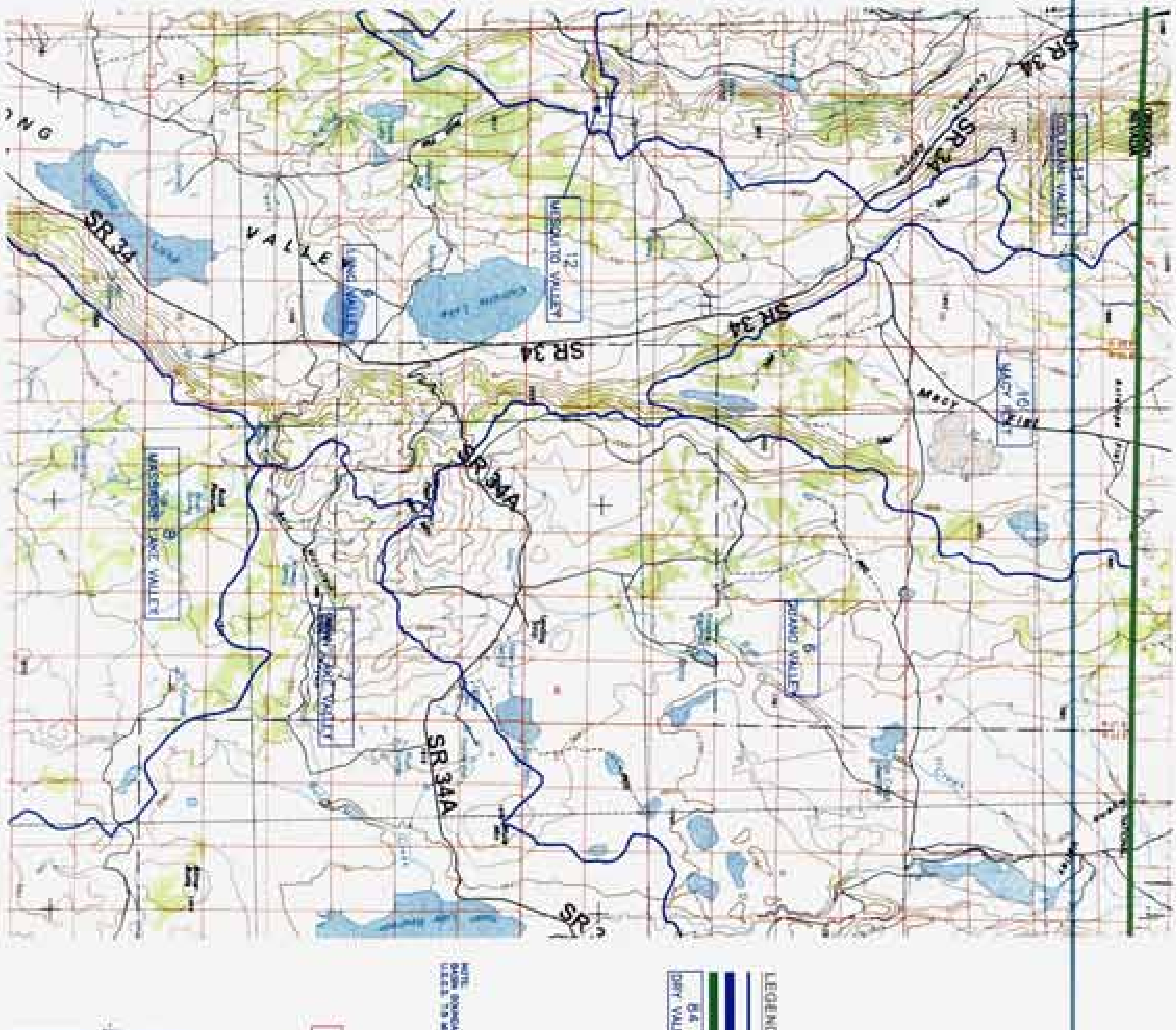

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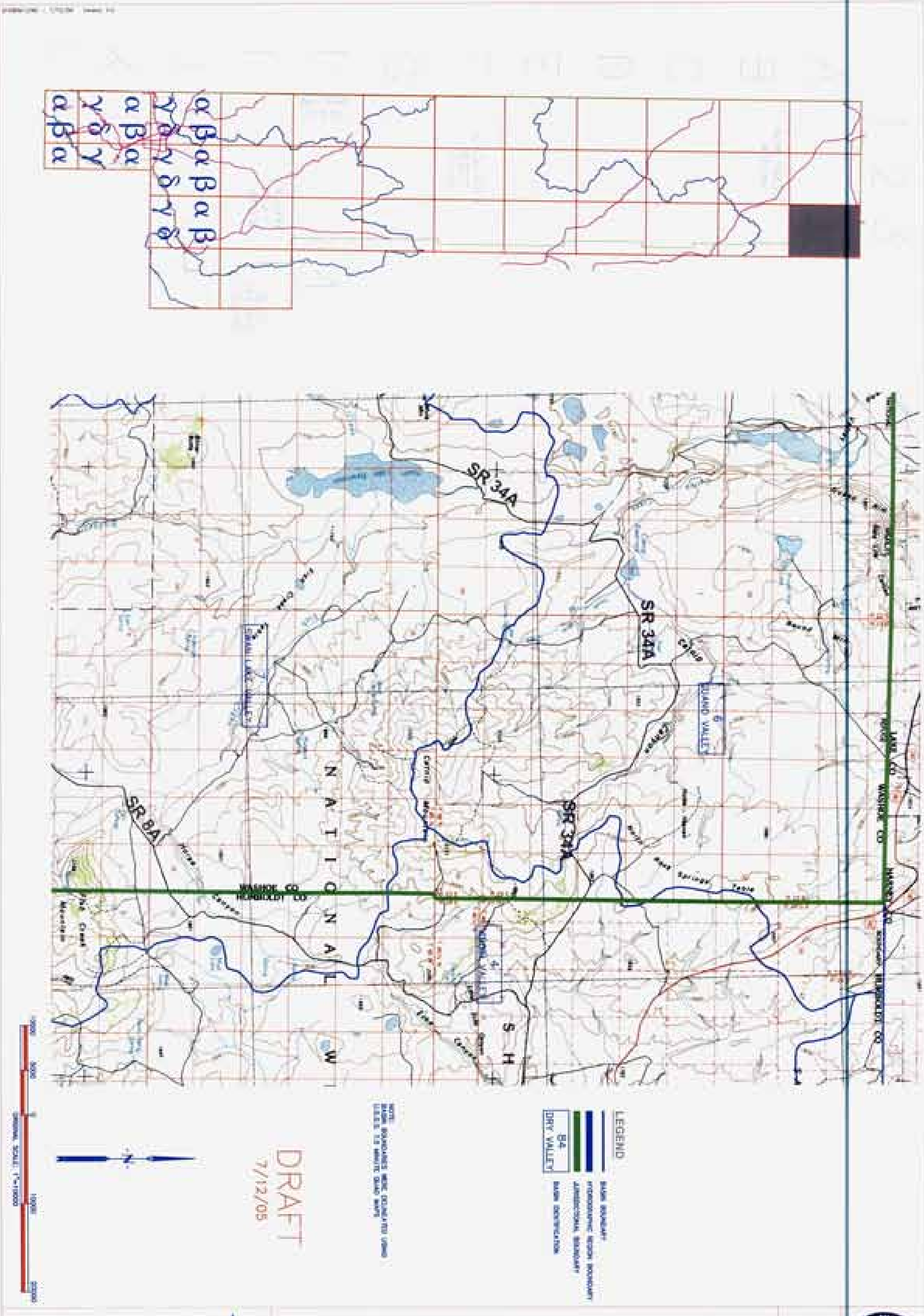

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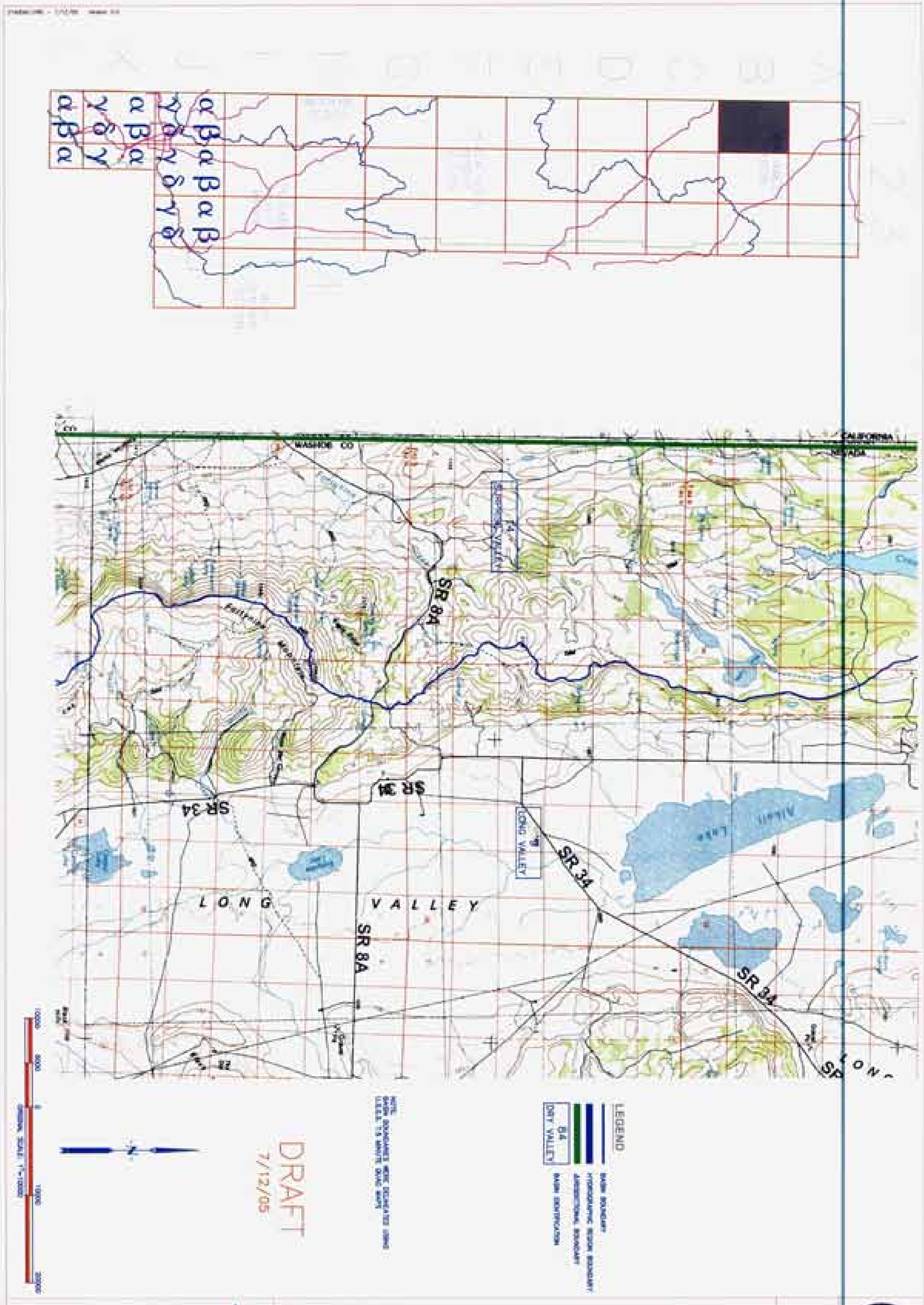

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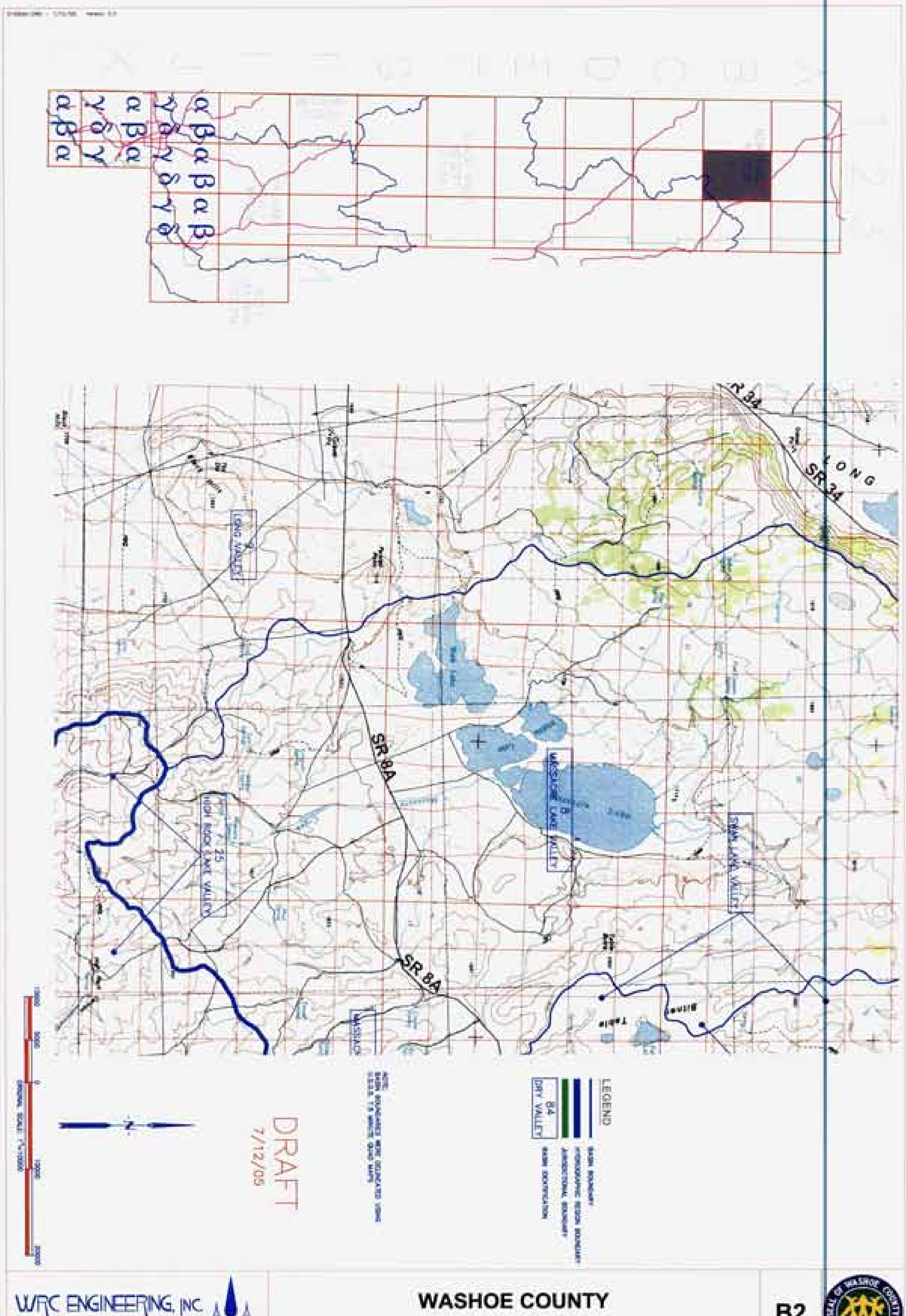
STATE OF NEVADA



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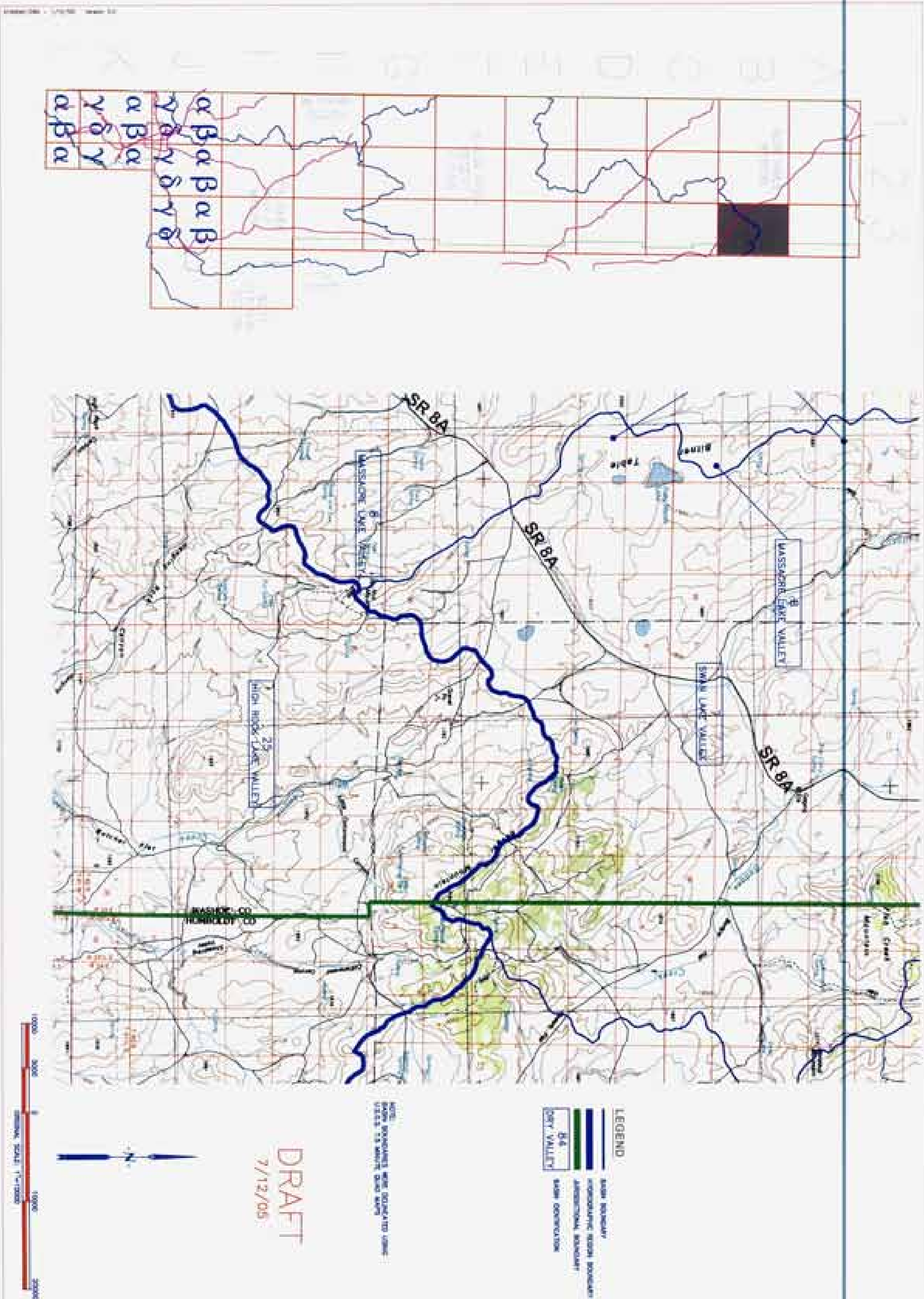

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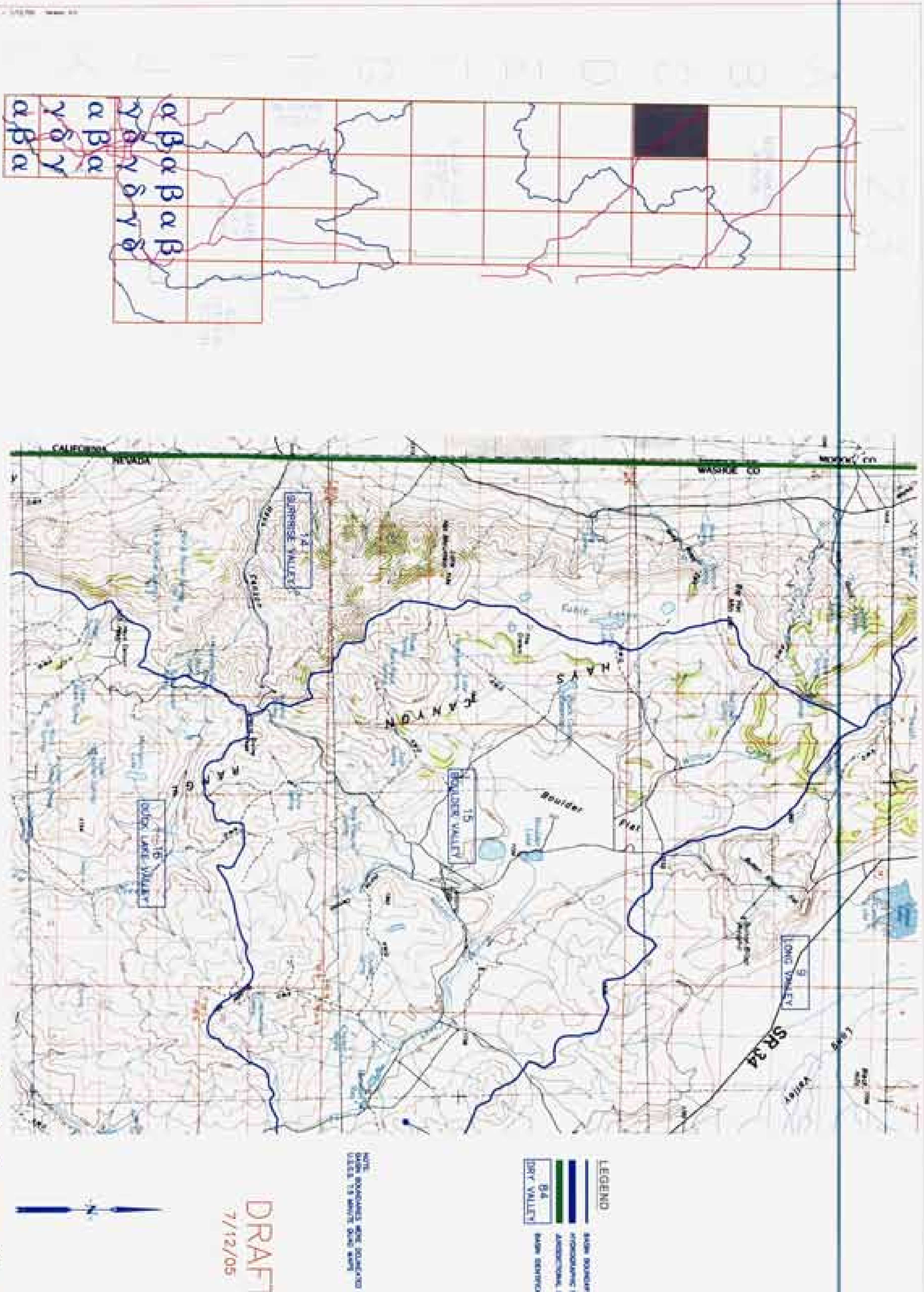

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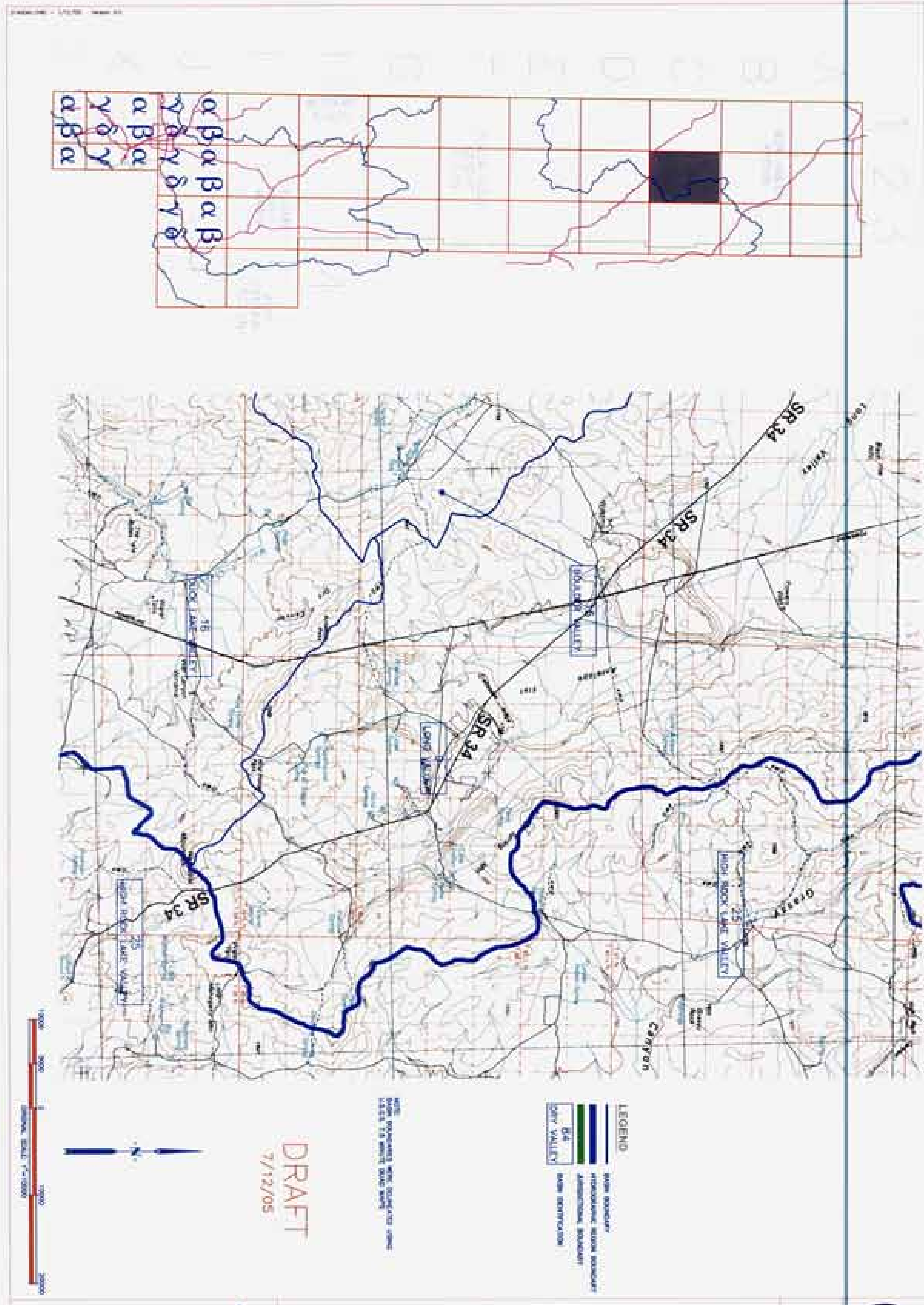

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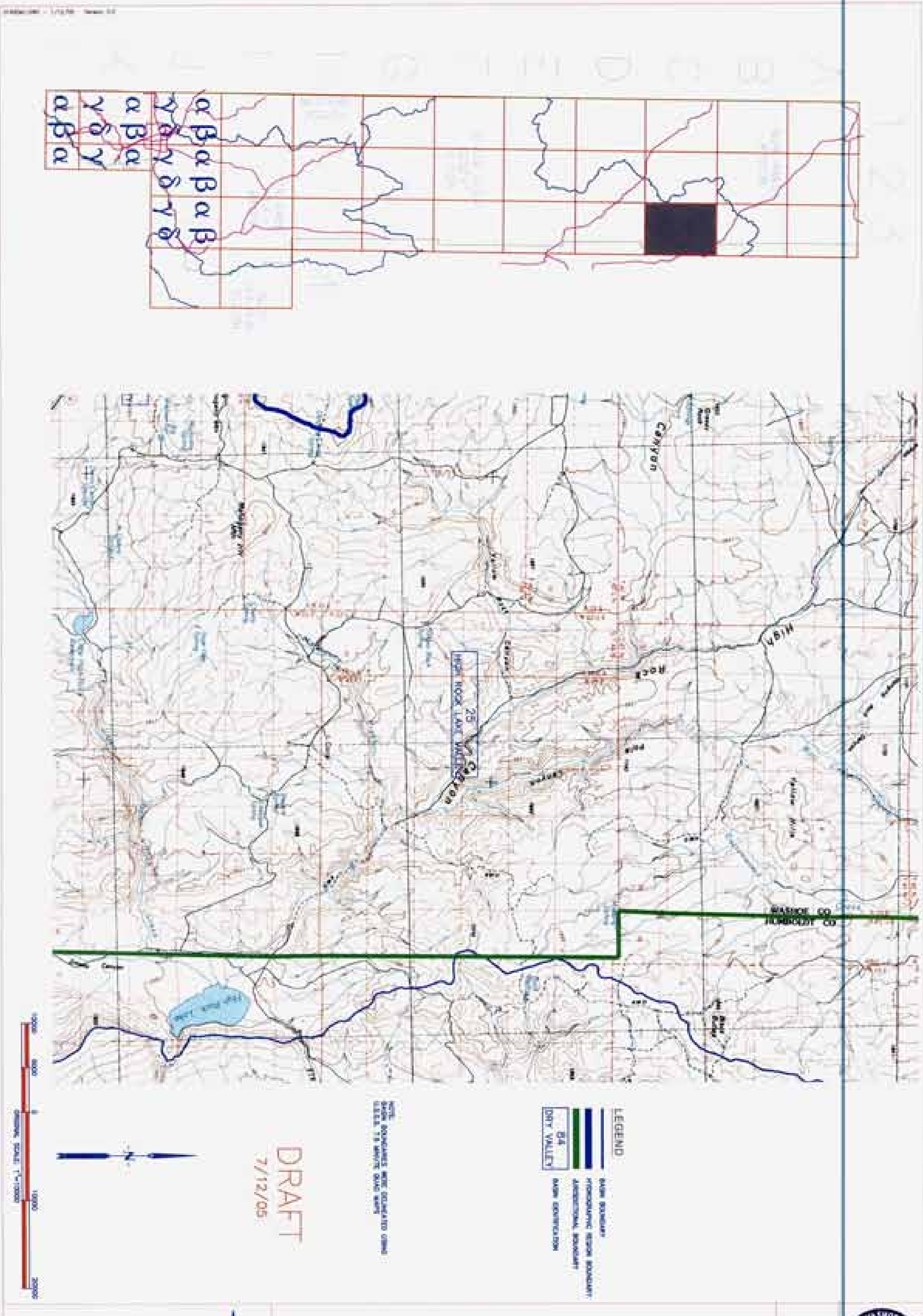

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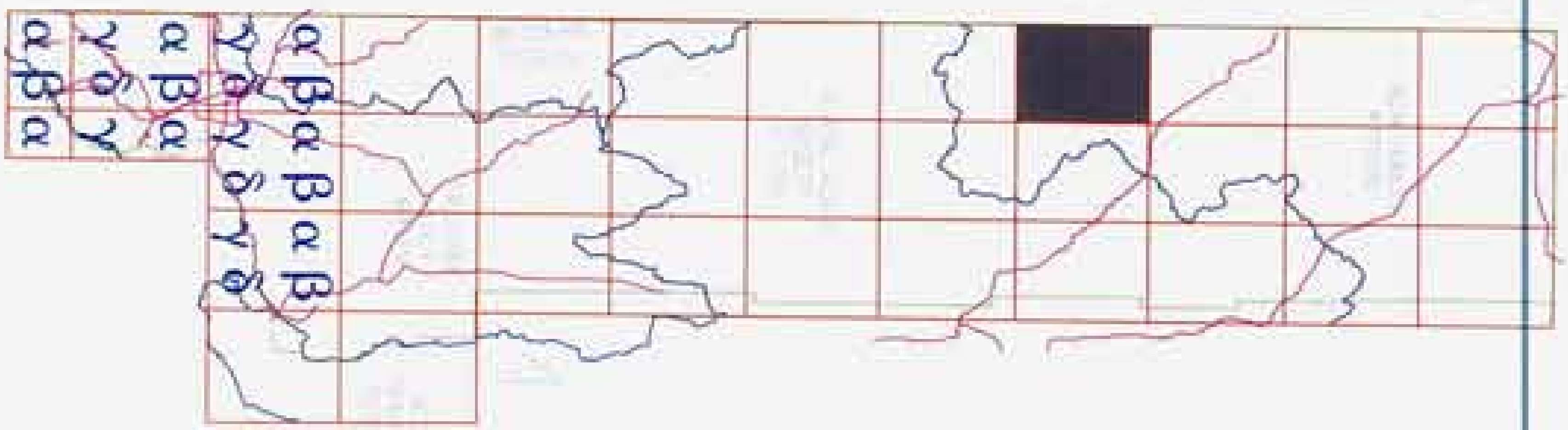

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BASIN BOUNDARY

HYDROGRAPHIC REGION BOUNDARY

JURISDICTIONAL BOUNDARY

84 DRY VALLEY — BASIN IDENTIFICATION

NOTE:
BASIN BOUNDARIES WERE DELINEATED USING U.S.G.S. 7.5 MINUTE QUAD MAPS

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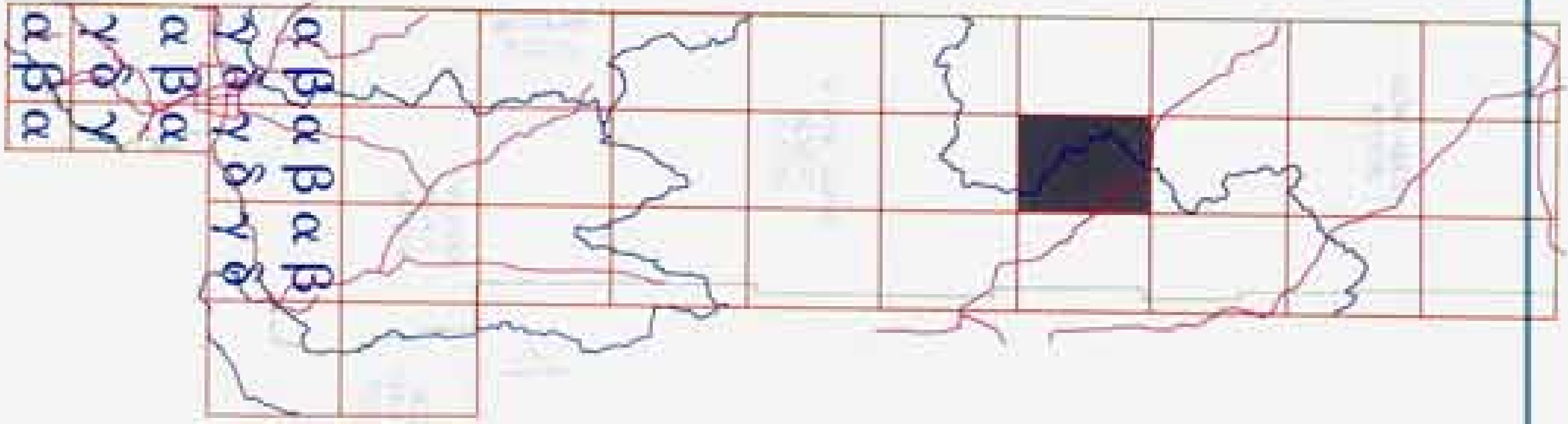

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ORIGINAL SCALE 1"=1000'

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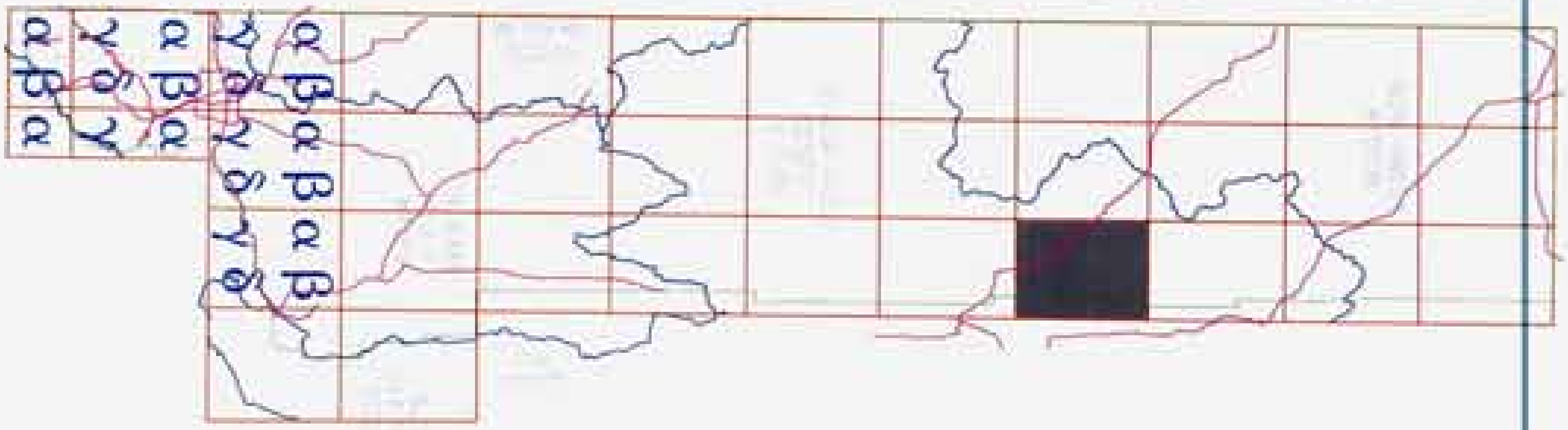

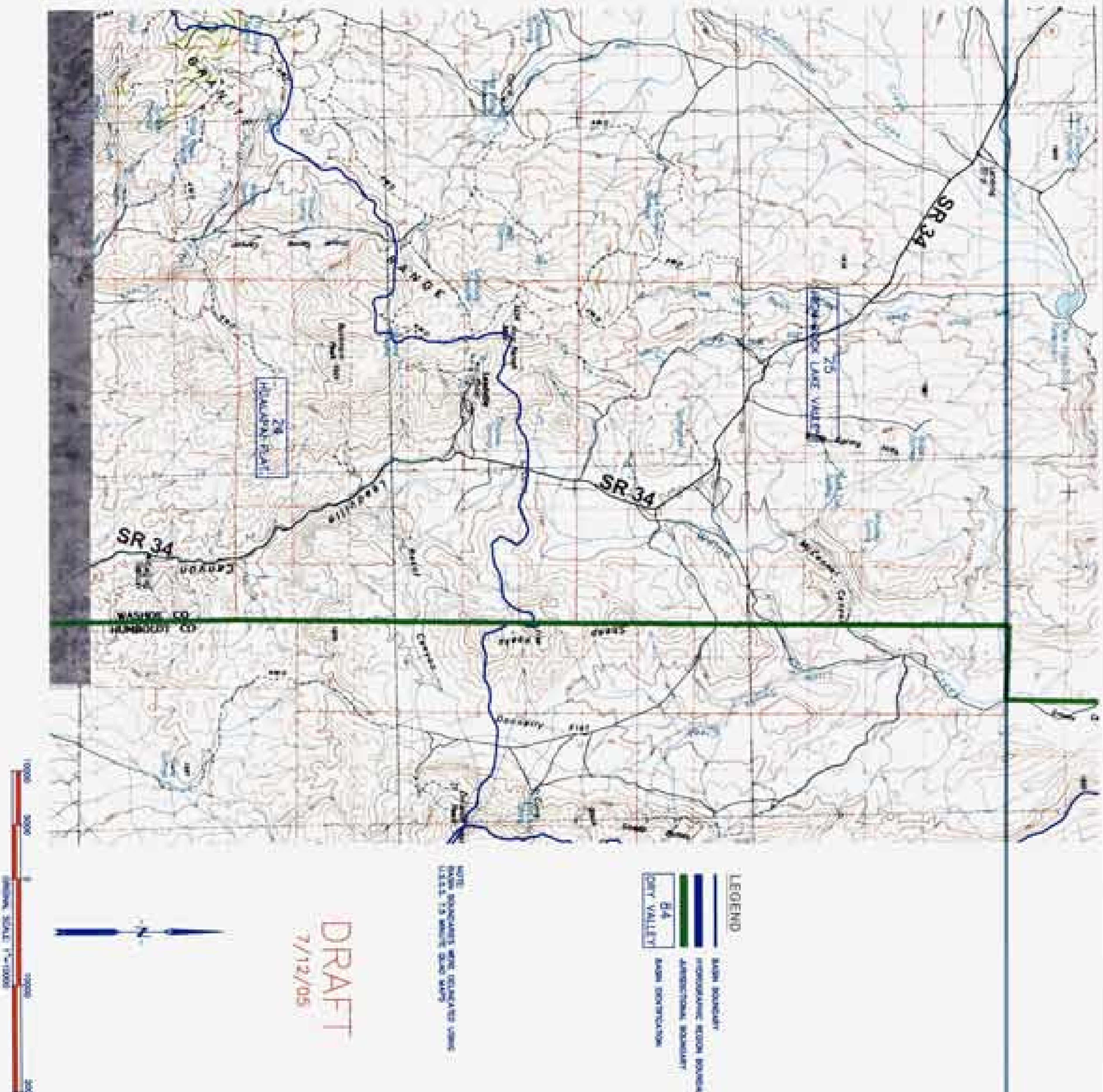

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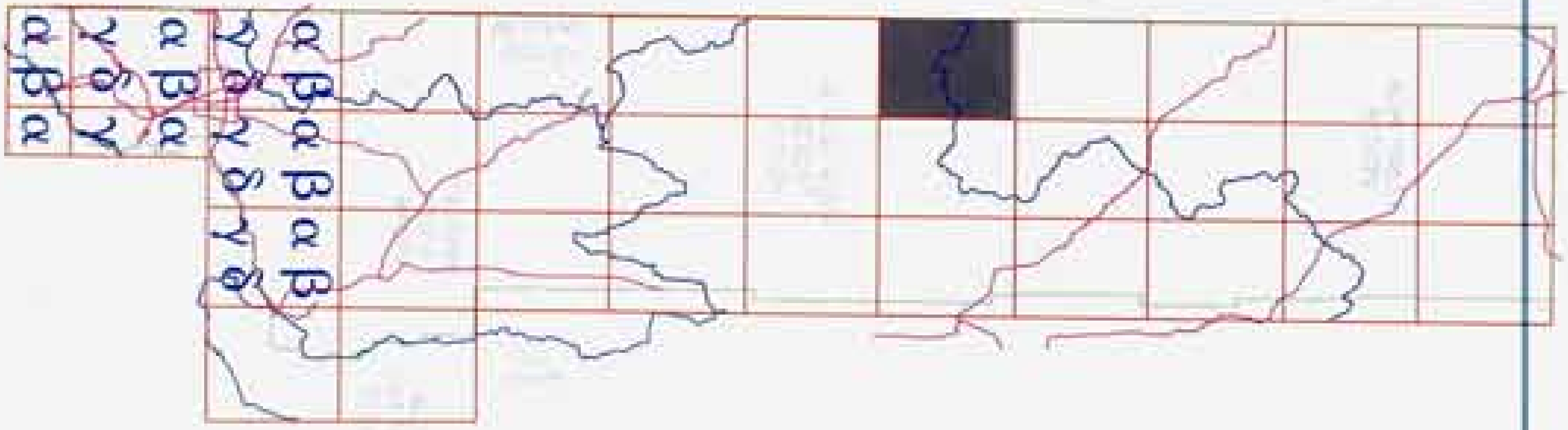

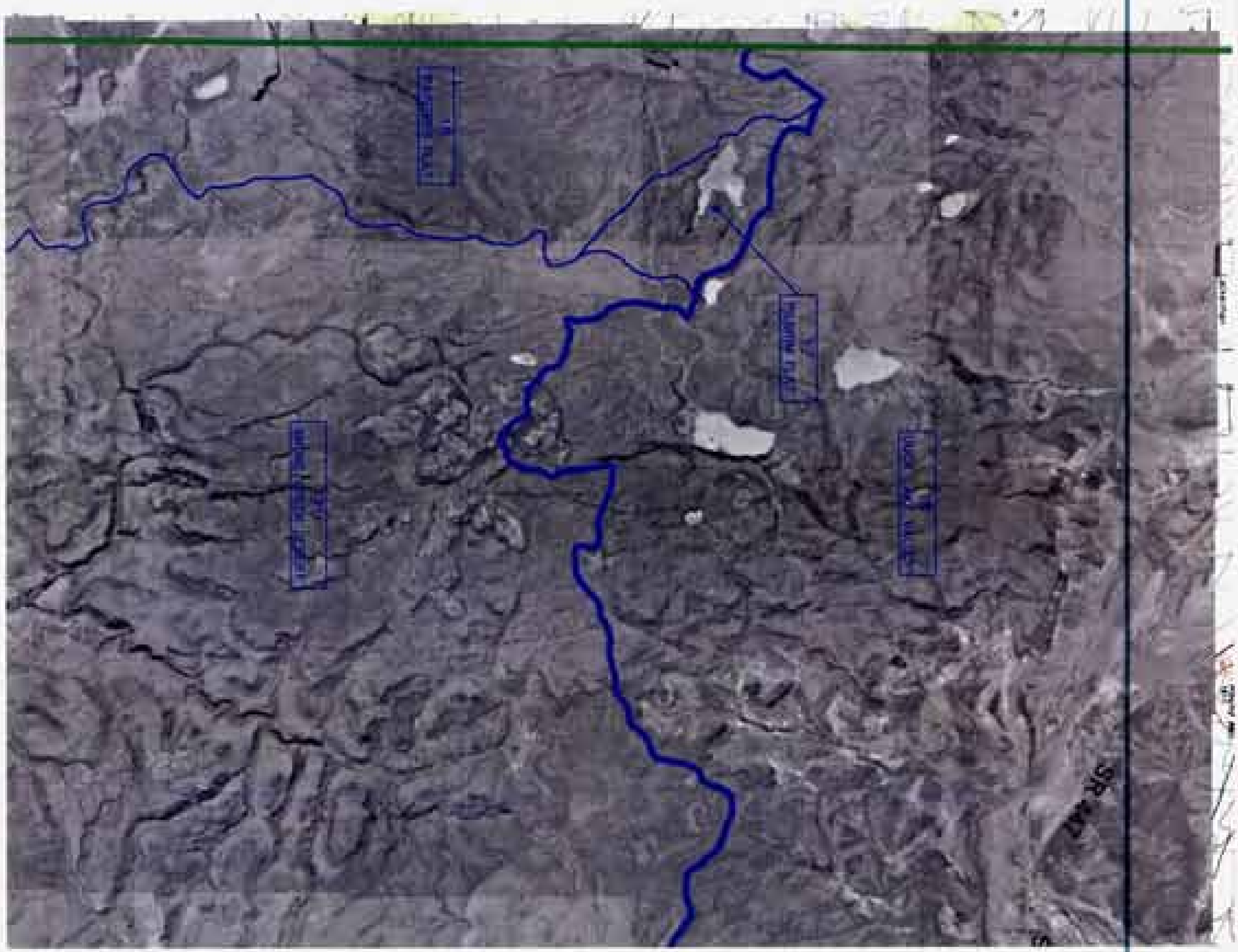

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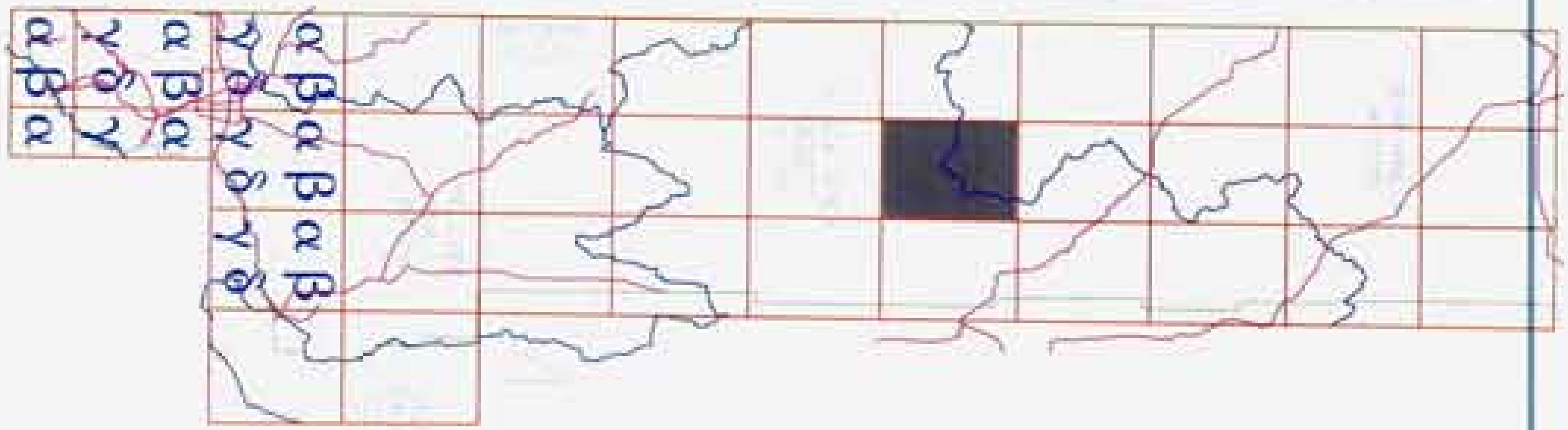

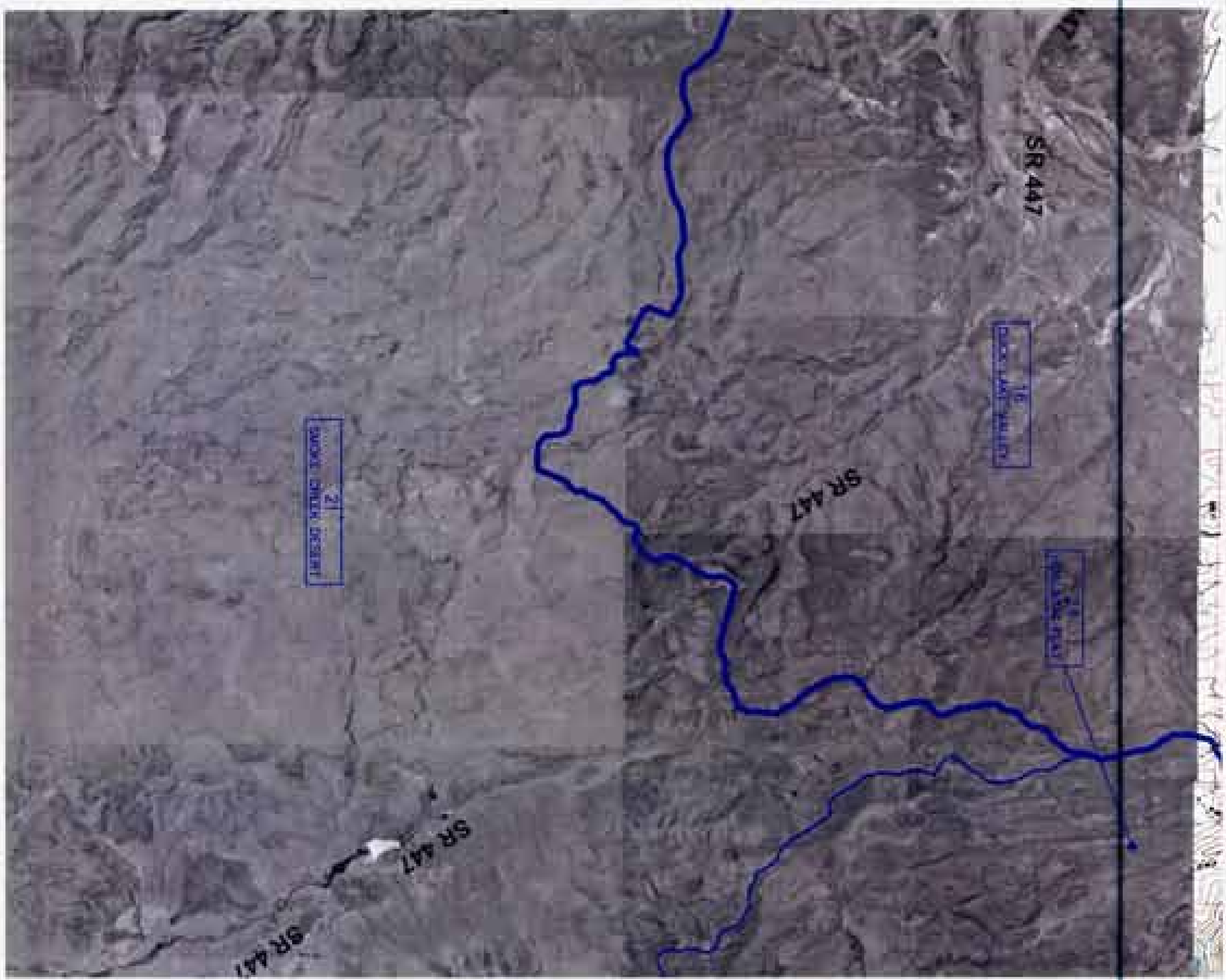

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84 DRY VALLEY — BASIN IDENTIFICATION

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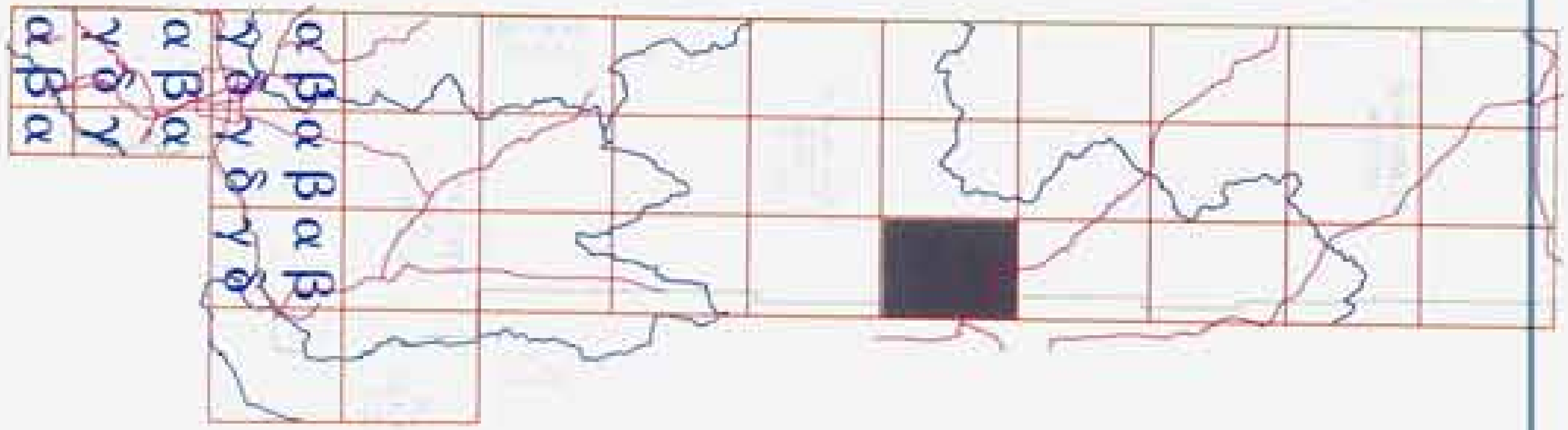

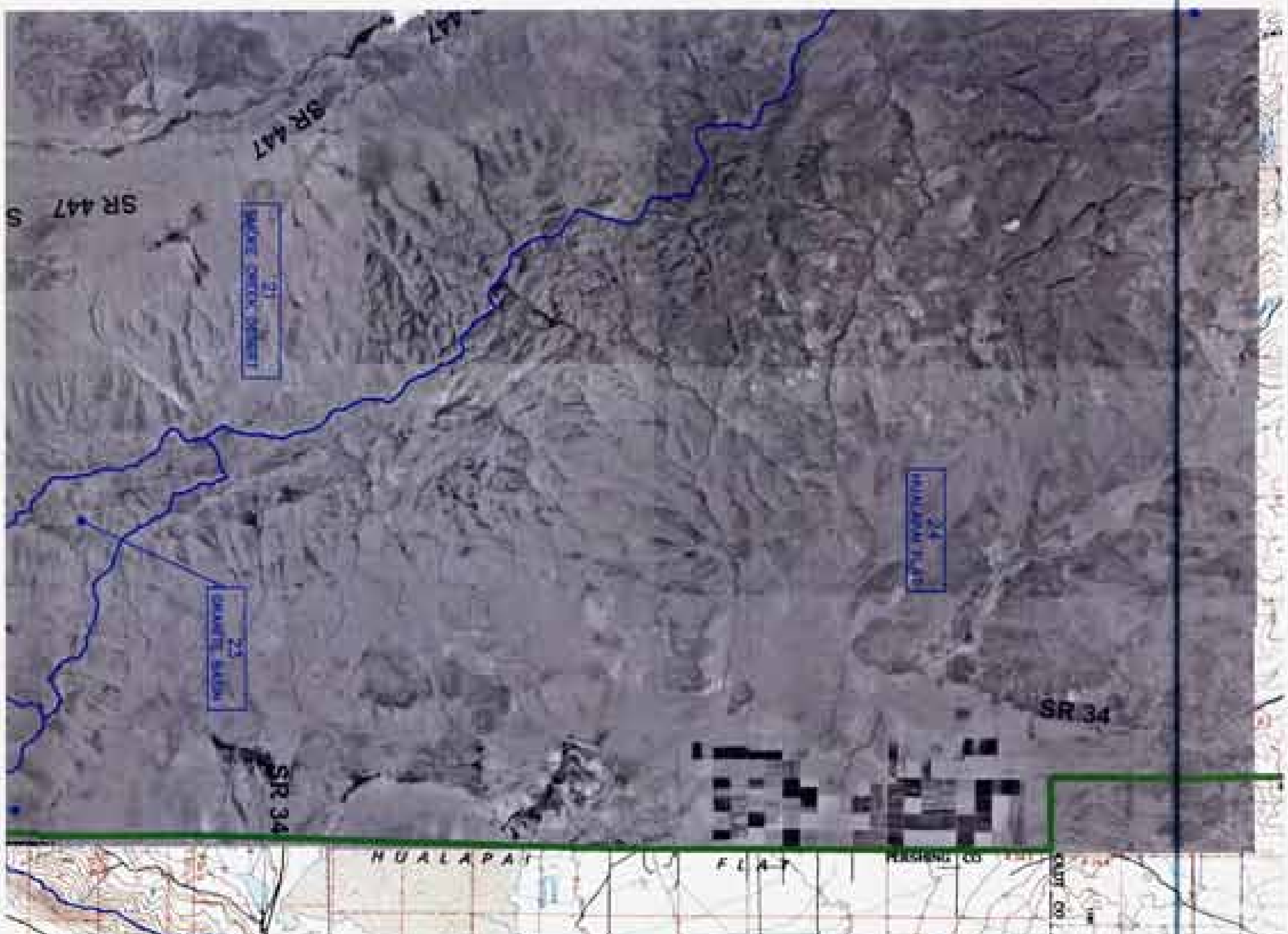

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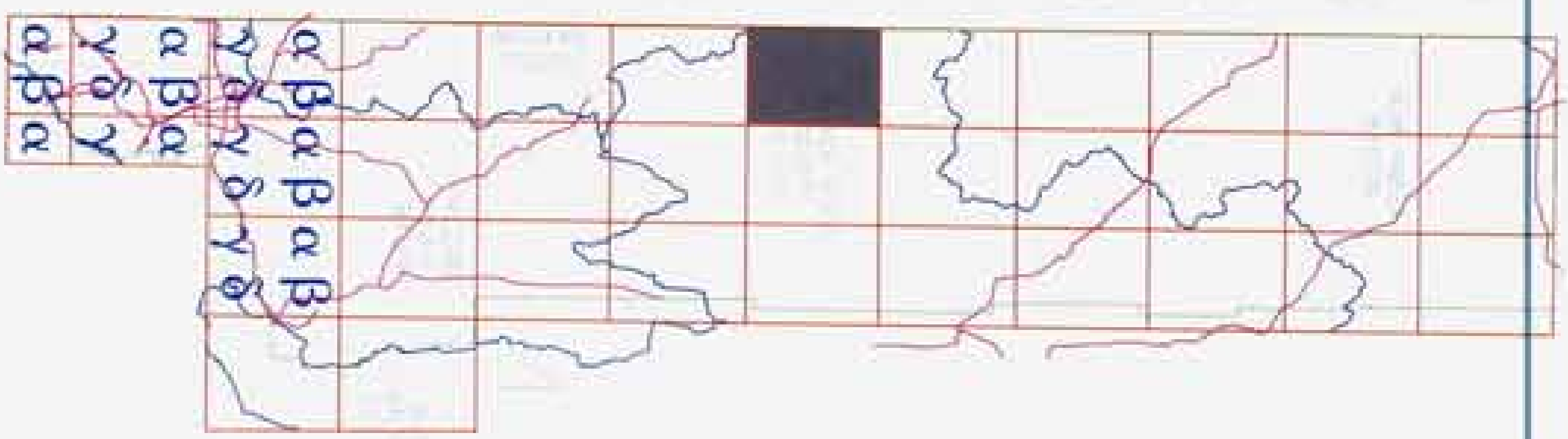

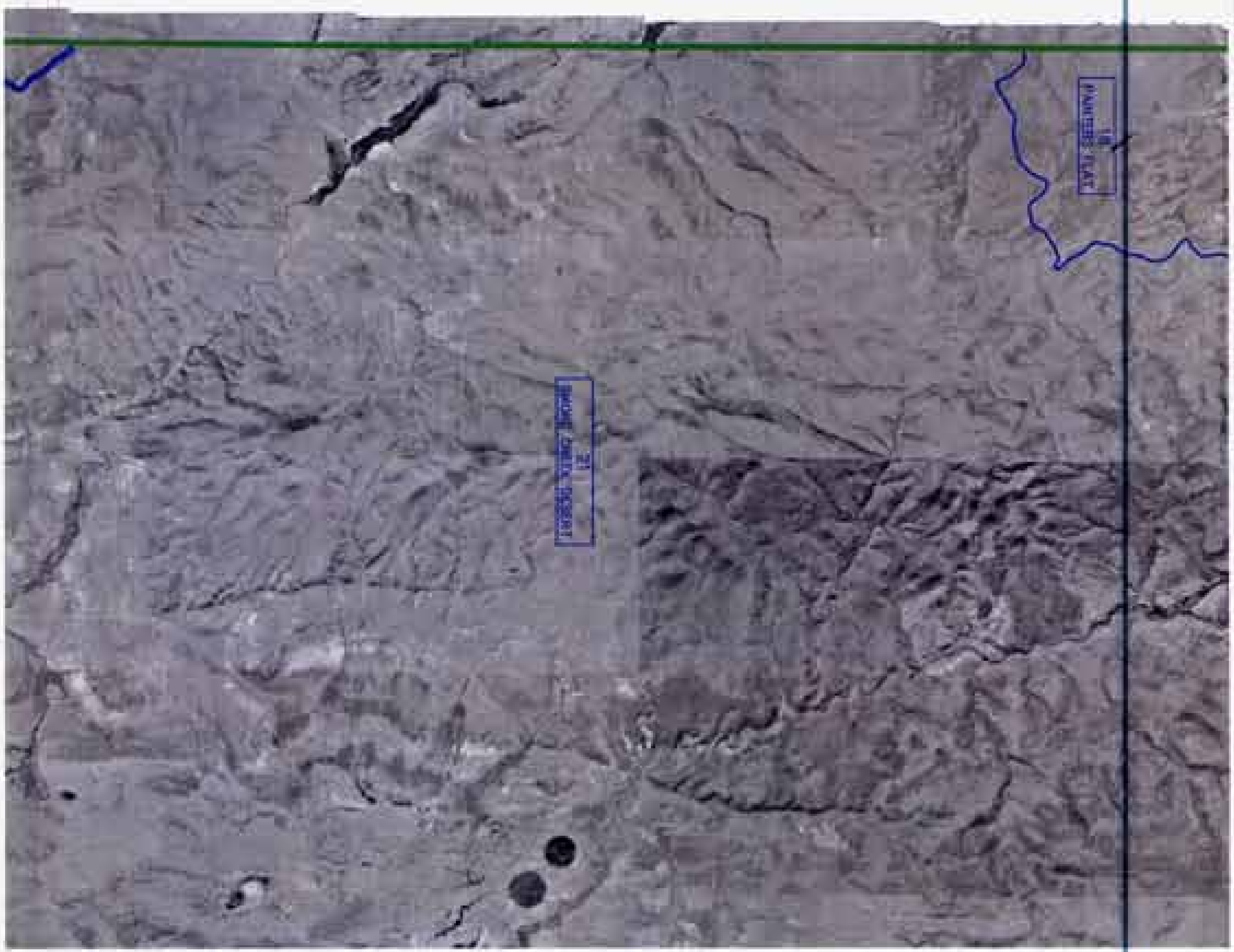

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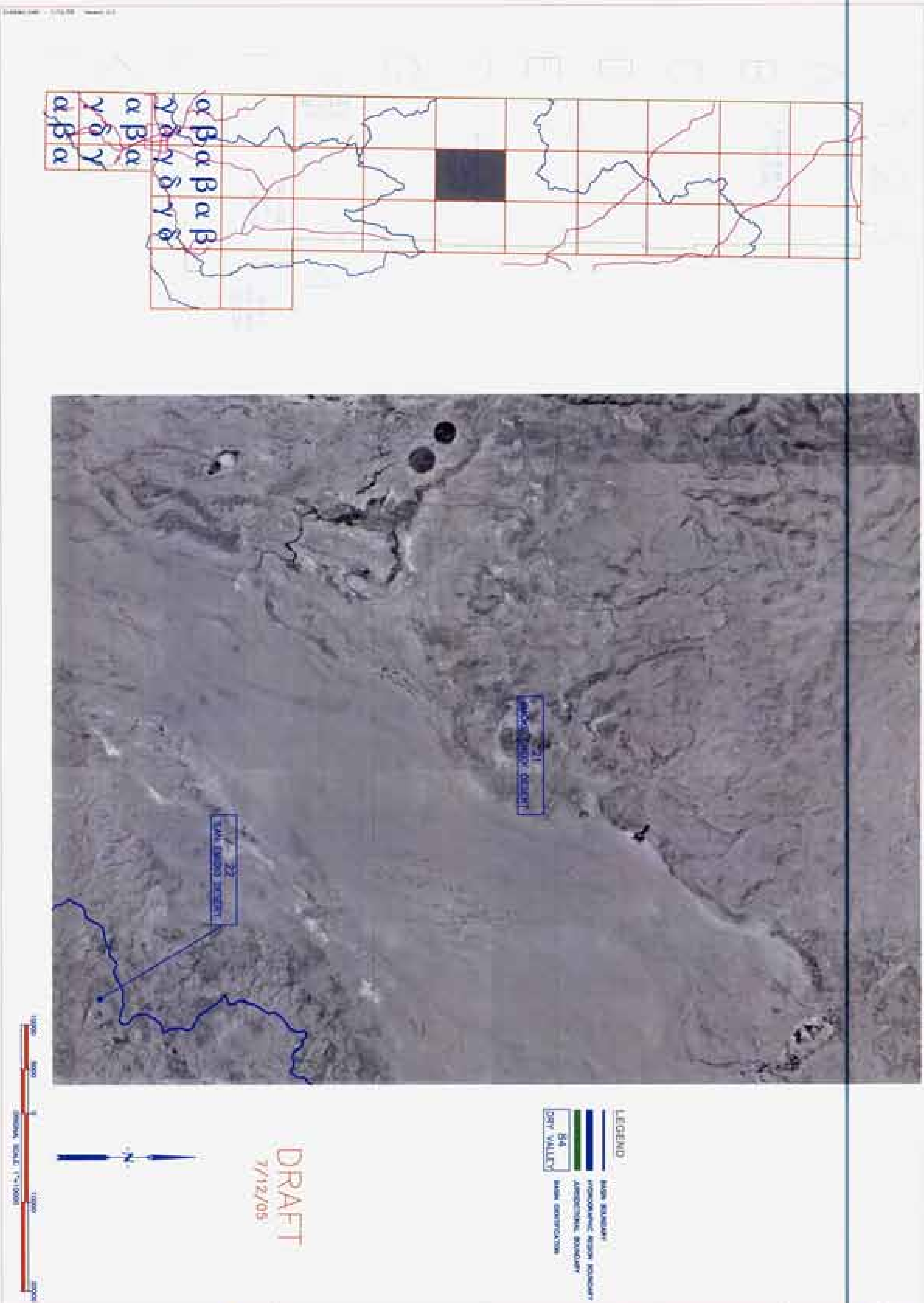

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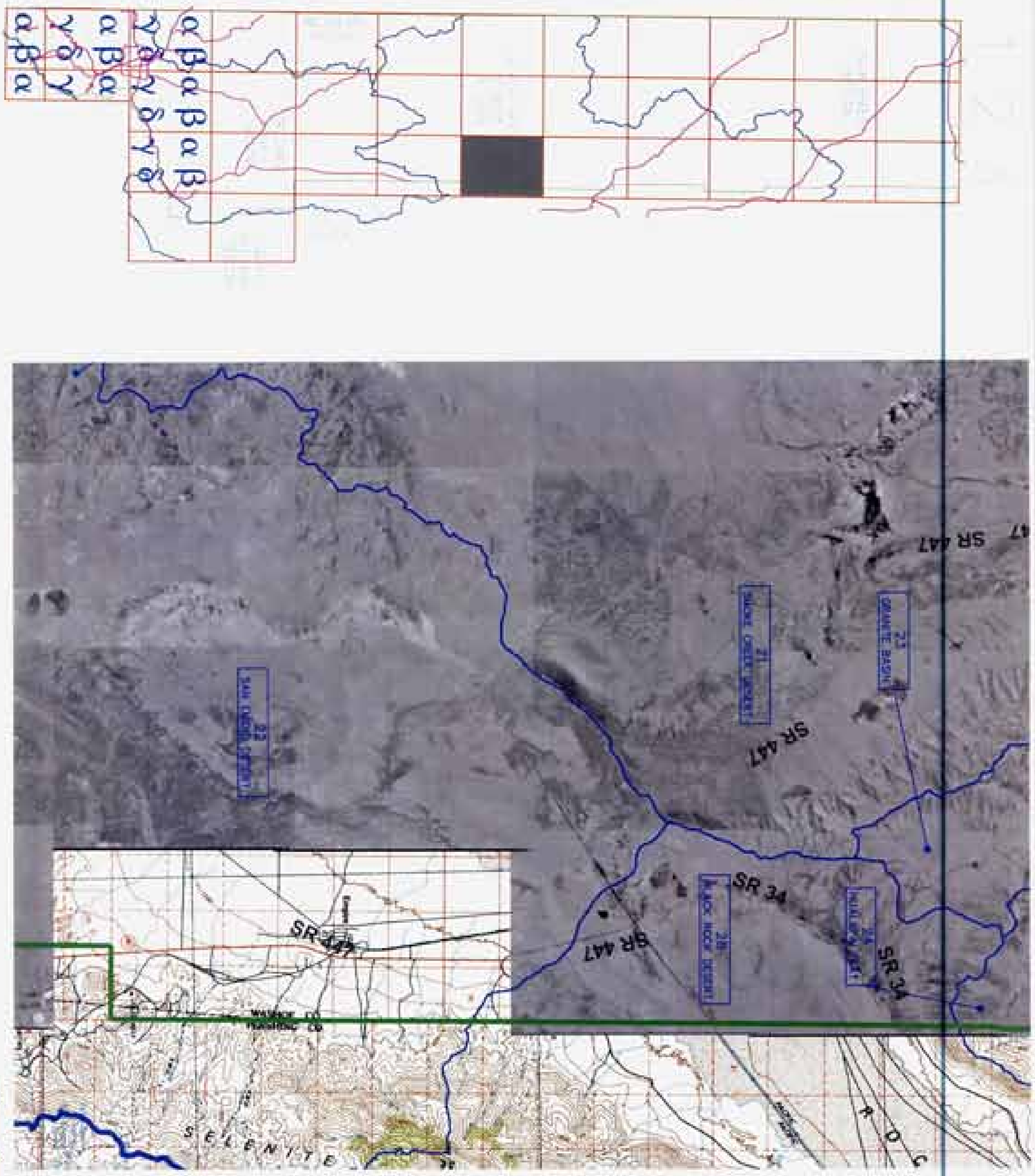

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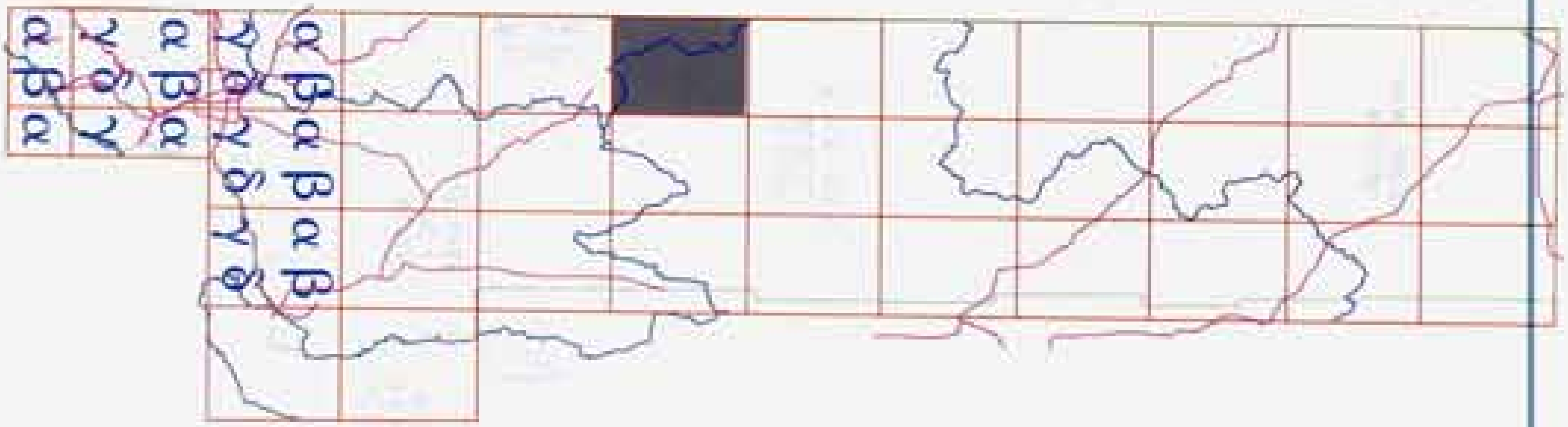

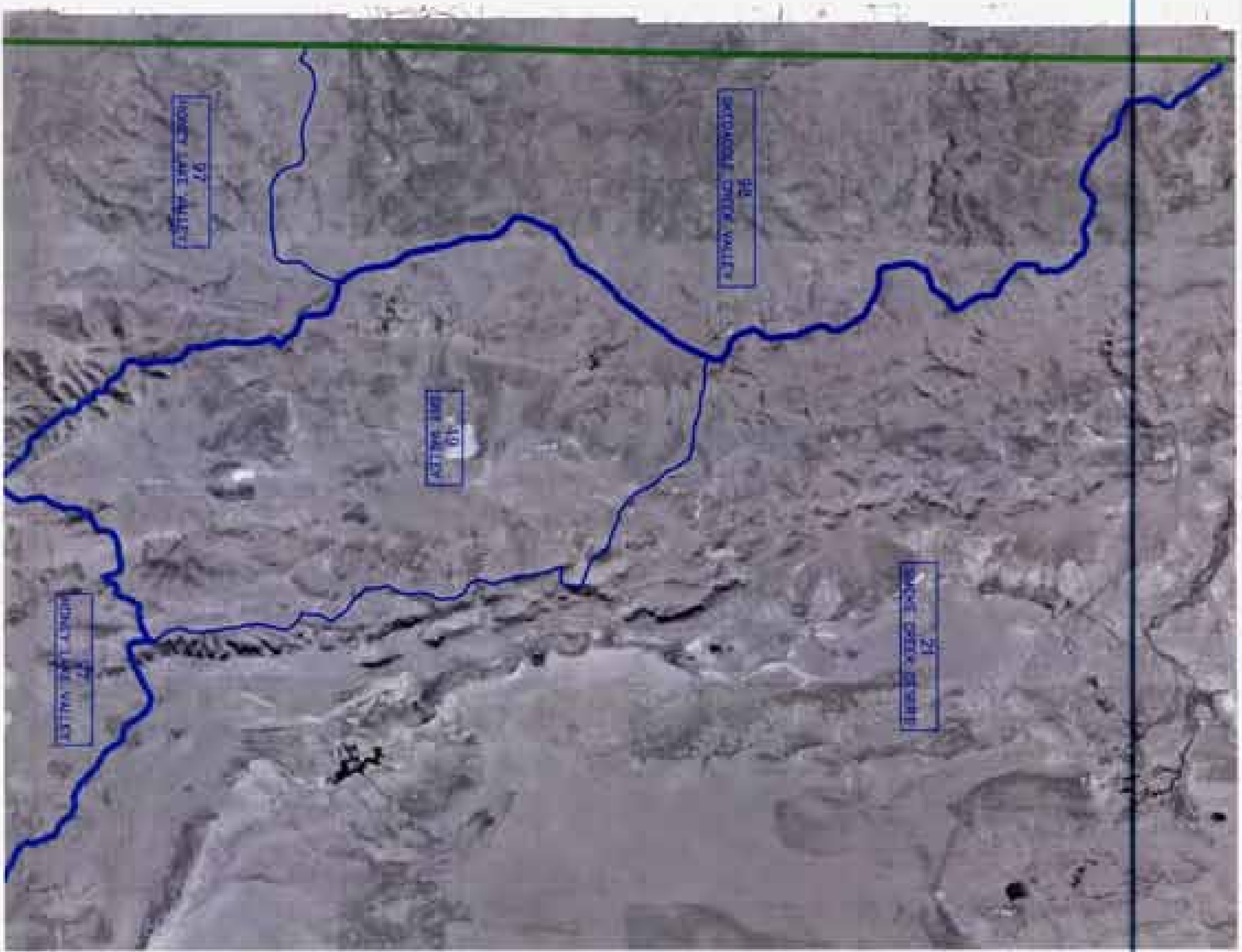

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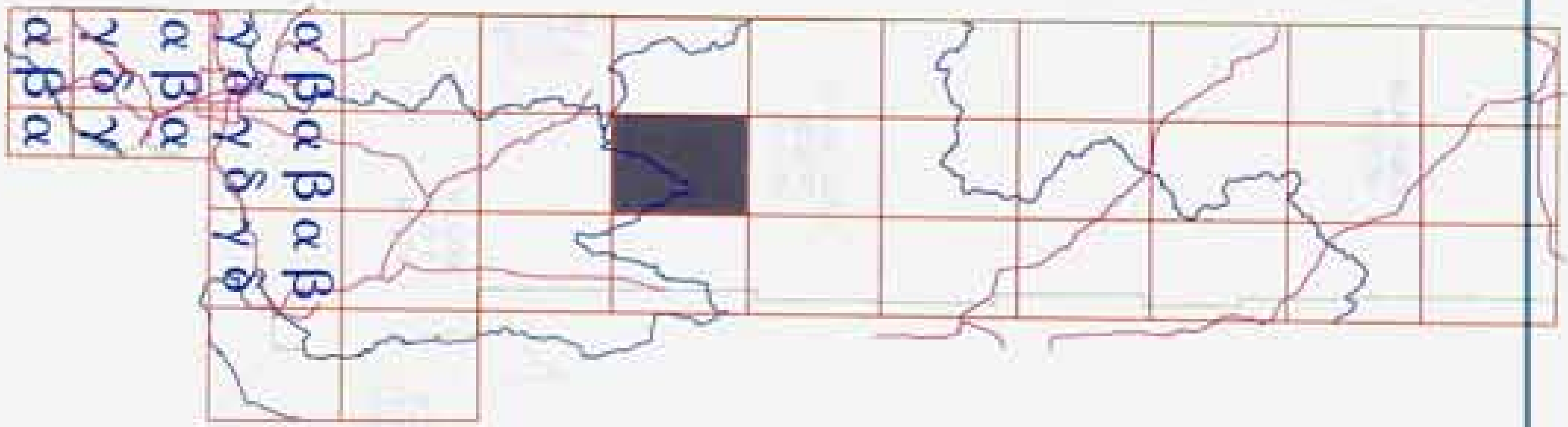

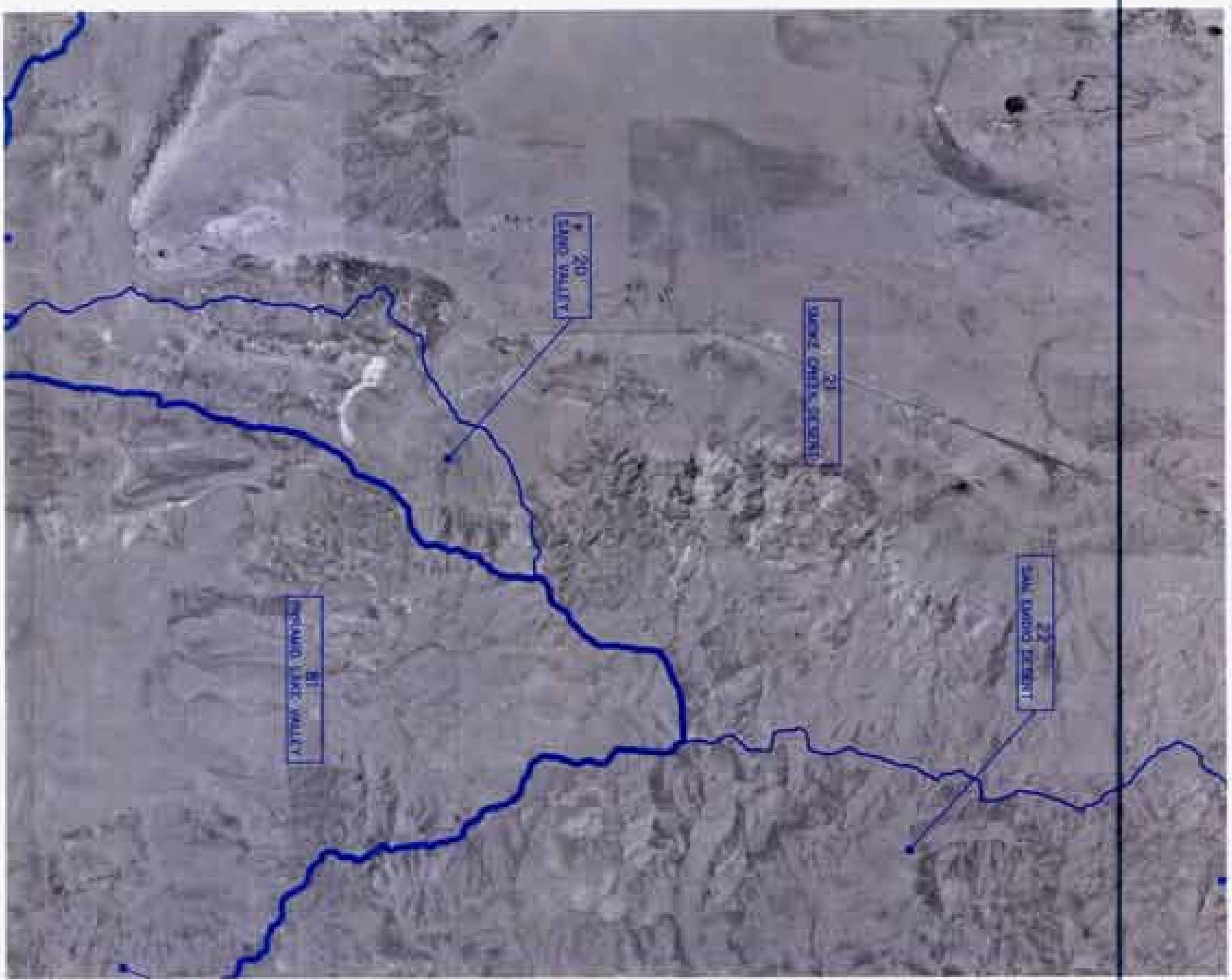

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REGIONAL FLOOD CONTROL MASTER PLAN

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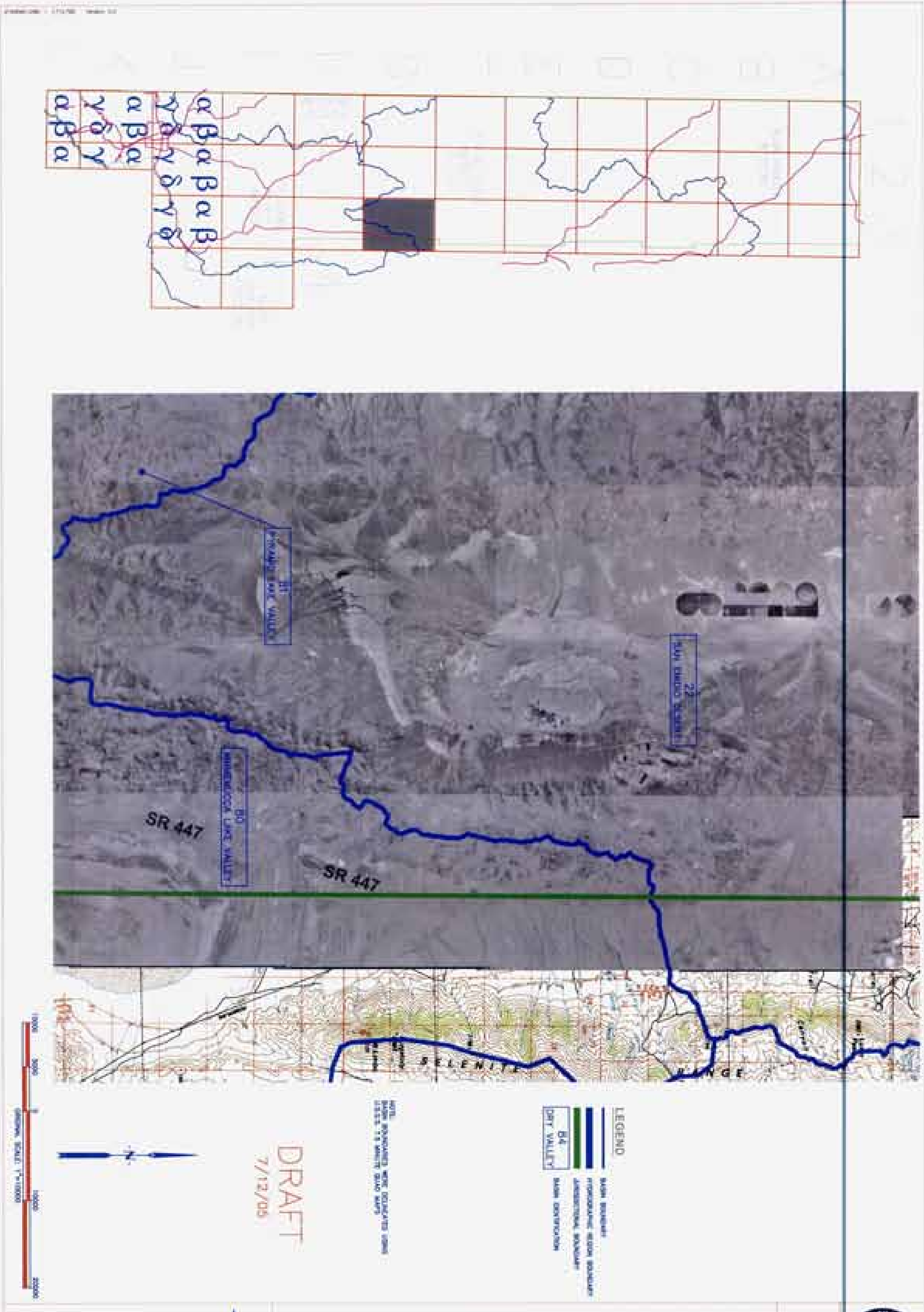

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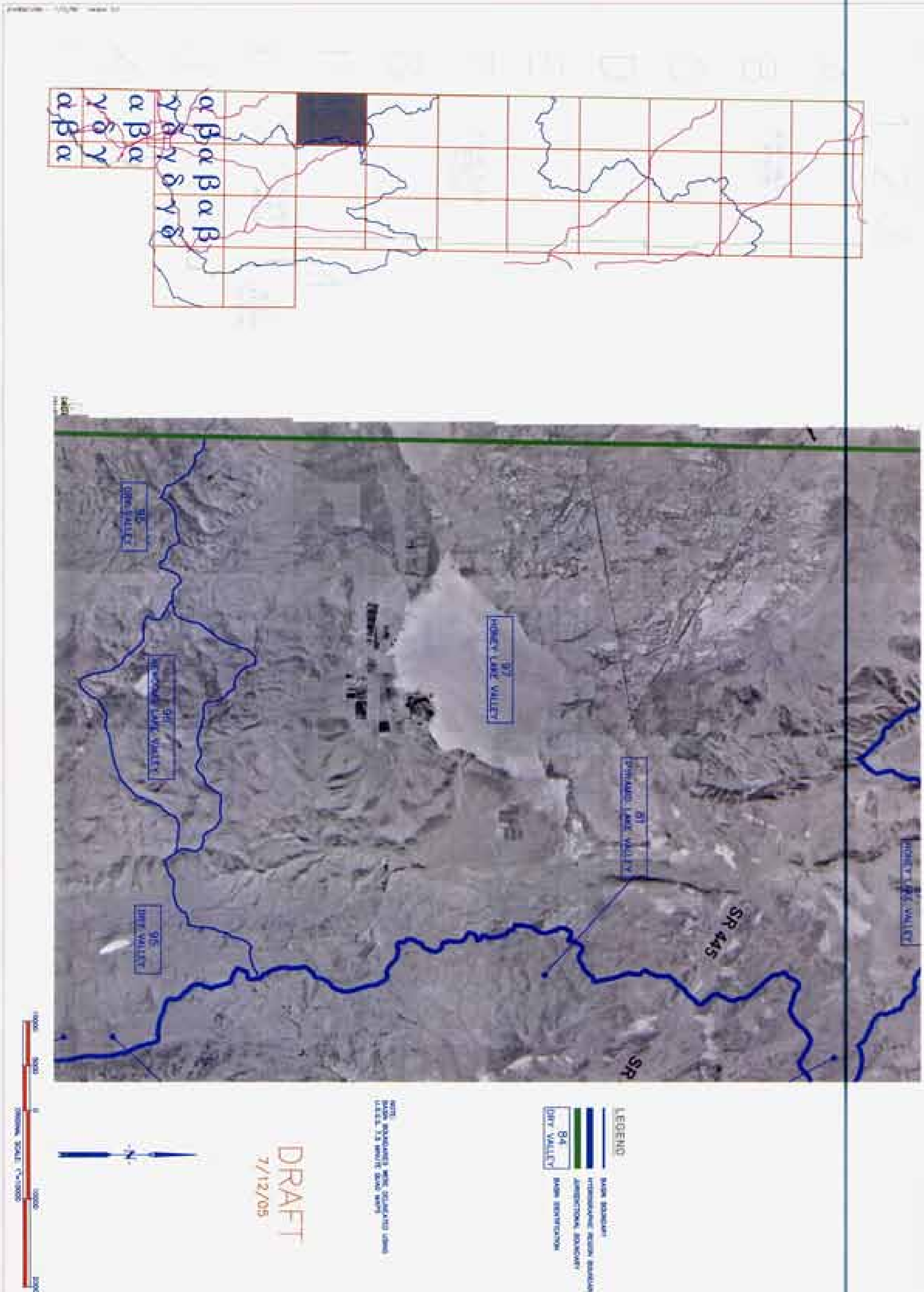
REGIONAL FLOOD CONTROL MASTER PLAN

G3

SEAL OF WASHOE COUNTY · STATE OF NEVADA

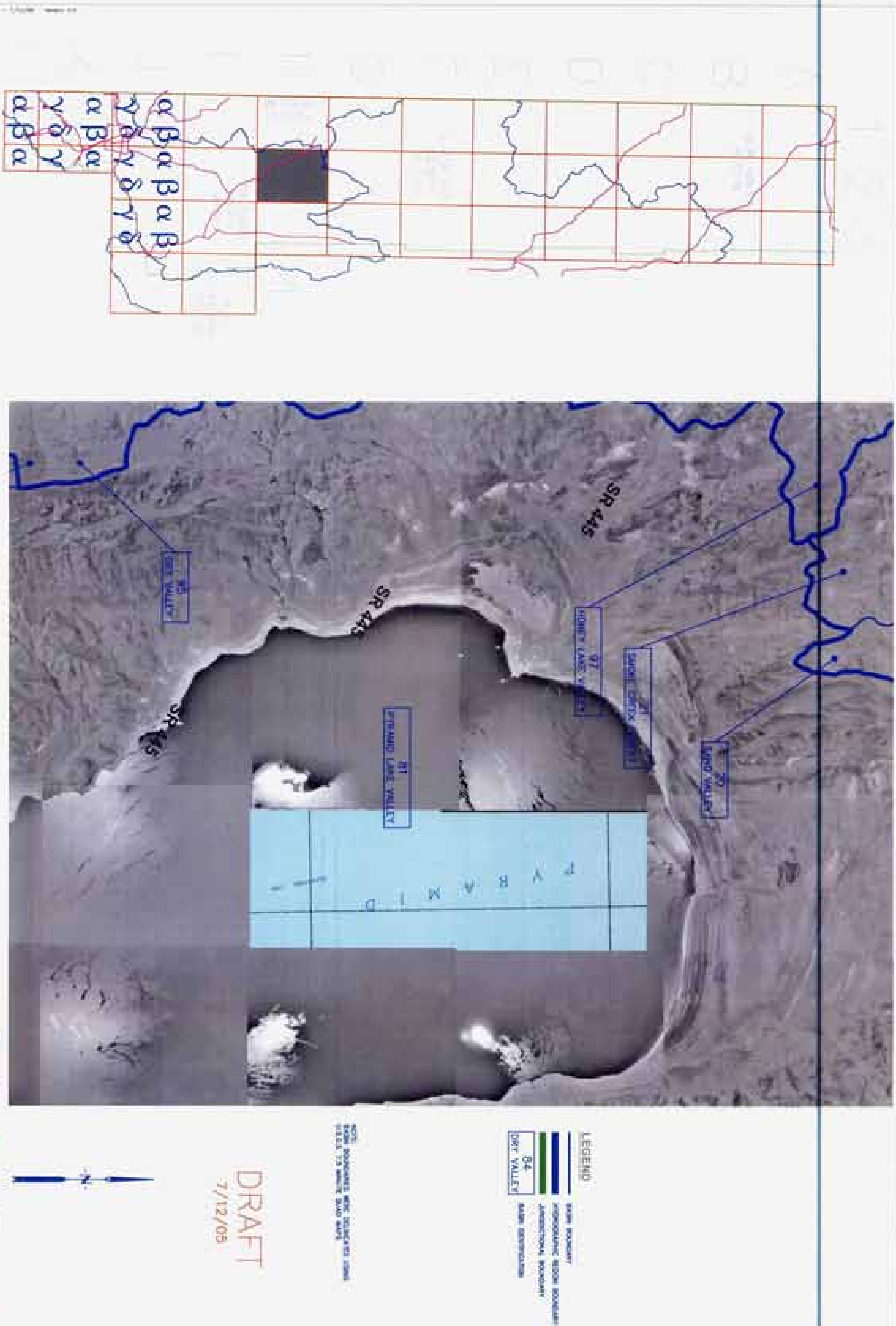


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

H1

SEAL OF WASHOE COUNTY STATE OF NEVADA

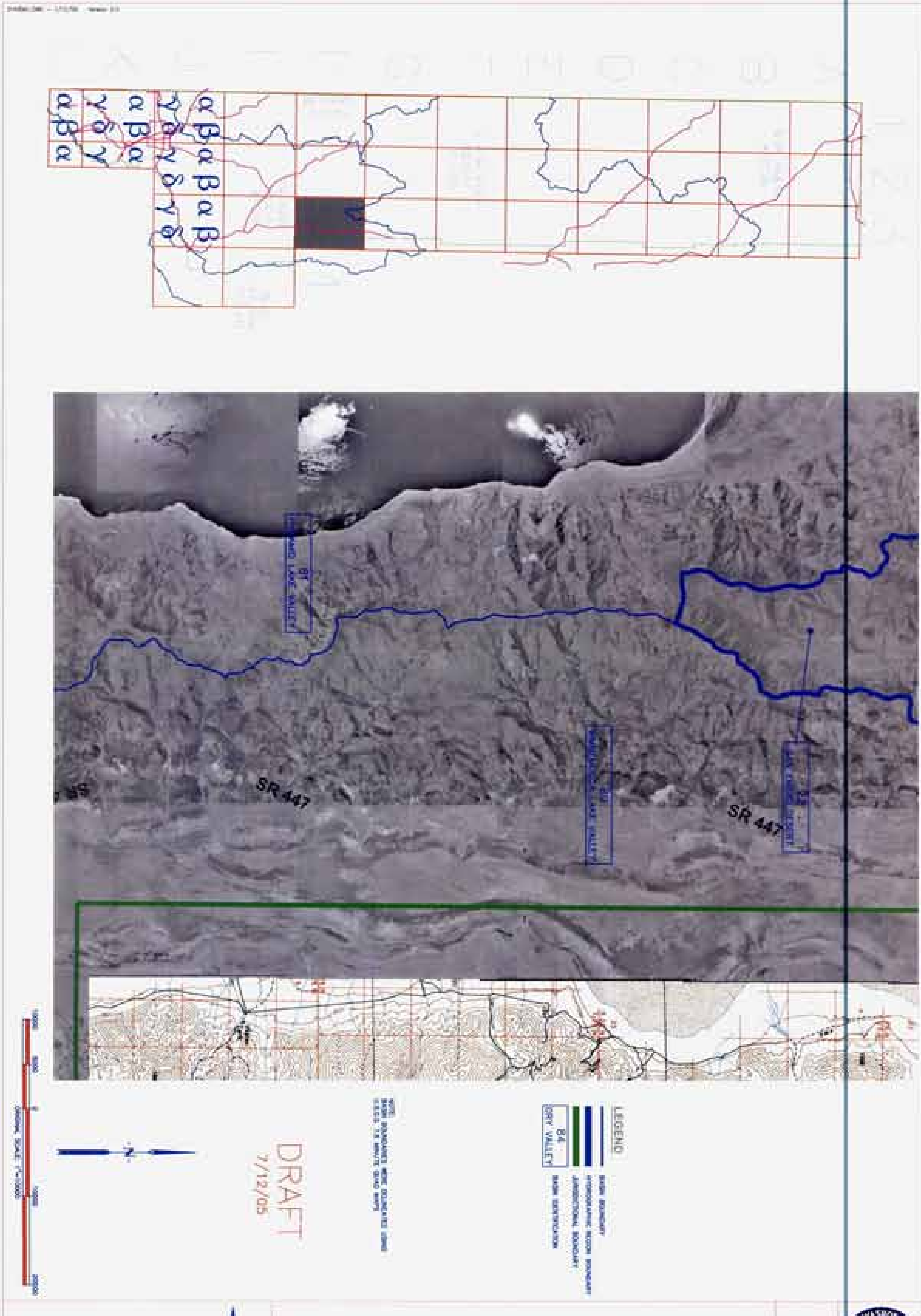


WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

H2

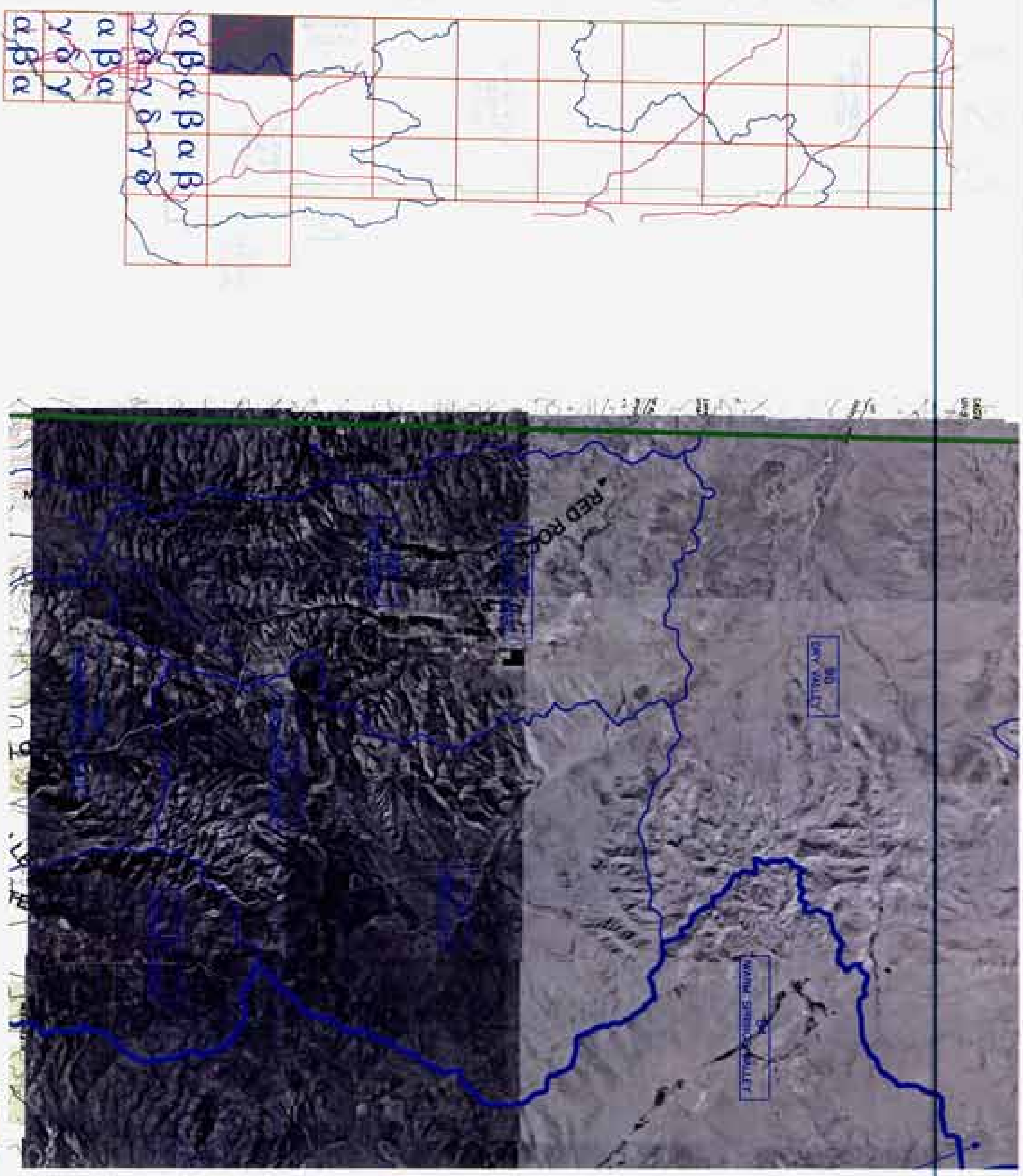
SEAL OF WASHOE COUNTY STATE OF NEVADA



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

H3



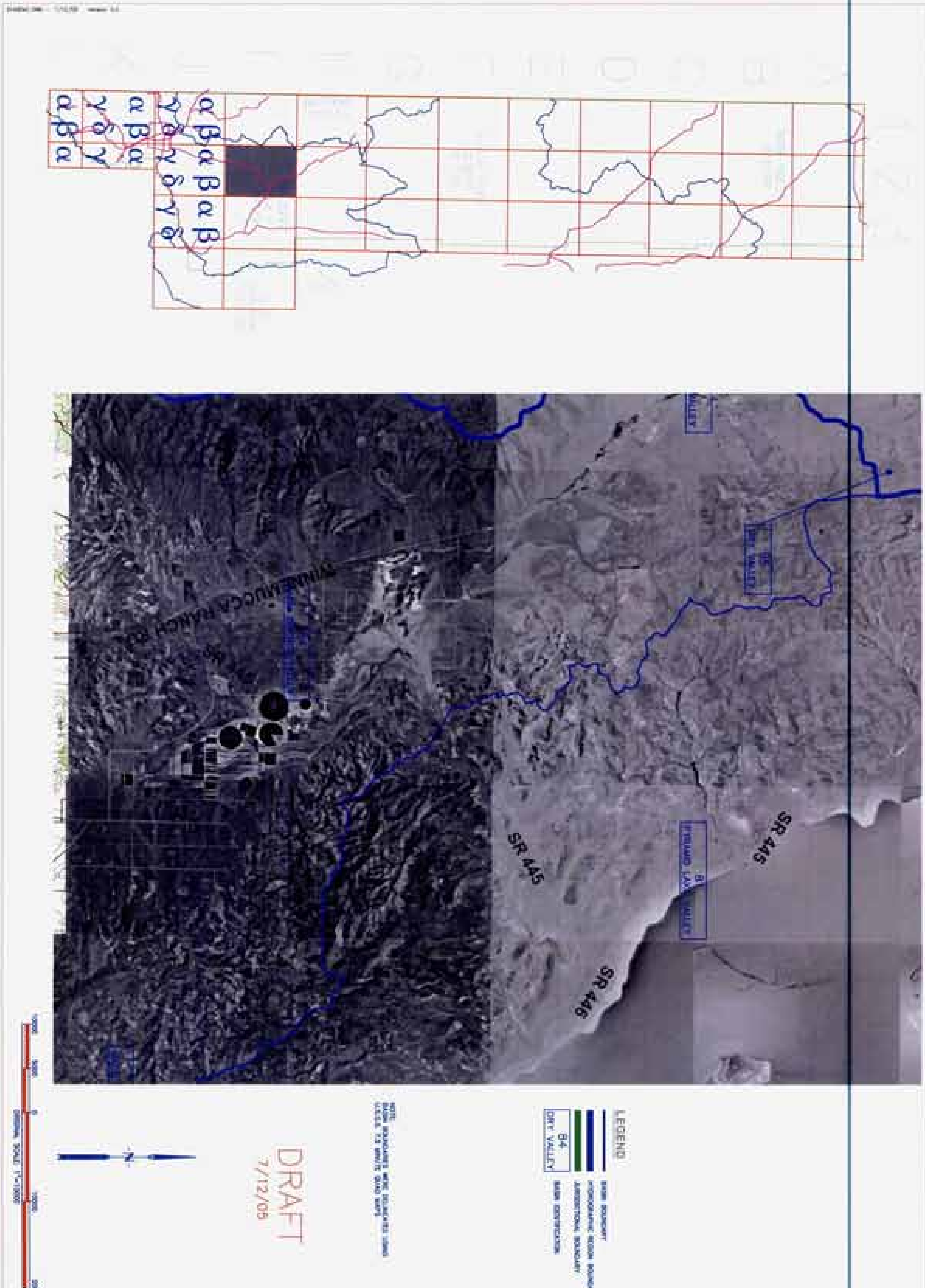
LEGEND

DRAFT
7/12/05

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

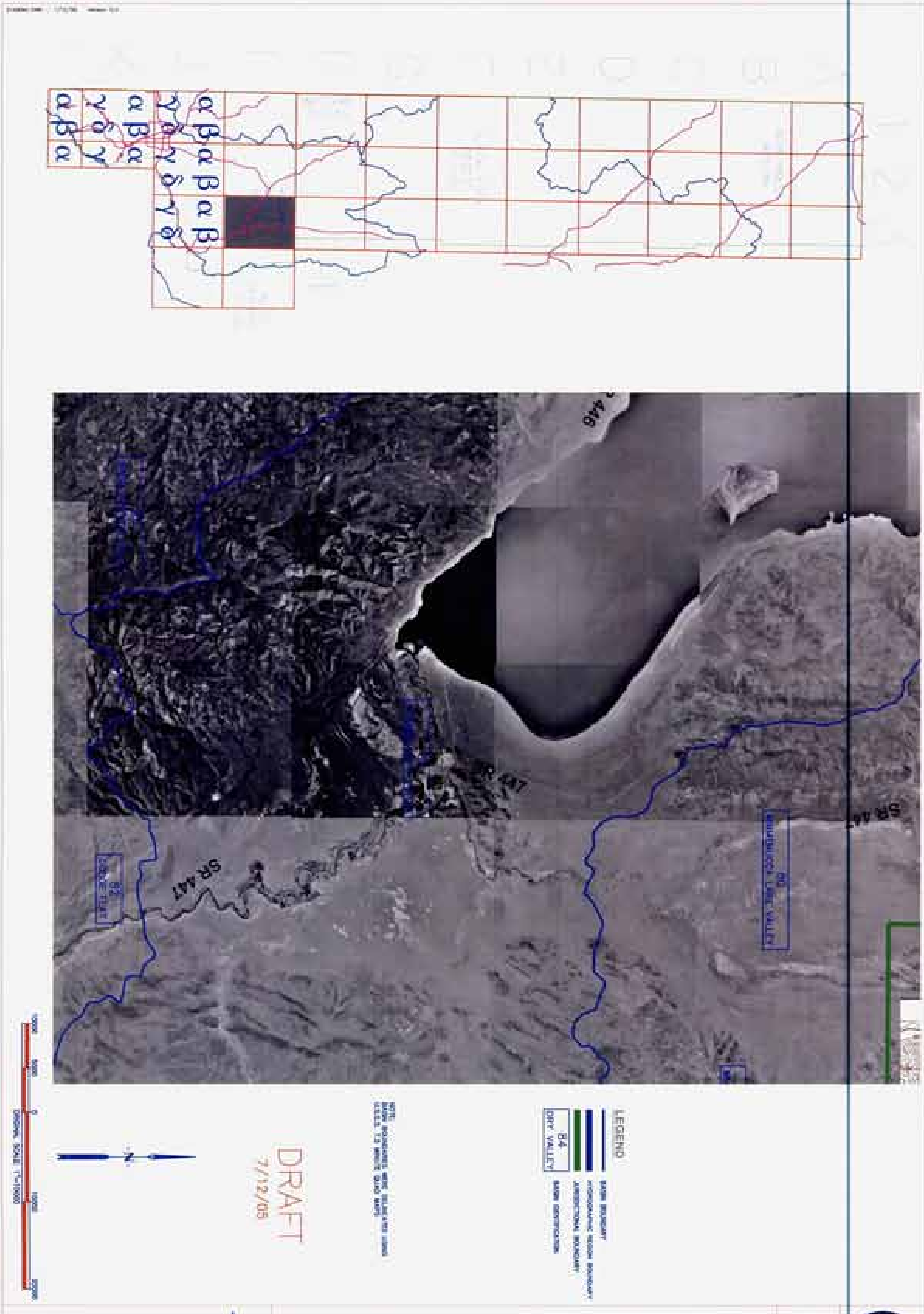
I1



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

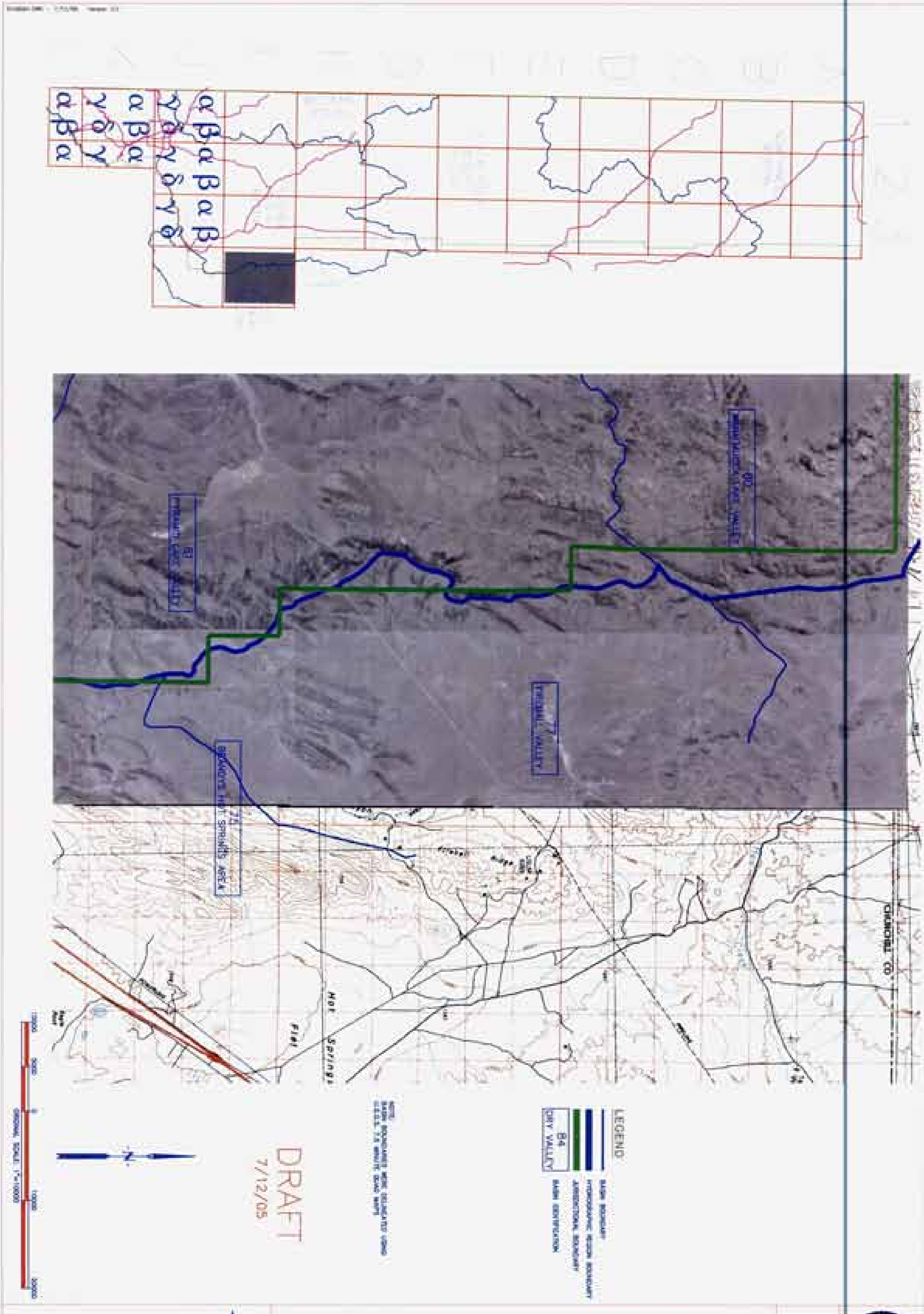
I2



WRC ENGINEERING, INC.

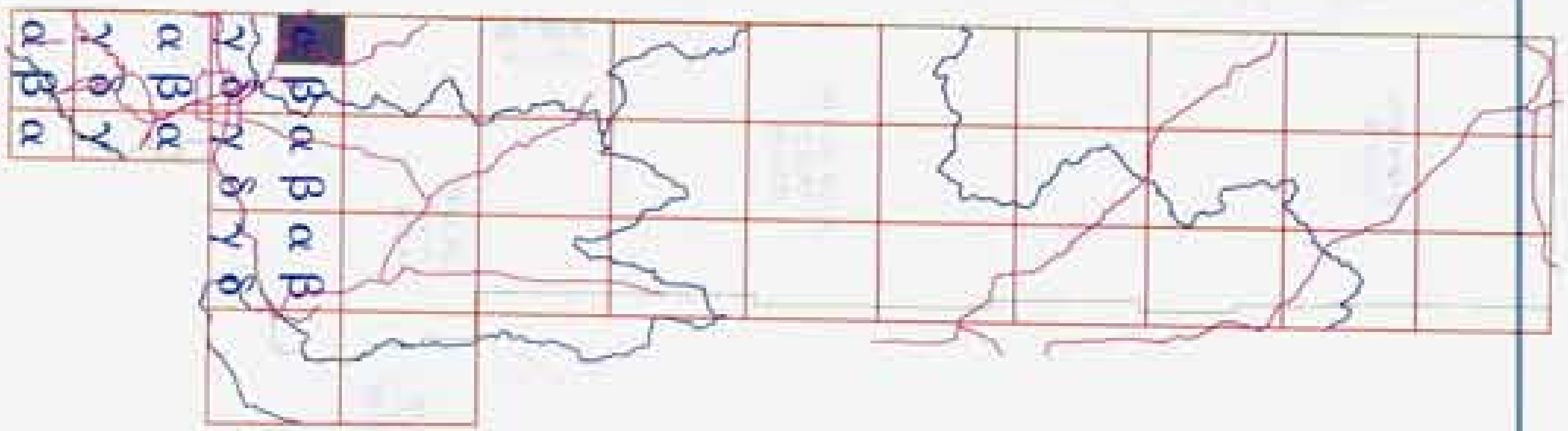
WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

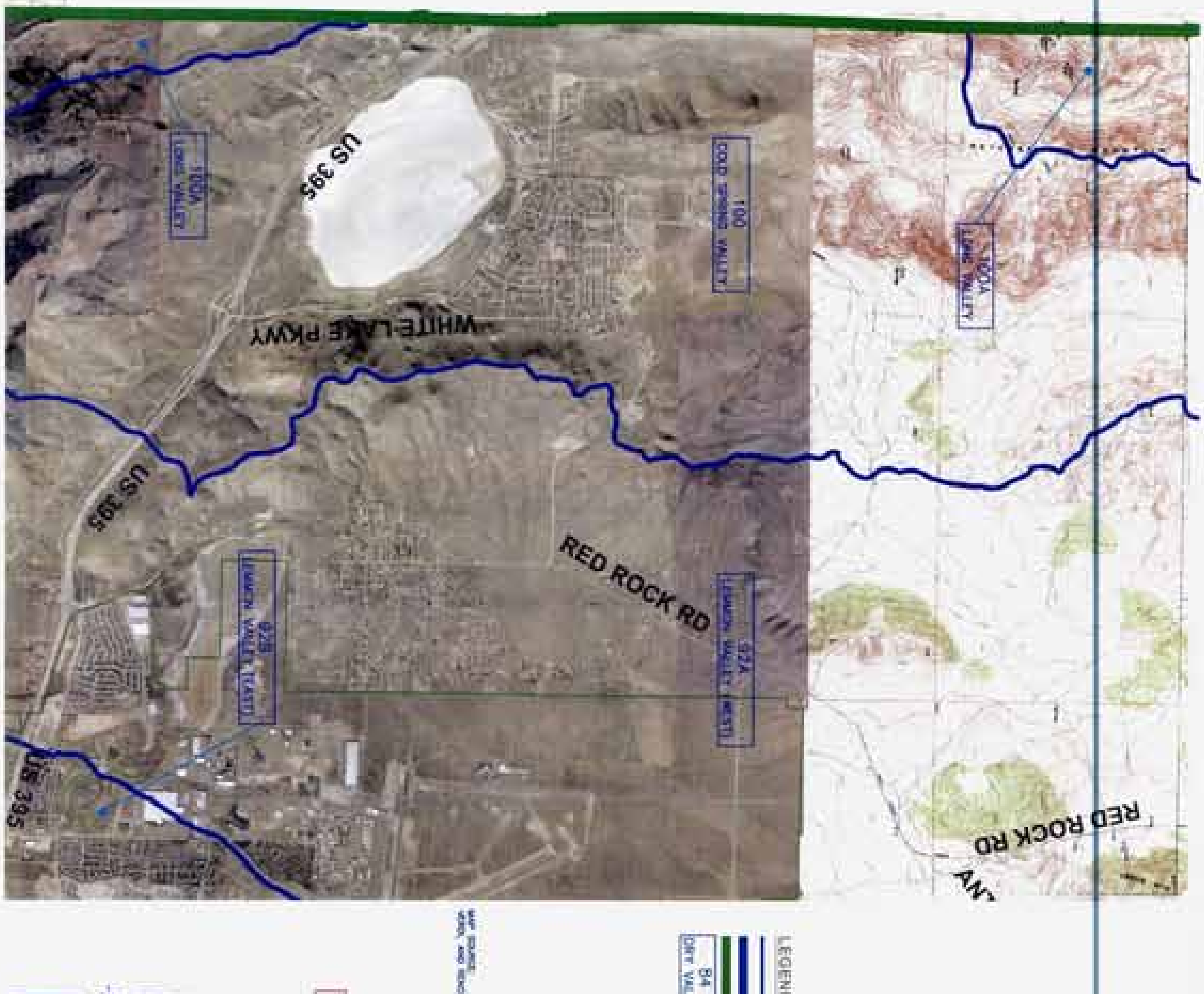
13



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN





LEGEND

84
DRY VALLEY

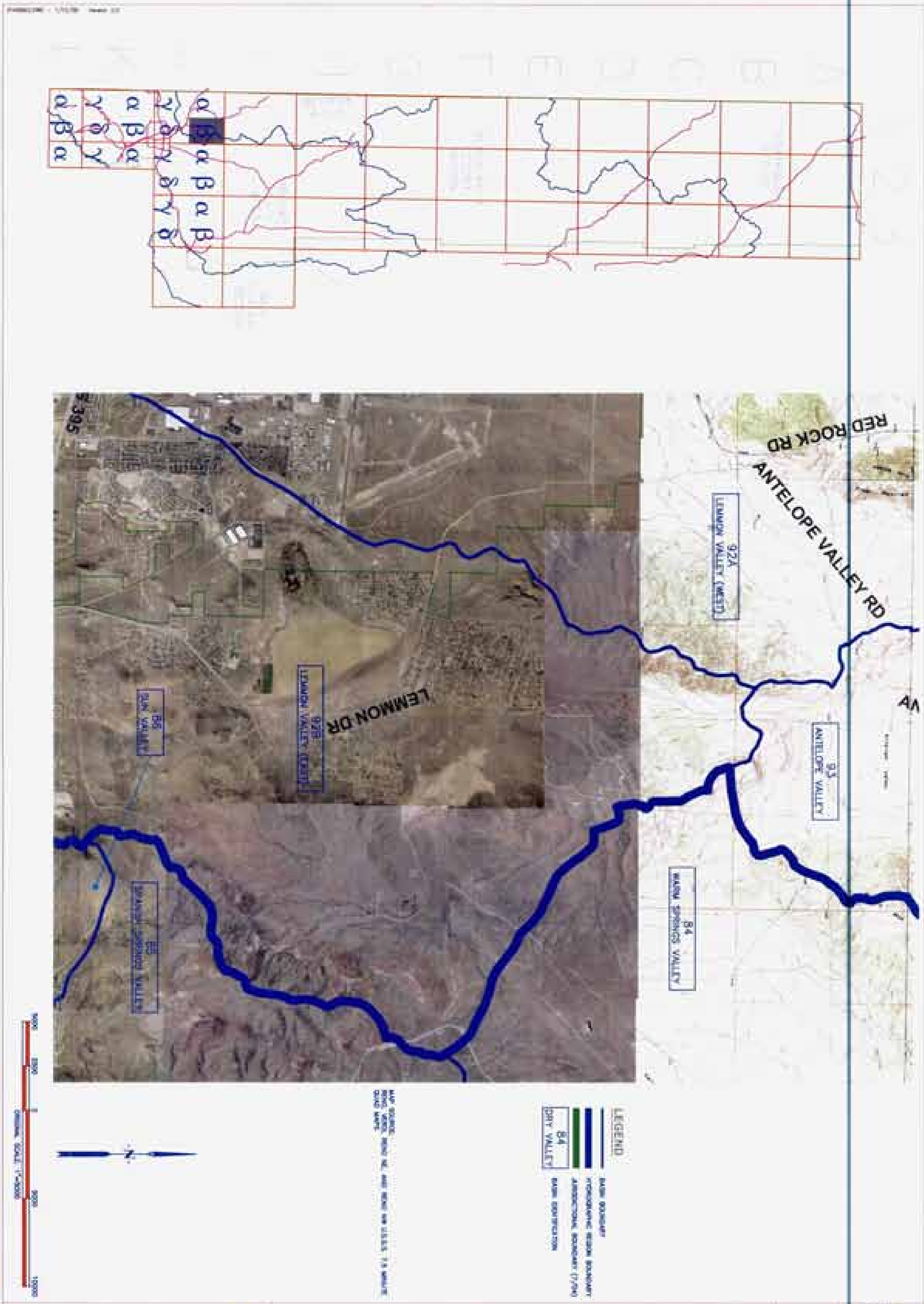
DRAFT
7/12/05

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

WRC ENGINEERING, INC.

J1α

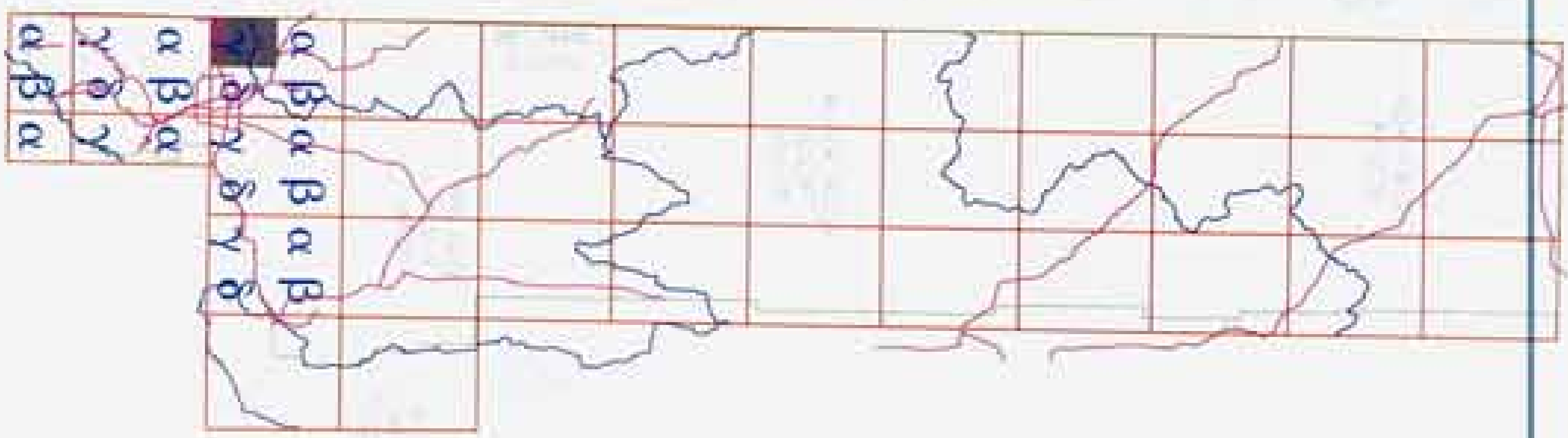
SEAL OF WASHOE COUNTY
STATE OF NEVADA



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

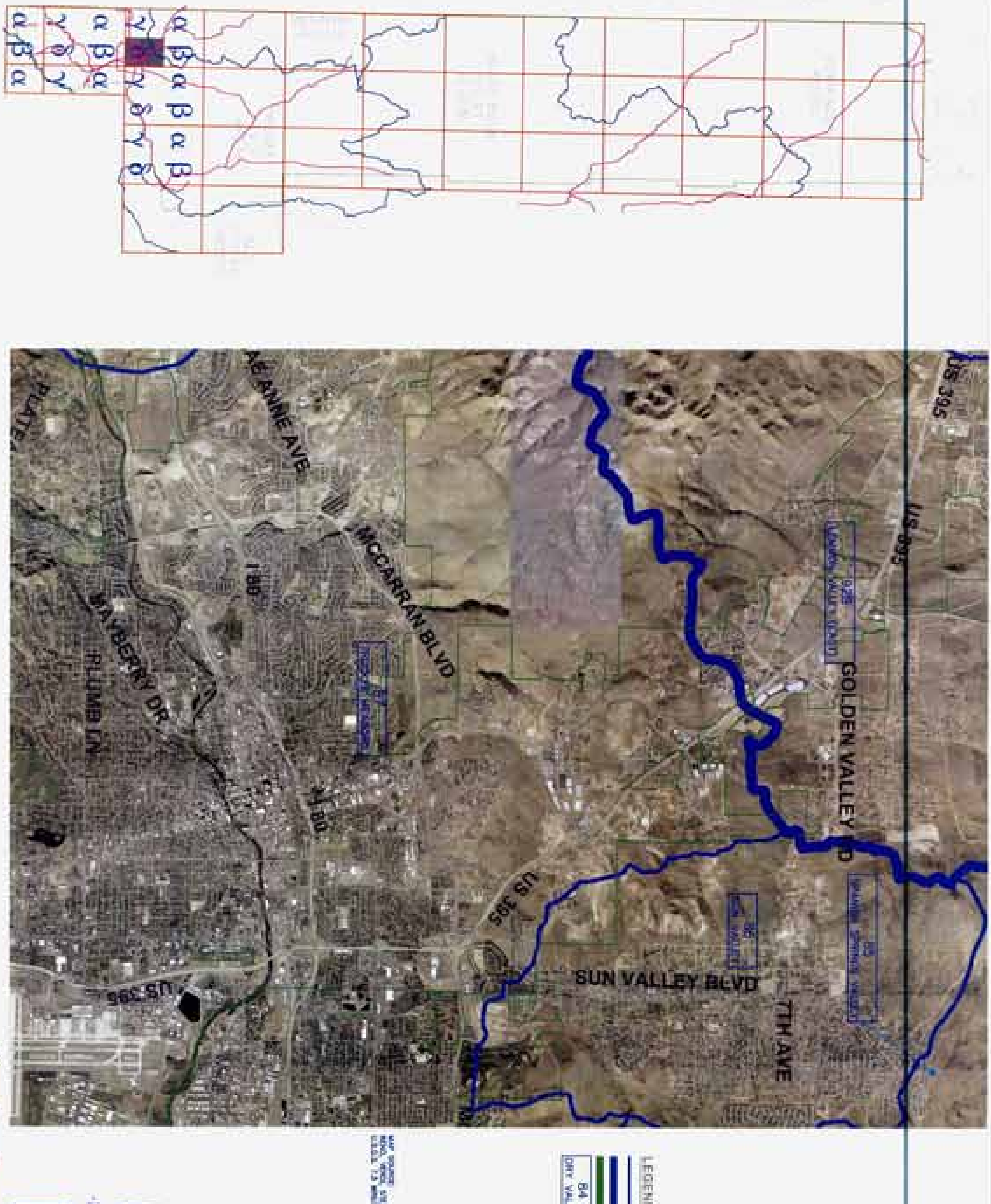
J1β



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

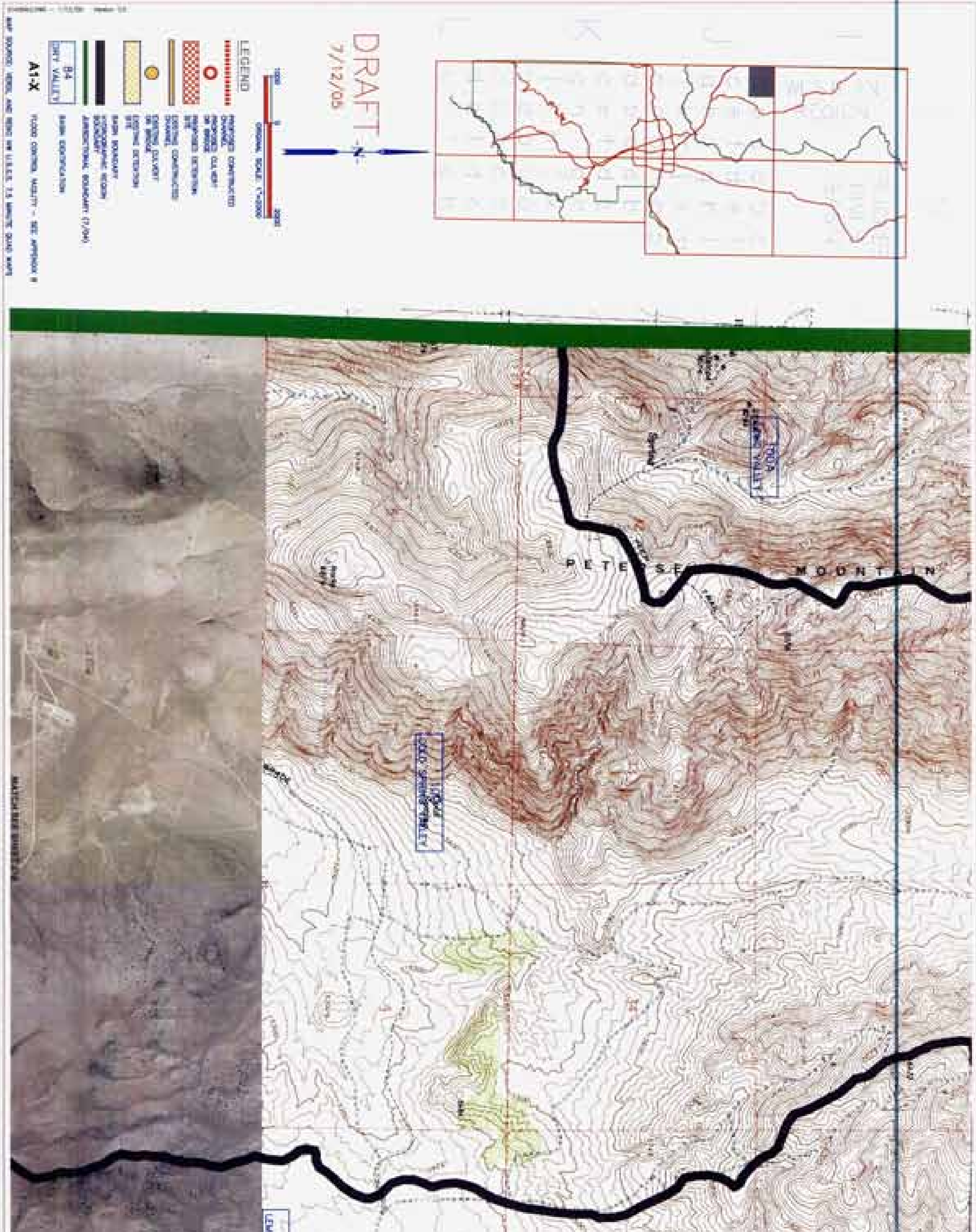
J1γ



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1δ

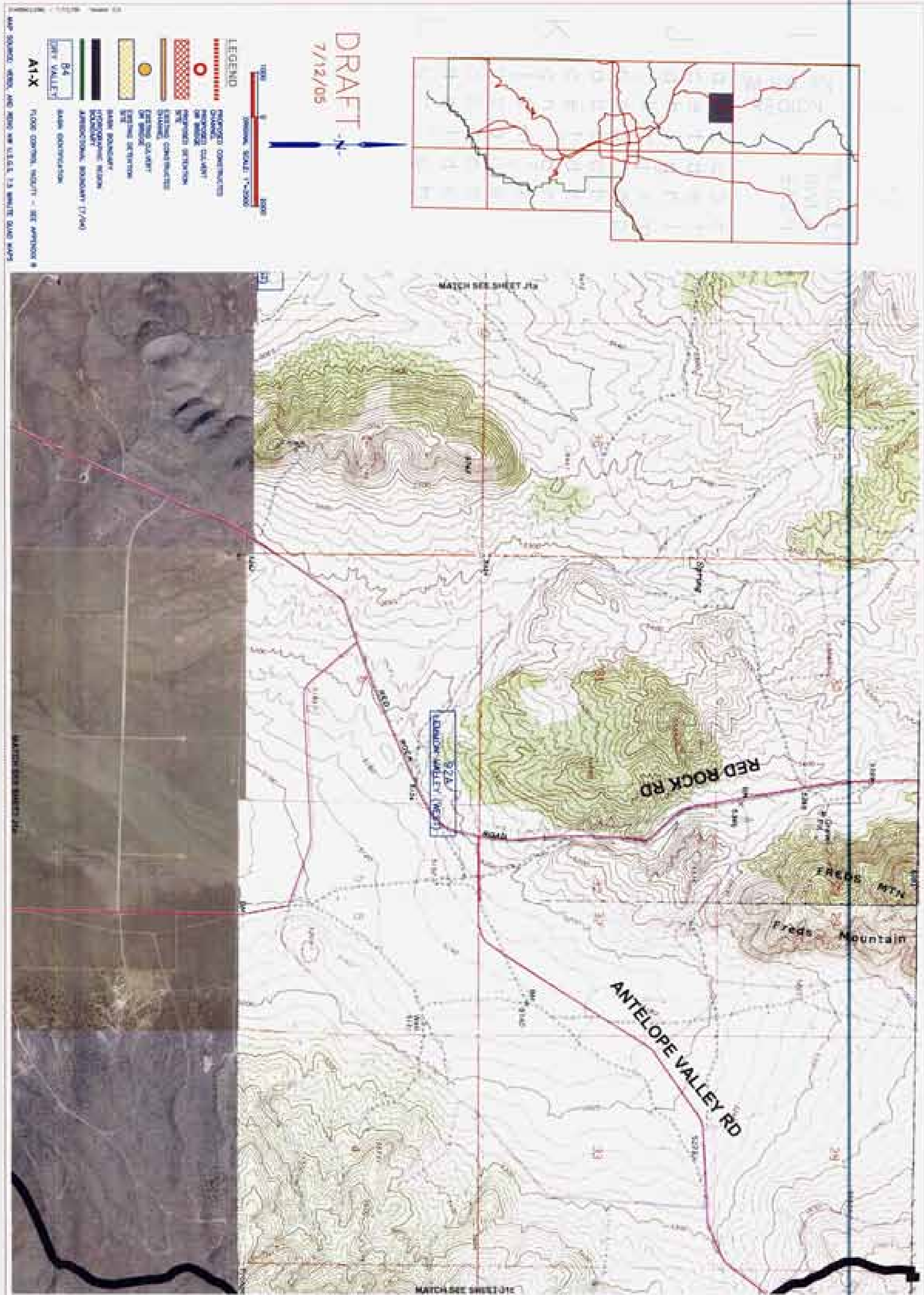


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1a

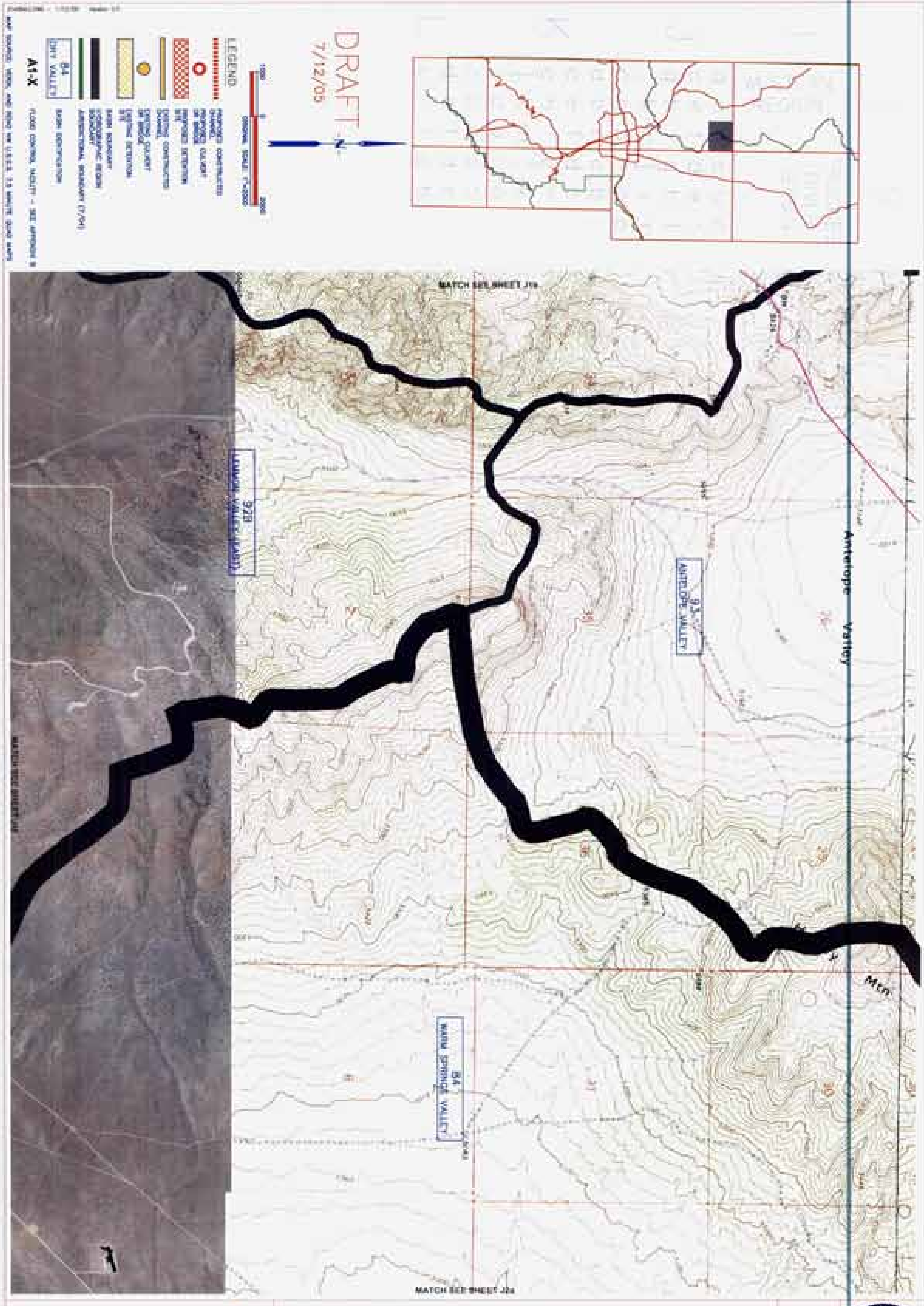
SEAL OF WASHOE COUNTY · STATE OF NEVADA



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

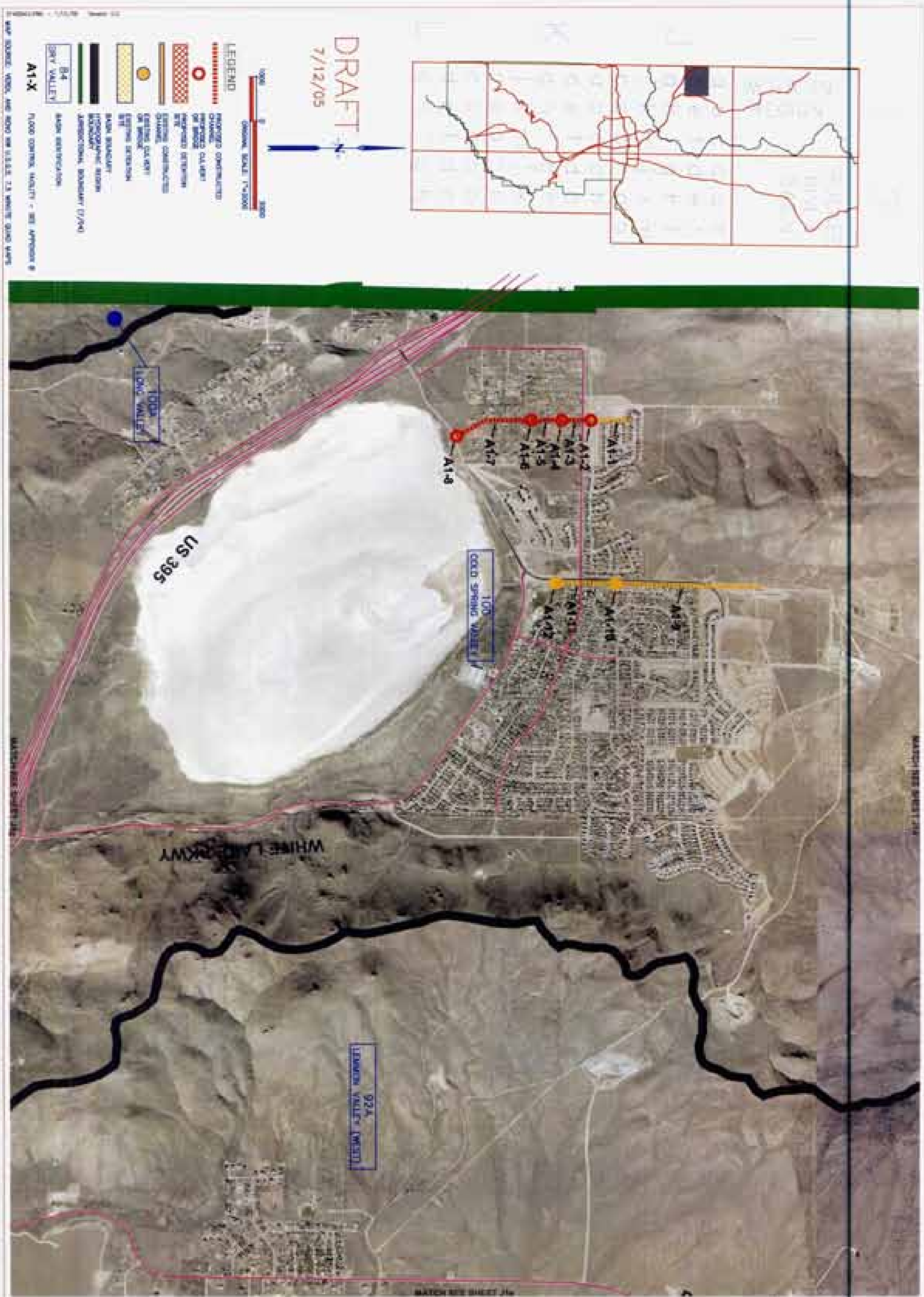
J1b



WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1c

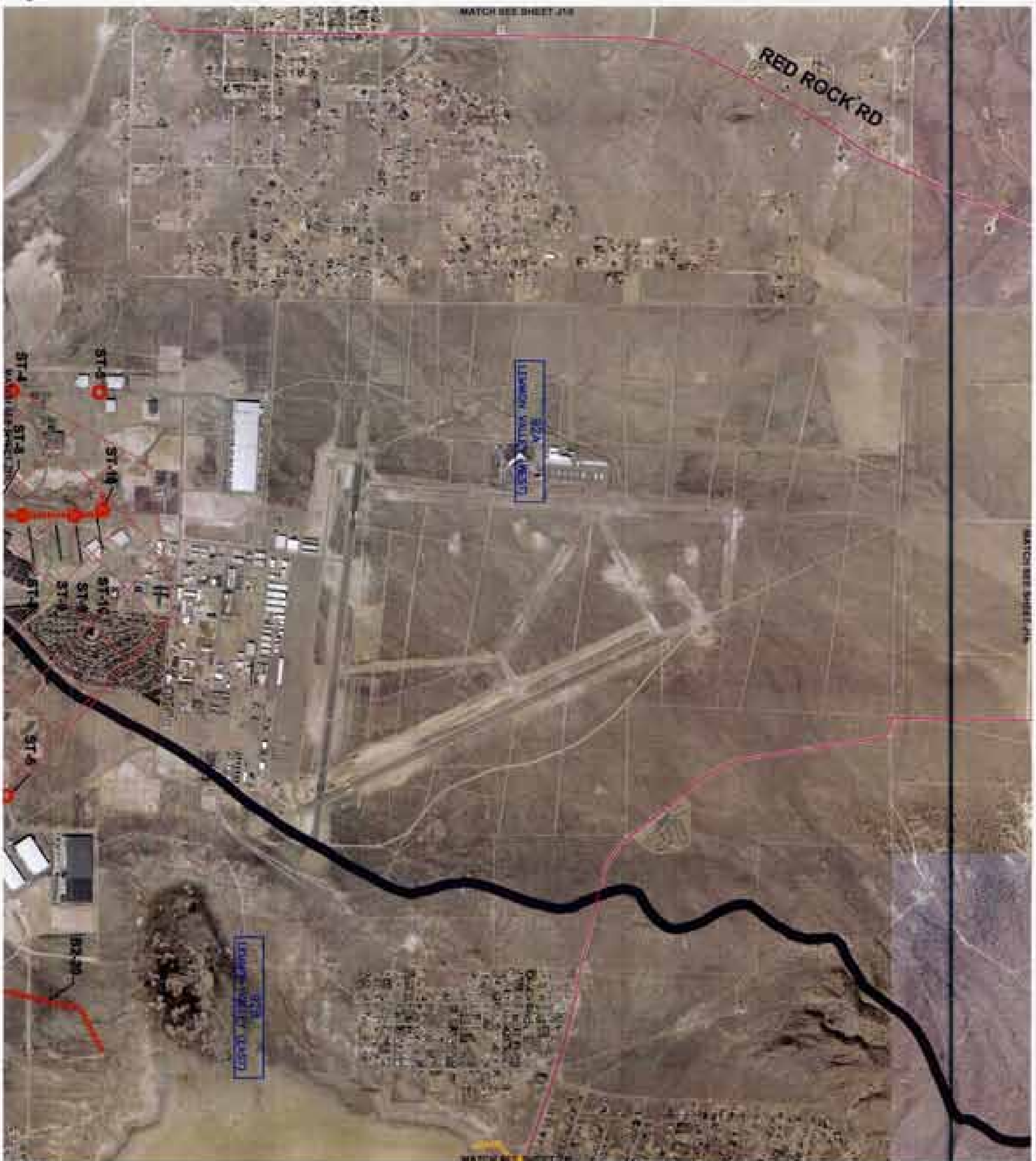


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1d

DRAFT
7/12/05



WRC ENGINEERING, INC.

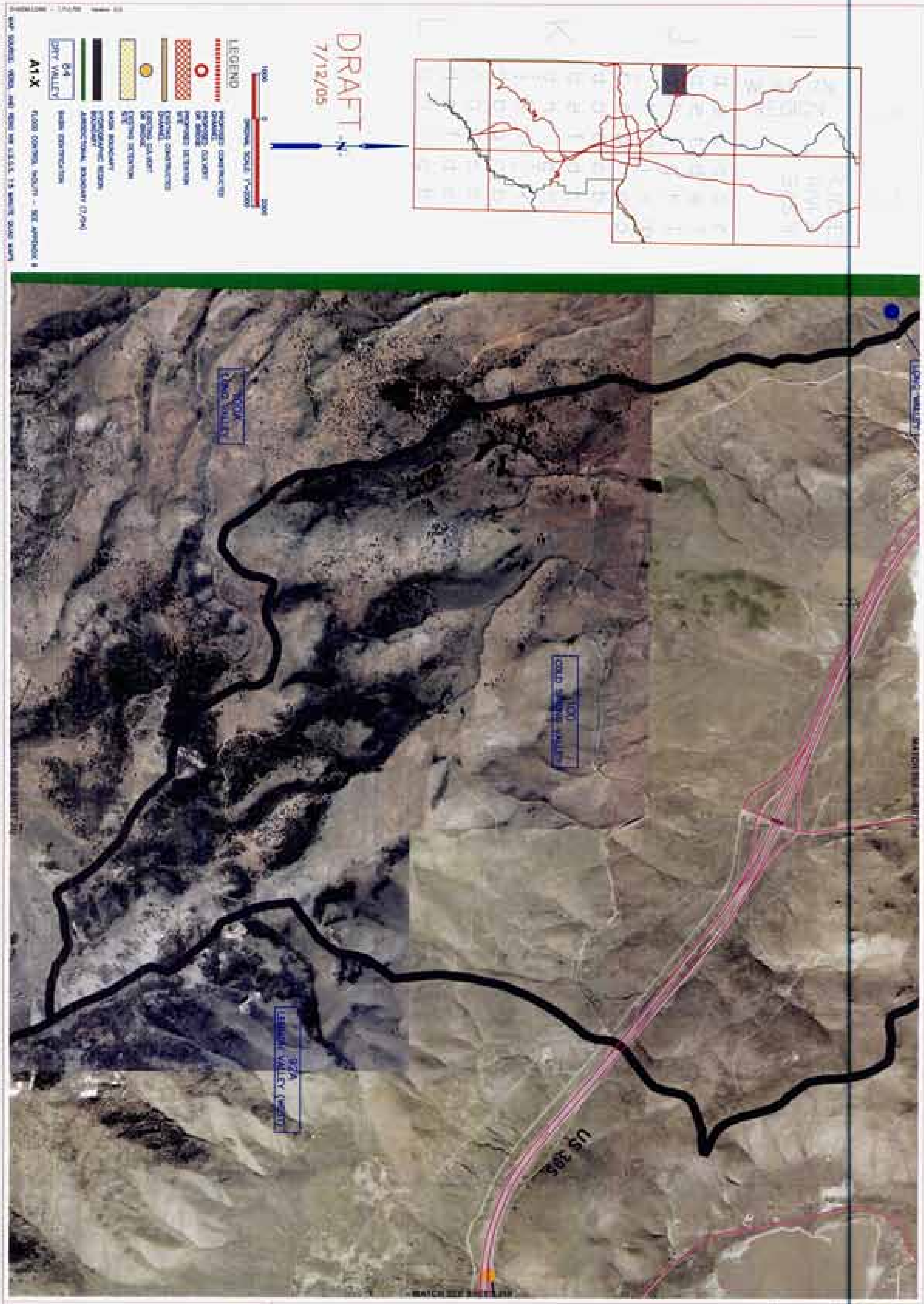
WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1e

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

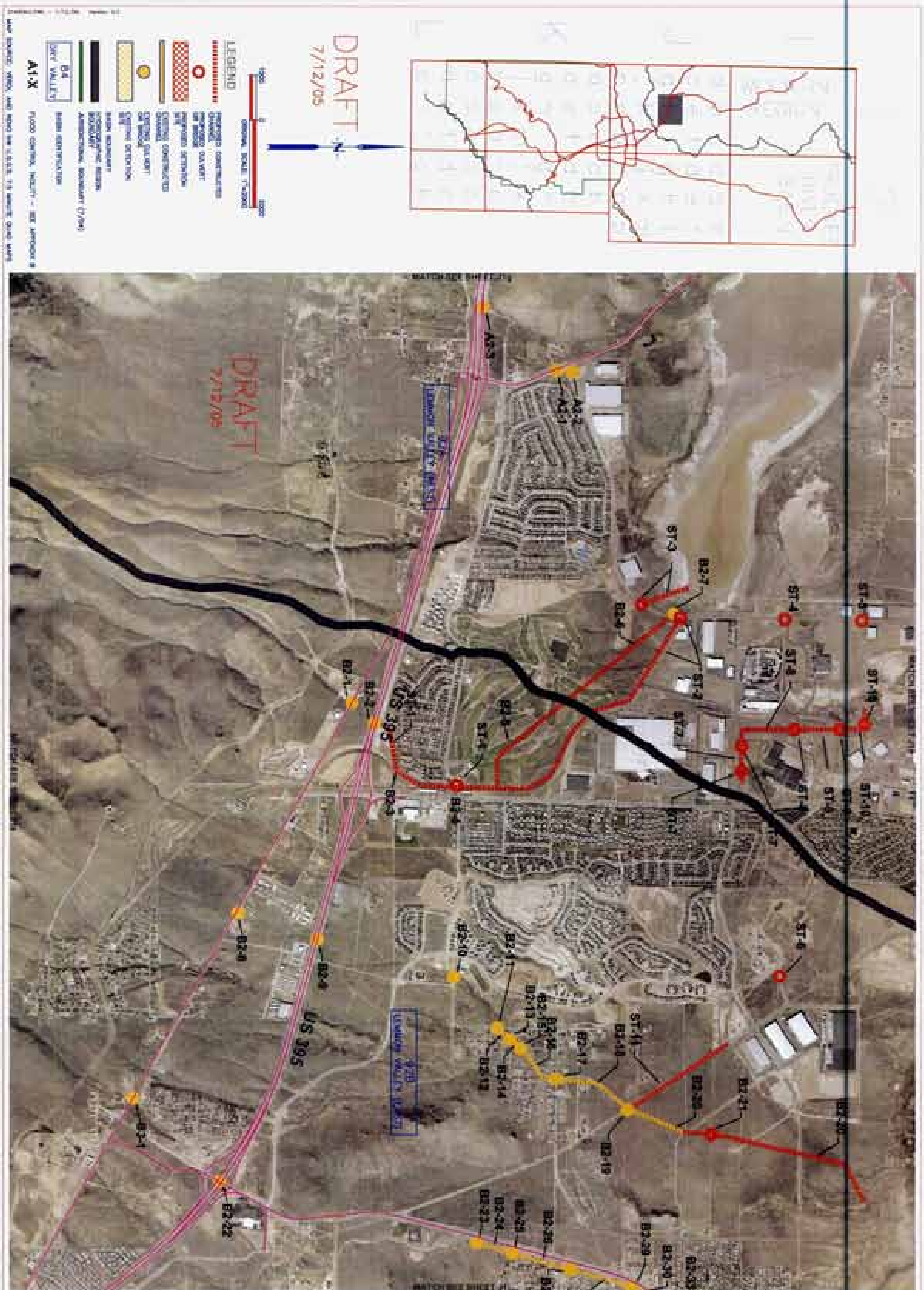
J1f



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

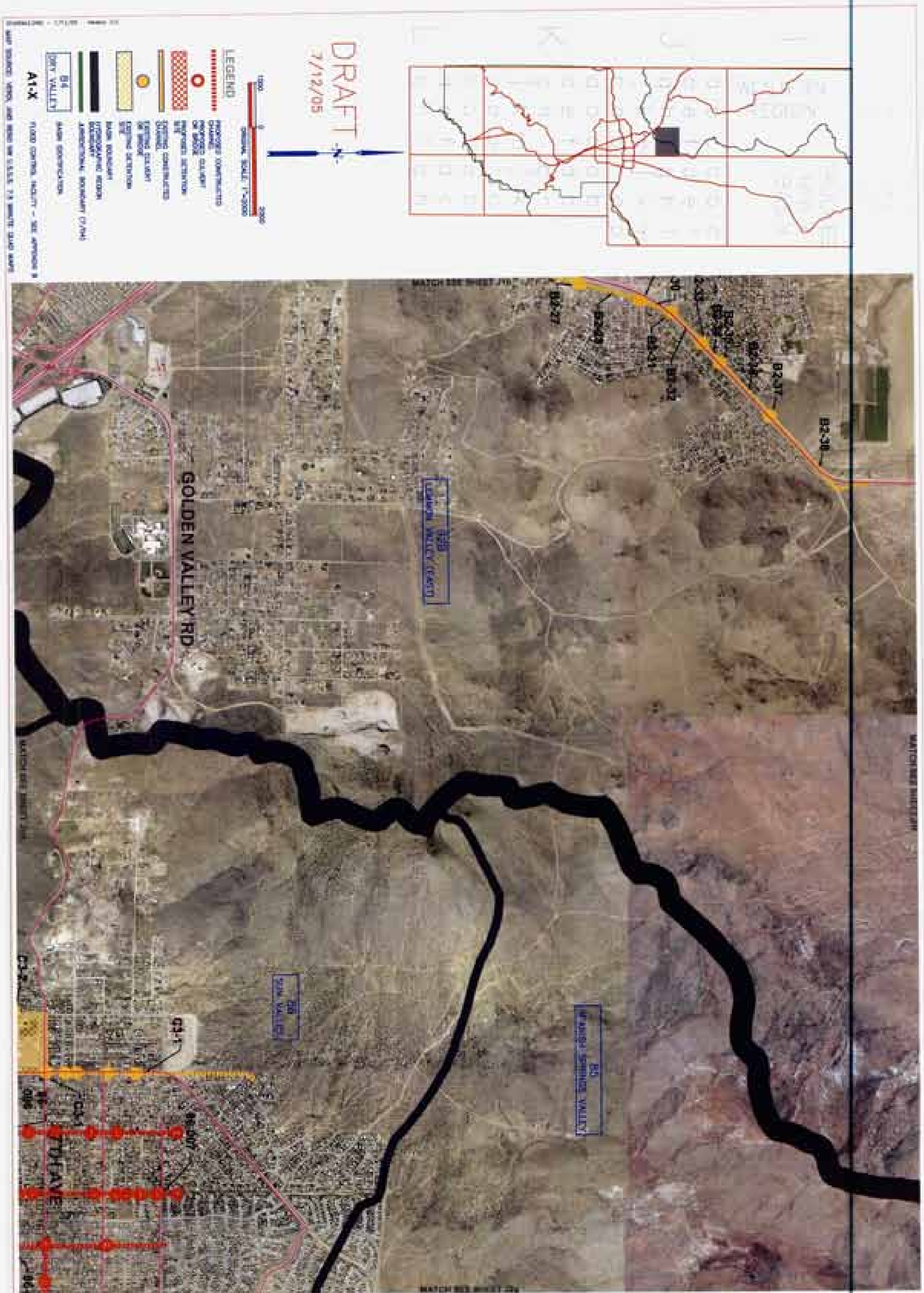
J1g



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

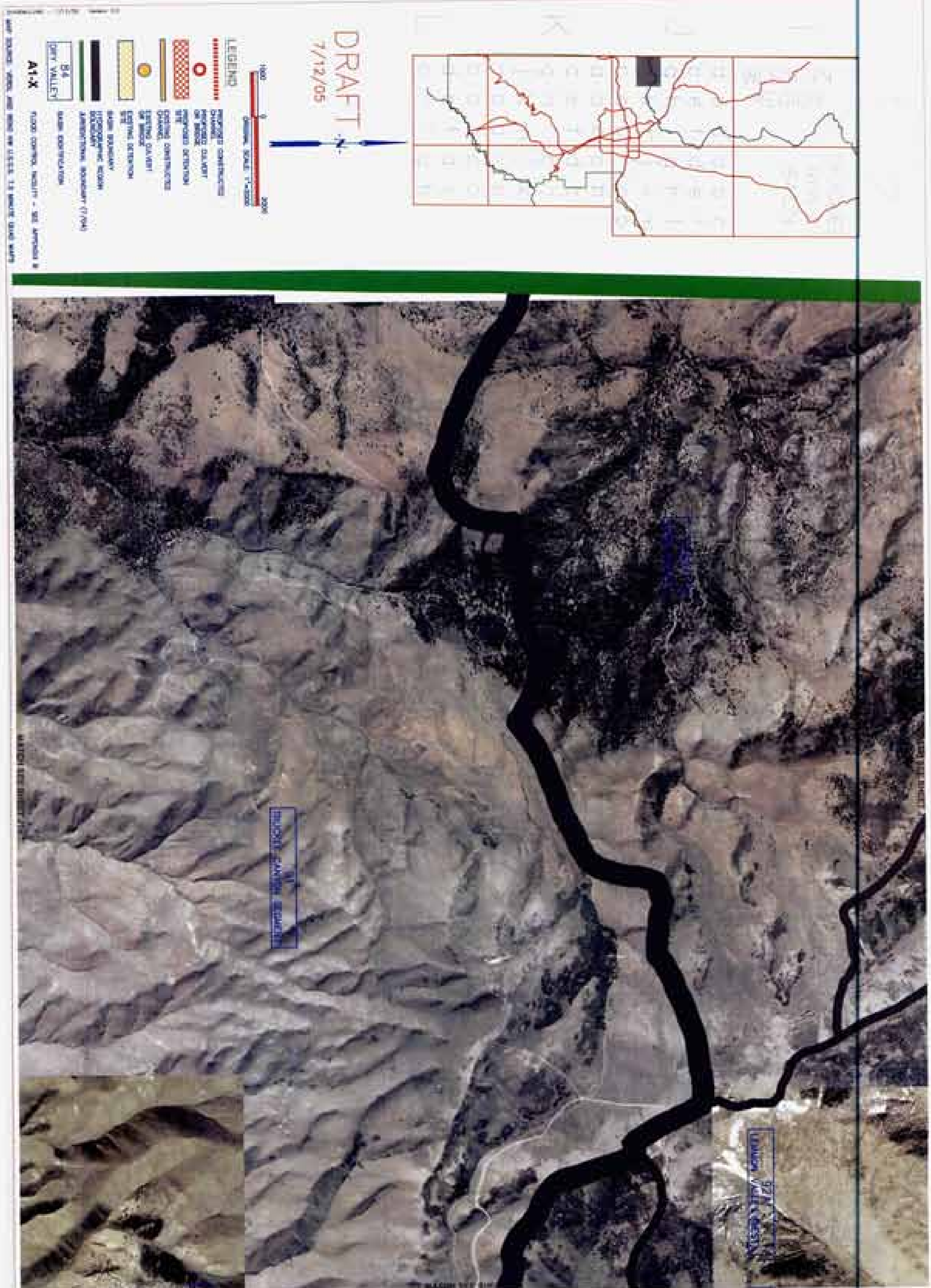
J1h



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

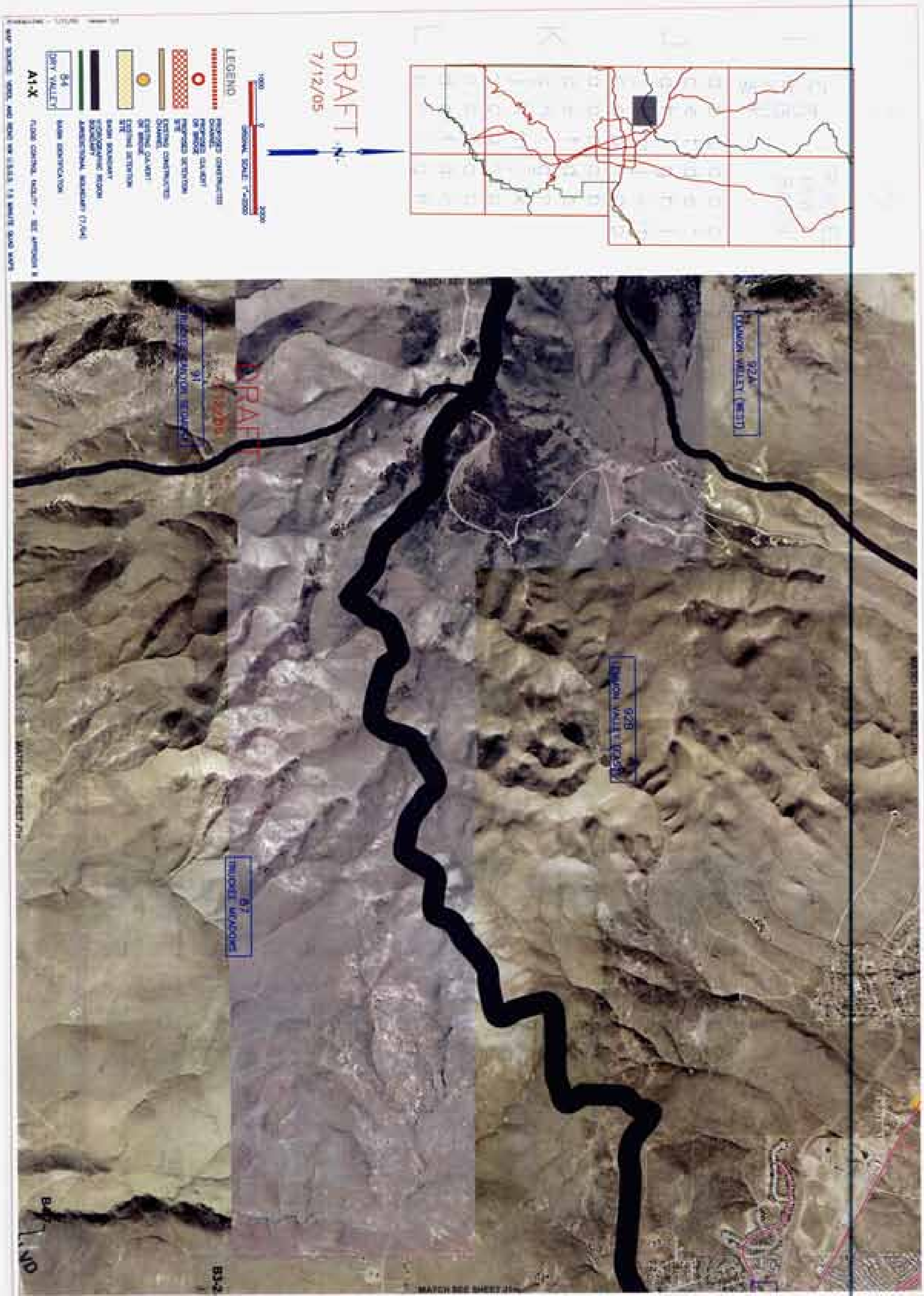
J1i



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

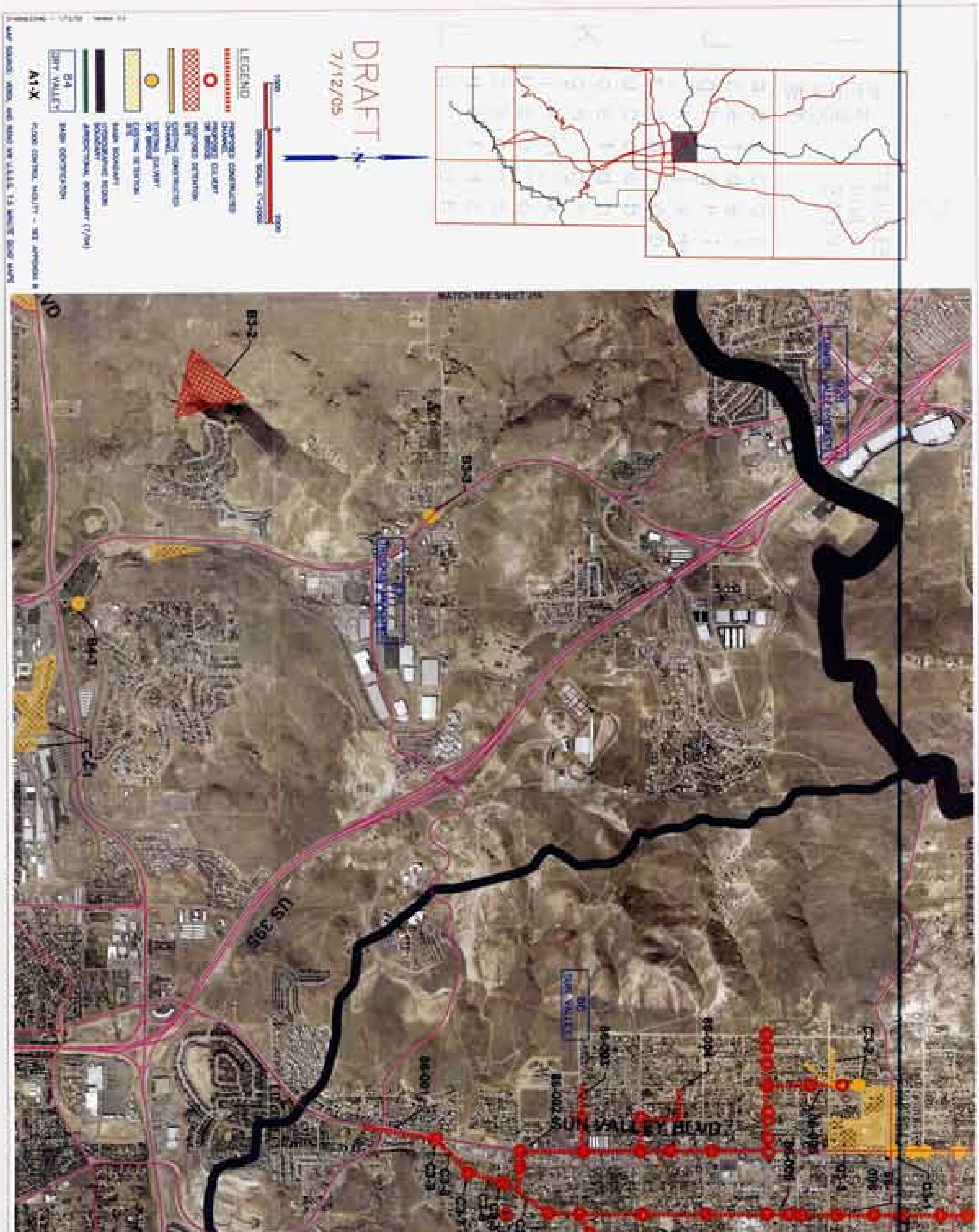
J1j



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1k

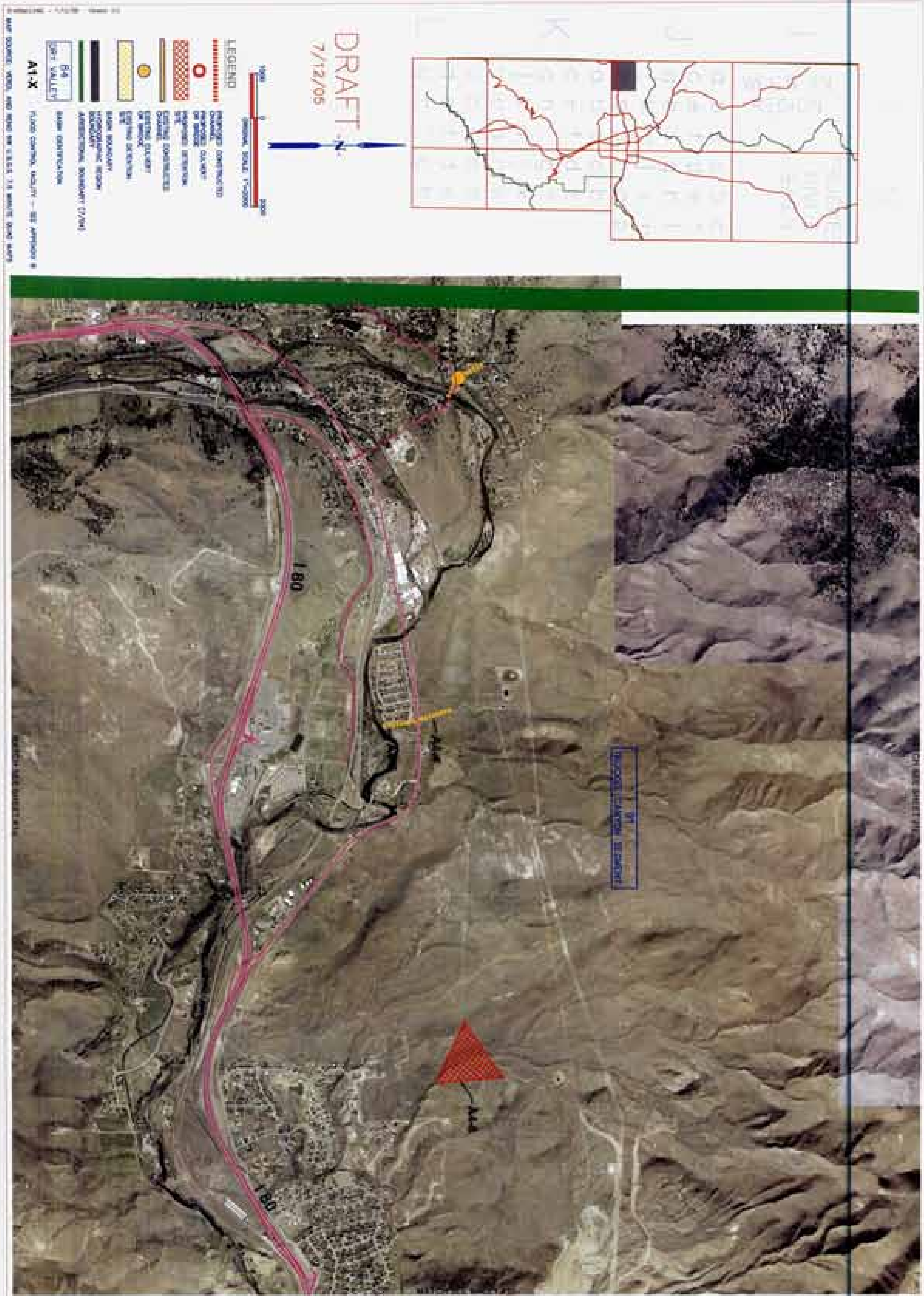


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1m

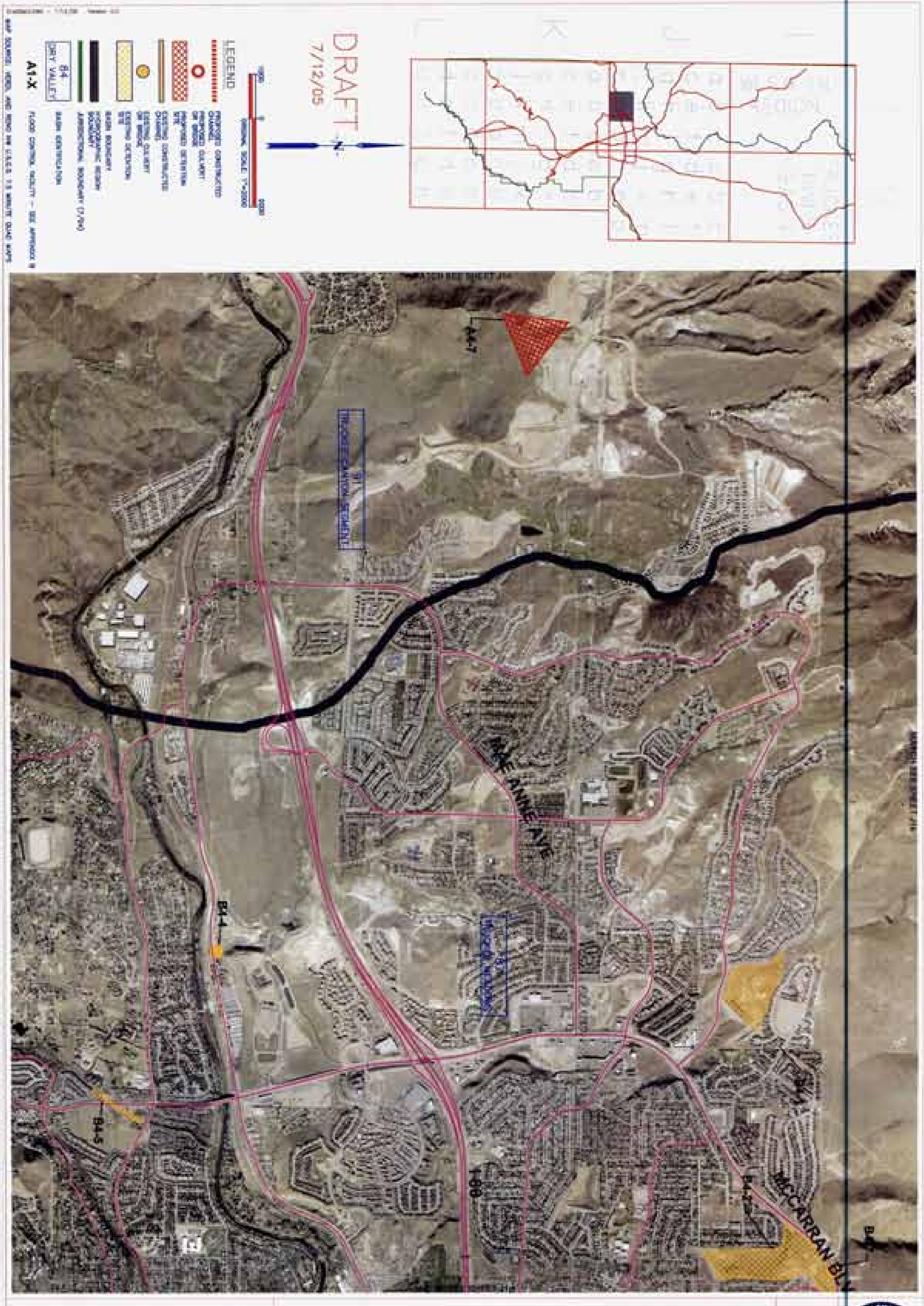
SEAL OF WASHOE COUNTY
STATE OF NEVADA



WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

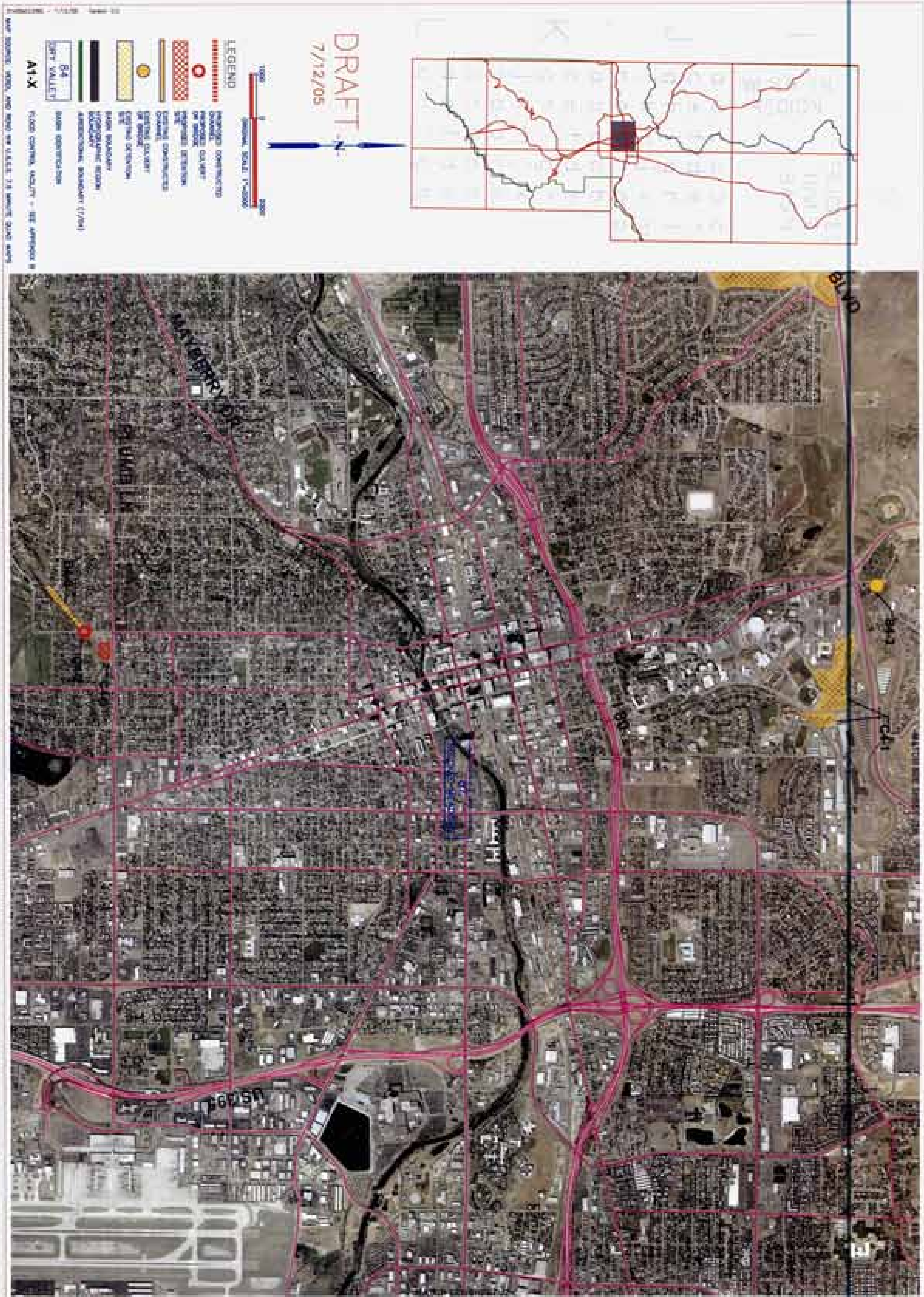
J1n



WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

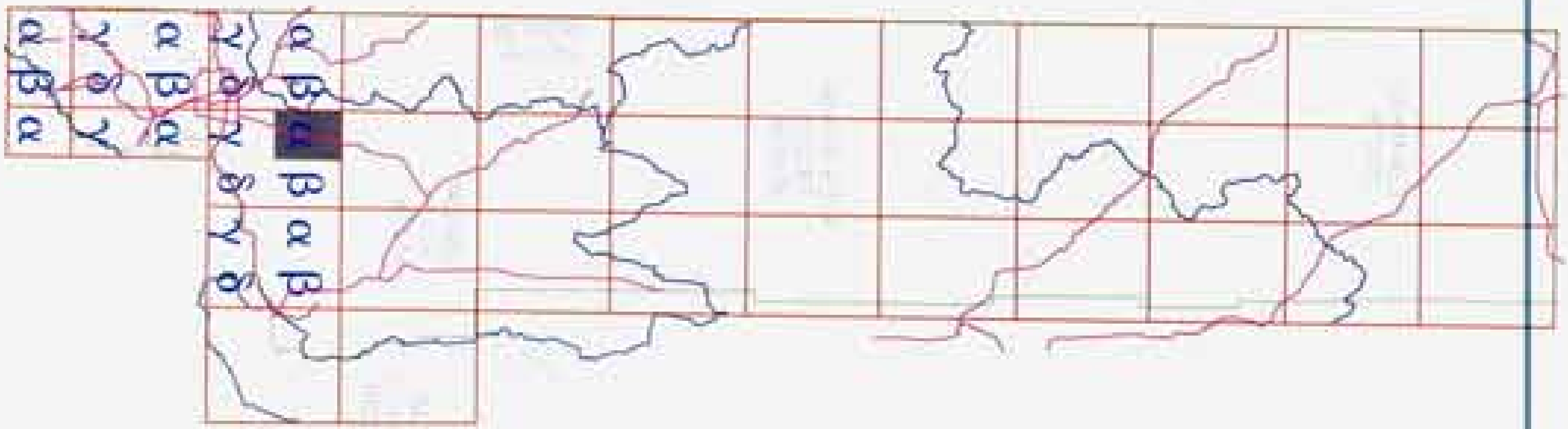
J1o

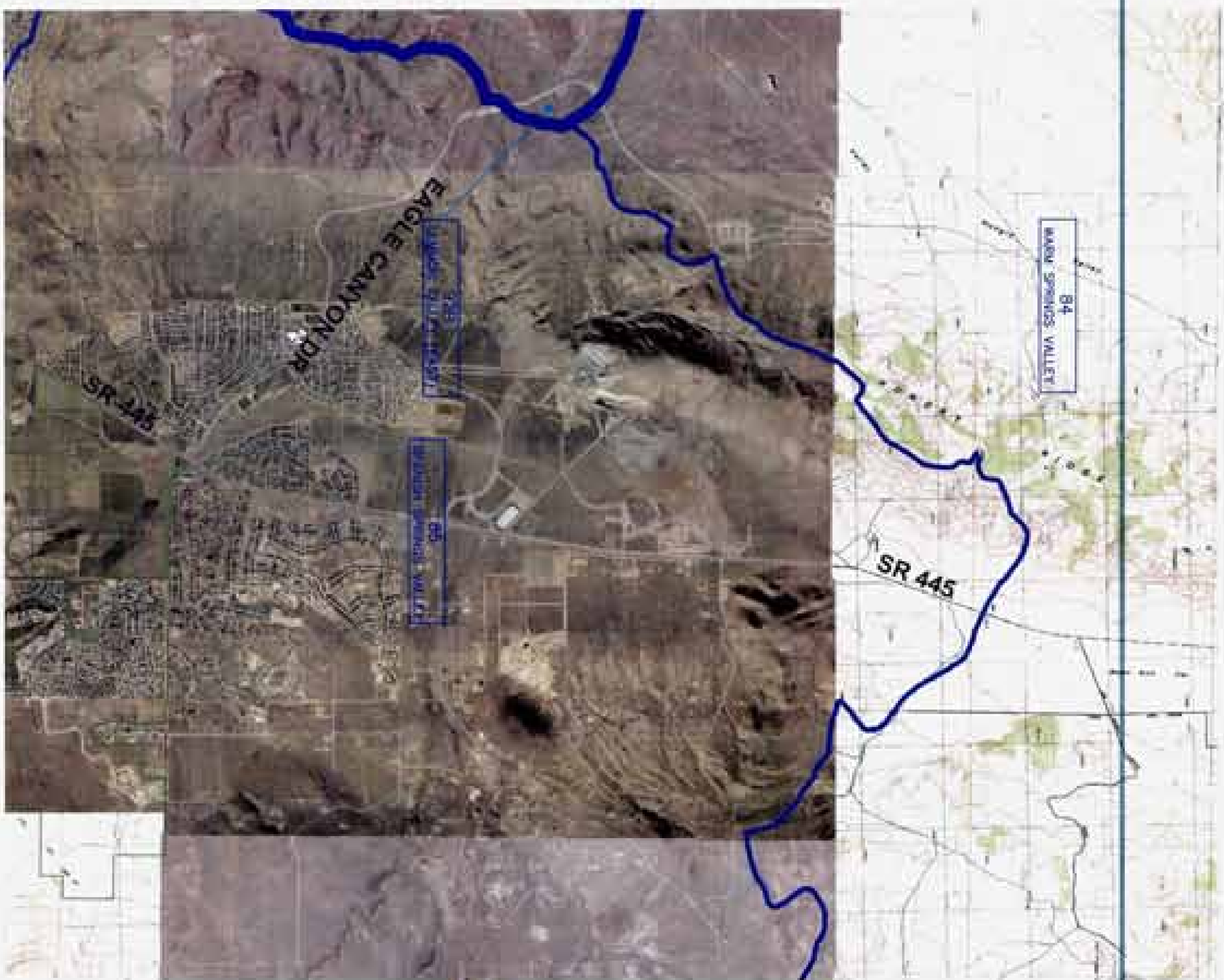


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J1p

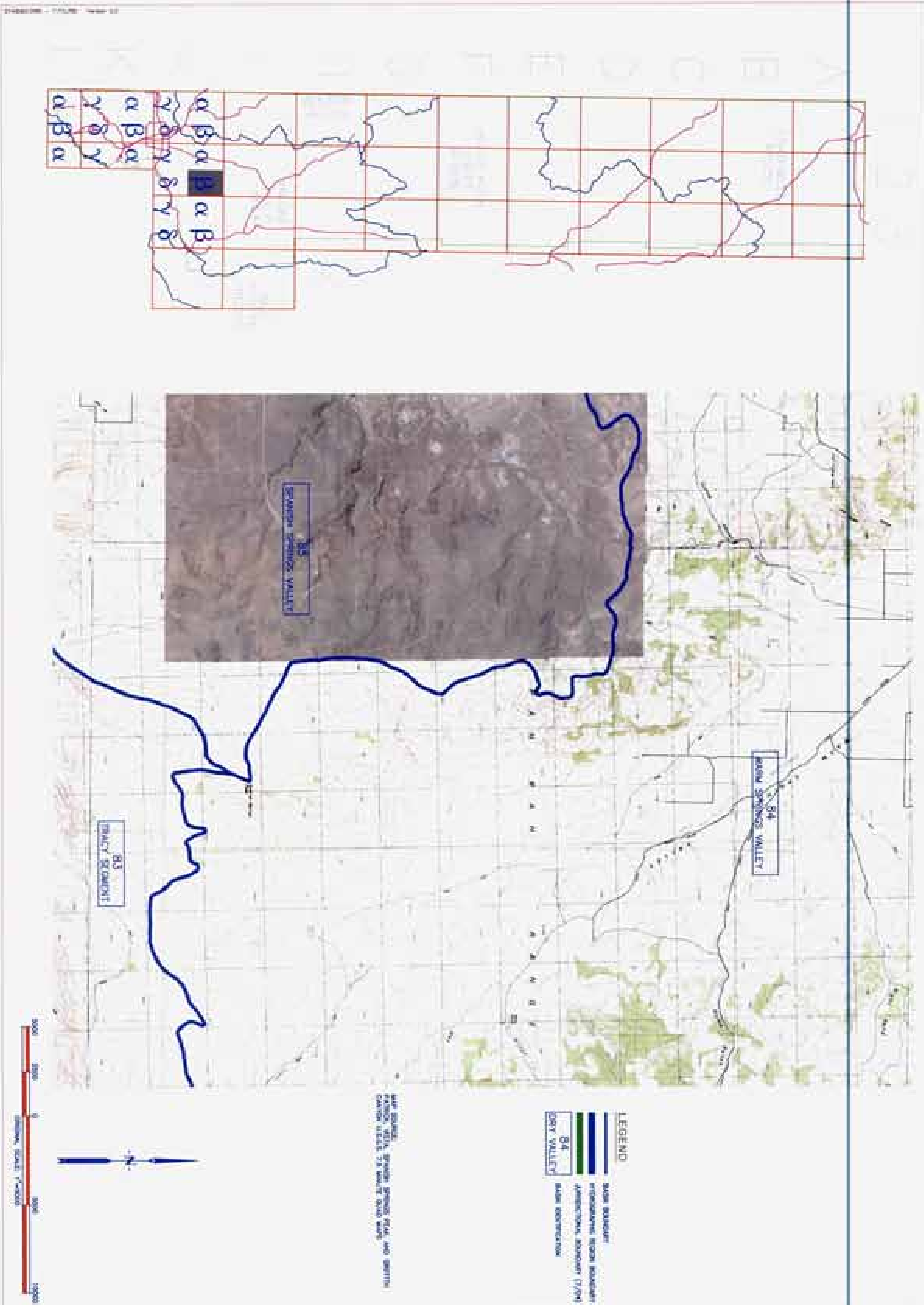




WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2α

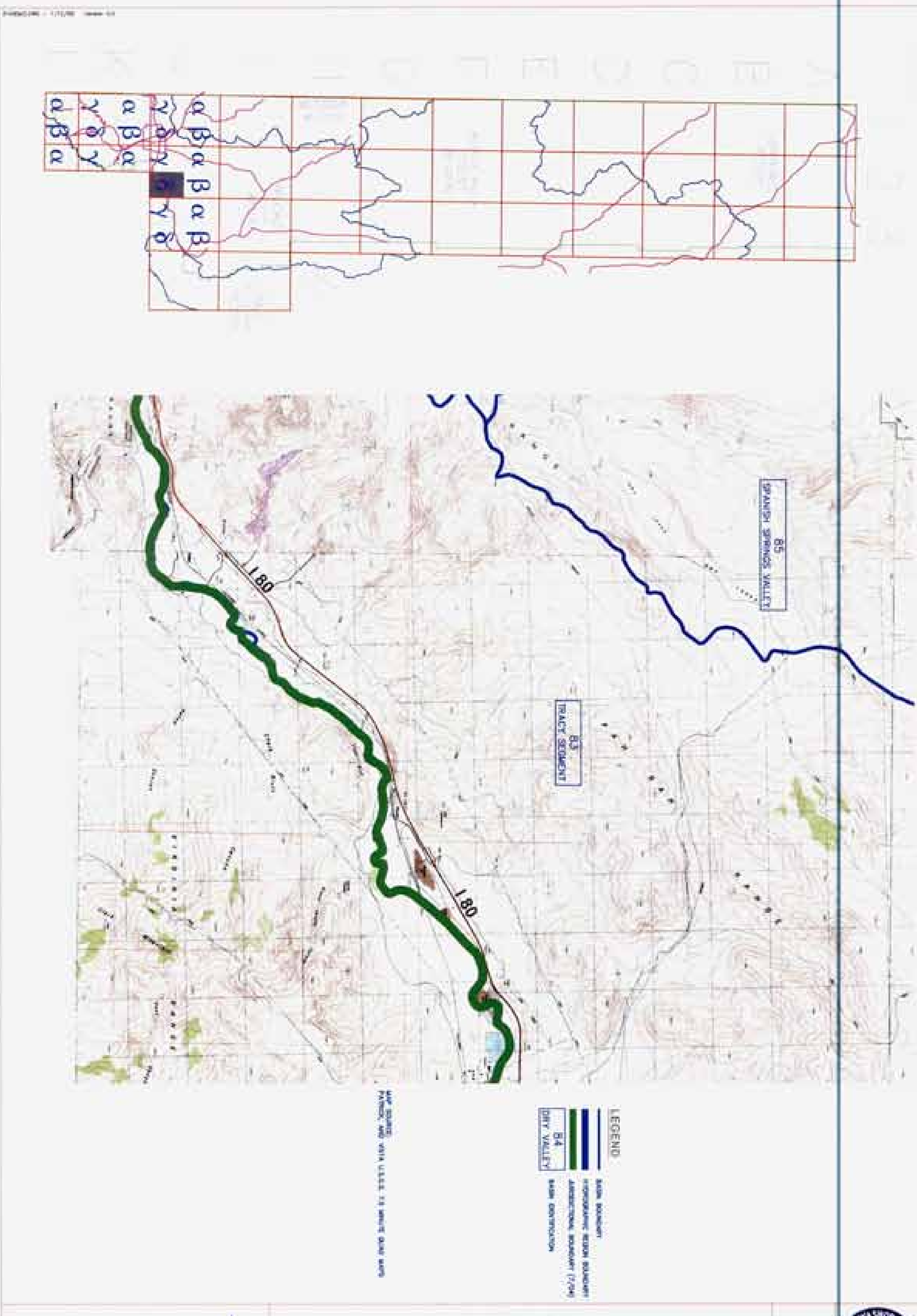


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2β

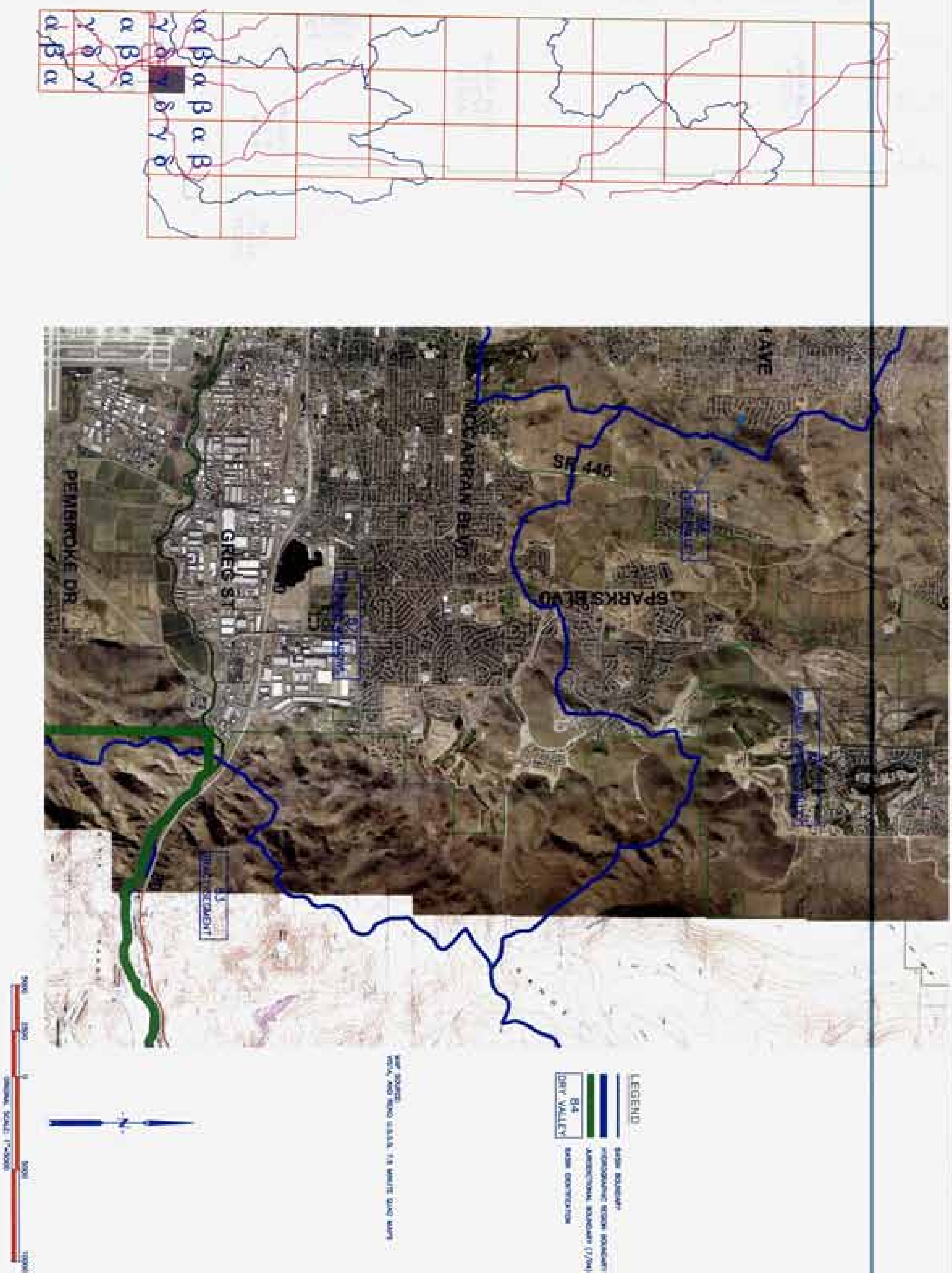
SEAL OF WASHOE COUNTY · STATE OF NEVADA



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

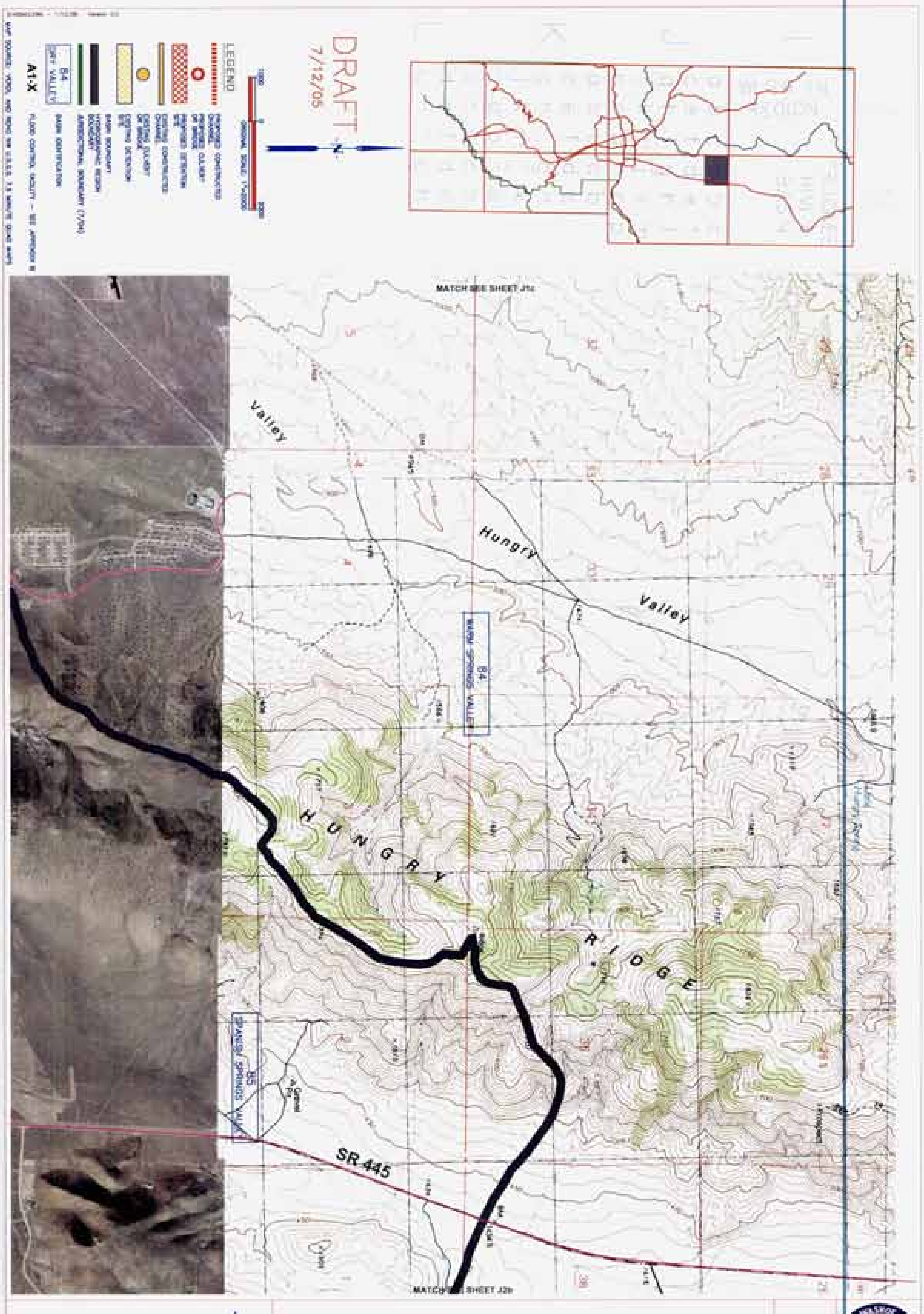
J2δ



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2γ



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

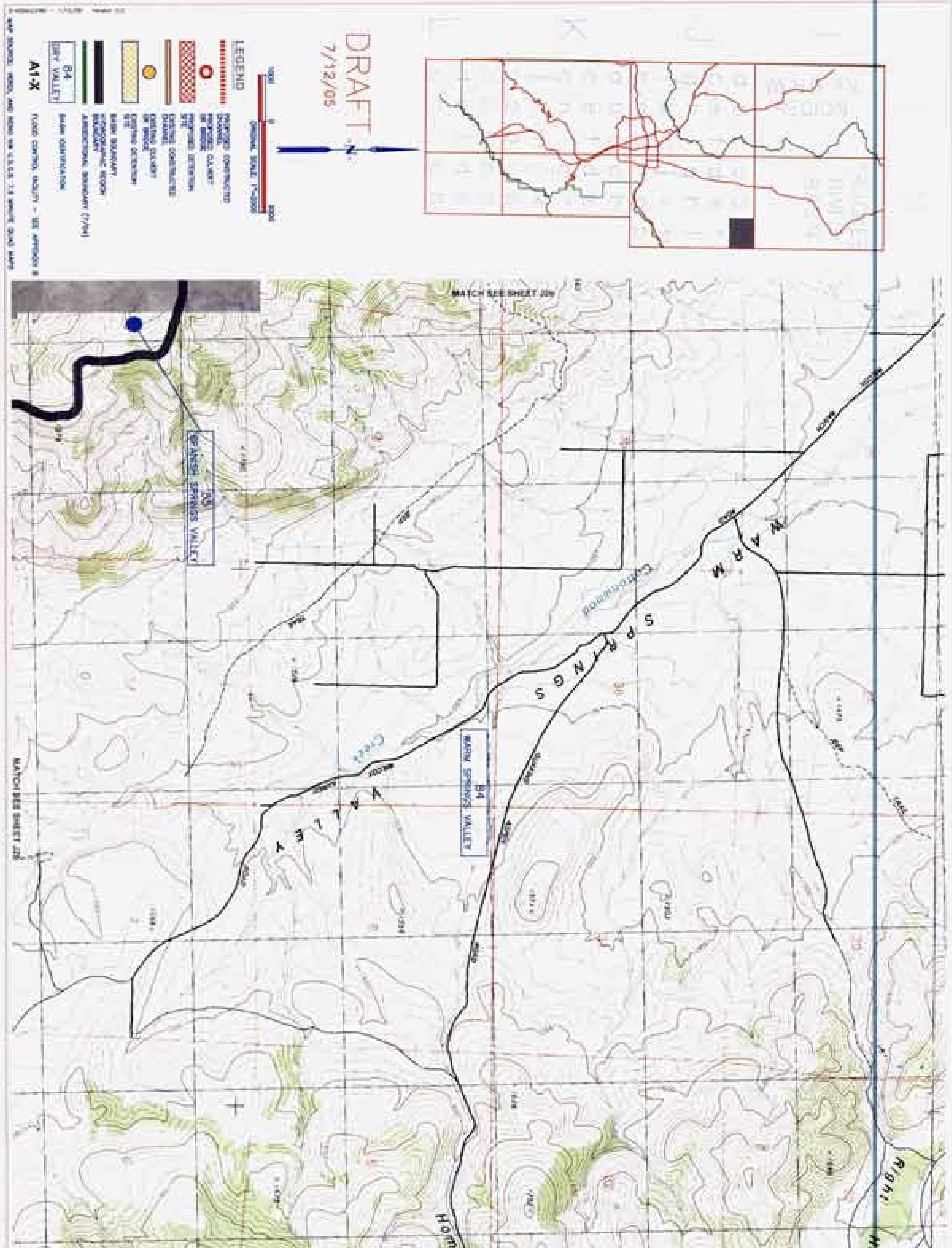
J2a

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2b

SEAL OF WASHOE COUNTY
STATE OF NEVADA



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

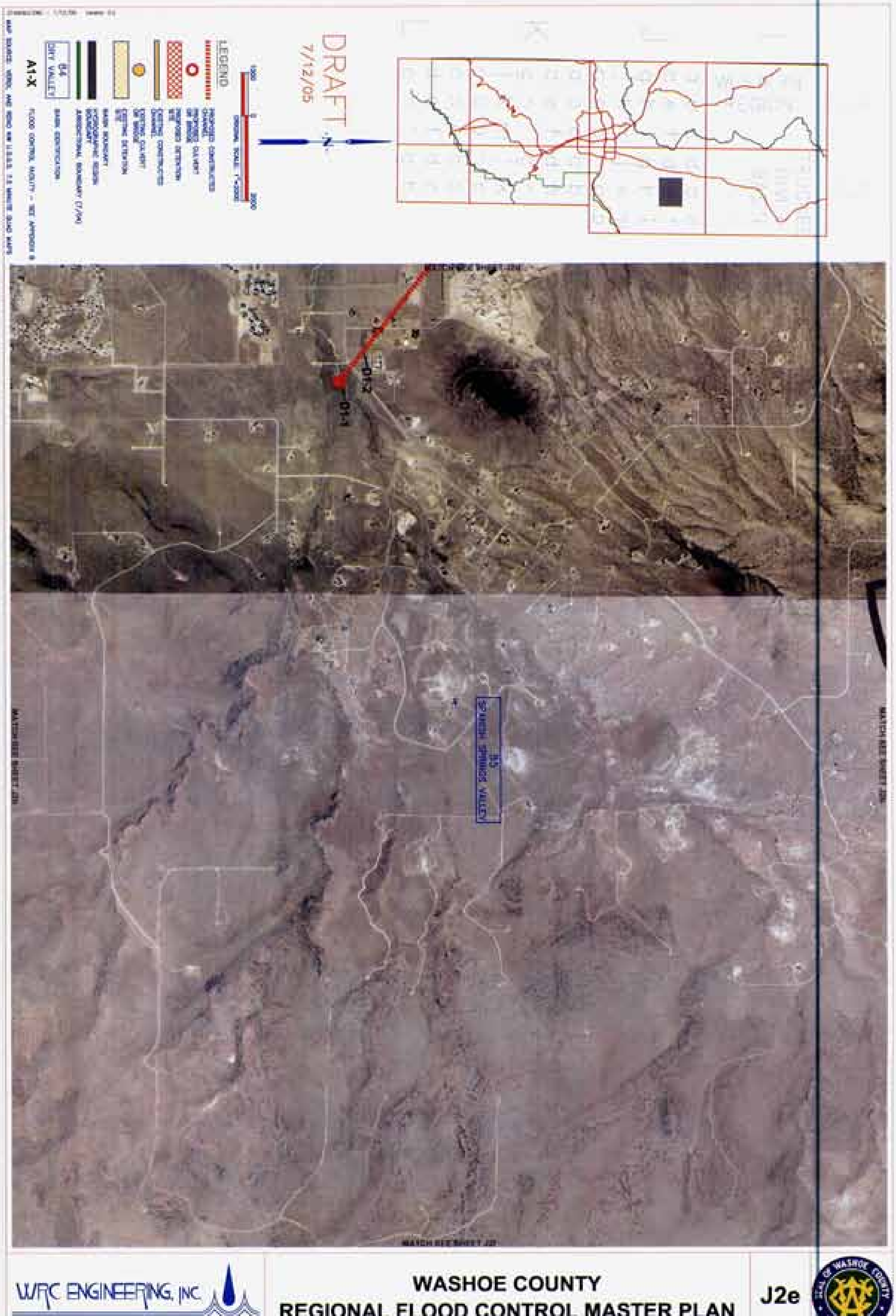
J2c

SEAL OF WASHOE COUNTY STATE OF NEVADA

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

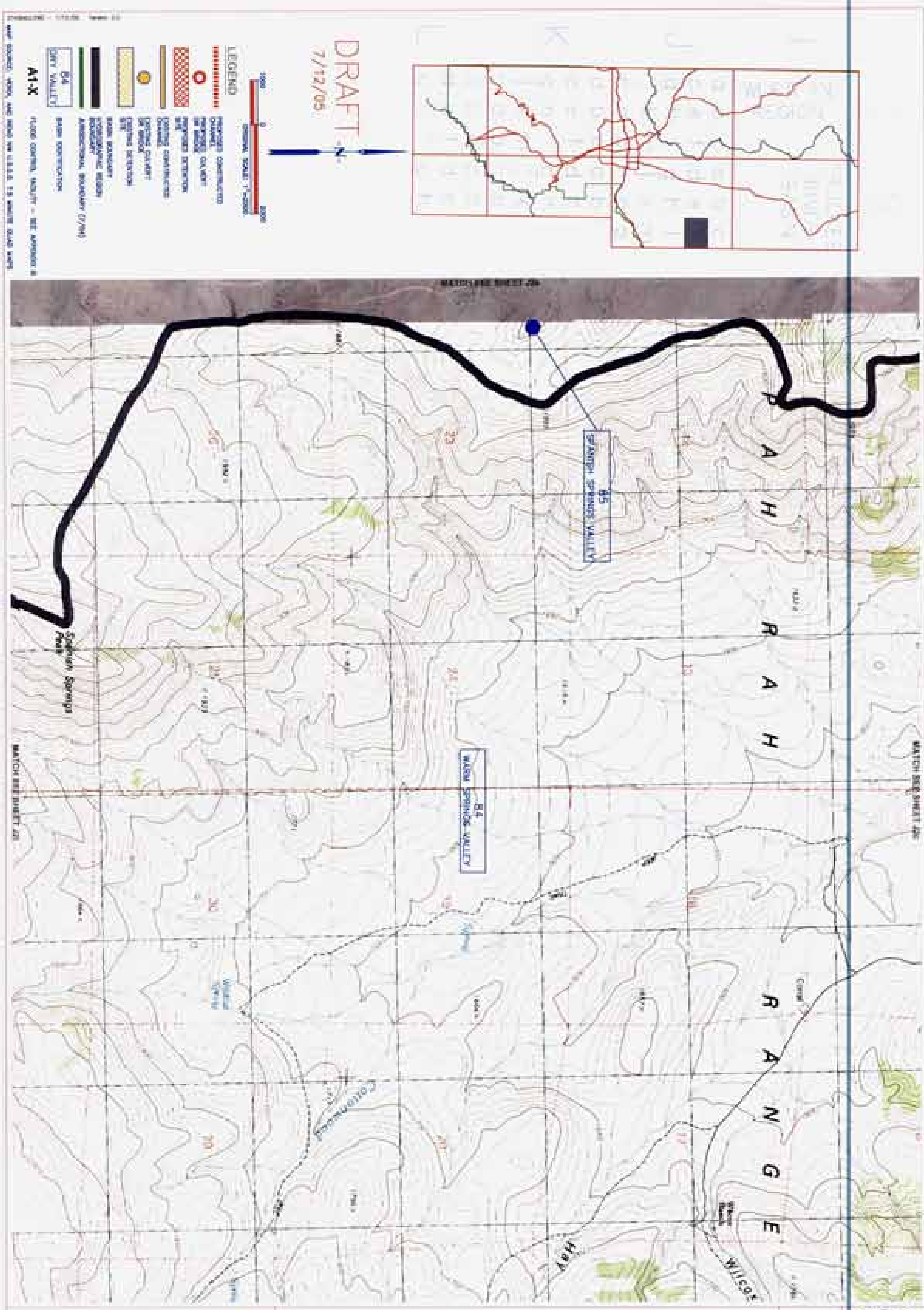
J2d



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

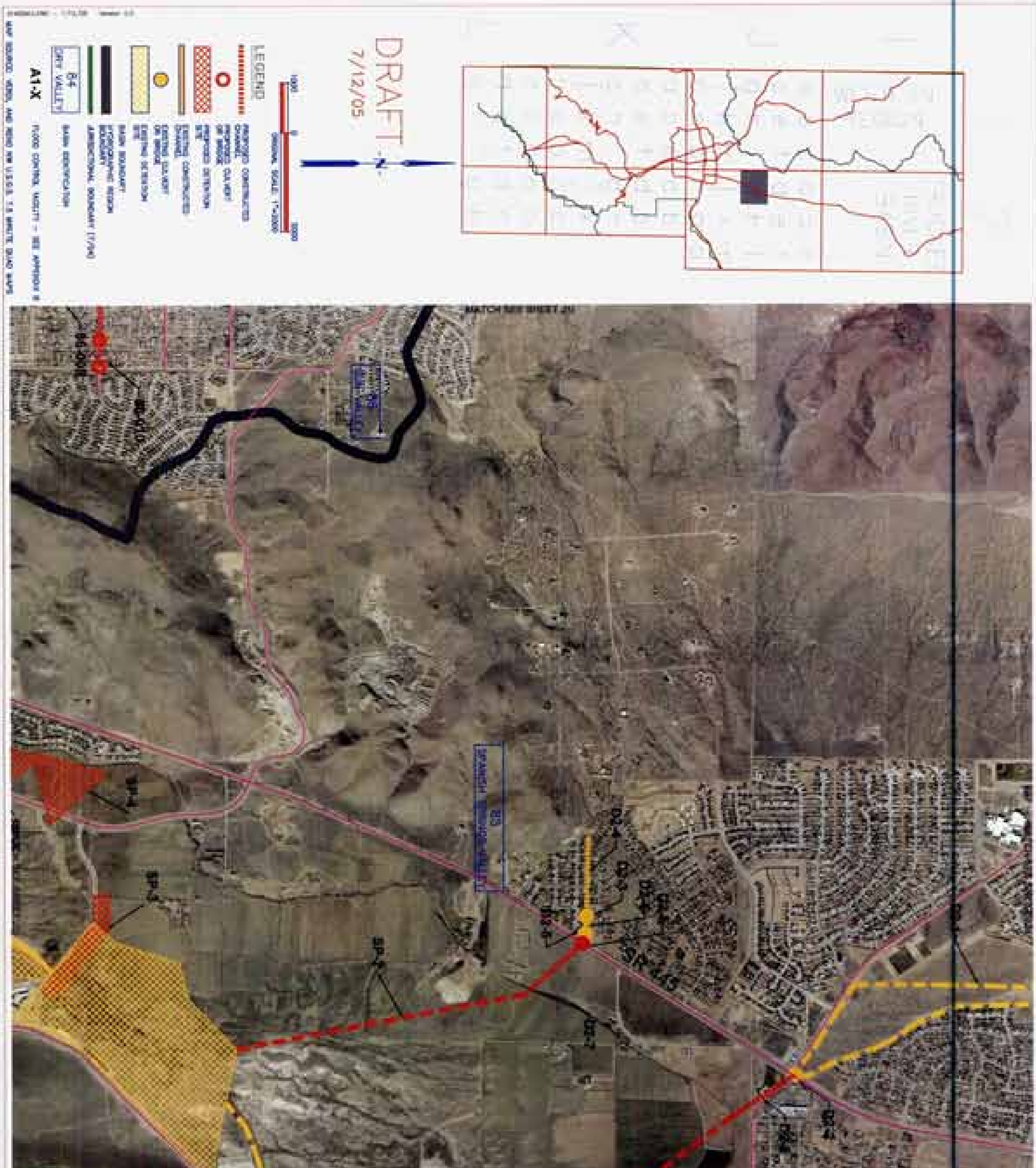
J2e



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

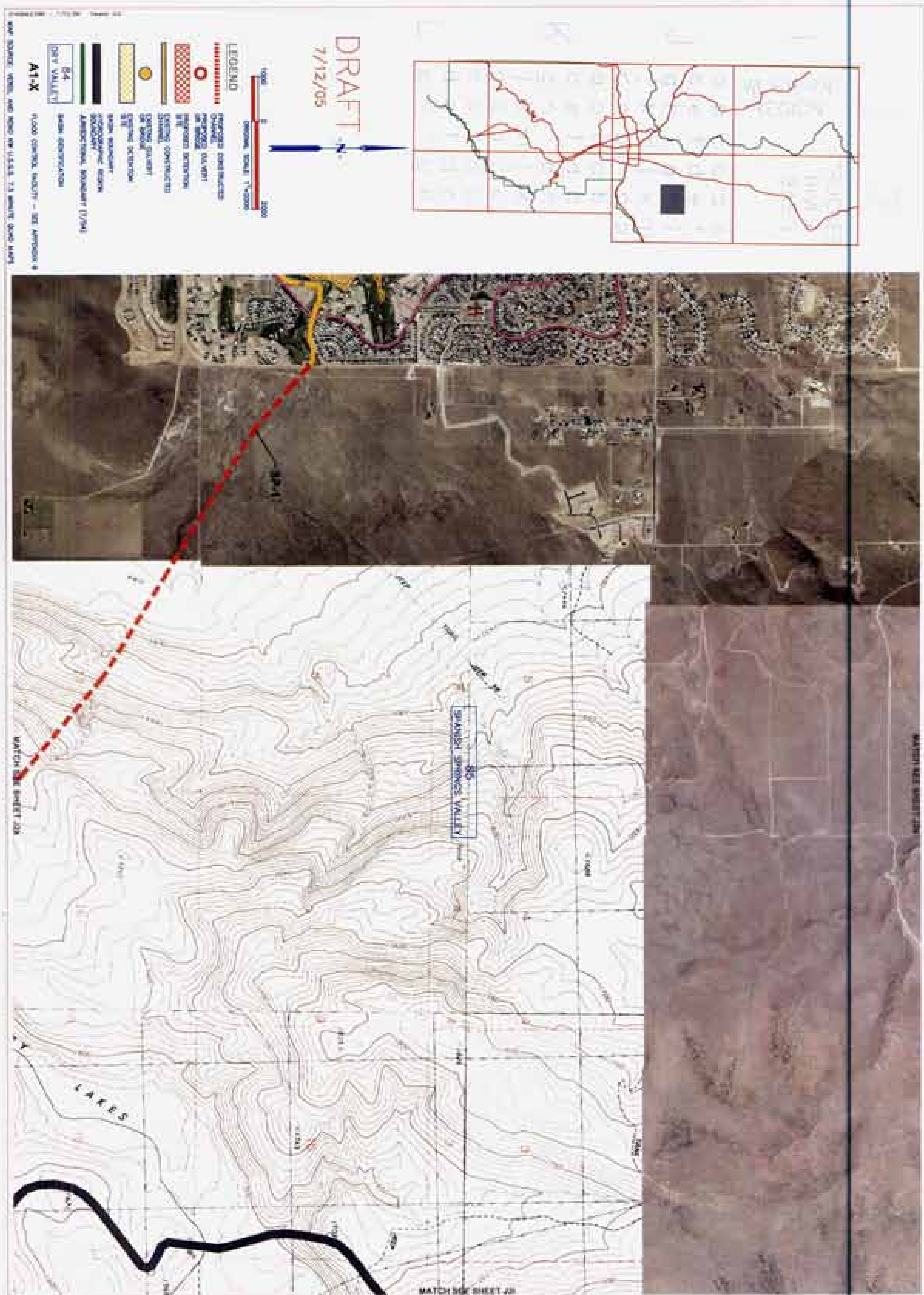
J2f



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

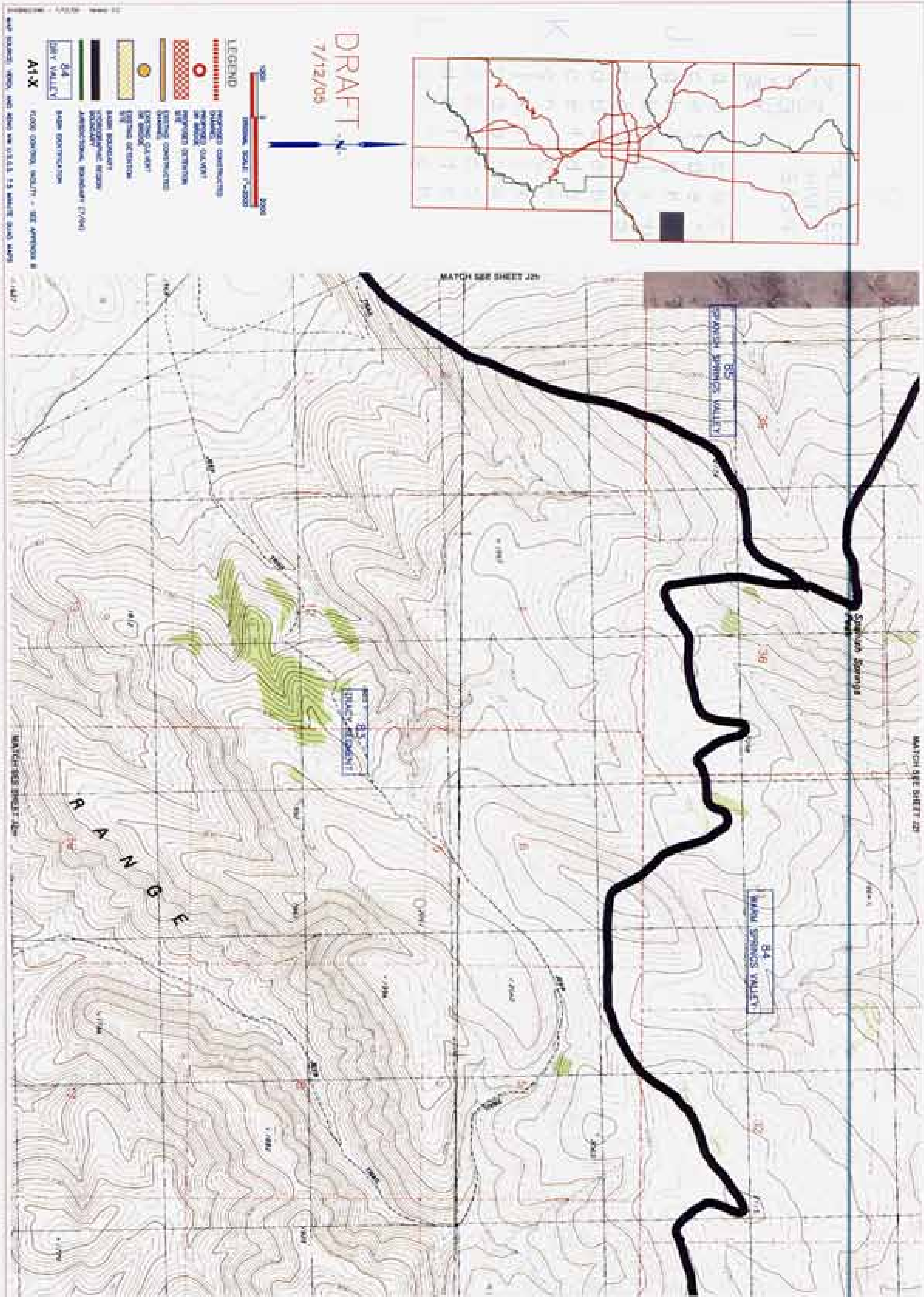
J2g



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2h



WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

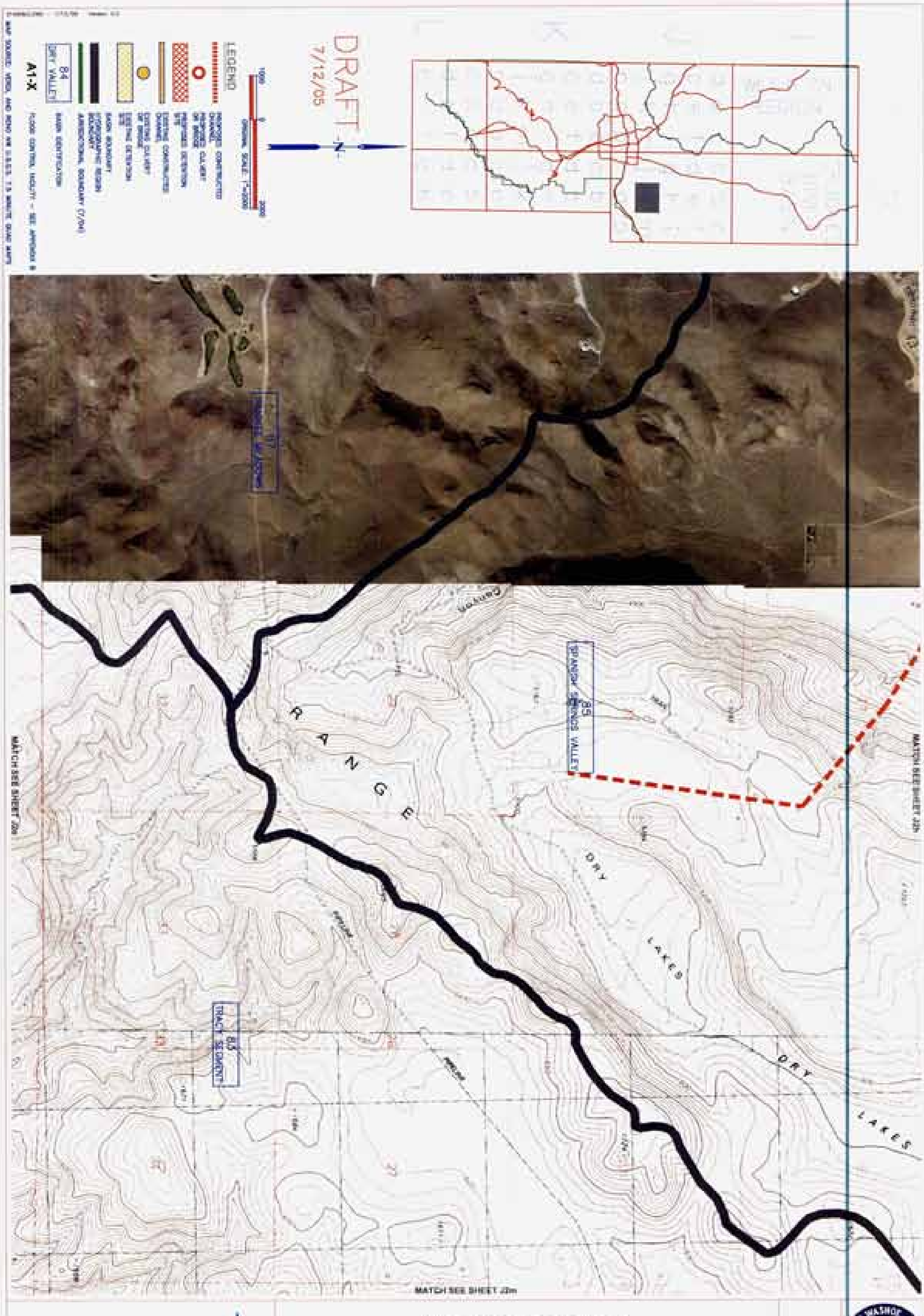
J2i

SEAL OF WASHOE COUNTY
STATE OF NEVADA

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2j



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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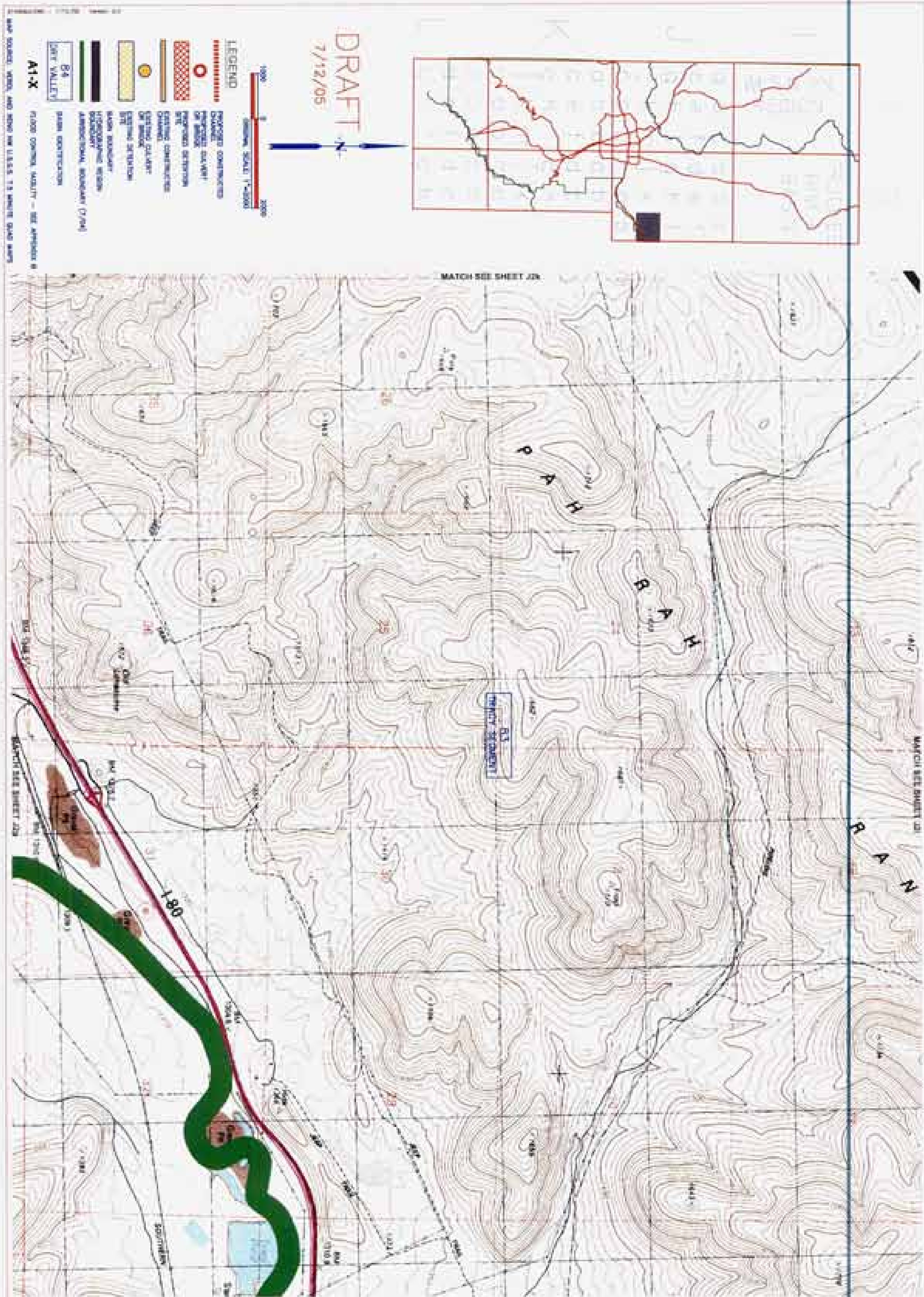
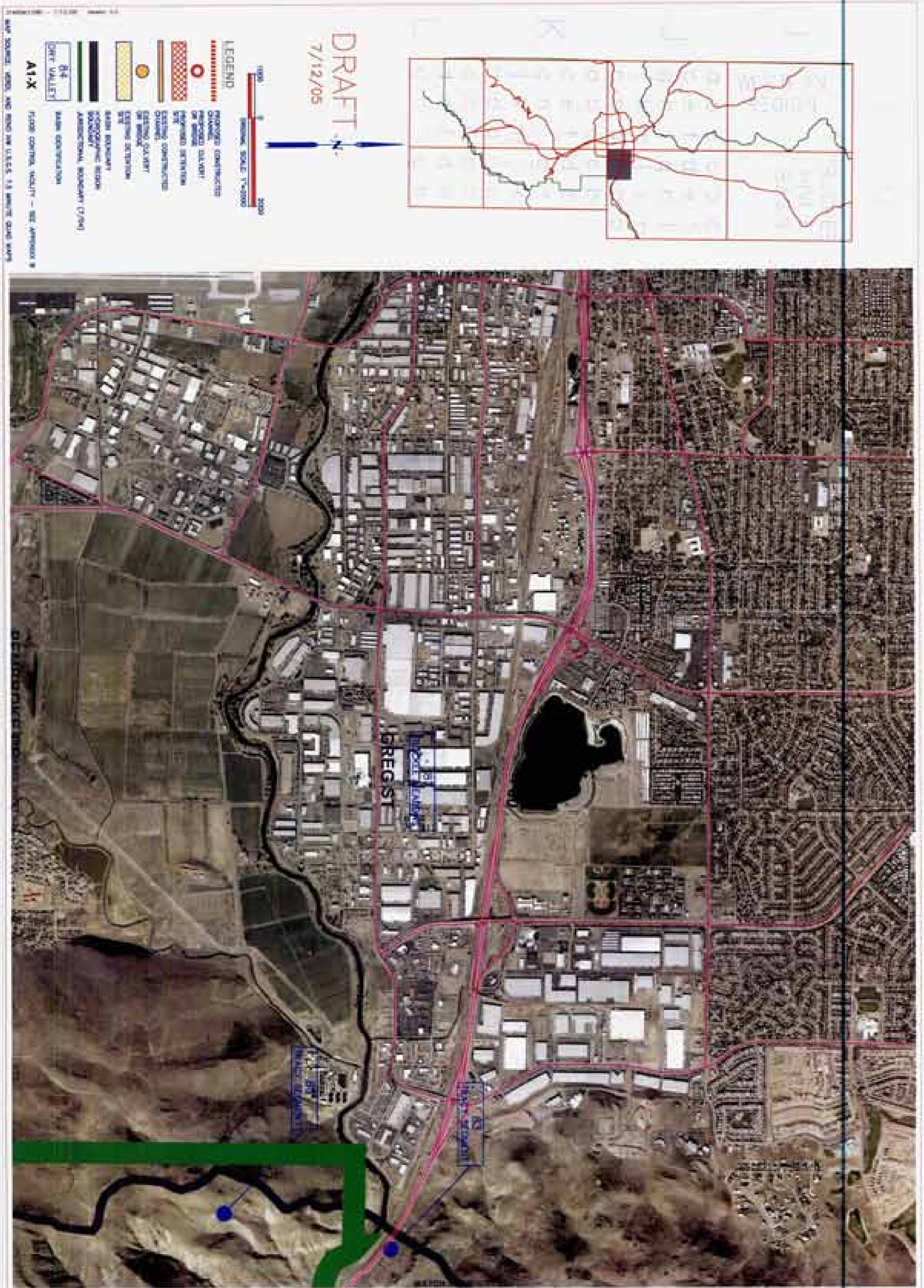


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

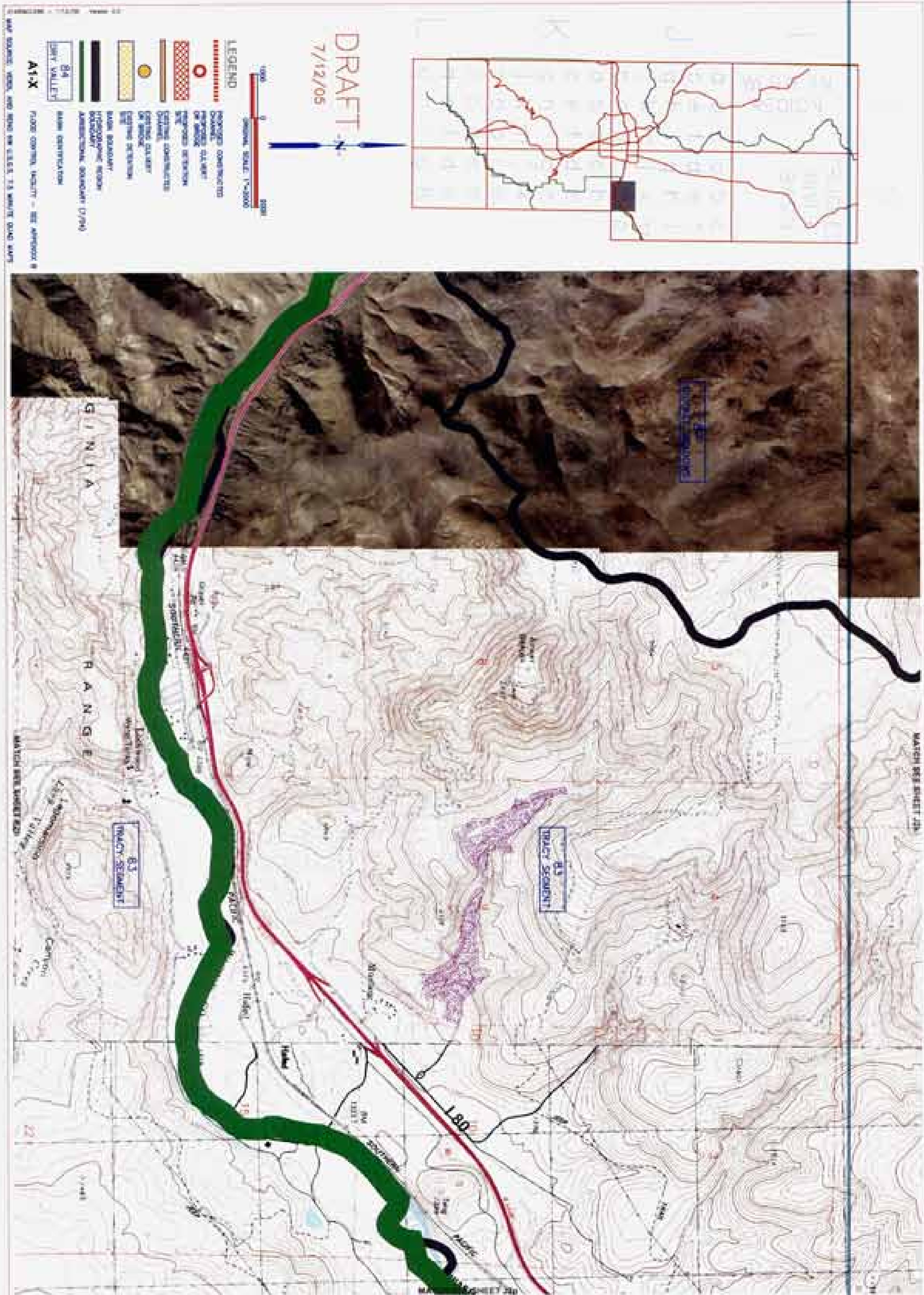
J2m



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

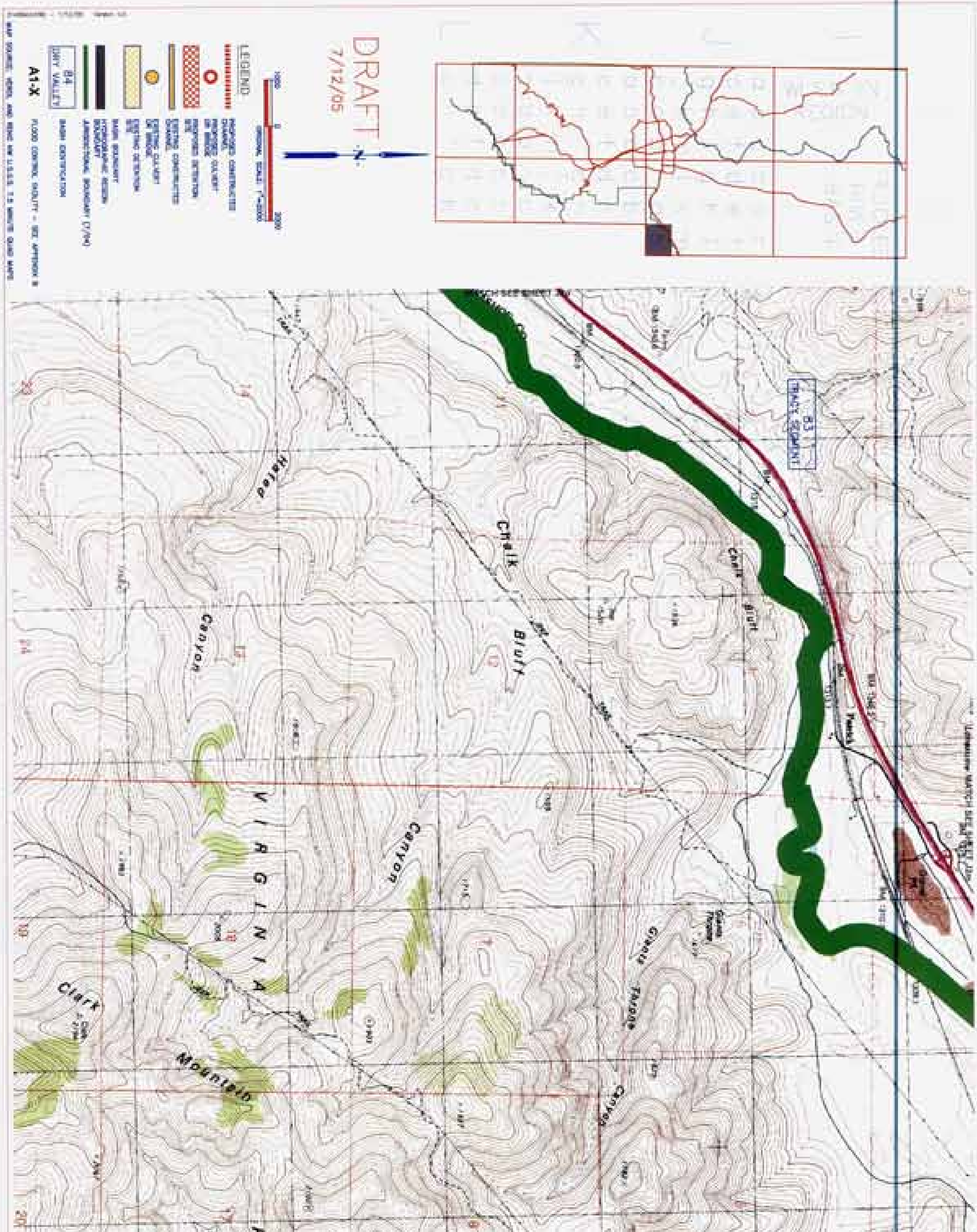
J2n



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2o

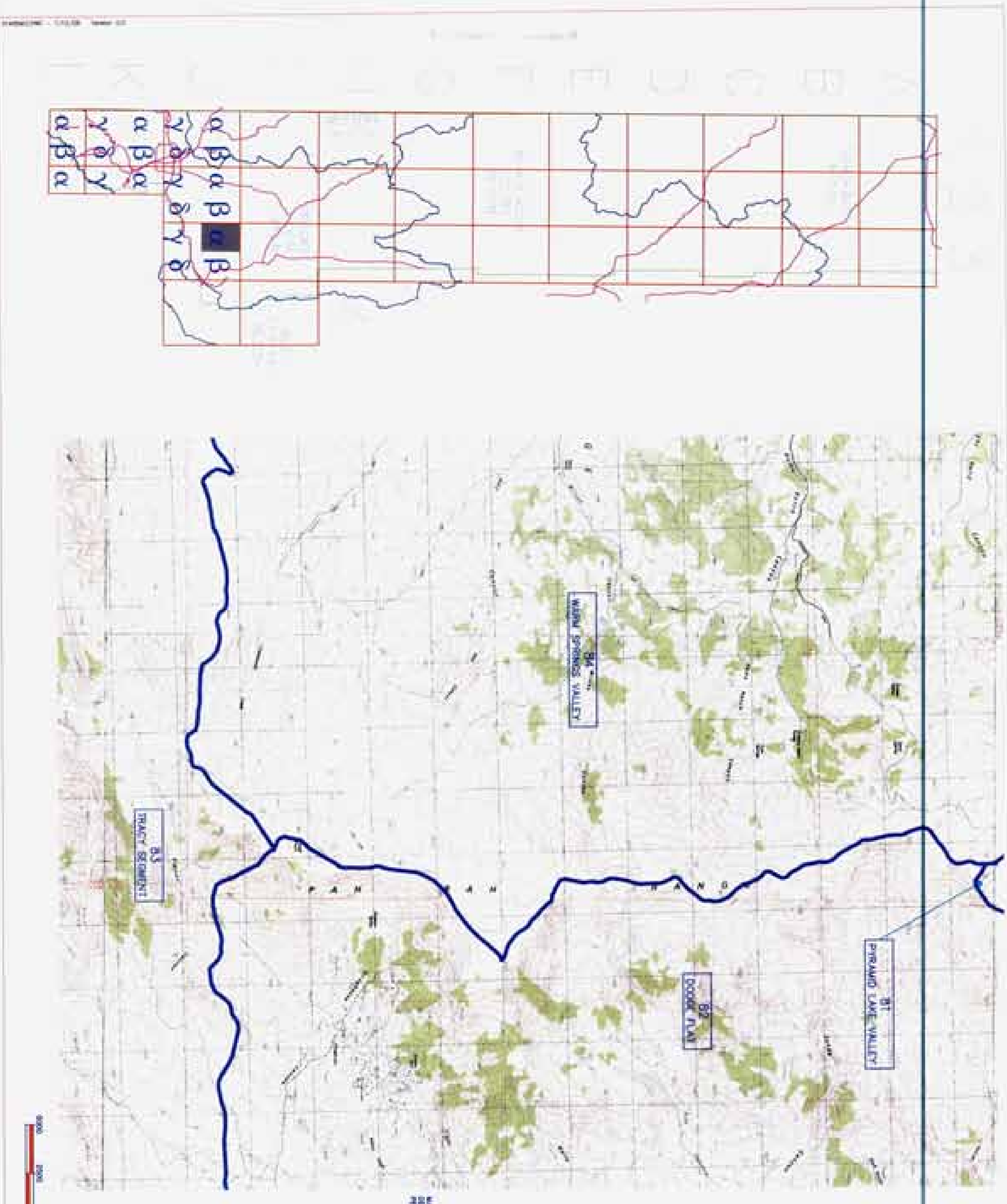


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J2p

SEAL OF WASHOE COUNTY
STATE OF NEVADA

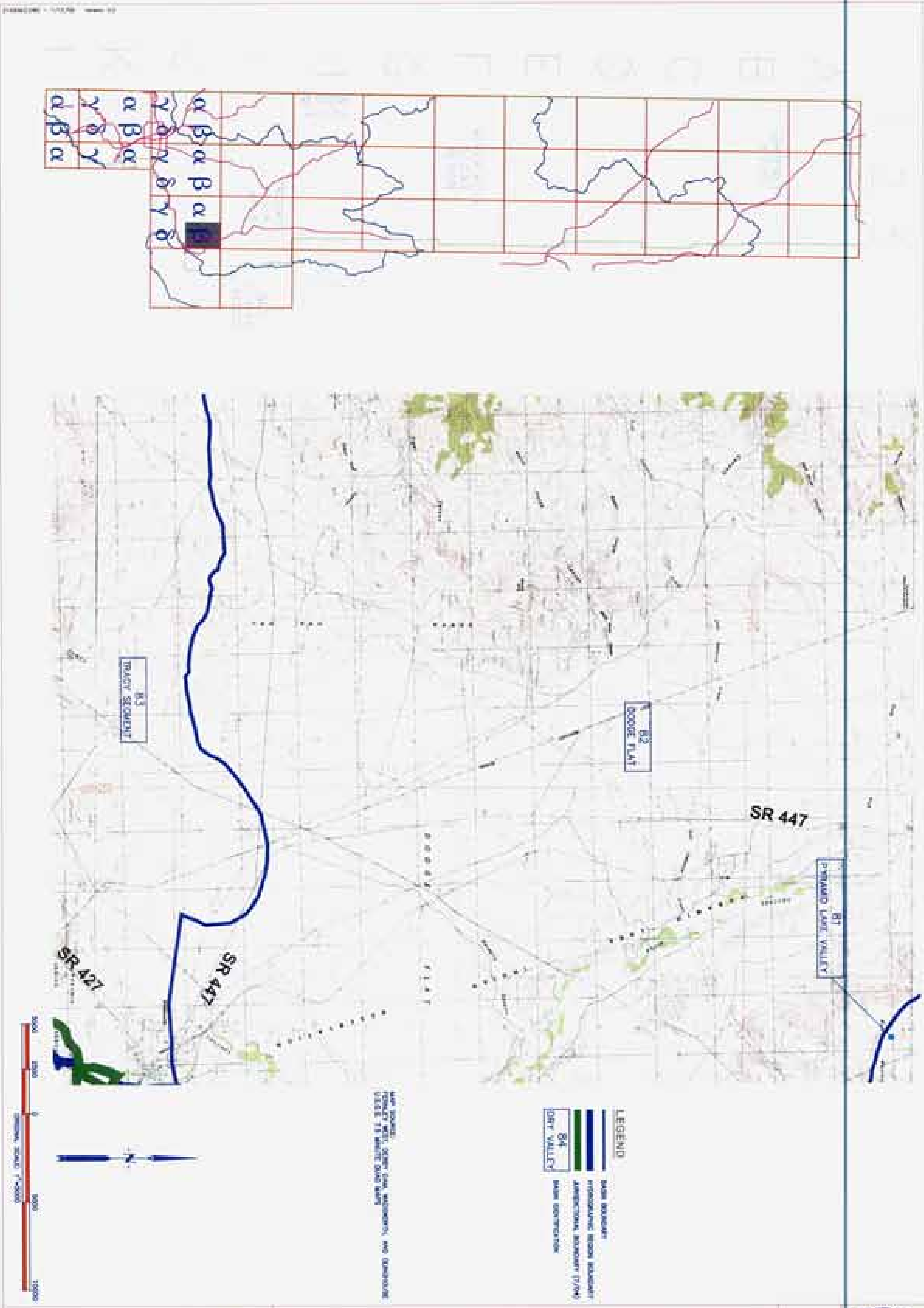


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J3α

SEAL OF WASHOE COUNTY
STATE OF NEVADA

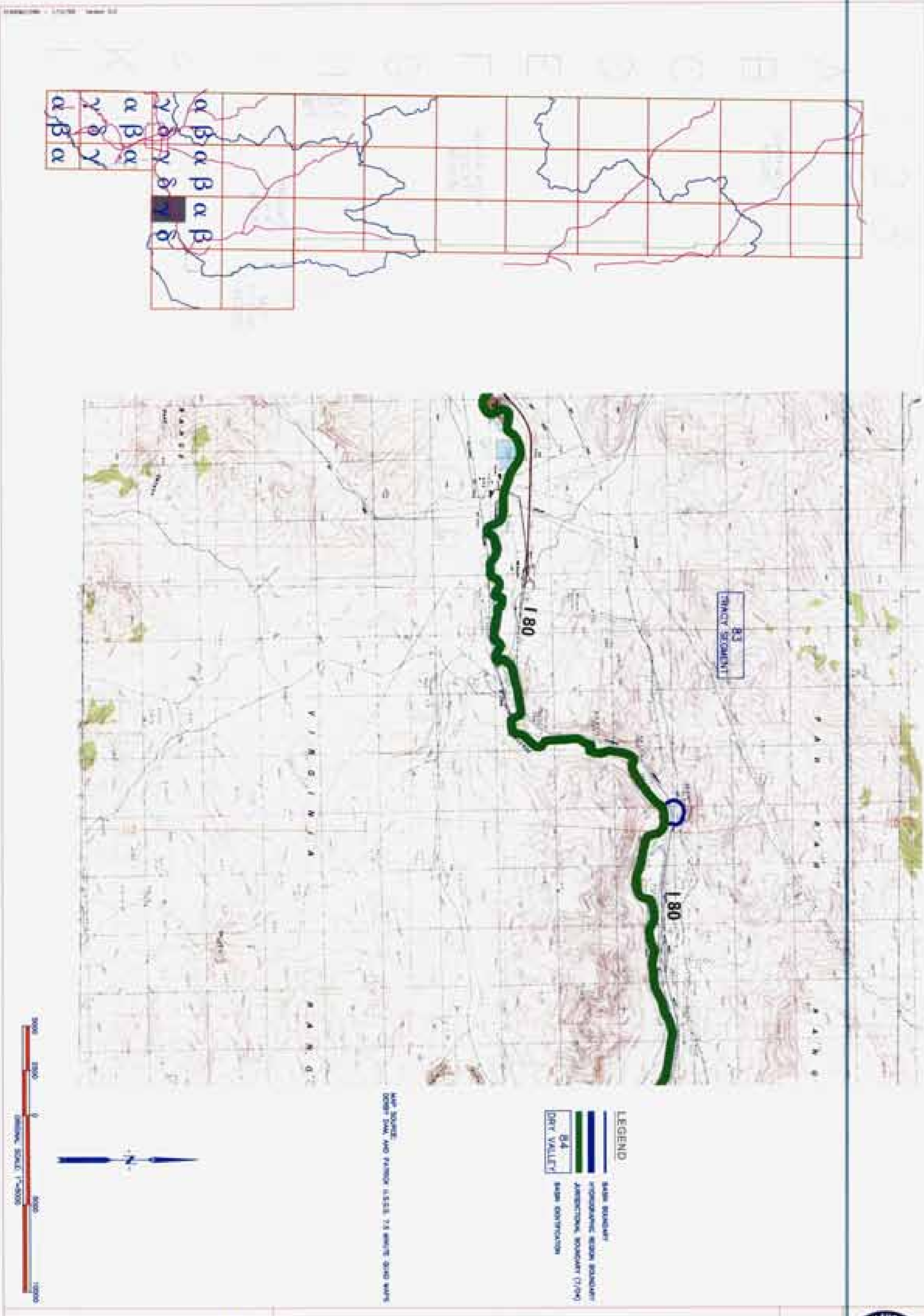


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J3β

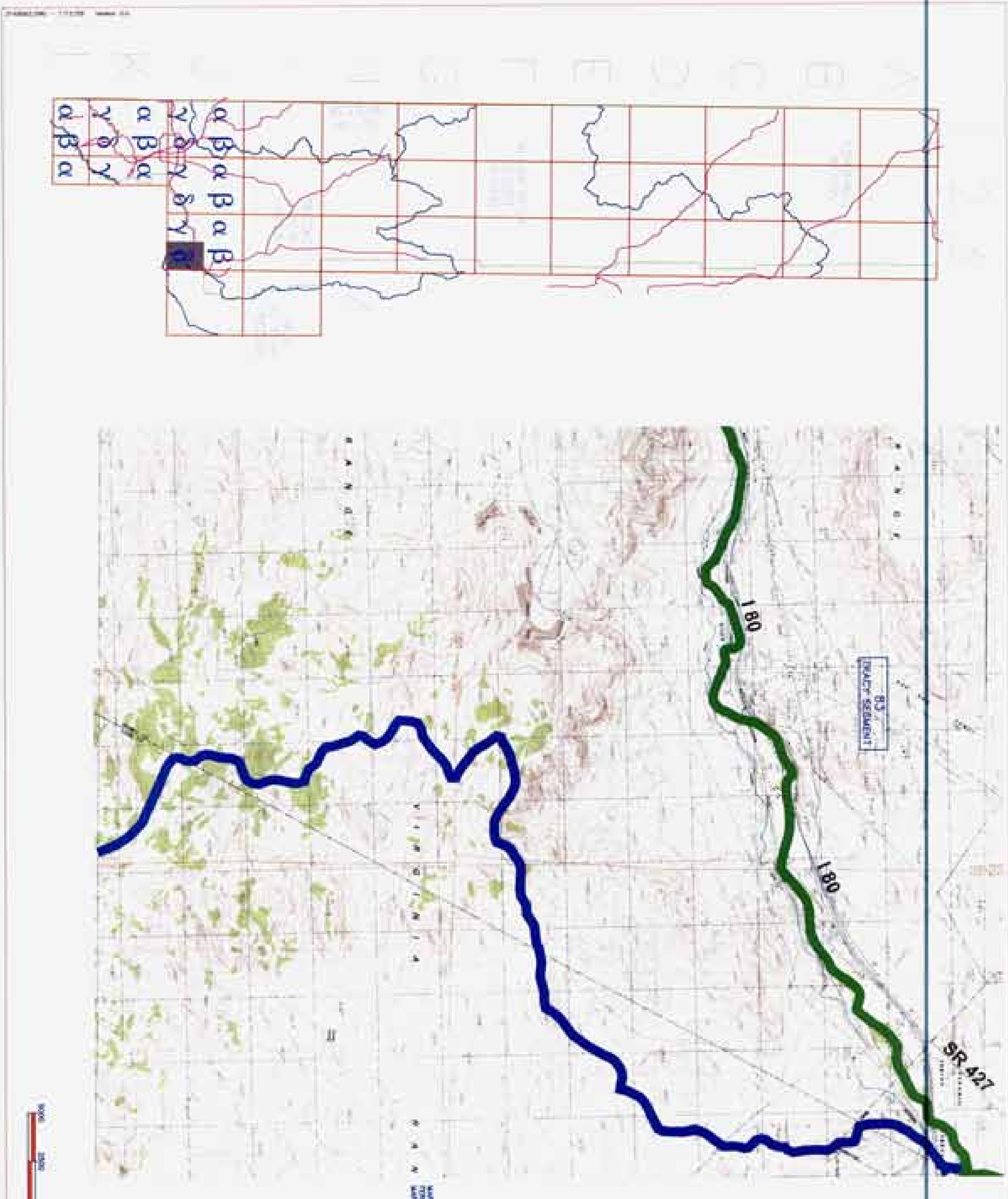
SEAL OF WASHOE COUNTY · STATE OF NEVADA



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J3γ

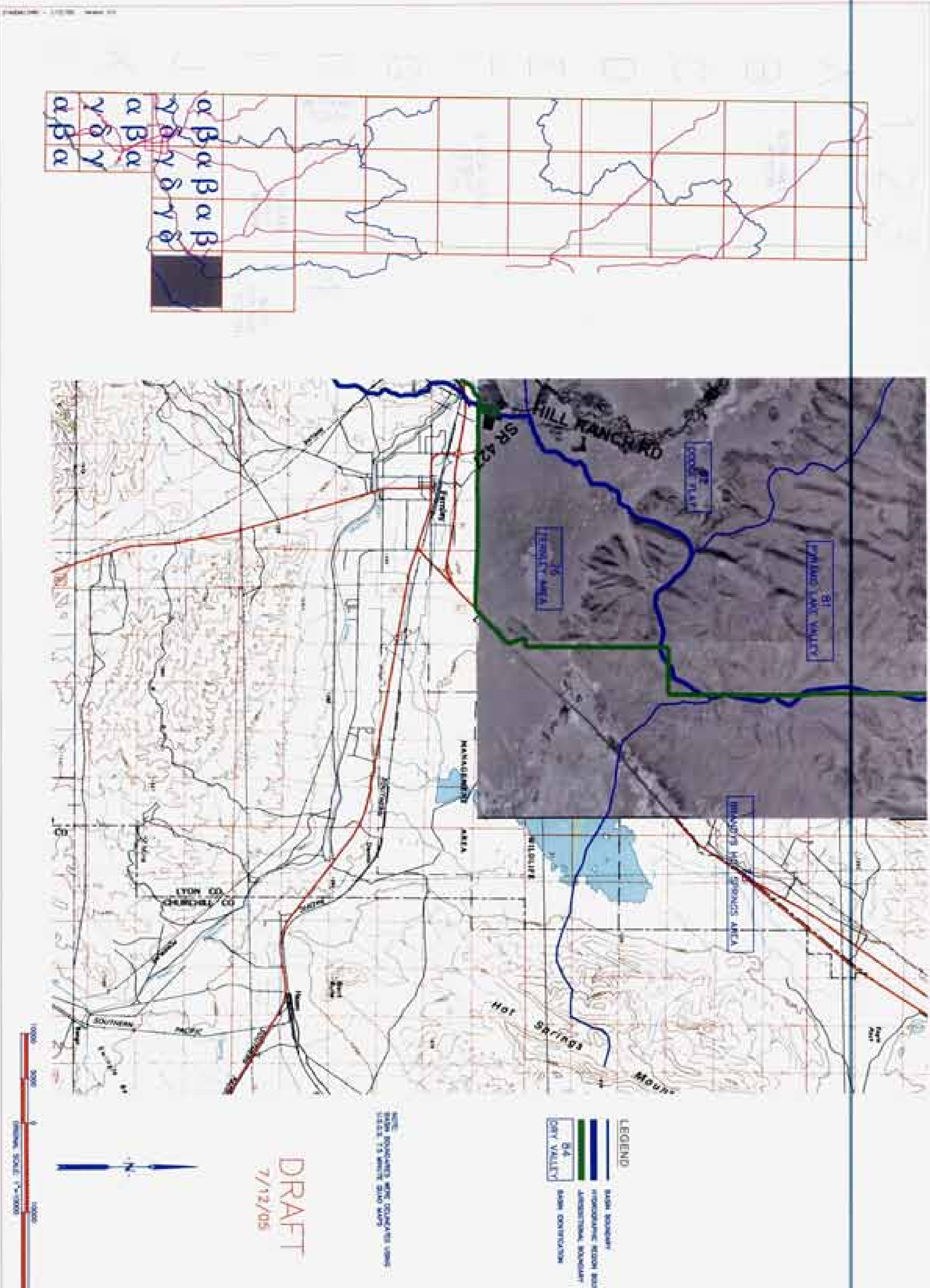


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J3δ

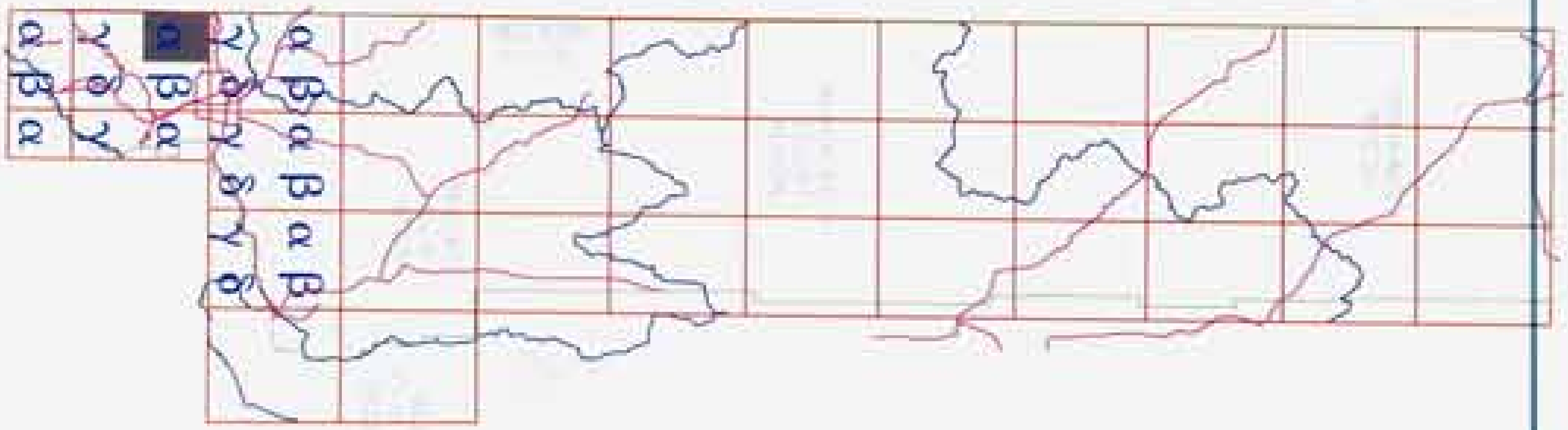
SEAL OF WASHOE COUNTY
STATE OF NEVADA

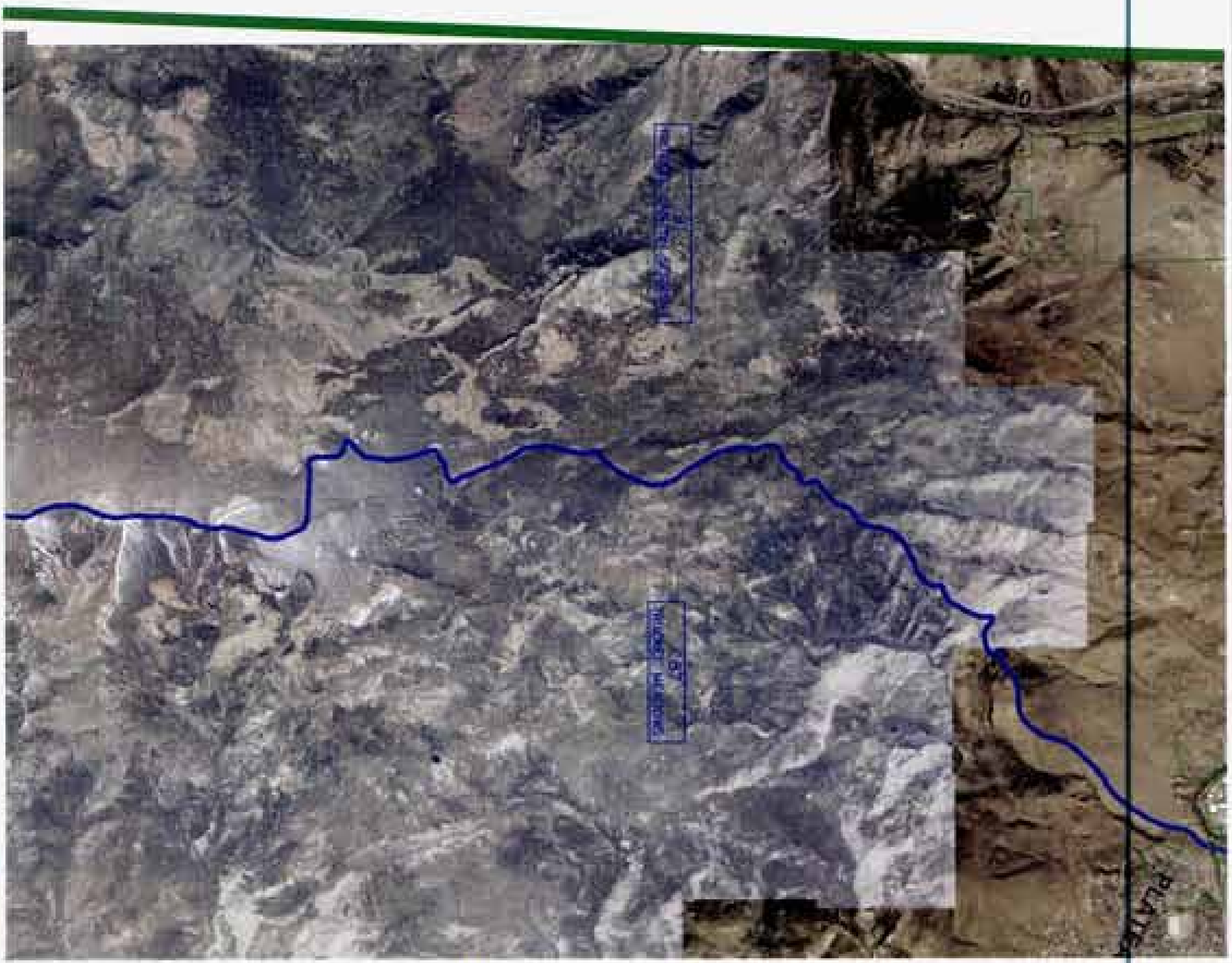


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

J4

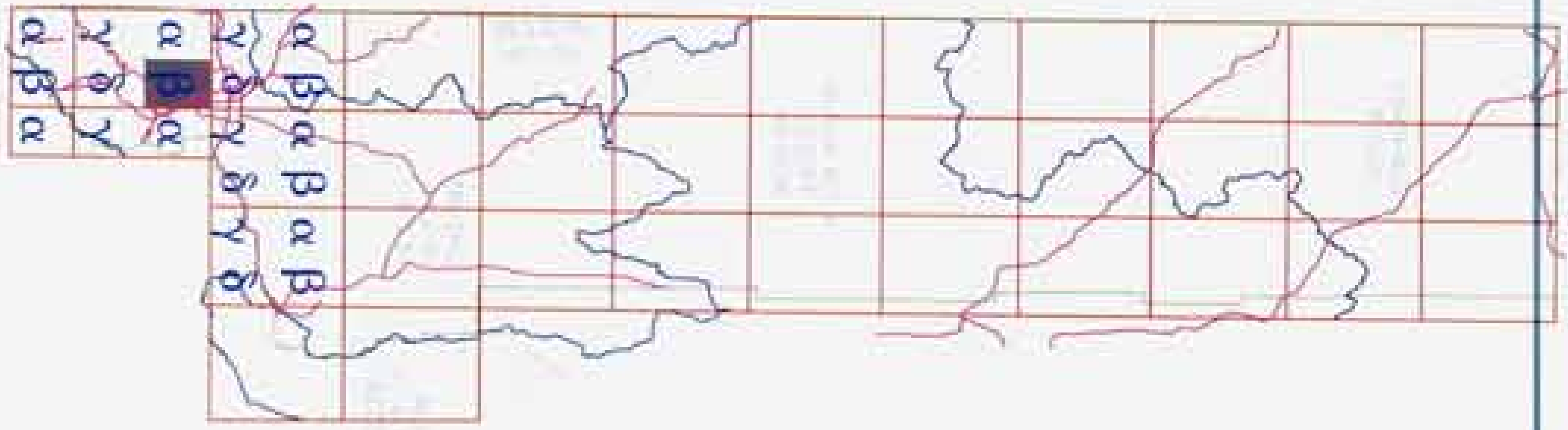




WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K1α



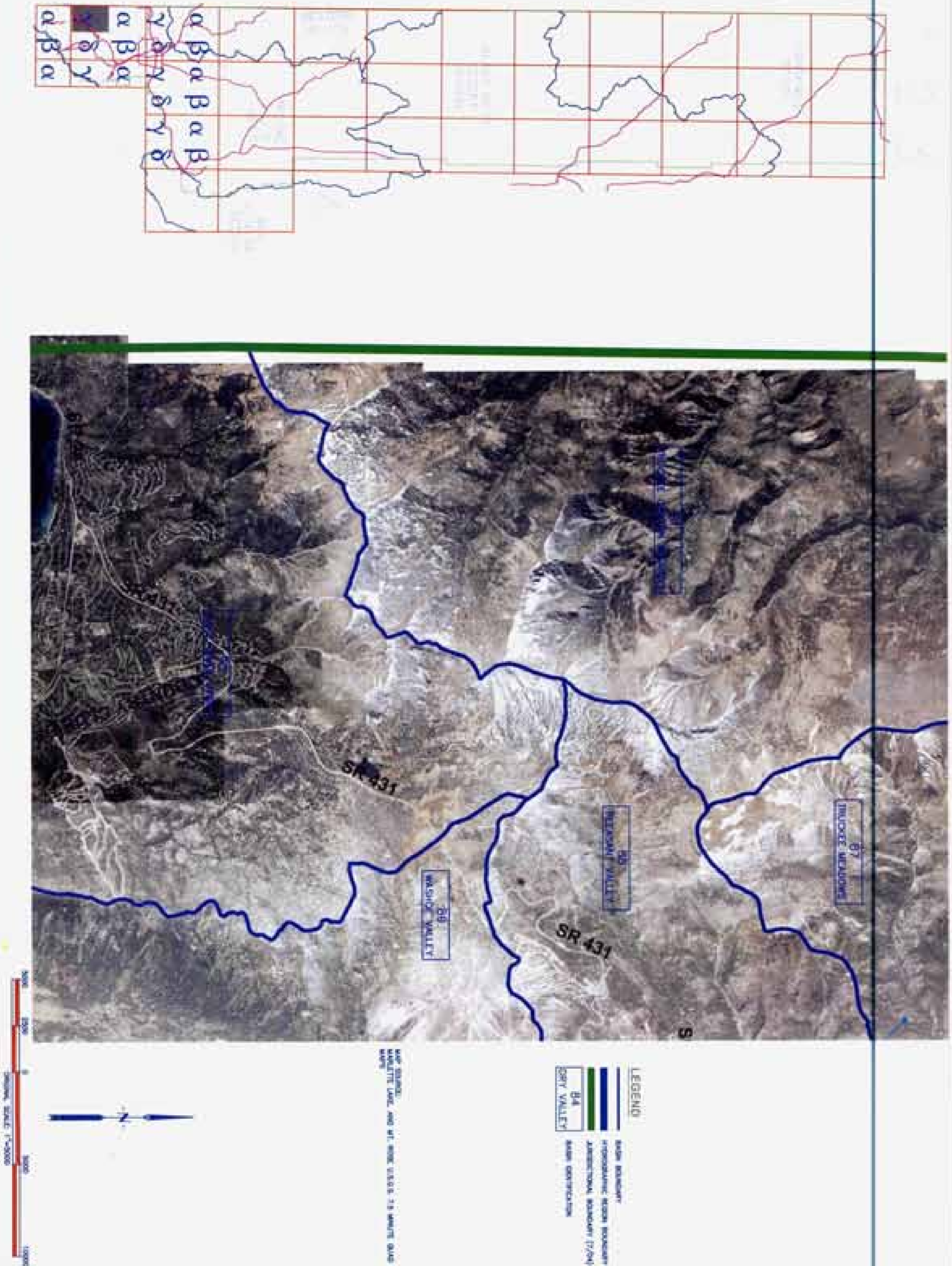
LEGEND

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K1β

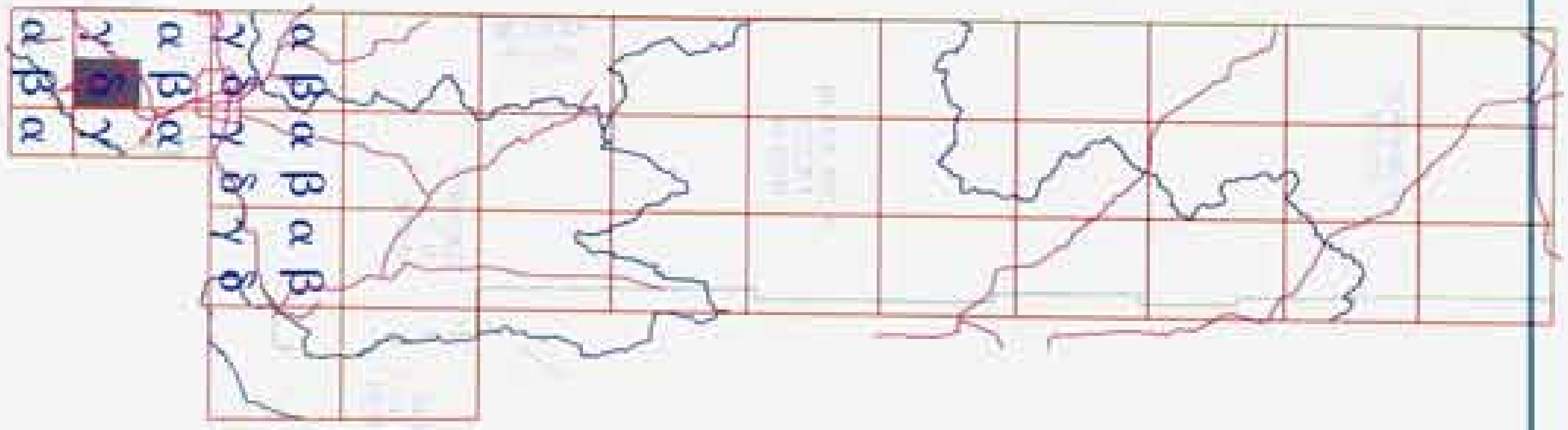
SEAL OF WASHOE COUNTY STATE OF NEVADA

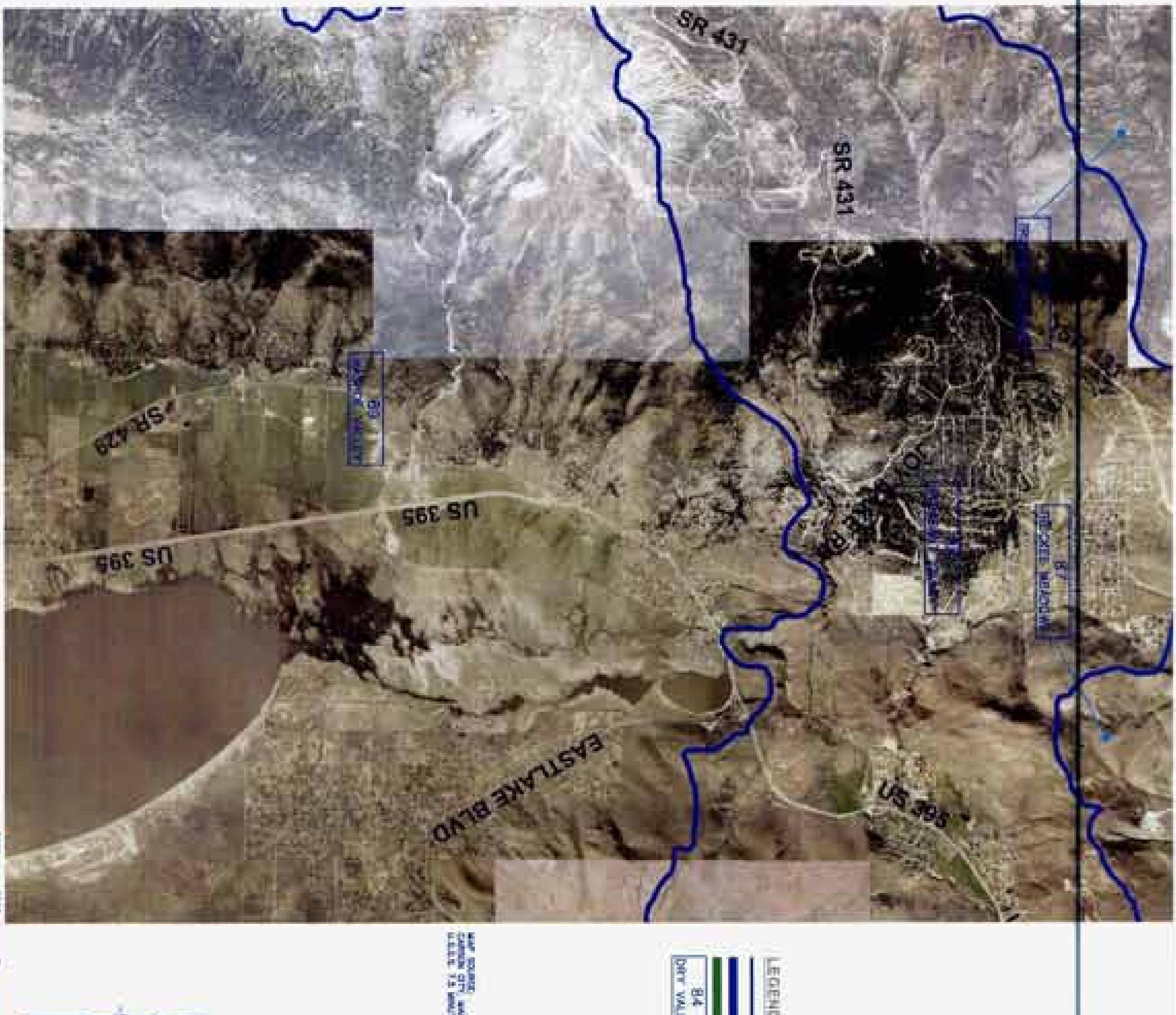


WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K1γ





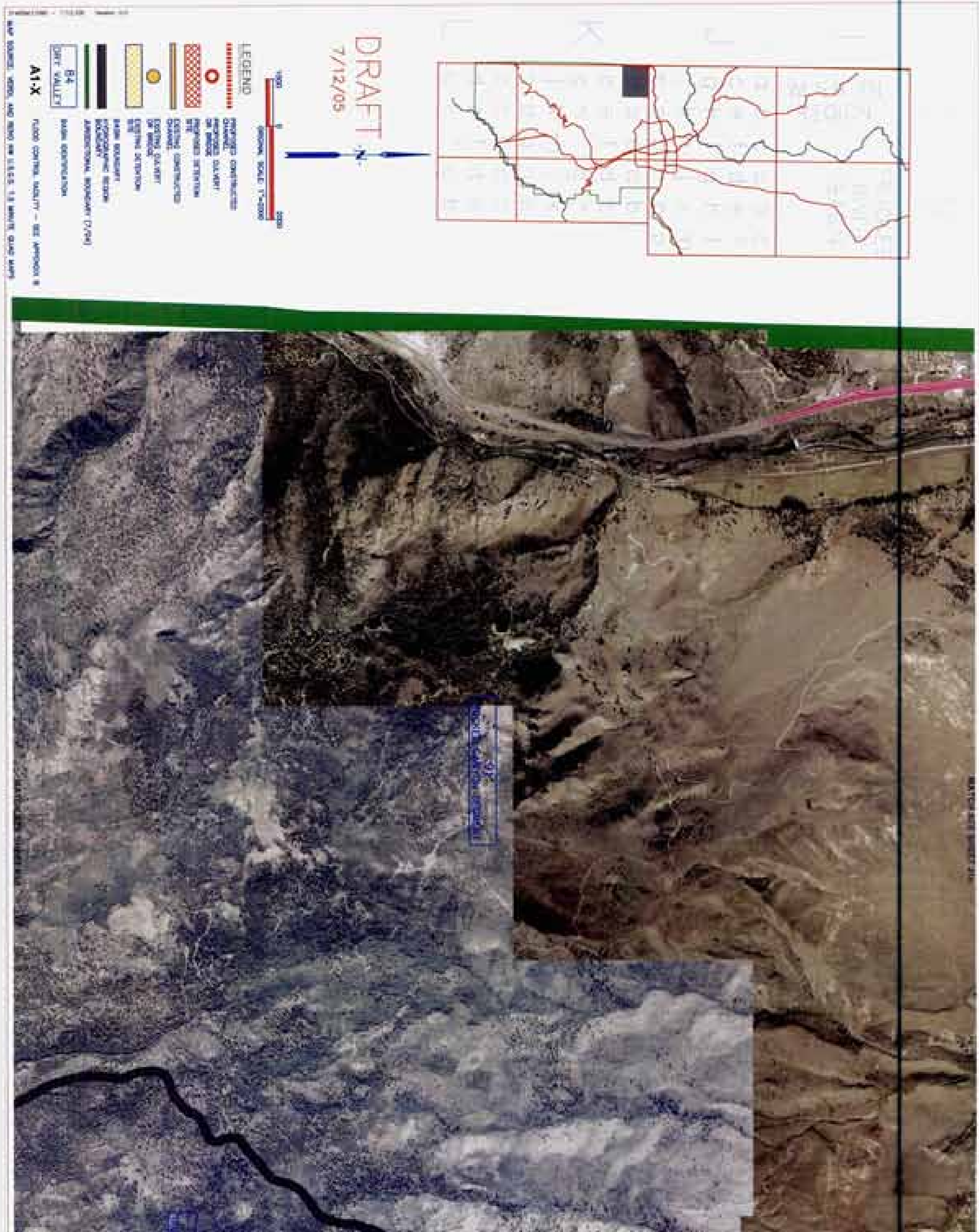
LEGEND

84
DRY VALLEY

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

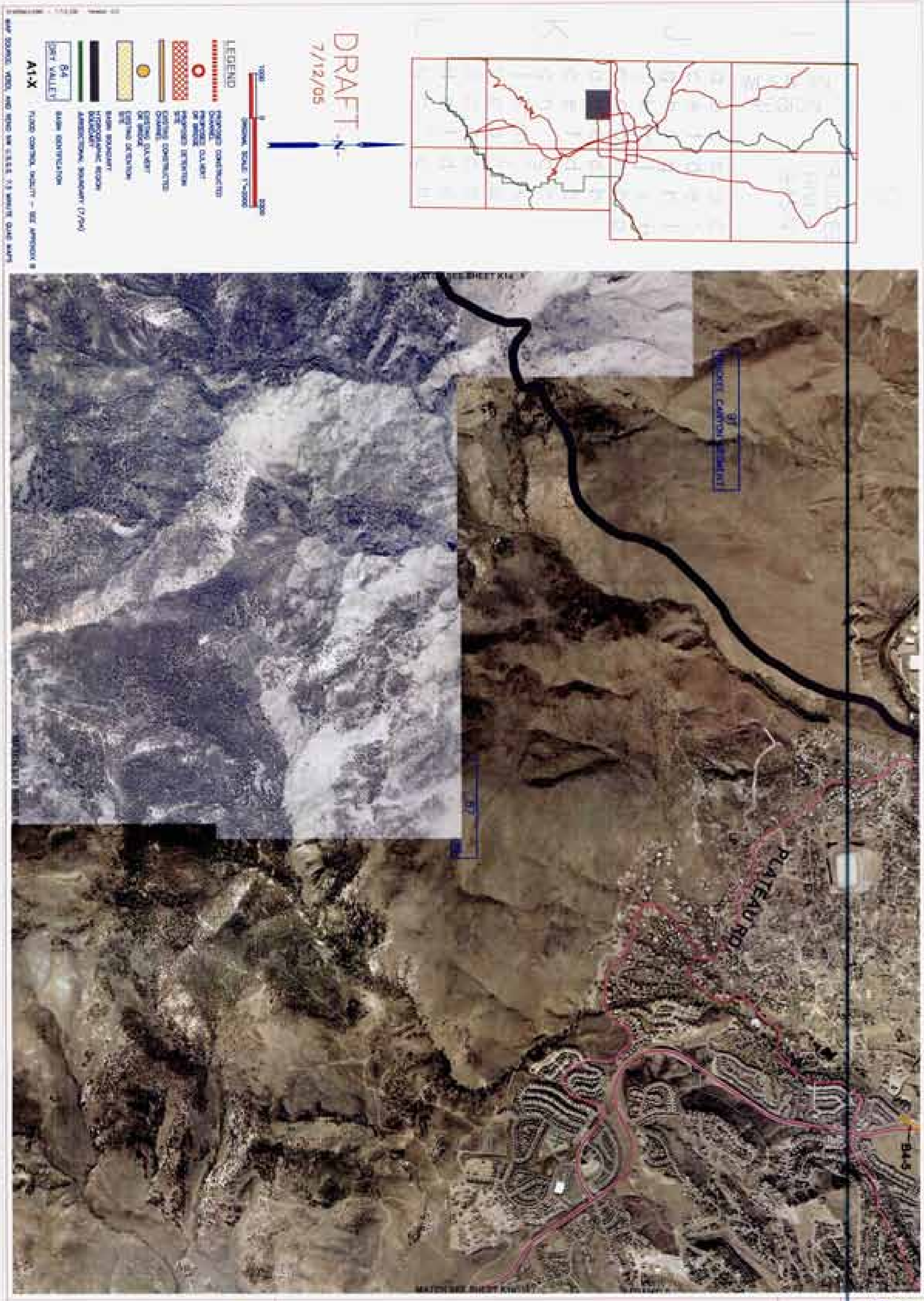
K1δ



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

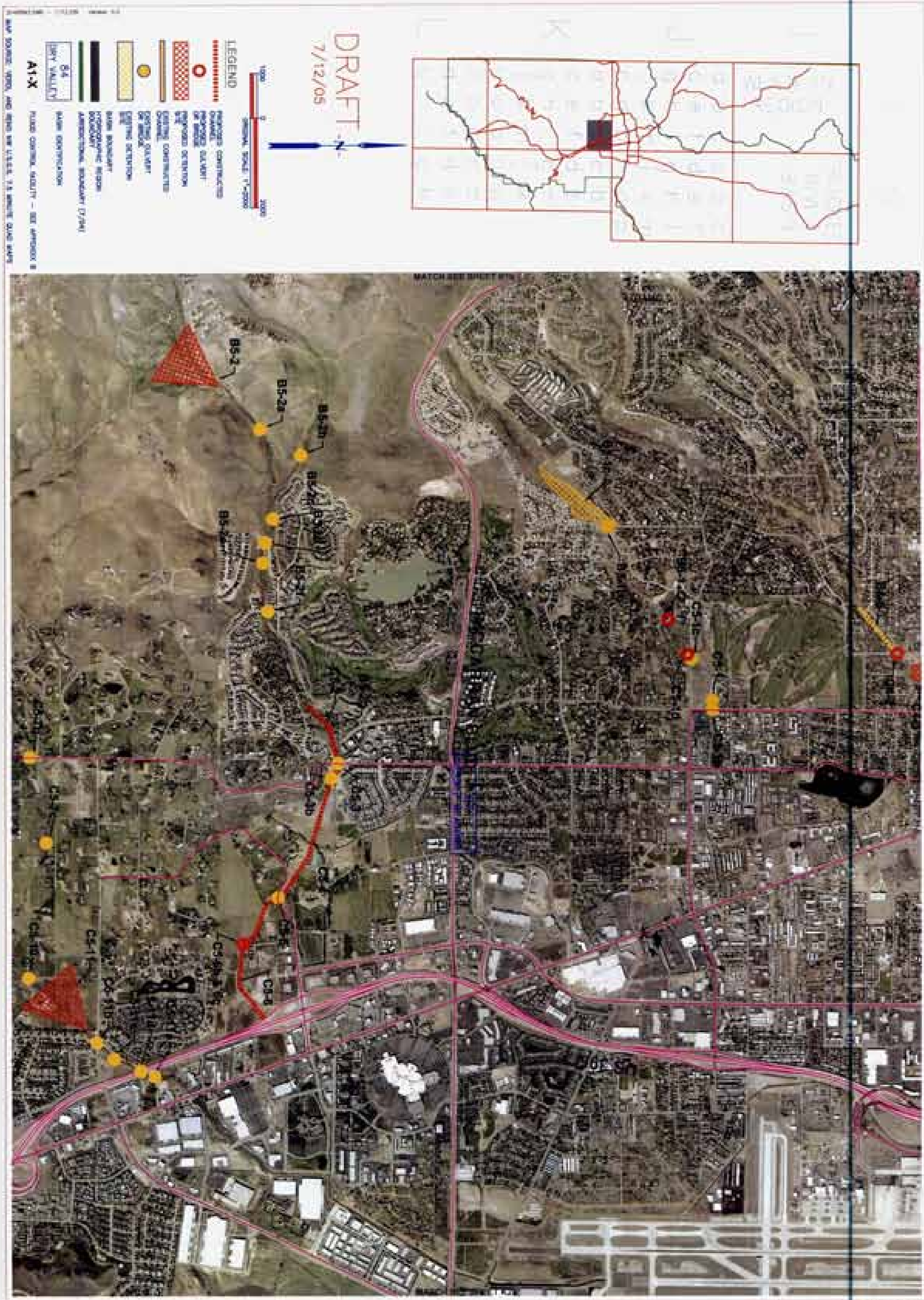
K1a



WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K1b



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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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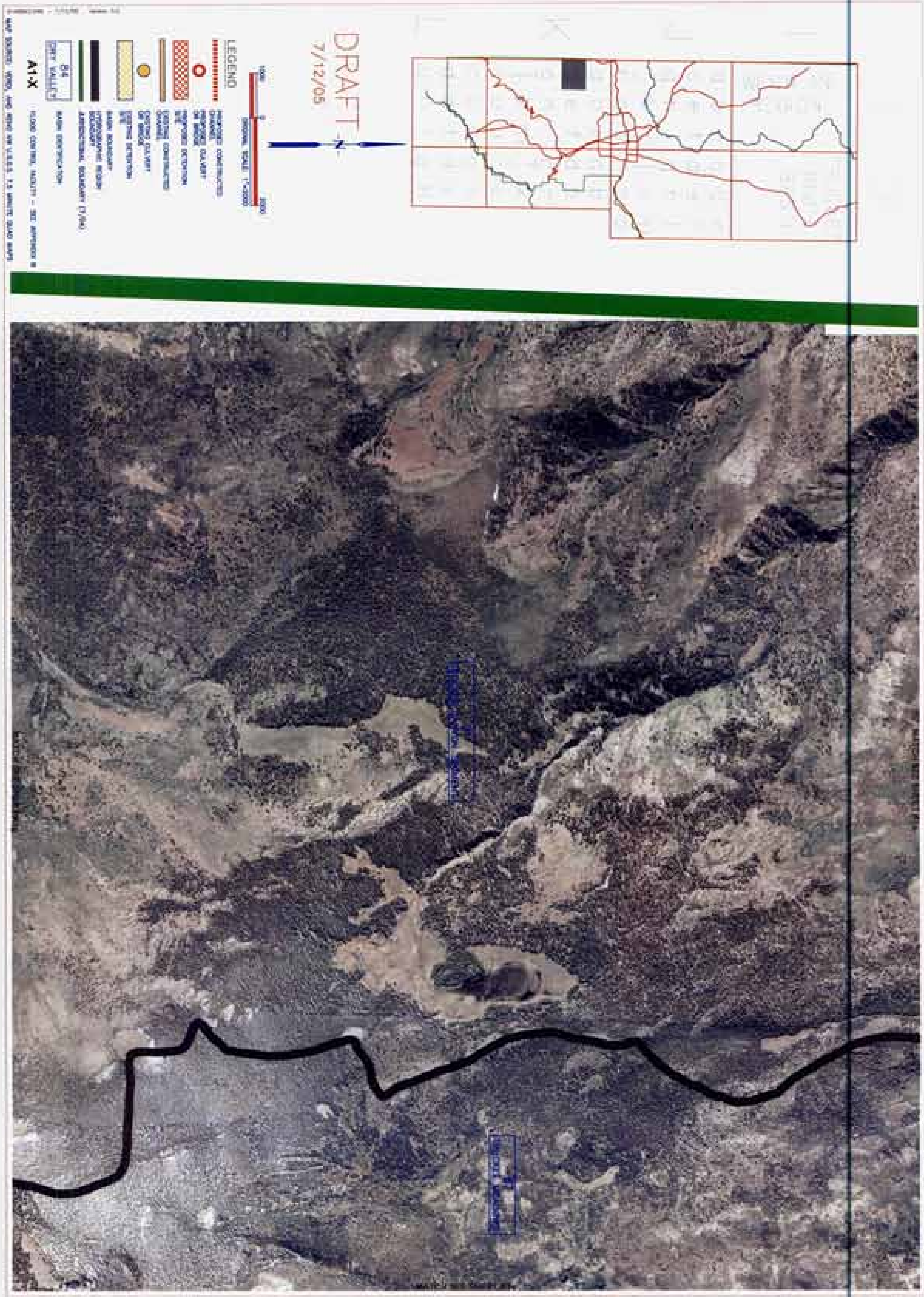

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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LEGEND

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WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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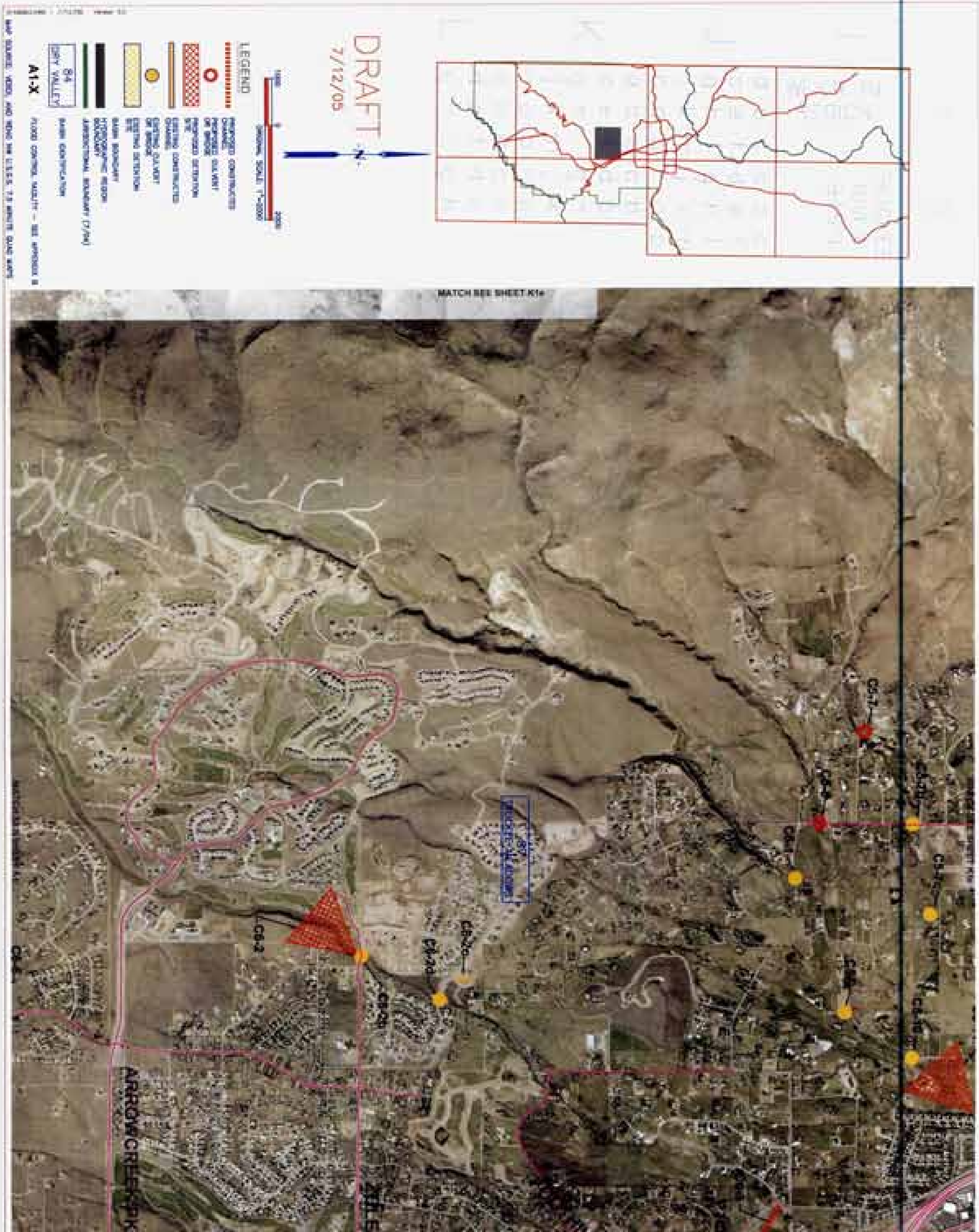

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REGIONAL FLOOD CONTROL MASTER PLAN

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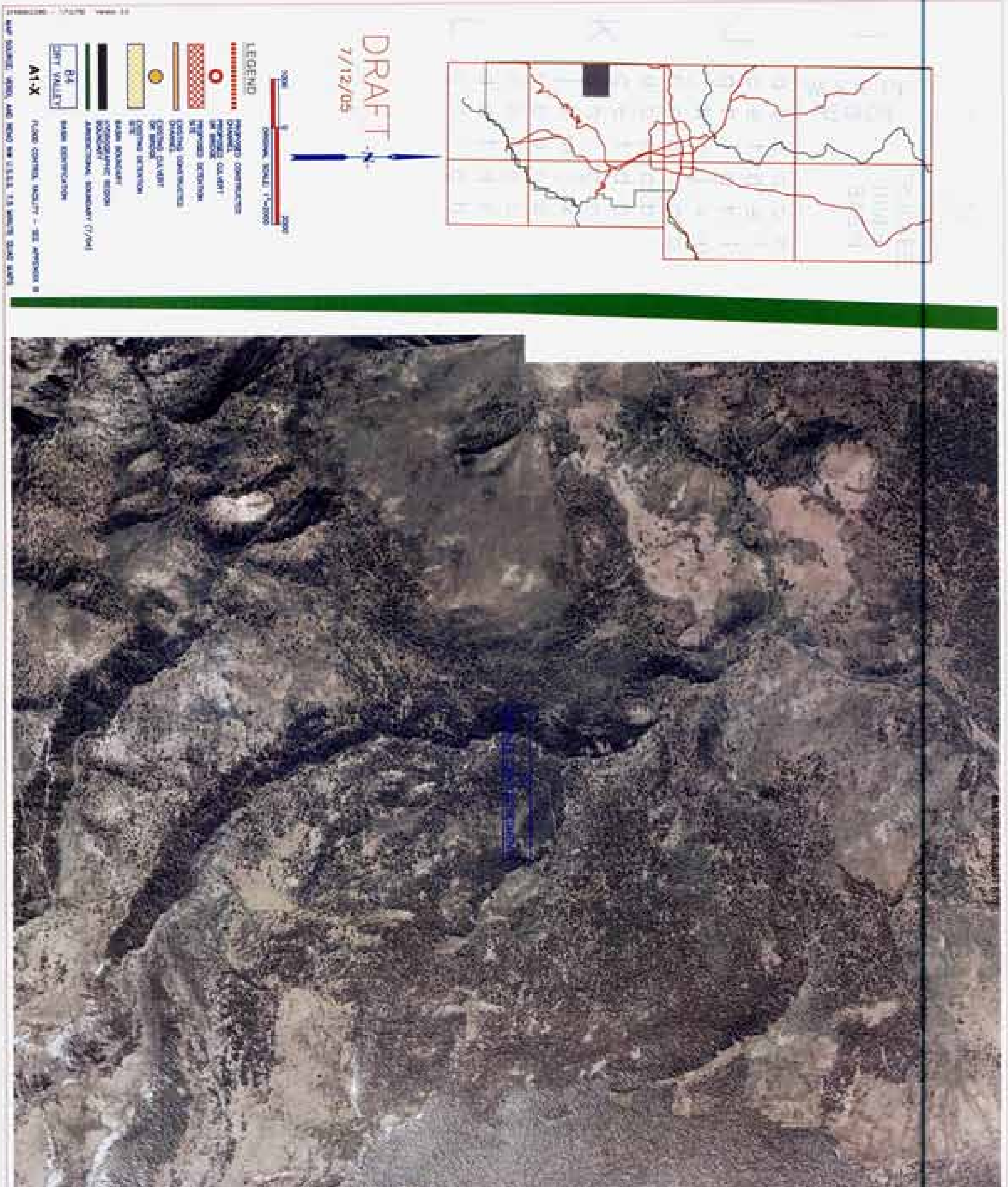

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WASHOE COUNTY
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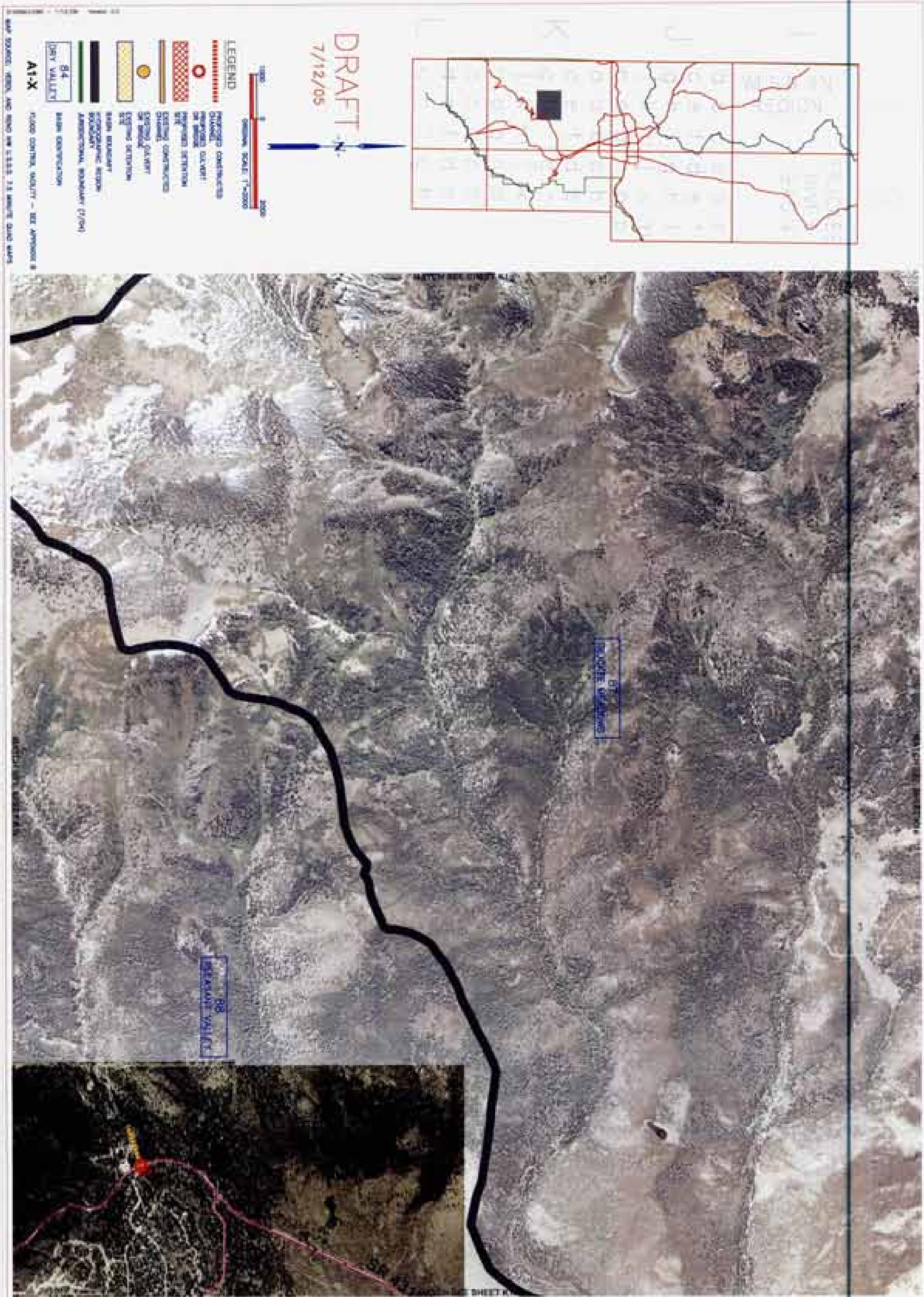

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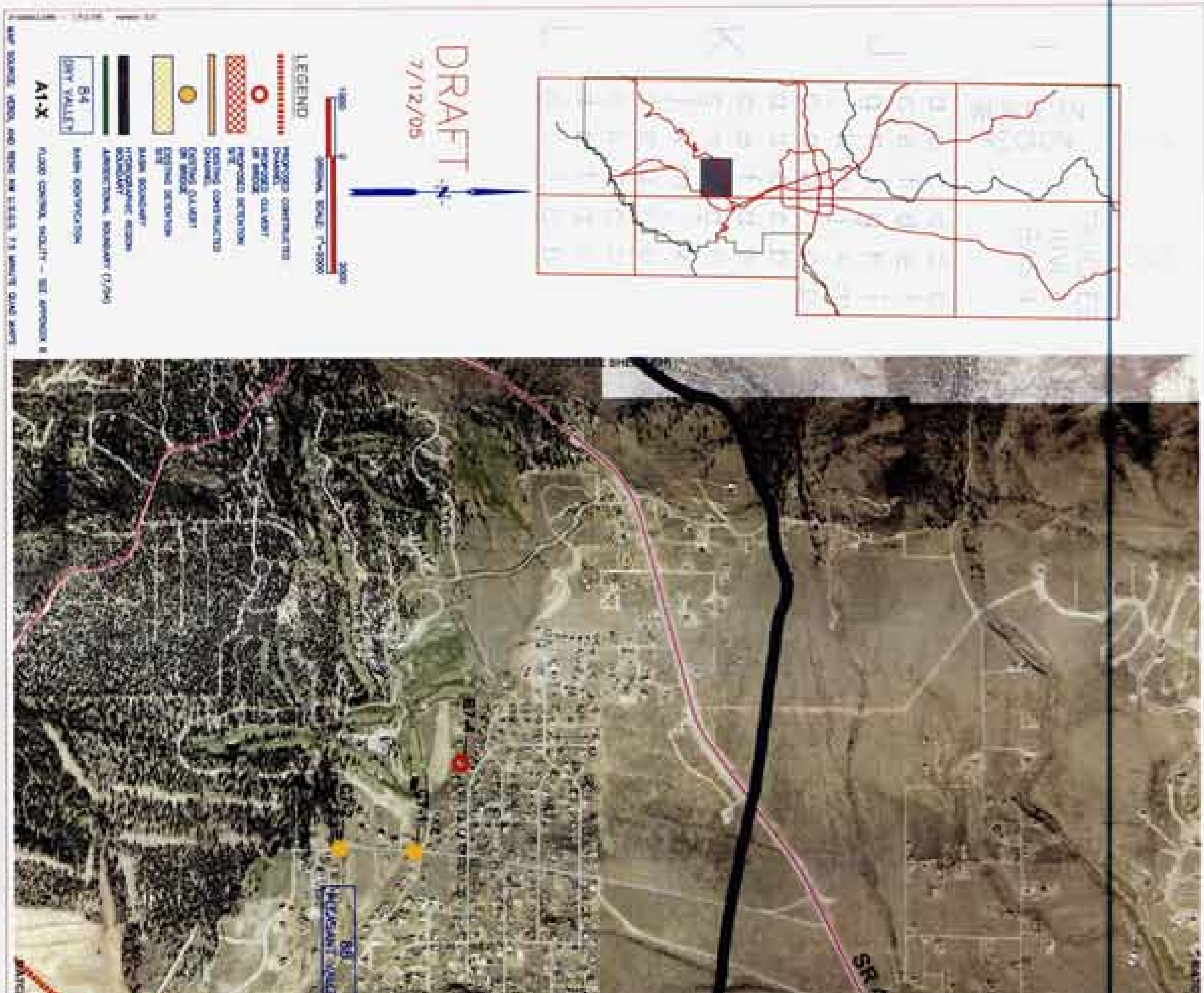

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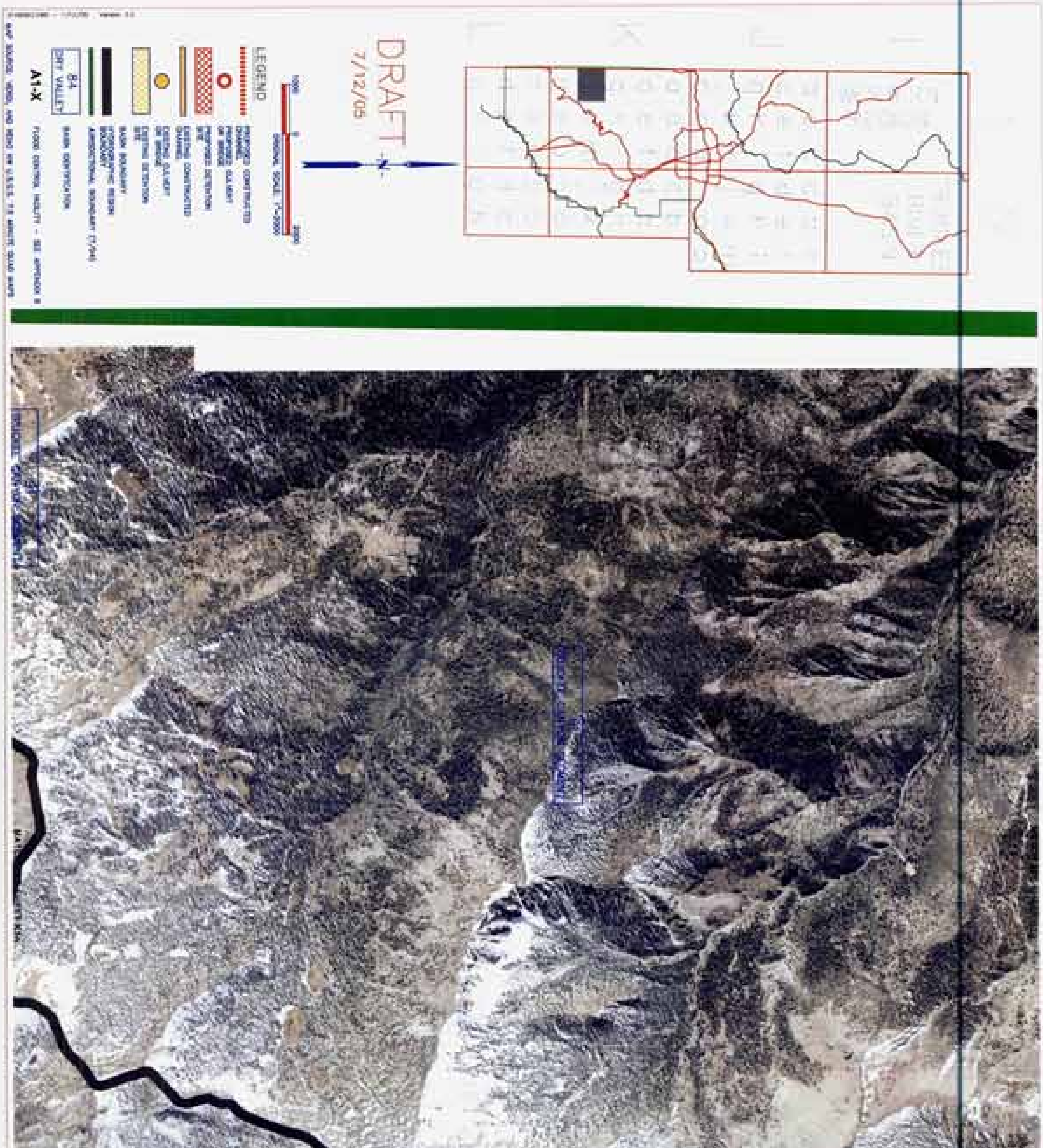
WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K1i

SEAL OF WASHOE COUNTY
STATE OF NEVADA

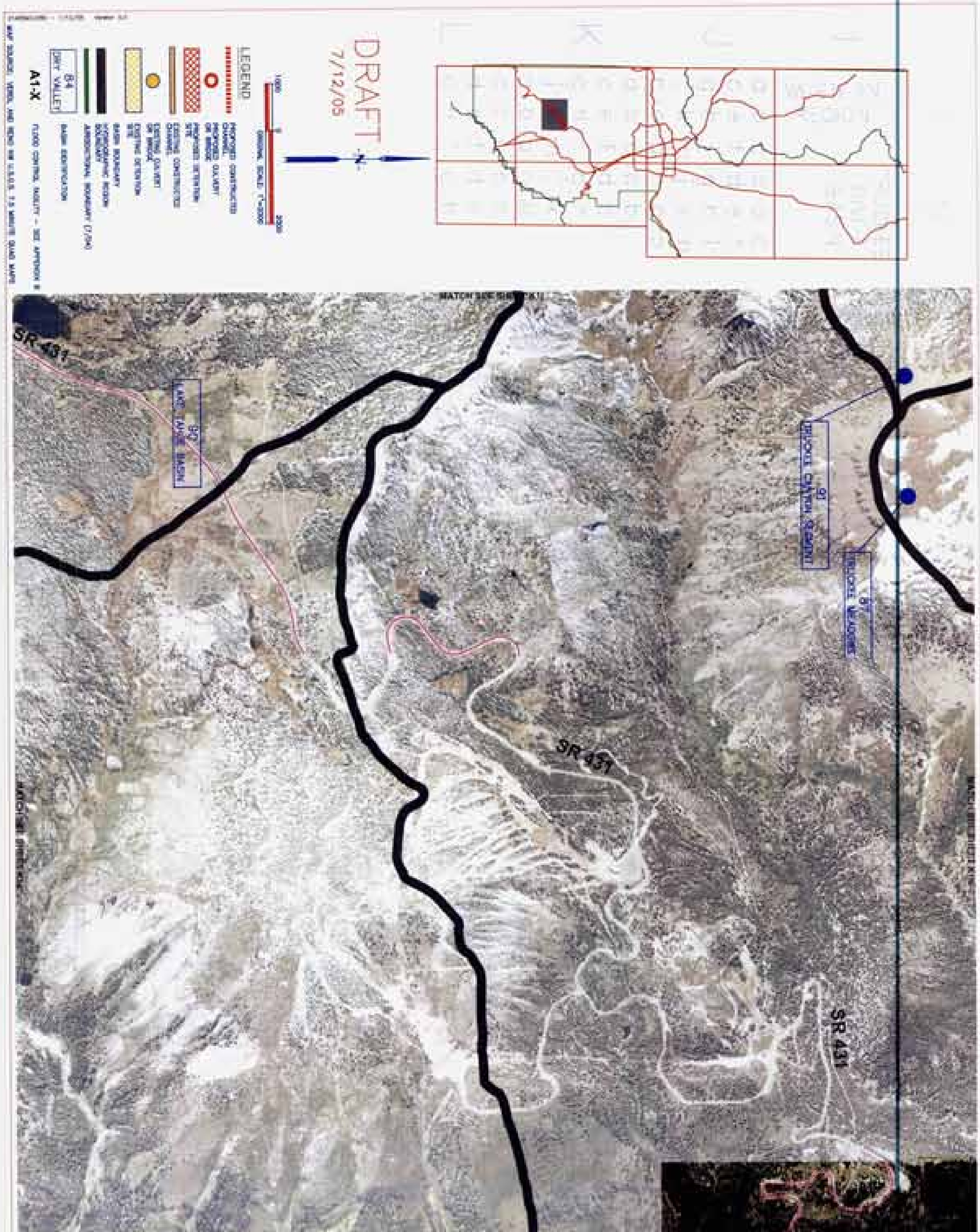


WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K1j

SEAL OF WASHOE COUNTY · STATE OF NEVADA



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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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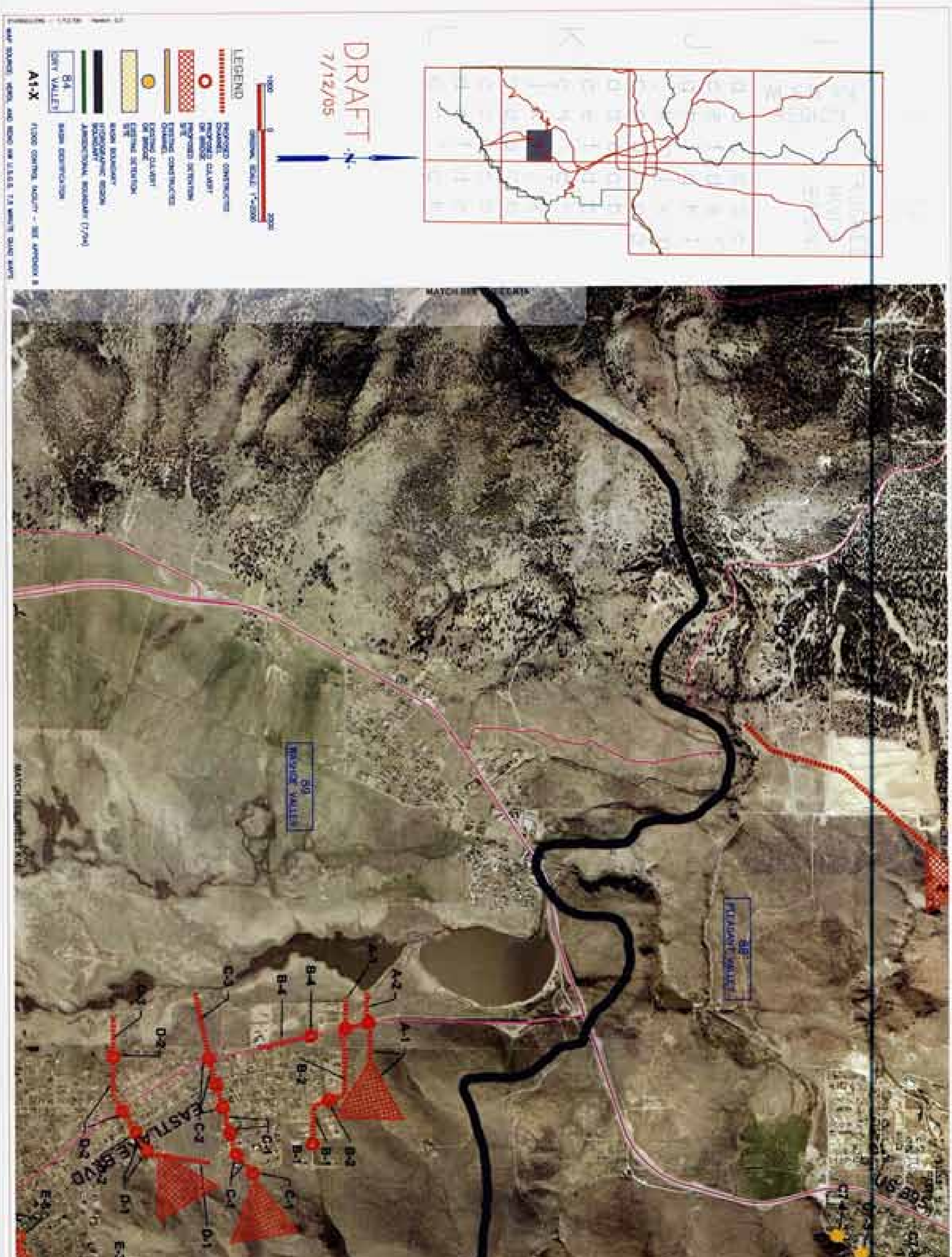

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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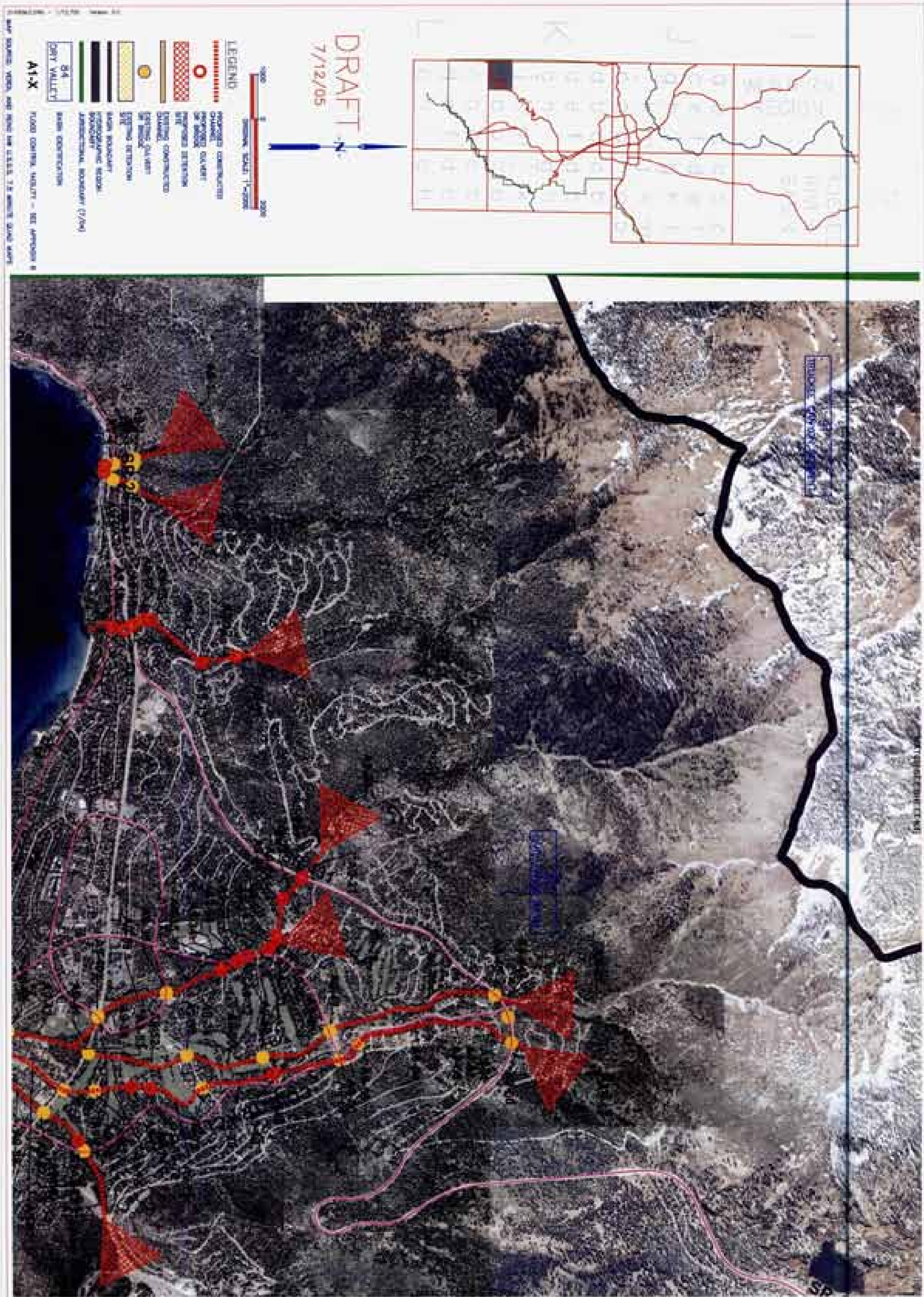

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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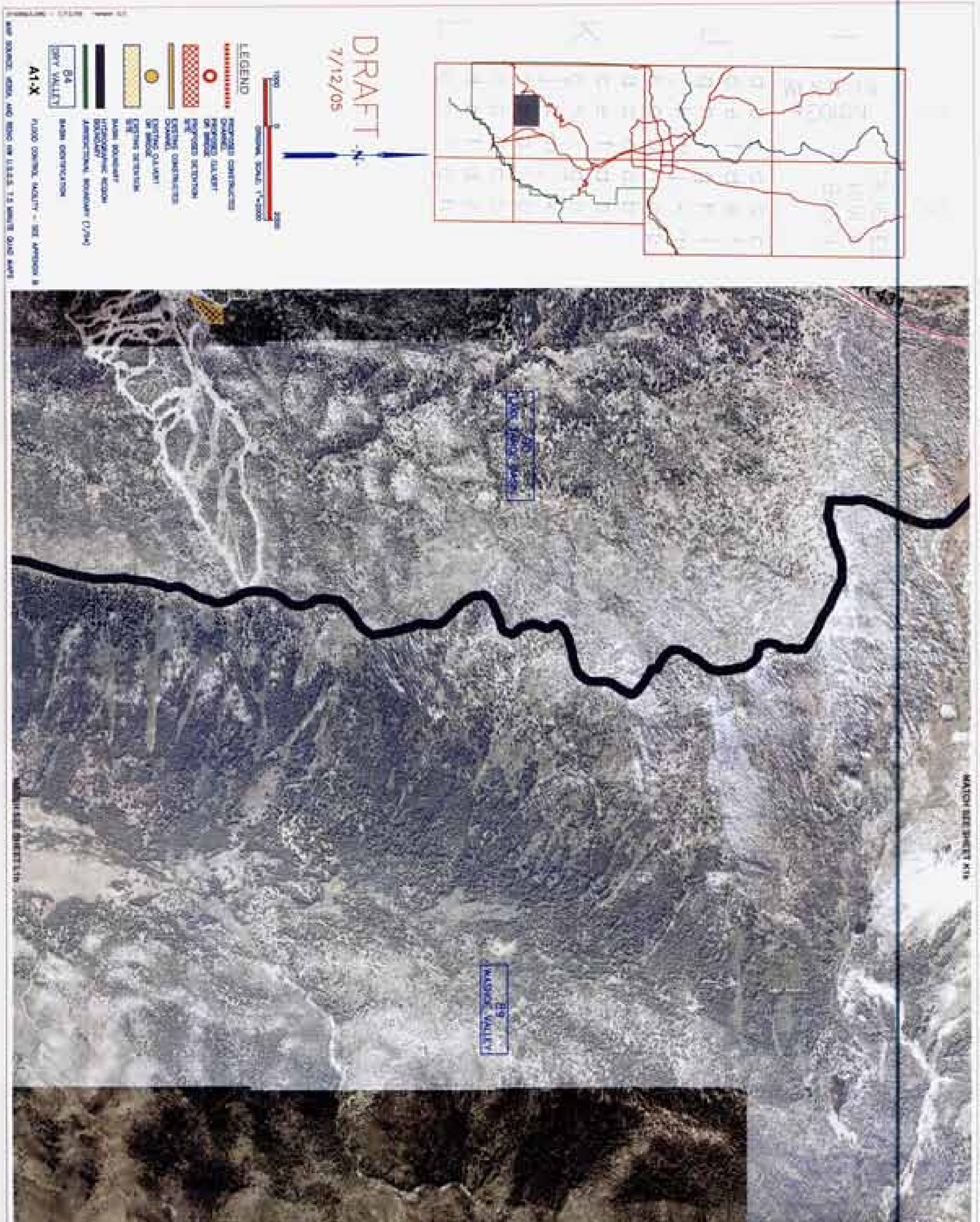

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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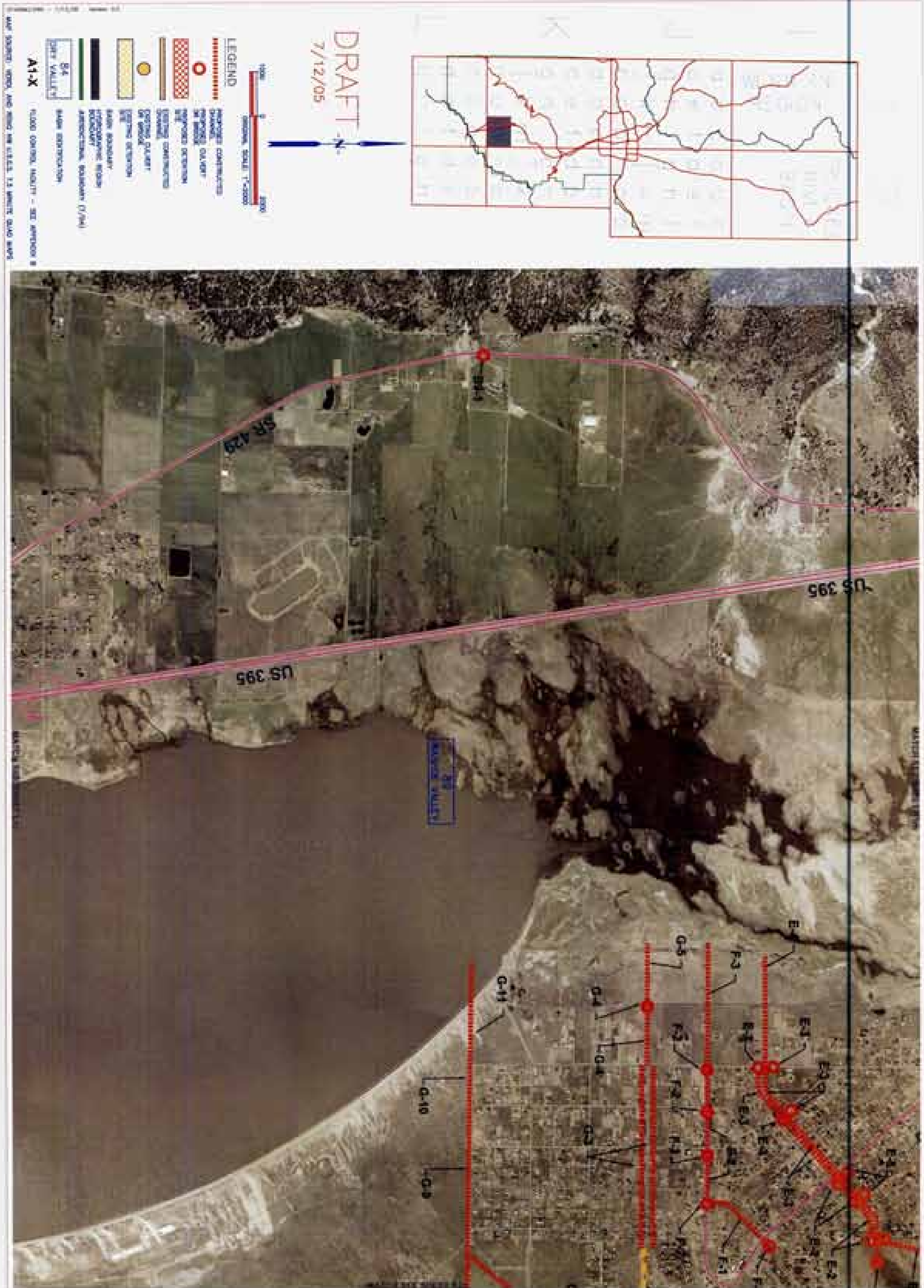

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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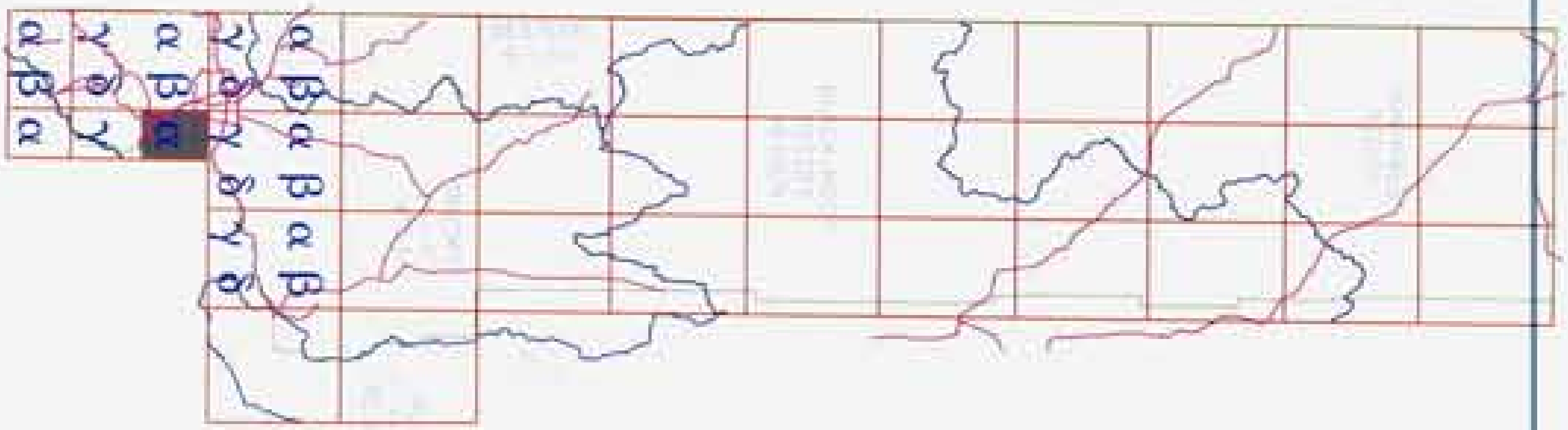
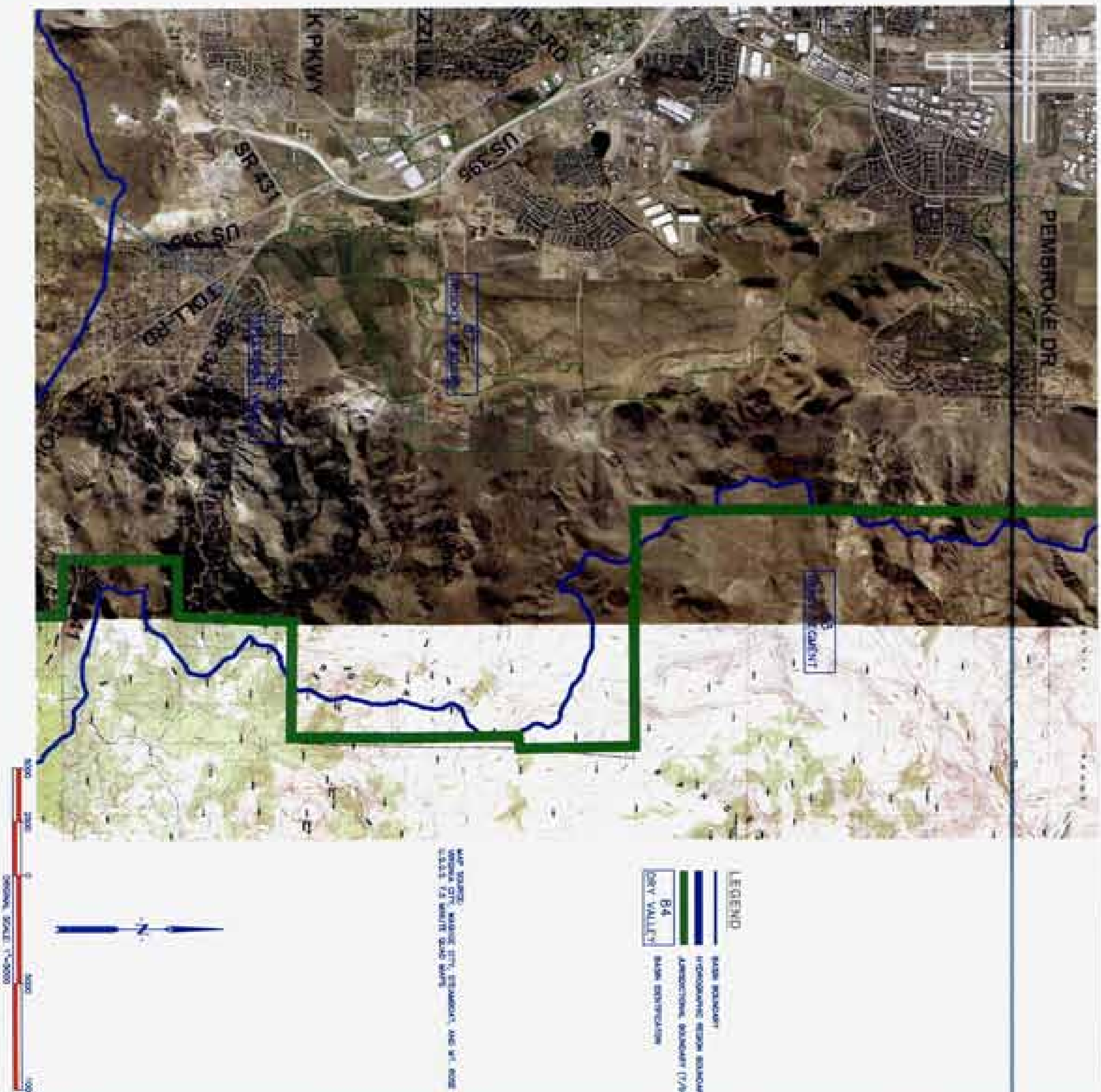
SEAL OF WASHOE COUNTY
STATE OF NEVADA

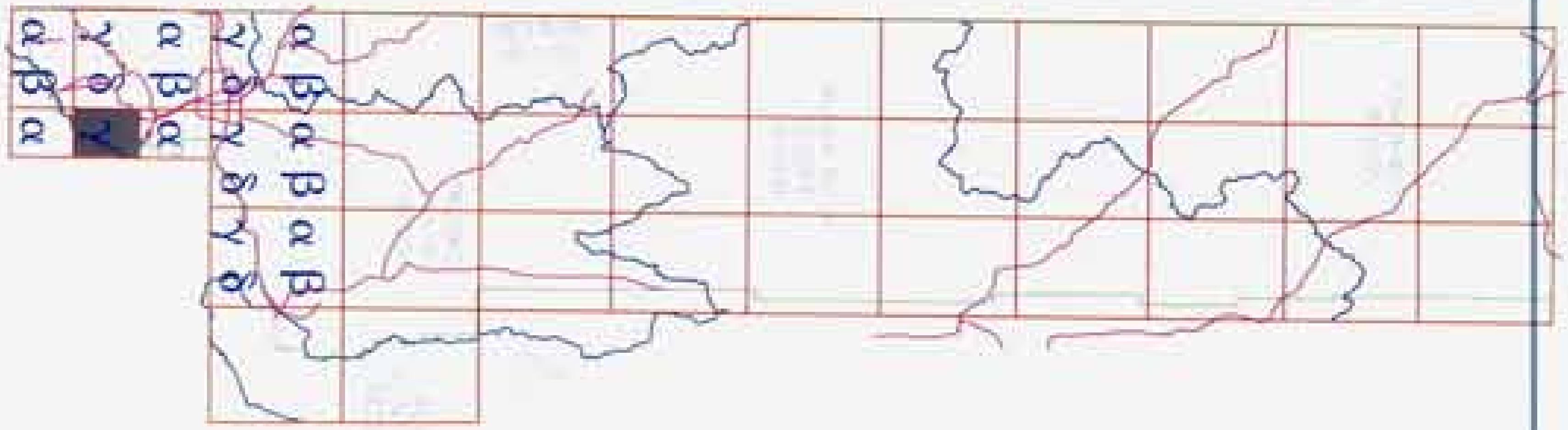


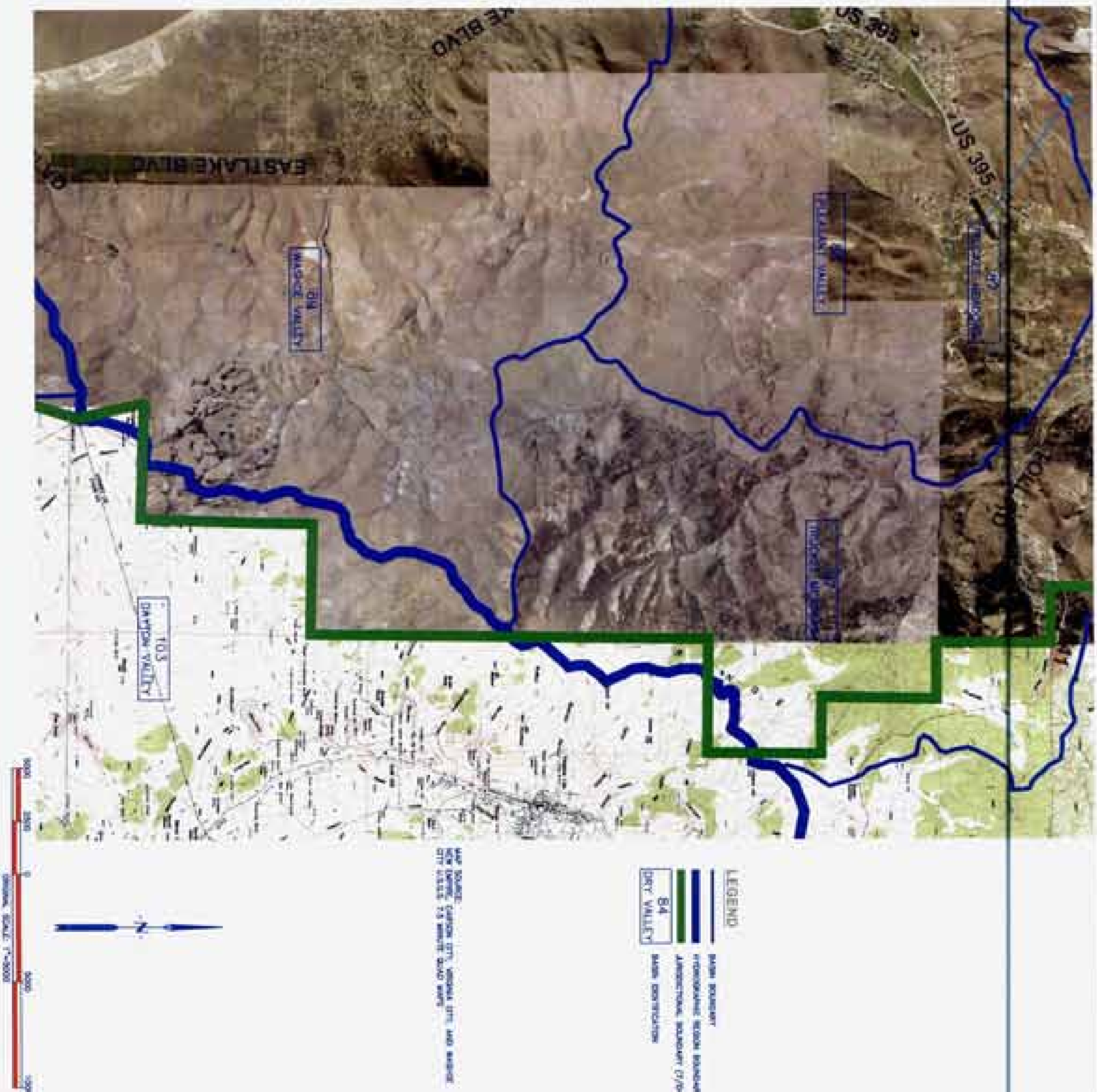


WRC ENGINEERING, INC

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K2α





WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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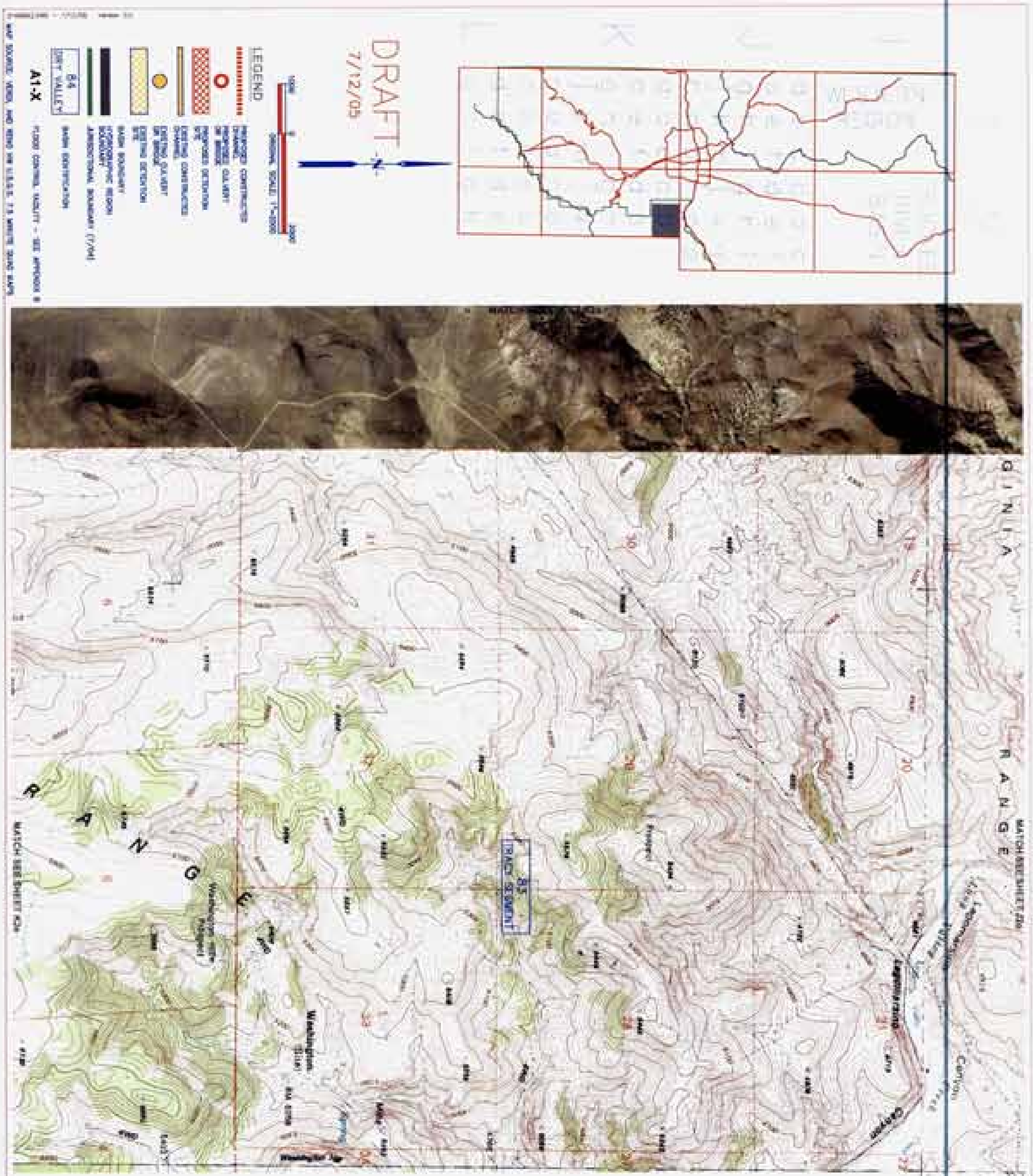
SEAL OF WASHOE COUNTY
STATE OF NEVADA

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

K2a



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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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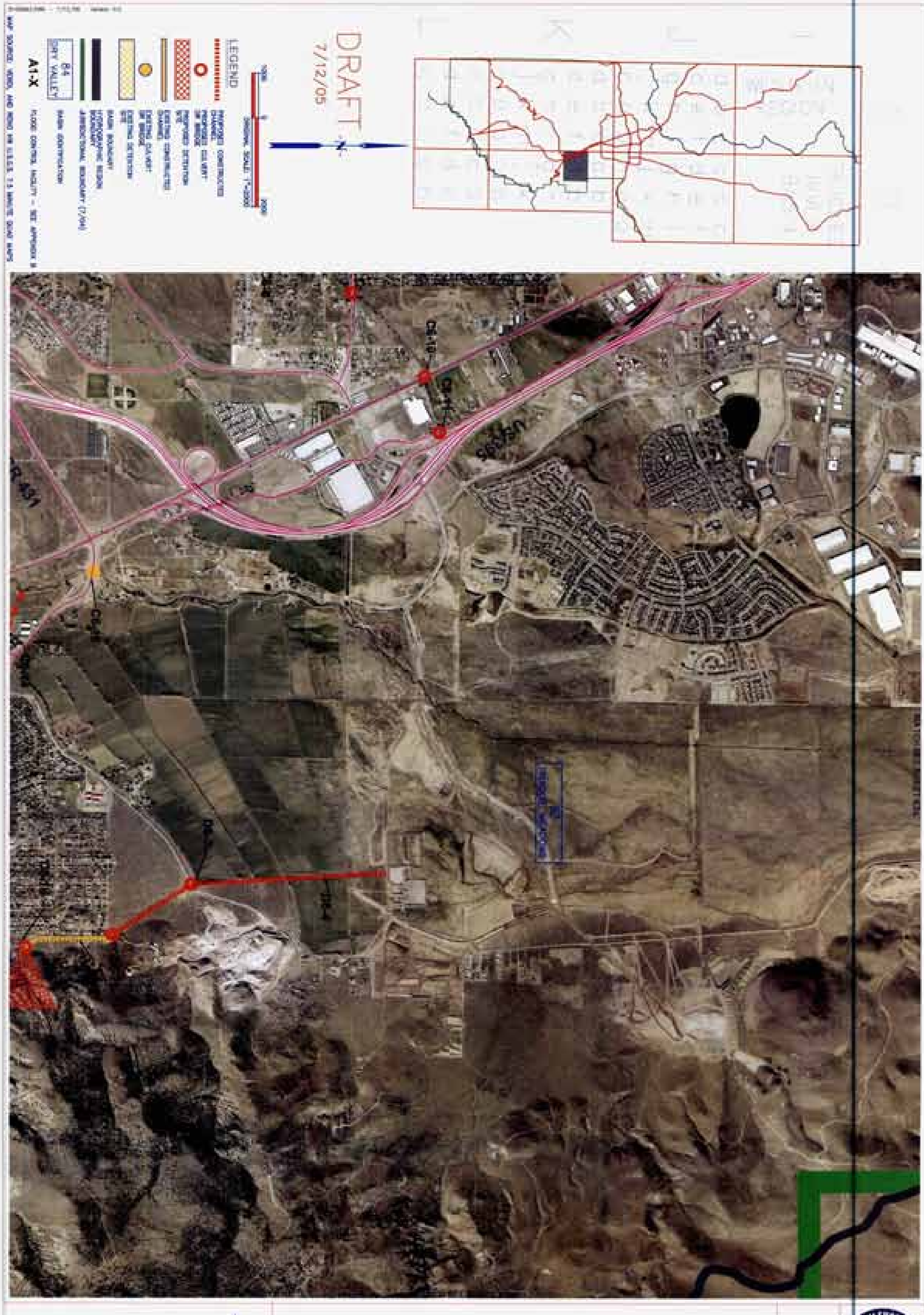

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WASHOE COUNTY
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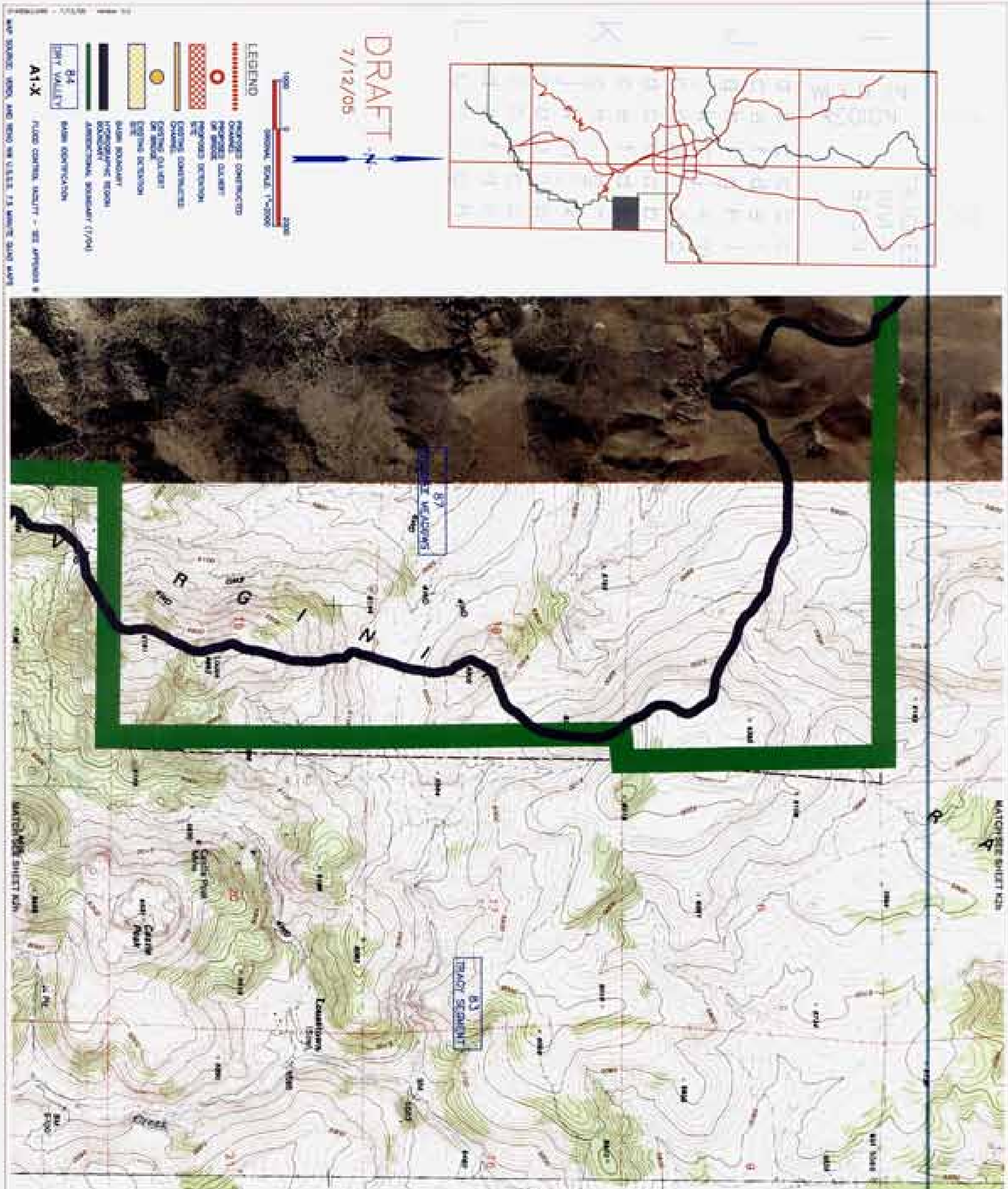

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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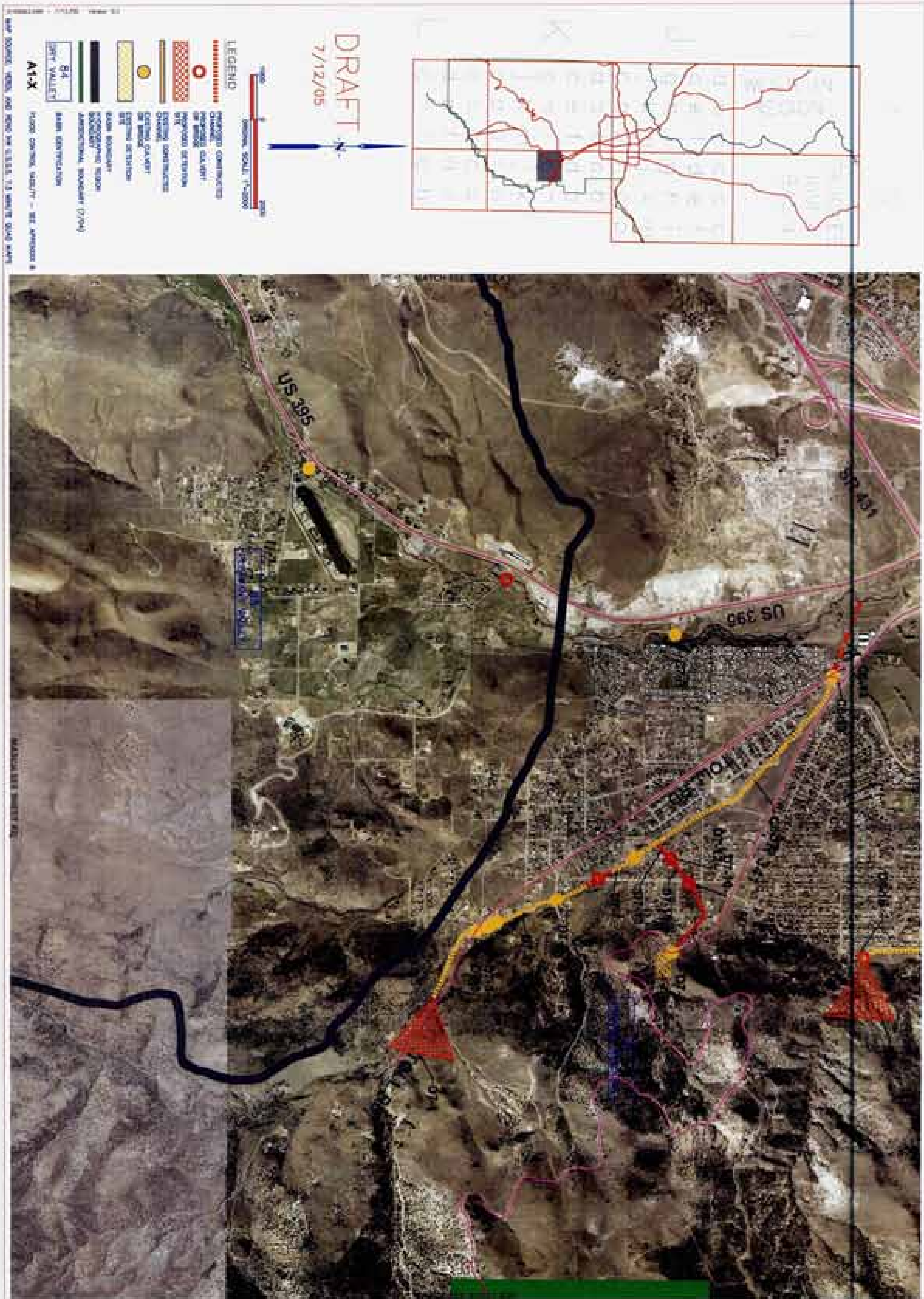

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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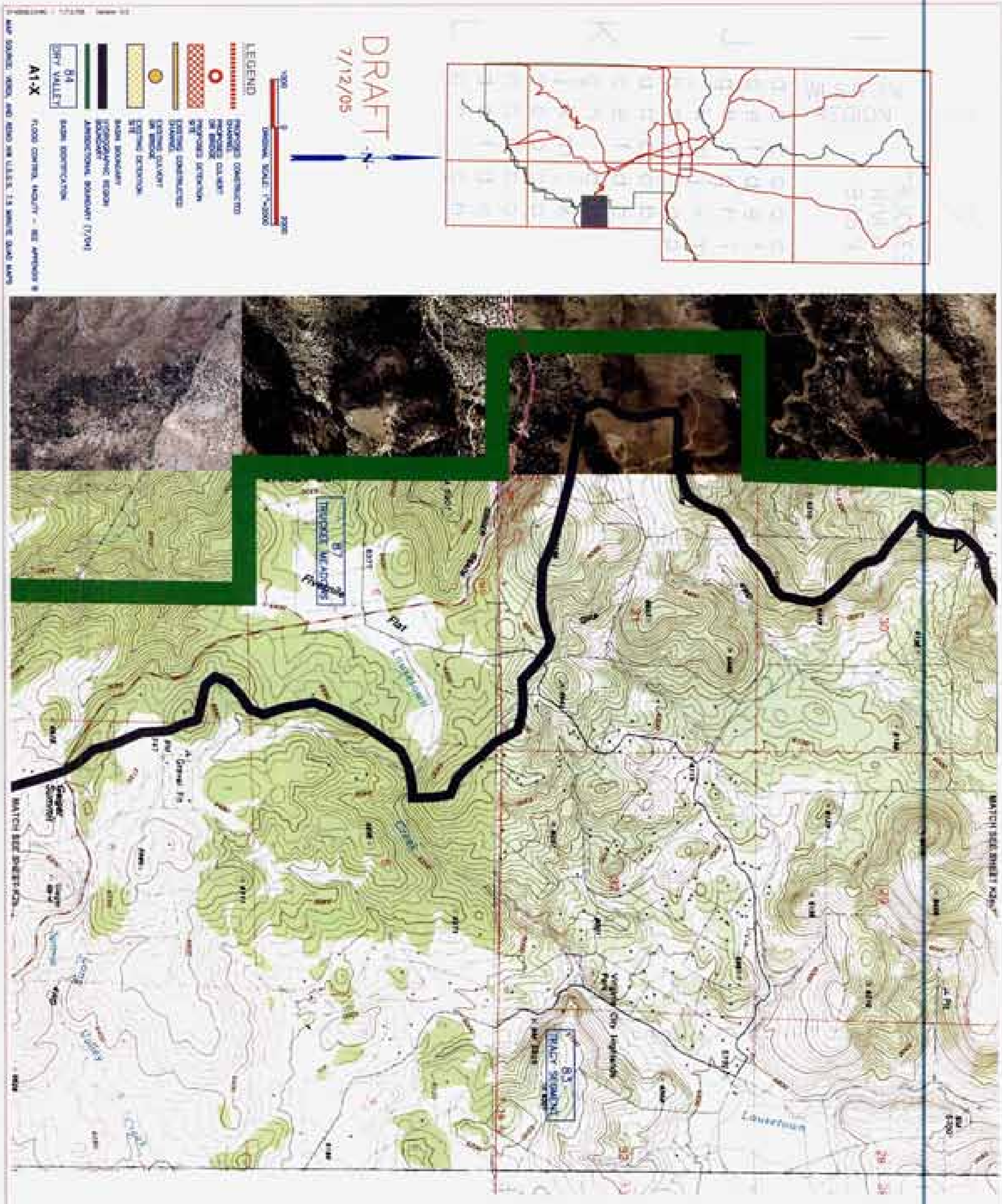

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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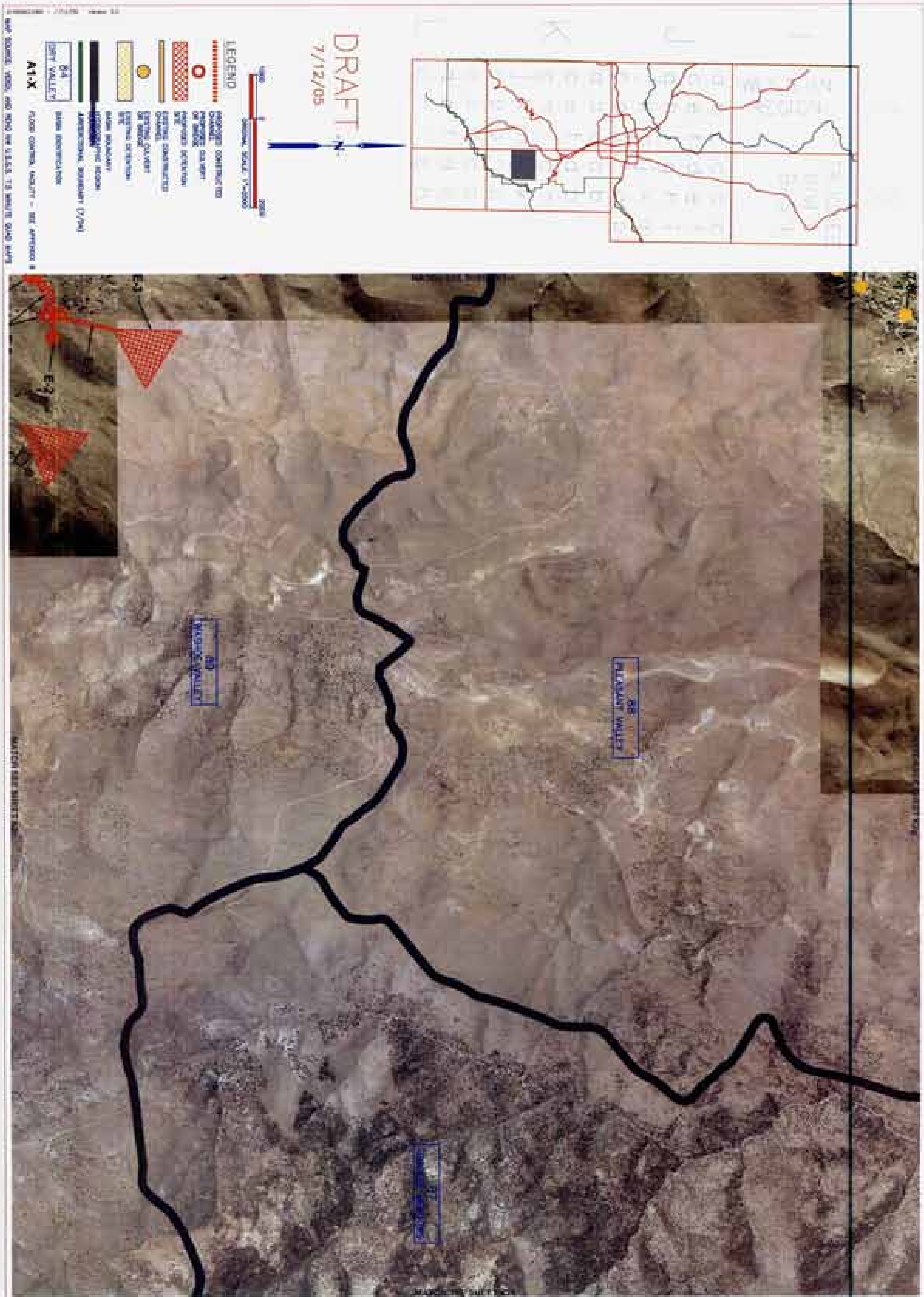

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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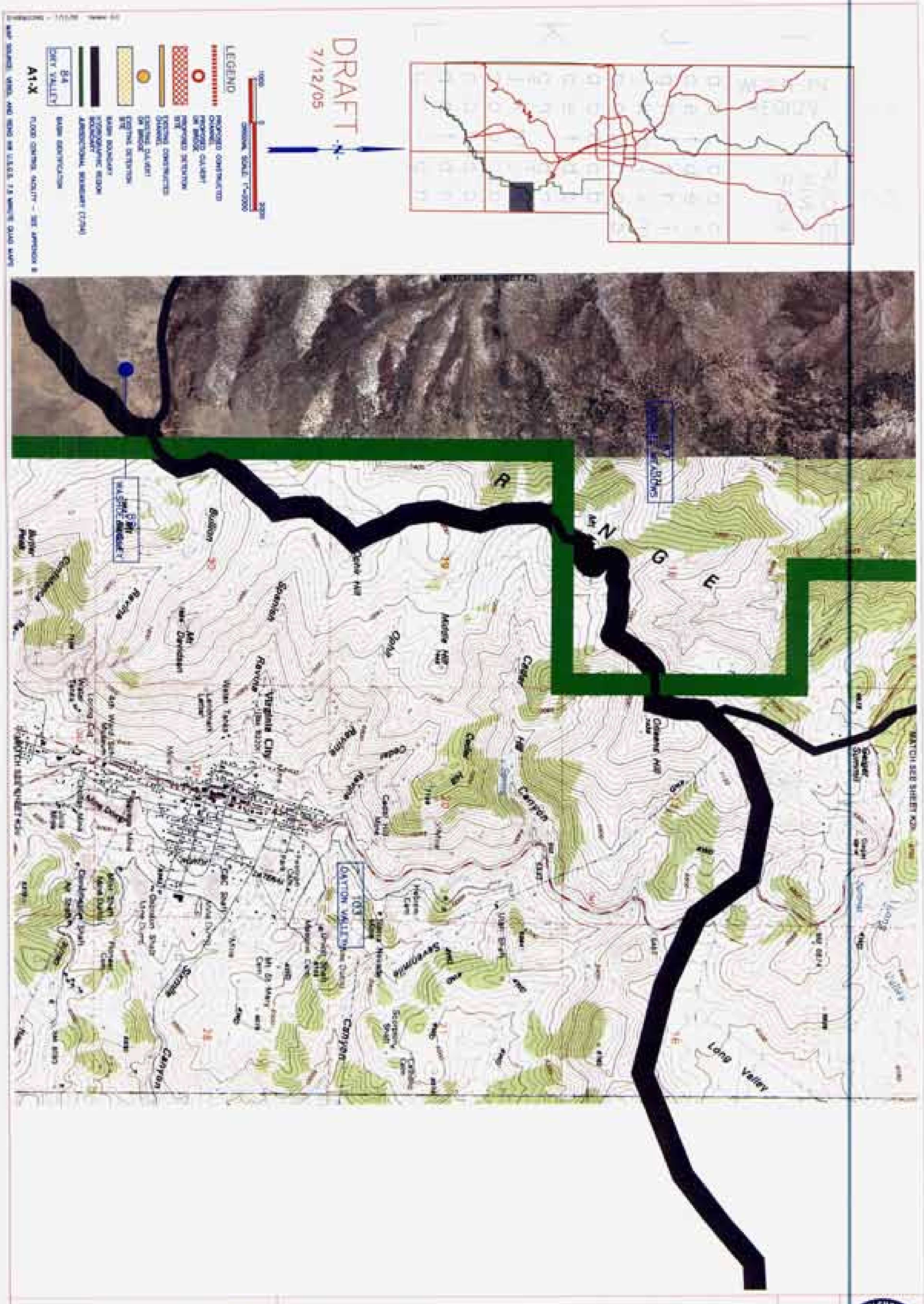

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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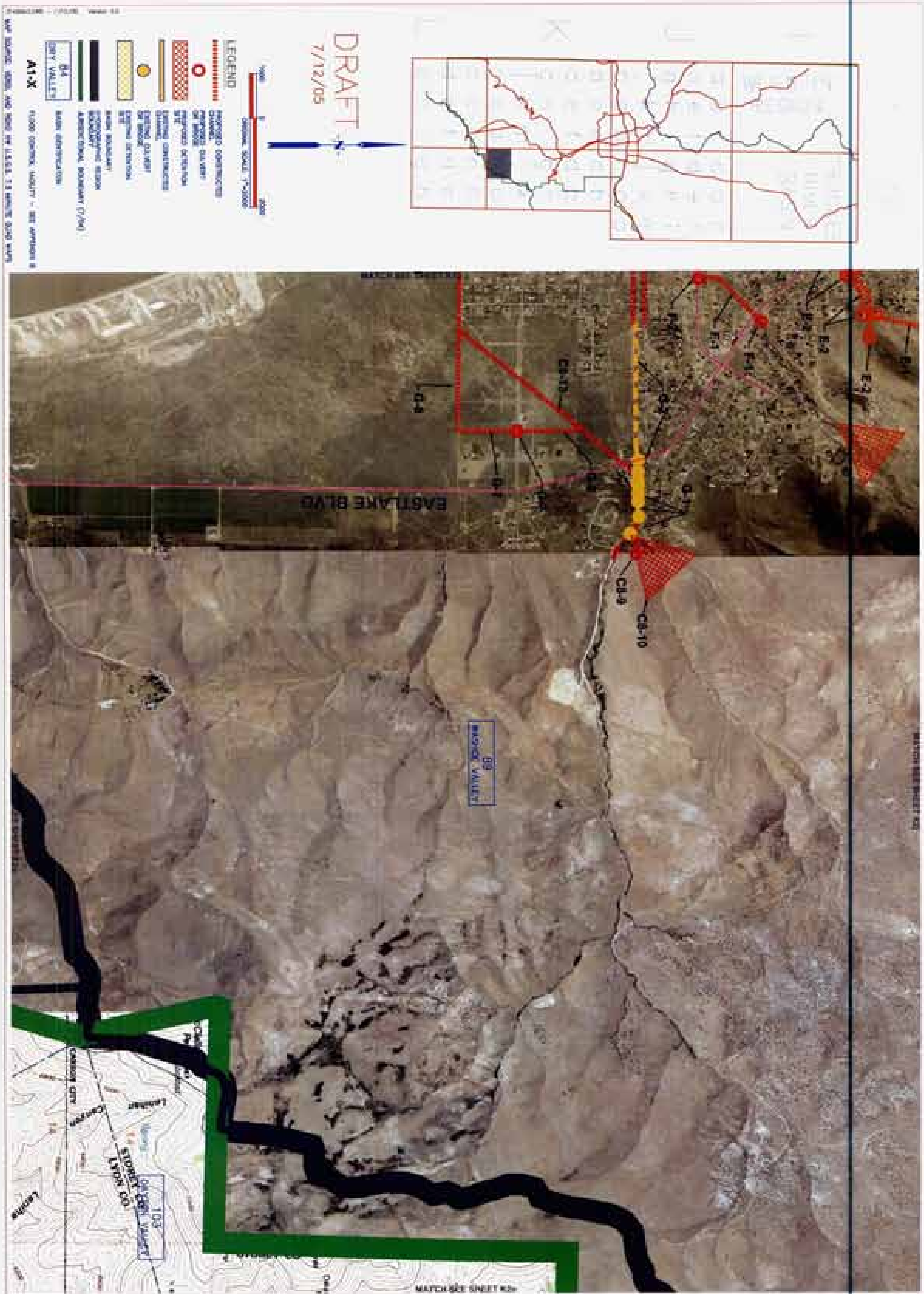

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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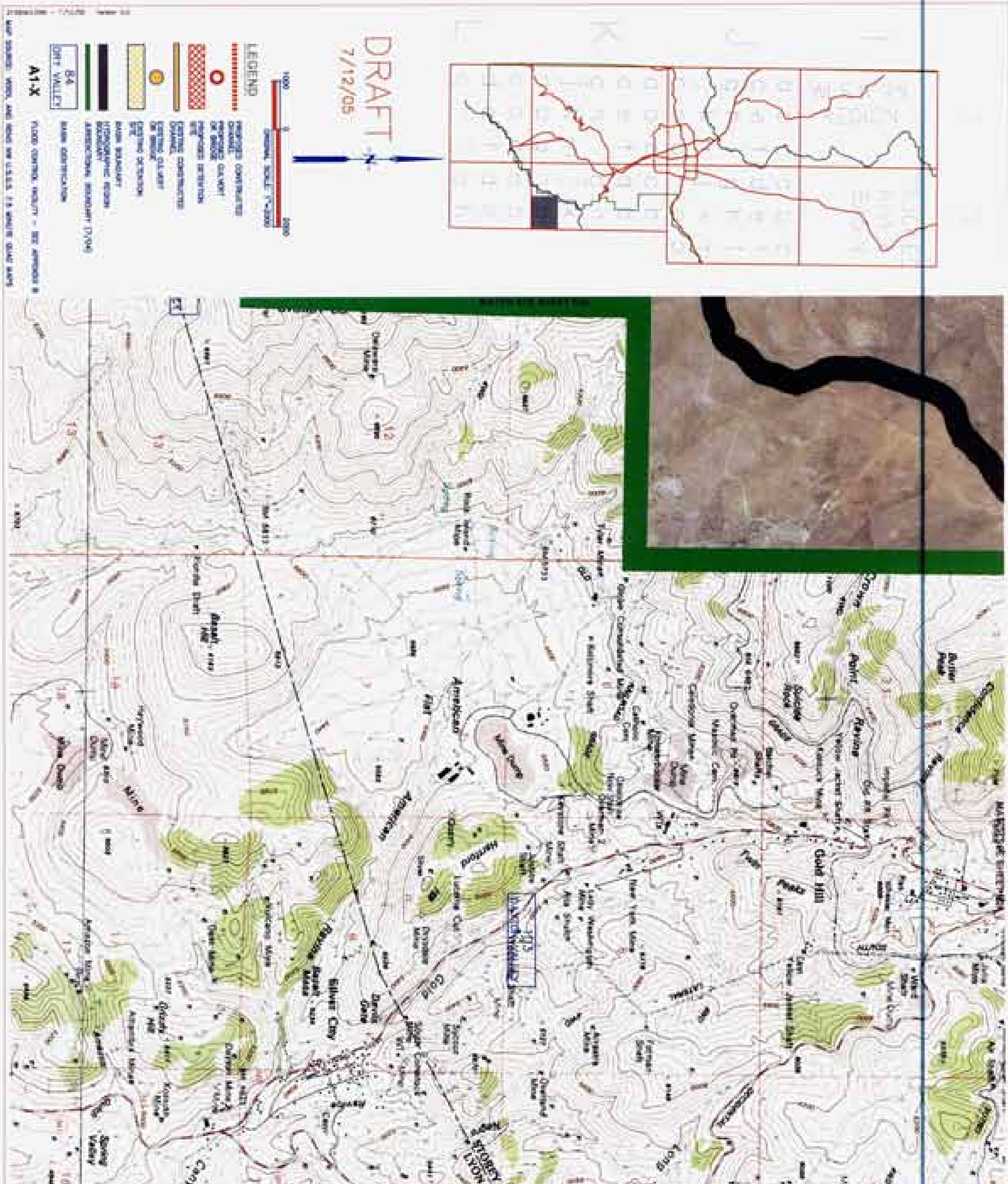
SEAL OF WASHOE COUNTY
STATE OF NEVADA



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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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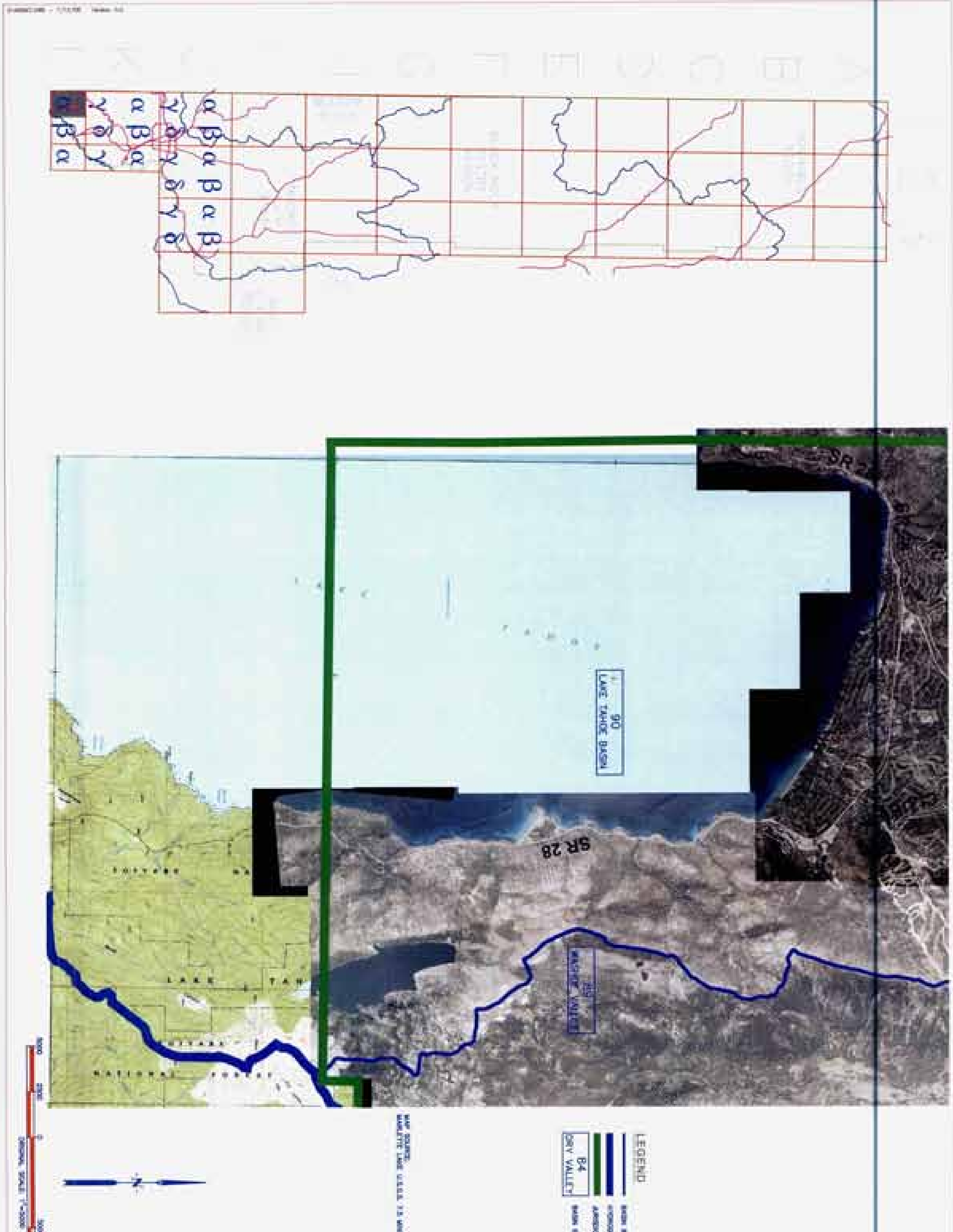

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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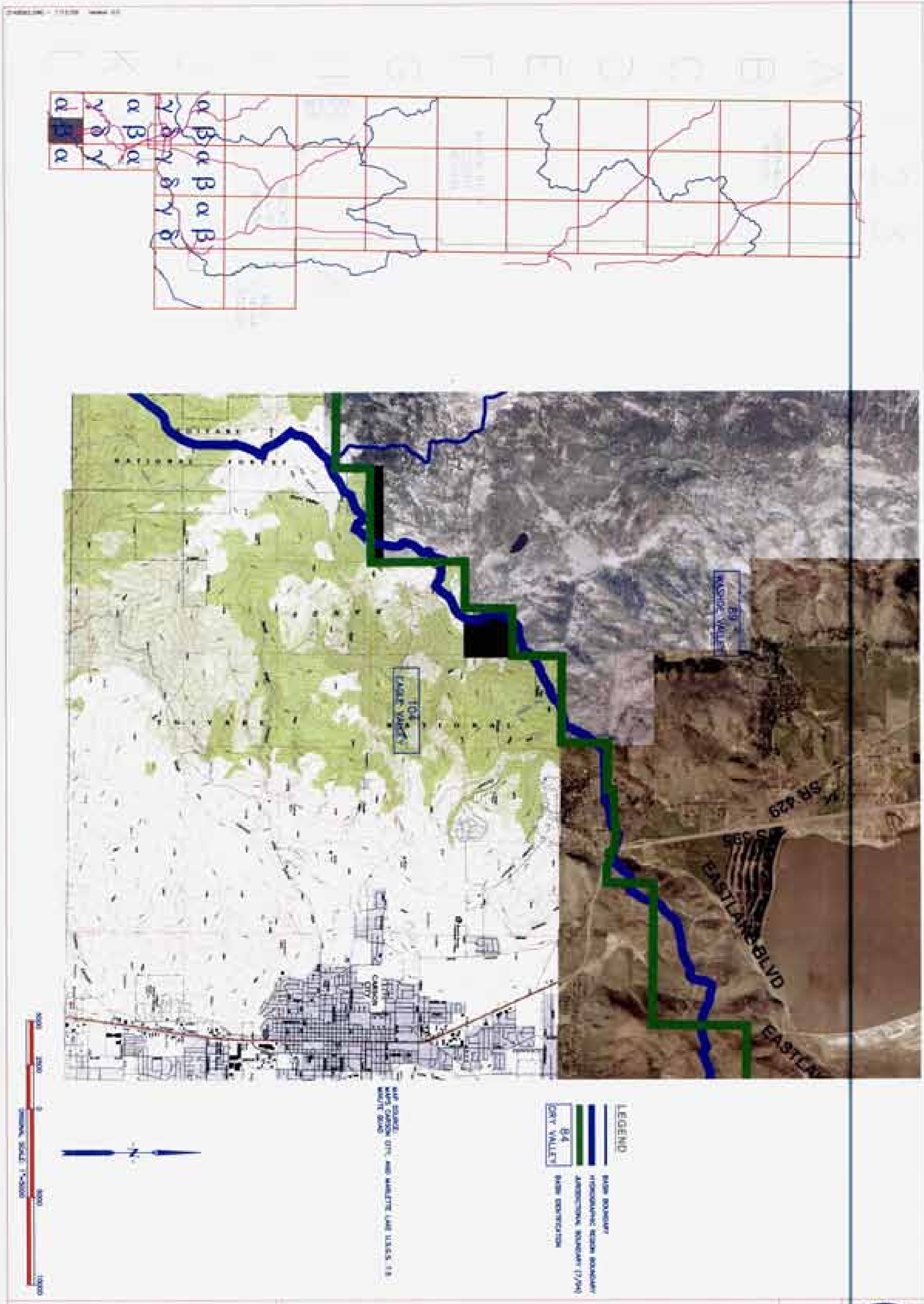

WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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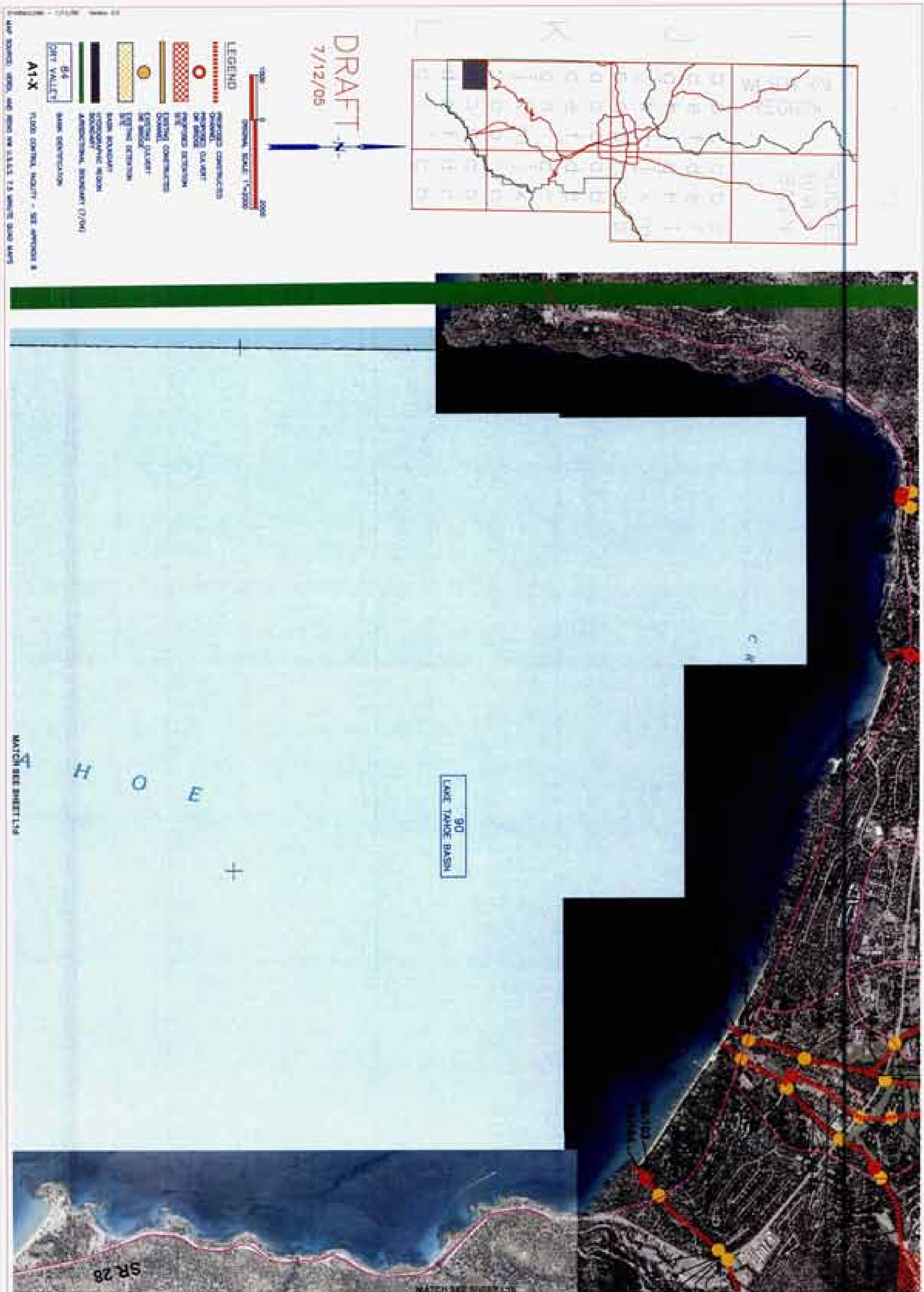

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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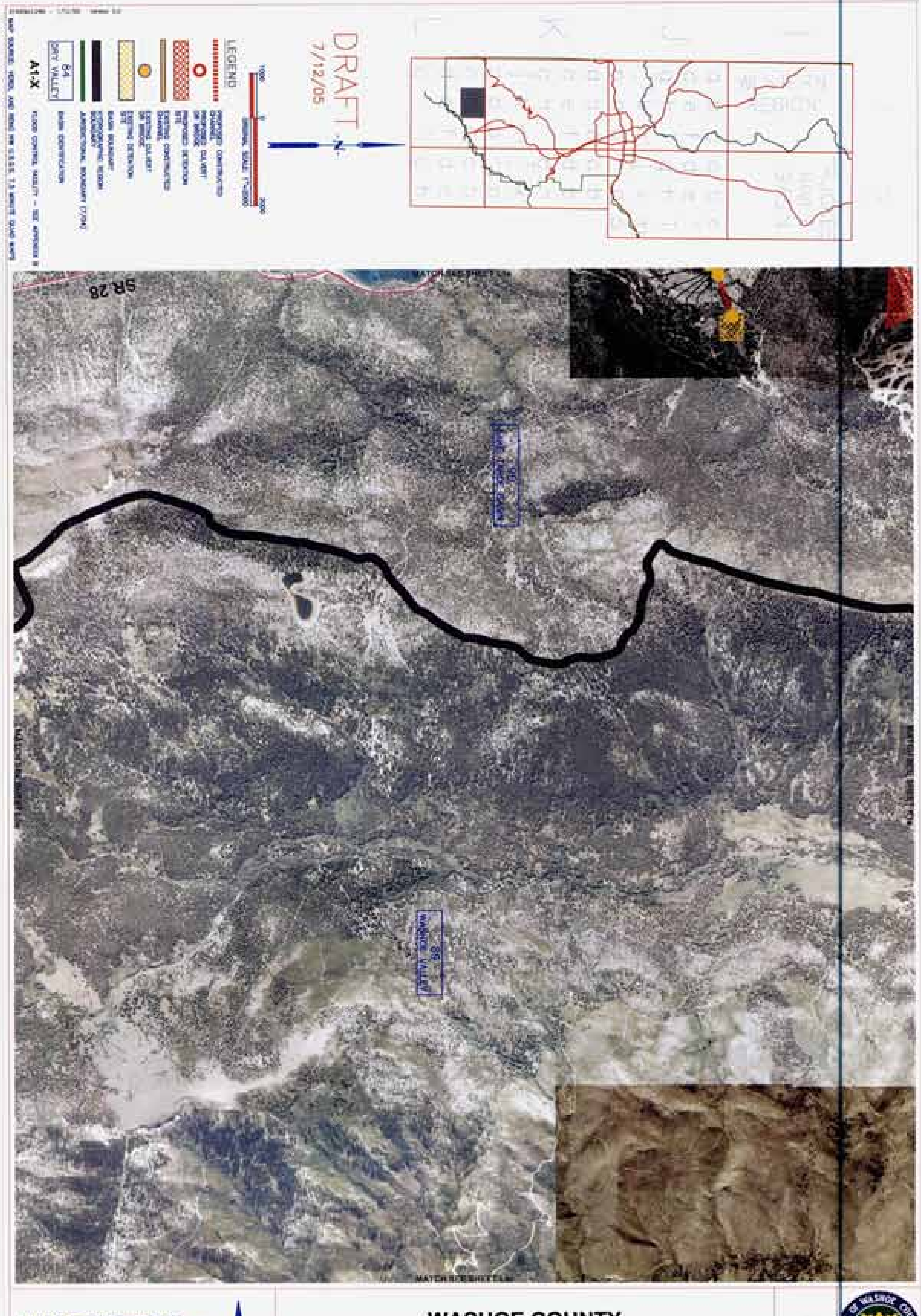

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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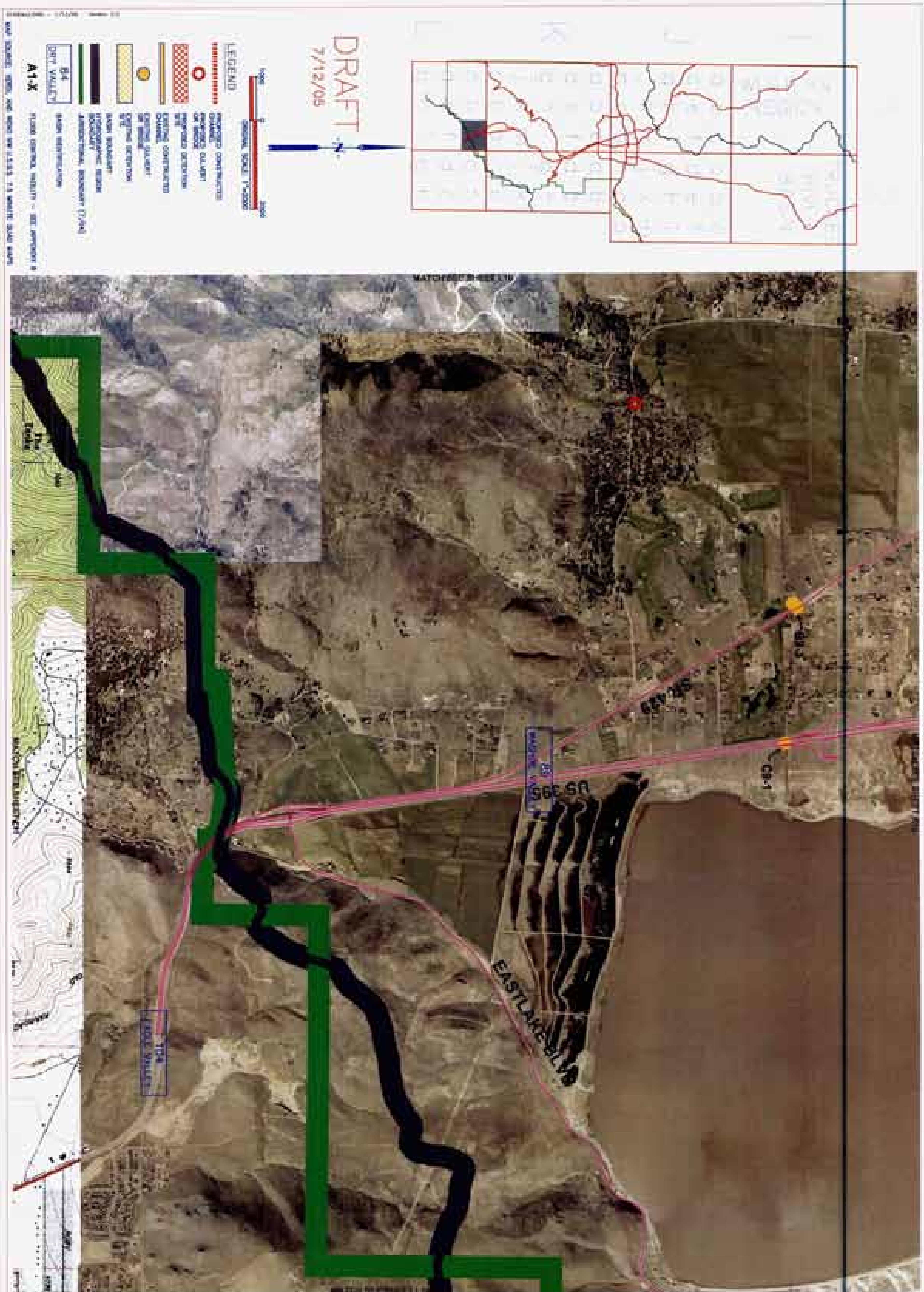

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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WRC ENGINEERING, INC.

WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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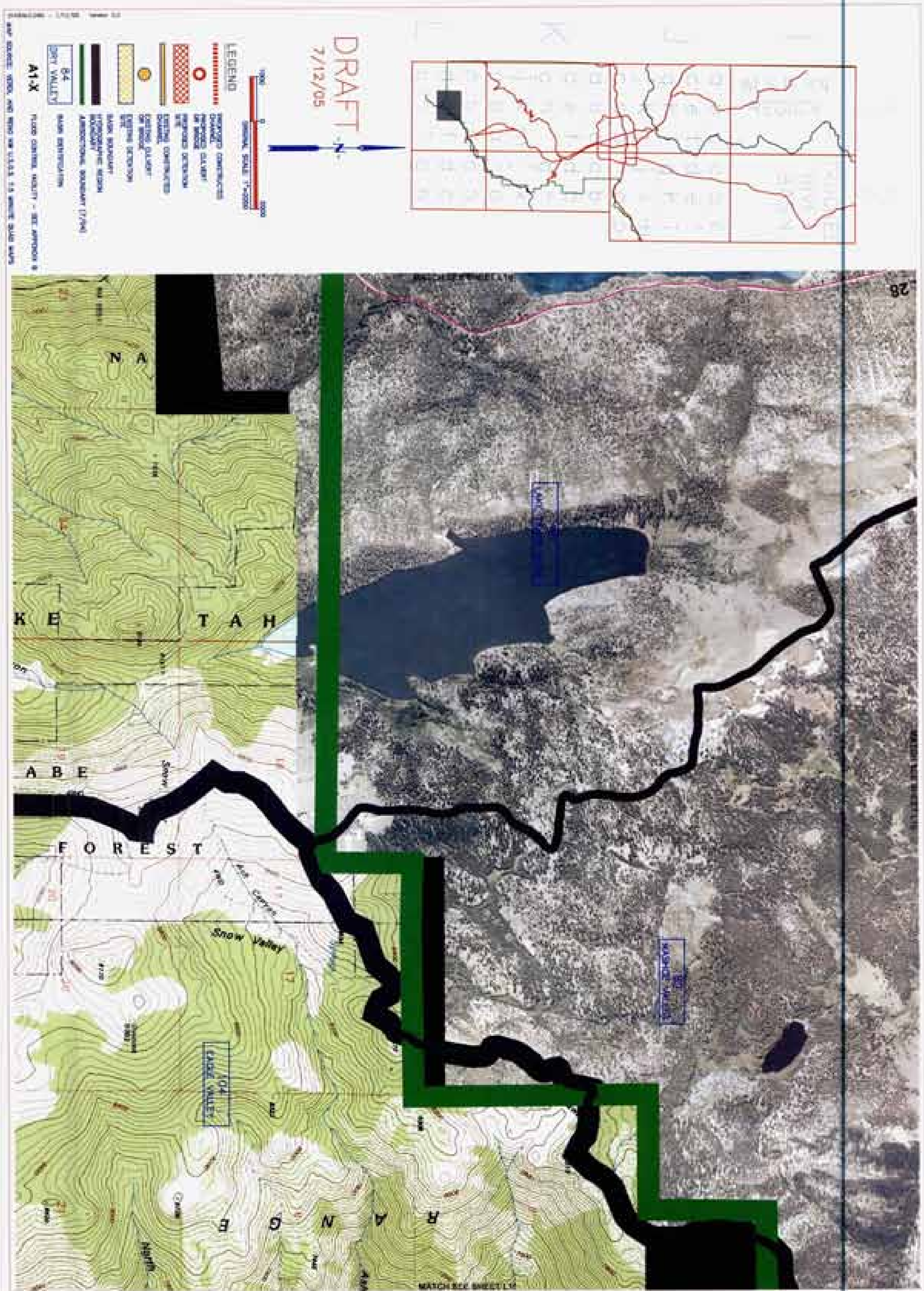

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REGIONAL FLOOD CONTROL MASTER PLAN

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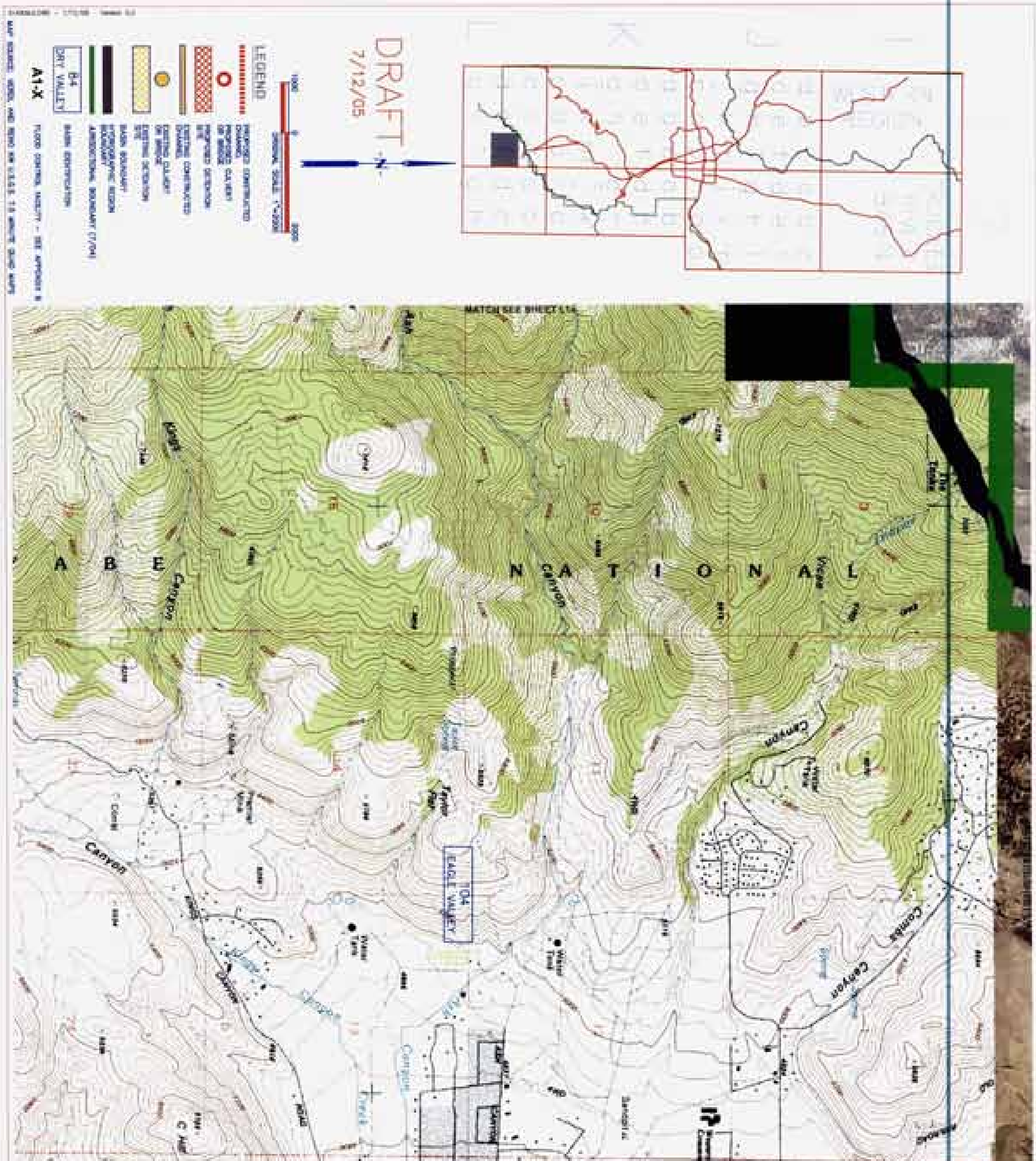

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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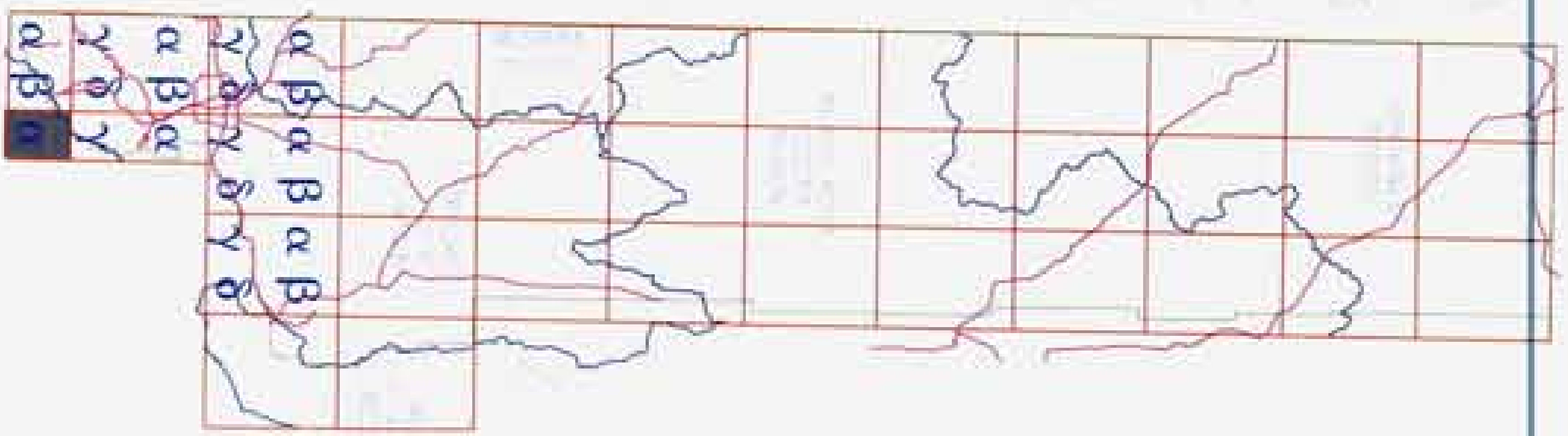

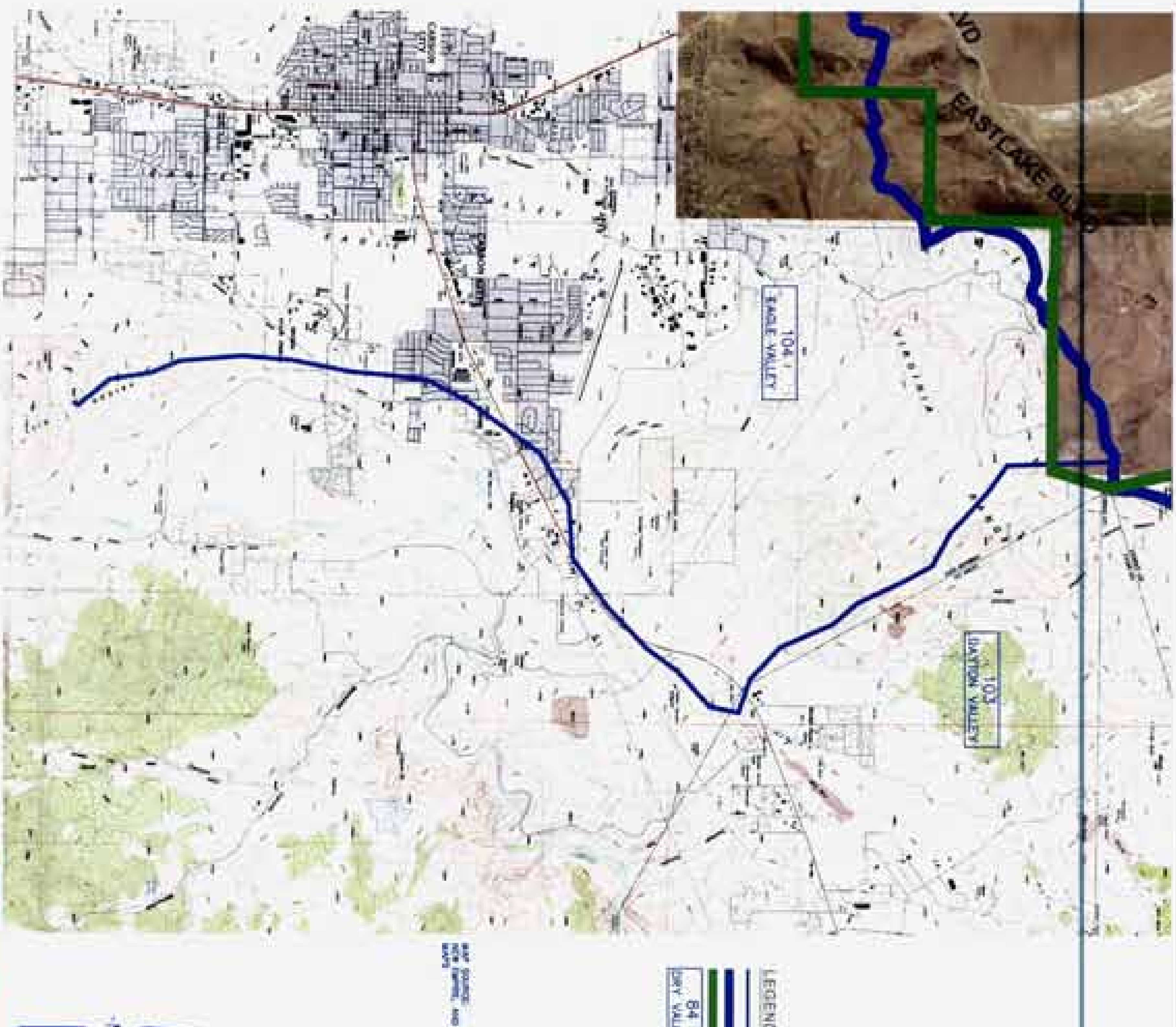

LEGEND

BASIN BOUNDARY
HYDROGRAPHIC REGION BOUNDARY
JURISDICTIONAL BOUNDARY (7/04)
84 DRY VALLEY — BASIN IDENTIFICATION

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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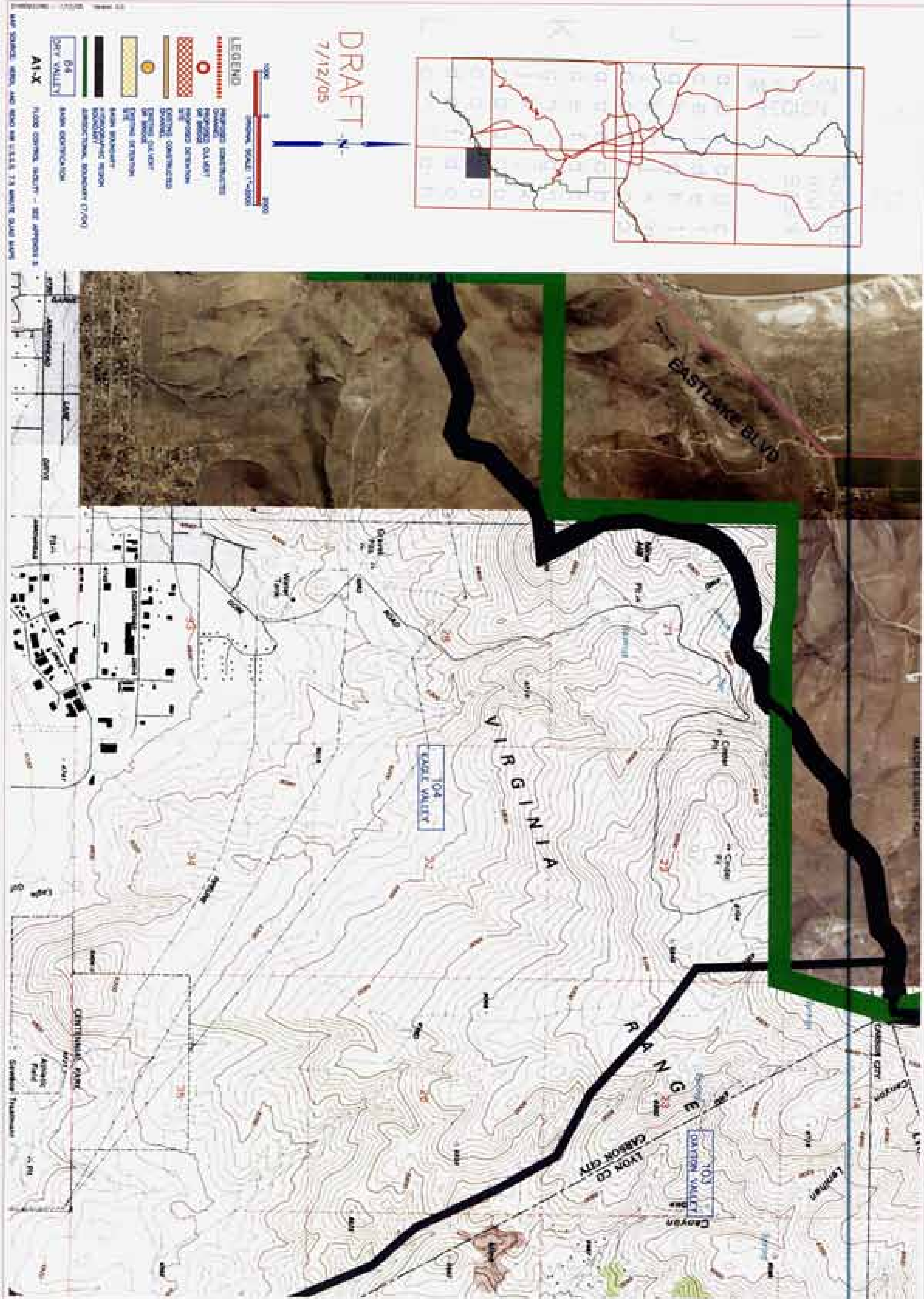

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WASHOE COUNTY
REGIONAL FLOOD CONTROL MASTER PLAN

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APPENDIX B

WATERSHED SPECIFIC REGIONAL FLOOD CONTROL MASTER PLANS

APPENDIX B. WATERSHED SPECIFIC REGIONAL FLOOD CONTROL MASTER PLANS

B1. GENERAL

As shown on Figure 1, watershed specific drainage/flood control master plans have been prepared and adopted for some of the developing watersheds within the southern part of Washoe County. These watershed-wide master plans have been prepared to identify the regional drainage facilities that are necessary to reduce the existing and future drainage/flooding problems within the study watersheds. Brief summaries of the adopted existing master plans are provided in this chapter. The regional flood control facilities identified by the adopted master plans are shown on the 1"=2000' scale maps (Maps in Appendix A). For detailed discussions and backup documentations for the master plans that are included in this chapter, readers are referred to the individual master plan reports.

It is envisioned that for the watersheds that are currently without adopted master plans, separate watershed specific master plans would be prepared in the future for all development affected streams, drainage ways, and watersheds. The framework of this chapter has been developed to readily allow for inclusion of future watershed drainage/flood control master plans. All future master plans should be prepared in accordance with the guidelines previously provided in Section V.

Adopted drainage master plans for individual developments are not included in this chapter. The drainage facilities that are proposed and/or constructed for land development projects are usually constructed to mitigate the adverse impacts created by the respective developments, not for the benefit of the region/watershed where the developments are located in.

Tables B1 and B2 list currently available watershed specific master plans and their proposed improvement costs, respectively. When additional watershed specific master plans become available, they can be added to these tables and summaries of the plans can be added to this appendix.

Table B1 List of Areas with Watershed Specific Master Plans

Watershed Plan Area	Plan Date	Section
Spanish Springs Valley	January 2001	B2
Sun Valley	April 1997	B3
Stead/Lemmon Valley	August 2000	B4
East Washoe Valley	June 1998	B5
Reno Re-Trac	June 2003	B6

Table B2 Summary of Improvement Cost Estimates

Watershed Plan Area	Total Cost Estimate of Improvements (Thousand U.S. Dollars)
Spanish Springs Valley	6,030
Sun Valley	No Cost Estimates
Stead/Lemmon Valley	8,369
East Washoe Valley	8,066
Reno Re-Trac	No Cost Estimate

B2. SPANISH SPRINGS VALLEY

Spanish Springs Valley Flood Control Master Plan, January 2001
Prepared by Harding ESE
Prepared for City of Sparks, Nevada

The Spanish Springs Valley Flood Control Master Plan (SSVFCMP) was prepared by Harding ESE for the City of Sparks in January 2001. The 2001 SSVFCMP was prepared to update the original 1991 Spanish Springs Master Plan and the 1996 Addendum Drainage Master Plan to reflect the development and drainage conditions that existed or planned at the time of their study.

The original Drainage Master Plan was prepared by SEA Inc. in 1991 for the Nevada Hereford Ranch. Two main alternatives were evaluated as part of the original Master Plan. Alternative A included the diversion of a portion of the Spanish Springs Valley watershed to Boneyard Flats located in the northern part of the valley along with full channelization within the valley and additional detention facilities downstream of the Spanish Springs Detention Facility. Alternative B did not include the Boneyard Flats. Instead all of the ultimate condition flows would be accommodated in the Spanish Springs Valley within the present drainage pattern by full channelization within the valley. It also included raising the existing Spanish Springs Detention Dam and spillway crest to provide additional storage, restricting the Spanish Springs Detention Dam box culvert outlets with restrictor plates, and providing additional detention facilities downstream of the Spanish Springs Detention Facility.

In 1996, SEA, Inc. updated the original 1991 Master plan to include the planned developments located in the northeast portion of Spanish Springs Valley. This revised version is referred to as the Addendum Drainage Master Plan and was prepared for the City of Sparks and major land developers in the area. As part of this Plan, the maximum allowable peak flow rates for the 100-year storm event were determined for ultimate developed conditions at selected points in the Valley. This Addendum Plan incorporated both Alternatives A and B from the previous 1991 Drainage Master Plan.

The latest 2001 Spanish Springs Valley Master Plan was updated to provide recommendations for implementing flood control measures that would allow continued development of the area without causing significant impacts on peak flood flows downstream. A separate HEC-1 model was developed for the proposed floodplain detention facility located in north Spanish Springs Valley.

For the existing conditions, the HEC-1 model was modified to include all existing and ongoing residential and commercial developments in unincorporated Washoe County and the City of Sparks through approximately July 2000. The current conditions model met all Addendum flow constraints except one. At the east boundary of one of the subdivisions, the flow entering Reach 7 Channel was calculated to be 1,071 cfs which exceeded the Addendum flow constraint of 973 cfs. The storage volumes in the detention basins were not adequate to sufficiently detain runoff from the sub watersheds, but in the ultimate conditions model, the storage volumes were increased in order to meet the Addendum flow constraint.

The ultimate conditions HEC-1 model for Spanish Springs Valley was modified to include all existing and planned residential and commercial developments within Washoe County and the City of Sparks through the final stages of development. Changes made to the ultimate conditions were made based upon the models contained in the flood control master plans for proposed developments in the area. The ultimate conditions model contained higher flow as a result of a shorter lag time because flow is routed toward Reach 9 and not north through the longer flow path along Pyramid Highway as in the current conditions model. Total inflow into the Spanish Springs Detention Facility (3,501 cfs) also exceeded the Addendum flow of 3,196 cfs. However, at the detention facility the water surface elevation in the ultimate conditions model (4455.6 feet) did not exceed the spillway elevation of 4455.8 feet. The overall results of the ultimate hydrologic model showed that many of the peak flows approached Addendum flow constraint values but did not exceed them.

B3. SUN VALLEY

Drainage Master Plan for Sun Valley, Washoe County, Nevada, April 1997
Prepared by SEA, Inc.
Prepared for Washoe County

SEA, Inc. was contracted by Washoe County to prepare a valley-wide hydrologic analysis and a conceptual 10-year storm drain master plan for Sun Valley, located in Washoe County, Nevada. Due to the inadequate capacity of the existing storm drain systems, Sun Valley has been experiencing frequent flooding/drainage problems even during minor storm events. This Master Plan addresses the storm drainage improvement needs for a portion of the Sun Valley watershed. Phase I of the project included a development of the hydrology for the eastern portion of Sun Valley along Yukon Drive and Lupin Drive. Phase II included a completion of the valley-wide hydrologic analysis, and the development of a conceptual storm drain master plan for a 10-year, 24-hour storm event.

Sun Valley is located in Washoe County, just north of the City of Reno, within Sections 6, 7, 8, 17, 18, 19, 20, 29, and 30 of Township 20 North, Range 20 East, and Sections 12, 13, 24, and 25 of Township 20 North, Range 19 East. The total contributing Sun Valley watershed is approximately 9.6 square miles, and ranges in elevation from 5861 feet to 4520 feet at the Wildcreek Detention Dam. The upper watersheds are mostly vegetated and the lower part of the watershed contains mainly residential and commercial developments.

The existing storm drain system through the developed areas of Sun Valley includes roadside ditches with culverts under roads and driveways. The capacity of the ditches and culverts are minimal. The storm runoff flows from the valley eventually enter into the Wildcreek Detention Dam, located just upstream of Wildcreek Golf Course. The Wildcreek Detention Dam was designed by SEA in 1987 to reduce the 100-year, 6-hour event outflows to approximately 213 cfs.

The Drainage Master Plan was prepared based upon methods outlined in the Draft Washoe County Hydrologic Criteria and Drainage Design Manual and/or decisions made by Washoe County during progress meetings between Washoe County and SEA.

In order to create a consistent methodology used for the entire watershed, SEA utilized the U.S. Army Corps of Engineers (COE) HEC-1 Flood Hydrograph package to calculate all flow rates for the Sun Valley watershed. Three hydrologic models were developed for the master plan including proposed conditions 10-year, proposed conditions 100-year, and existing condition 100-year models.

Undersized culverts and channels located within the developed area caused storm flows to divert to different ~~areas. To simplify the hydrology, diversions within the developed areas were not analyzed. At other locations,~~ split flow ratings and diversions were calculated using the survey data supplied by Washoe County. The proposed Sun Valley master storm drain system was designed to convey the 10-year, 24-hour event storm runoff utilizing open channels and culverts under roadways and driveways.

The total outflow from Stone Creek Detention Basin F during a 100-year, 24-hour event was calculated to be approximately 210 cfs. In proposed conditions, approximately 120 cfs will be diverted to the Spanish Springs watershed and 21 cfs of the remaining flow routed through the Stone Creek detention basins. The remaining flows will be conveyed in Klondike Drive and remain in the Sun Valley drainage basin.

The proposed system is very similar in nature to the existing drainage system. The total storm water runoff from Sun Valley basins were assumed to flow into the retention basin at the southwest corner of 7th Avenue and Sun Valley Drive intersection. Proposed open channels and trapezoidal channels were sized accordingly and all proposed culverts were sized assuming inlet control conditions.

B4. STEAD/LEMMON VALLEY

Drainage Master Plan for Stead, Nevada, August 2000
Prepared by Stantec Consulting, Inc.
Prepared for City of Reno, Nevada

The Stead Drainage Master Plan was prepared by Stantec in August 2000 at the request of the City of Reno. The purpose of this report was to develop a comprehensive drainage document specifically for the Lemmon Valley Basin. The report and associated models identified existing hydrologic drainage patterns in the Lemmon Valley Basin, and quantified amounts of storm runoff at specific locations. The results of the analysis provided identification of present condition flooding and problem areas within the region, so that capital flood improvements may be scheduled and undertaken. The projected hydrologic models may be used to provide a strong foundation for planning and future development in the area.

Stead is a small suburb of Reno located approximately 10 miles north of Reno. Stead lies within Lemmon Valley, one of numerous desert valleys found throughout the region. Lemmon Valley is bounded on the south by Peavine Mountain and on the west by the Granite Hills range. The northern boundary is defined by Fred's Mountain and the Hungry Mountains and to the east by the Hungry Ridge.

The Master Plan was initiated under contract with the City of Reno in December 1997. The plan was prepared solely for the City of Reno for the purposes of analyzing existing and proposed hydrology, to incorporate proposed design improvements from previous studies, to provide scheduling and opinions of probable construction costs for proposed improvements, and lastly, to provide conceptual sizing of a regional retention basin for the Silver Lake area.

Previous studies prepared for the Stead area were compiled and reviewed with regard to identifying previous hydrologic criteria, drainage basins, and proposed improvements. Pertinent information was incorporated into the Stead Master Plan. The Stead Master Plan hydrologic models included almost 100 separate sub-basins. The Lemmon Valley watershed shared many of the same growth increases as those found in the Reno-Sparks area. The Airport Authority of Washoe County has a master plan in place for the Stead Airport that included new roadway, infrastructure and industry. Easy access to transportation corridors had spawned the growth of manufacturing and warehousing throughout the area. The Master Plan hydrologic models prepared for the City are intended to provide a planning level view of the impacts of continued growth throughout the watershed. The models included revisions in several areas that will profoundly affect the existing drainage patterns. Modifications to the existing conditions model are summarized in more detail under the specific improvement plans.

The major difference between the existing conditions hydrologic models and the proposed models was the use of higher runoff curve numbers. The higher numbers were a direct result of projected development within the overall watershed. Other changes within the models included proposed channelization and improvements west of Stead Boulevard, and in the Military Road/Lemmon Drive area, as well as a regional retention basin north of the airport.

In summary, this Master Plan identified existing hydrologic patterns in the Lemmon Valley basin and quantified amounts of storm runoff at specific locations. Results of the analysis provided identification of present condition flooding and problem areas within the region, so that capital flood improvements may be scheduled and undertaken. Projected hydrologic models have been prepared with the intent to provide a strong foundation for planning and future development in the area. The recommendations presented in the Master Plan included following:

- Adopt and enforce master plan
- Implement the phased improvements as recommended.
- Review proposed developments for compliance with the master plan
- Require proposed developments to update the master plan for their specific development and show compliance with the master plan.
- Coordinate with Washoe County to develop threshold criteria for the implementation of a Regional Retention Basin.
- Coordinate with the Airport Authority on the development of an airport storm drainage master plan.
- Coordinate the implementation of the Southwest Lemmon Valley Flood Control projects.

B5. EAST WASHOE VALLEY

Storm Drain Master Plan for East Washoe Valley, Washoe County, Nevada, June 1998
Prepared by Stantec Consulting, Inc.
Prepared for Washoe County

The Conceptual Storm Drain Master Plan for East Washoe Valley, located in Washoe County, Nevada is based on the Floodplain Management Study conducted by the Natural Resources Conservation Service (NRCS) in July 1996. The watersheds studied in this Master plan are located in the northeastern portion of Washoe Valley and drain through the residential areas of New Washoe City.

The city has experienced numerous flooding events with significant erosion and sediment deposition due to insufficient capacity of the existing storm drain system. Sediment accumulation during storm events has significantly reduced the capacity of the existing drainage culverts and added to flood damage and maintenance costs over the years. Therefore, in addition to the need to increase the capacity of the existing system, sediment retention basins are required to retain the sediment produced from the upper watershed areas during storm events. The East Washoe Valley Master Plan addressed both the storm drainage and sediment control for East Washoe Valley. The design for the East Washoe Valley Storm Drain System was based upon methods outlined in the Final Draft of the Washoe County Hydrologic Criteria and Drainage Design Manual.

New Washoe City is located in the northeastern portion of Washoe Valley, about 15 miles south of Reno, in the southern part of Washoe County, Nevada. The study area is located between the crest of the Virginia Range on the east and northeastern shore of Washoe Lake on the west. The watersheds in the study area lie within Sections 19, 20, 21, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36 of Township 17 North, Range 21 East and Sections 1, 2, 3, 4, 5, 6, 7, 10, and 11 of Township 16 North, Range 21 East. The study area is comprised of seven watersheds, identified by the NRCS as watersheds A through G. These watersheds encompass approximately 10,000 acres with six relatively small watersheds and one large watershed.

Past mining and current recreational activities in the watershed have introduced numerous roads, which are sources of additional sediment during storm events. Existing culverts and ditches are generally undersized and most have a maximum capacity of only 5 to 10 cfs. Peak flows from a 10-year event have caused significant damage to houses, buildings, roadways, culverts, and channels, particularly in the Jumbo Watershed. The current flow capacity of several existing roadside ditches is sufficient to convey the 10-year storm event flow. However, significant sediment deposition has occurred at several locations along the channel. Therefore, all existing channels will require cleaning and deepening to accommodate larger culverts. In addition, many channel sections will require a protective lining or rip rap to reduce erosion.

After discussions with Washoe County, it was agreed that the 10-year recurrence interval peak flow rate and sediment yields from the study done by NRCS in July 1996 would be utilized in the Stantec analysis.

At the minimum, the sedimentation basins should be designed to retain the 10-year estimated sediment yields. Sediment retention basins upstream were proposed to minimize sediment deposition problems in proposed storm drain systems. These basins were designed to retain the estimated sediment yields produced by a 10-year, 24-hour storm event. In larger storm events, it is anticipated that storm water will overtop the proposed sediment basins. Therefore, design criteria for each basin should include overflow protection with an emergency spillway. In addition each basin is designed with a low flow channel, a low flow outflow culvert, and equipment access for periodic cleaning and maintenance.

The data used for analysis were obtained from Stantec survey data, Washoe County and USGS topographic maps, and field observations. All proposed channel sections were designed to convey the 10-year peak flows estimated in the NRCS study with a minimum of 1 foot freeboard. With the exception of the open channel sections at the downstream end of each watershed, all proposed storm drain open channels have a trapezoidal geometry with 2:1 side slopes. Open channels were constructed at the downstream end of each watershed drainage system. These channels were constructed with mild slopes that can be easily crossed by cattle and farm equipment.

Due to the highly erosive nature of the soils in the New Washoe City area and calculated 10-year flow velocities, the Washoe County Hydrologic Criteria and Drainage Design Manual require that the open channels be protected with a suitable lining. All proposed culvert structures were sized assuming inlet control conditions with headwater depths slightly less than or slightly greater than proposed culvert diameter or rise. Relatively large diameter culverts have been proposed in order to convey the 10-year peak flows in a single channel.

The proposed East Washoe Valley master storm drain system was conceptually designed to convey runoff from the 10-year, 24-hour storm event utilizing open channels and culverts under roadways and driveways. In larger storm events, it is anticipated that storm water will overtop the proposed storm drain system and roadways and travel in the existing flood paths as depicted in the 100-year and 500-year flood maps. The proposed system contains significantly larger open channels and culverts with the addition of upstream sediment retention basins. Also in the proposed systems for watersheds A through G, the alignment of the drainage channels and culverts were adjusted to remove the existing 90-degree bends in order to increase capacity.

This Storm Drain Master Plan utilizes the existing right-of-way information provided by Washoe County for the conceptual design of the proposed storm drain system for each watershed. All new and improved roadside channels were designed to fit within the existing right-of-way. In addition, proposed open channels crossing private property were routed along property lines to minimize disturbance and to reduce land acquisition costs when hydraulically feasible. Notably, peak flow rates for watersheds C, D and G indicate that flow at Washoe Lake will be less during the 10-year storm than flow at the upstream concentration points. This proposed drainage system was designed to convey the entire 10-year peak flow within open channels and culvert systems without flooding.

B6. Reno ReTrac

ReTRAC Drainage Report, June 2003
Prepared by Stantec Consulting, Inc.
Prepared for City of Reno, Nevada

The ReTrac Drainage report was prepared for the City of Reno by Stantec in June 2003. This report provided a hydrologic and hydraulic evaluation of the Reno Railroad Corridor from the Union Pacific Railroad (UPRR) crossing at West Second Street east to the railroad crossing at Sutro Street. This report was prepared for the limited purpose of evaluating the impacts of offsite watersheds on the project and to analyze proposed improvements for the project. It was not intended for identifying or solving existing flooding problem areas within the City of Reno, but to ensure that the ReTrac project did not increase existing flooding conditions.

The project consisted of lowering the rail within a trench through the City of Reno. Potential flooding sources for the project included the Truckee River and the watershed area up gradient of the project site. A multi-purpose barrier wall was proposed to border the entire depressed rail section. One of the functions of this barrier was to prevent any potential floodwaters from the Truckee River or the watershed area up gradient of the project site from entering the depressed rail section.

A series of storm drain systems were proposed to intercept storm runoff from the watershed area up gradient of the depressed rail section. The existing storm drain crossing and flow path remained in its current configuration for the West Second Street and Vine Street storm drain systems. A large portion of the proposed storm drain system would be located on the north side of the railroad corridor and extend from Arlington Street on the west, to Wells Avenue on the east. The storm drain system located on Vine Street would be routed under the proposed trench through an inverted siphon. Capacity for this system did not change and the discharge location remained the same.

The ReTrac drainage watershed covers an area of approximately 17 square miles and ranges in elevation from 4492-feet at Record Street and the UPRR up to 6603-feet at Upper Peavine. In the higher elevations of the numerous ranges, ground cover consists of a mixture of shrubs, sagebrush and grasses in undeveloped areas and single and multi-family residential and commercial areas. The lower elevations of downtown Reno are almost completely developed by casinos, business commercial and single-family residences.

Existing hydraulic analyses were performed on overland flows throughout the downtown Reno area. The Truckee River is the final drainage point of overland flows for the northern portion of the Reno area. In existing conditions overland flow meanders throughout the downtown area. Cross sections were analyzed in various parts of the downtown area to determine flow characteristics during the 100-year storm event.

Proposed improvements affecting hydraulics include trench wall installation along Third Street, elimination of existing Union Pacific Railroad natural drainage crossings, roadway profile improvements at existing street crossings and storm drain relocations due to the proposed trench section. It was assumed that the Third Street profile would not change with the exception of roadway intersection profile adjustments and trench wall encroachments. Proposed improvements were designed to minimize the impact to the existing 100-year event drainage patterns and convey existing storm drain capacities of disturbed systems. Water surface elevations were not increased in the downtown area and drainage patterns remained the same as existing conditions.

This report did not address any solutions for the existing flooding problems within the City of Reno. The analyses and designs were used as backup data to demonstrate that the project not only maintained existing flooding conditions, but improved flooding conditions in some areas for various storm events, including the 100-year event.

APPENDIX C

COST ESTIMATES OF FLOOD CONTROL IMPROVEMENTS

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	TOTAL COST DESCRIPTION DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
A1-1	U/S OF COLD SPRINGS DR	CHANNEL		*Constructed Trapz channel w/rip rap			$230				
A1-2	COLD SPRINGS DR	CULVERT		**Not constructed**			$165	$135	$147	$447	
A1-3	COLD SPR DR - PINON AV	CHANNEL		**Not constructed**			$160	$131	$143	$434	
A1-4	PINON AVENUE	CULVERT		**Not constructed**			$225	$185	$201	$611	
A1-5	PINON AV - MESQUITE	CHANNEL		**Not constructed**			$215	$176	$192	$583	
A1-6	MESQUITE AVENUE	CULVERT		**Not constructed**			$320	$262	$285	$867	
A1-7	MESQUITE - RENO PARK BL	CHANNEL		**Not constructed**			$550	$451	$490	$1,491	
A1-8	RENO PARK BOULEVARD	CULVERT		**Not constructed**			$155	$127	$138	$420	
A1-9	MUDSPRINGS - COLO SPR DR	CHANNEL		*Constructed Trapz T22', B12', D5' w/RipRap			$860				
A1-10	COLO SPRINGS DR	CULVERT	12'x4'	*Constructed concrete box culvert			$165				
A1-11	COLD SPR DR - RENO PK BL	CHANNEL		*Constructed Trapz T22', B12', D5, Vegetation			$390				
A1-12	RENO PARK BOULEVARD	CULVERT	2'	Constructed 3-2' circular culverts			$205				
A2-1	RED ROCK ROAD	CULVERT	8'x4'	2 Box culverts			$365				
A2-2	MOYA BLVD	CULVERT	8'x4'	3 Box culverts			$365				
A2-3	US 395	CULVERT	4'	4' CMP Under abandoned dead-end rd.			$700				
A4-1	DOG VALLEY CK U/S BDG ST	CHANNEL	T50', B30', D5'	*Constructed Trapz natural channel w/dense veg.			$400				
A4-2	DOG VALLEY CK @ BDG ST	BRIDGE	Span 30'	*Constructed One lane wide bridge			$215				
A4-3	DOG VALLEY CK D/S BDG ST	CHANNEL		*Constructed Trapz. Channel, wide shallow natural channel			$200				
A-4-4	N FLAT WASH U/S OLD 40	CHANNEL	Top 15'	*Constructed Triangular natural channel			$210				
A4-4A	HIGHWAY 40	CULVERT	8'x7'	*Constructed Concrete box culvert							
A4-5	N FLAT WASH U/S OLD 40	CHANNEL	T20', B10', D10'	*Constructed Trapz. Natural channel			$165				
A4-6	MOGUL WASH W	DET BASIN		**Not Constructed**			$695	$570	$620	$1,885	
A4-7	MOGUL WASH E	DET BASIN		**Not Constructed**			$1,105	$906	$985	$2,997	
A9-1 ~ A9-5	FIRST CREEK	DEBRIS BSN		**Not Constructed**			$860	$705	$767	$2,332	
	LAKESHORE BLVD	CULVERTS	5'	*Constructed 250-300' long CMP			$235	$193	$210	$637	
		CHANNELS		**Not Constructed**			$260	$213	$232	$705	
A9-6 ~ A9-10	W. FORK FIRST CREEK	DEBRIS BSN		**Not Constructed**			$860	$705	$767	$2,332	
	PONDEROSA AVE.	CULVERTS	4'	*Constructed CMP							
	LAKESHORE BLVD	CULVERTS	6'x5'	*Constructed Concrete Box culvert			$235	$193	$210	$637	
		CHANNELS		**Not Constructed**			$260	$213	$232	$705	
A9-11 ~ A9-19	SECOND CREEK	DEBRIS BSN		**Not Constructed**			$860	$705	$767	$2,332	
	TYNER WAY	CULVERTS	8'	*Constructed CMP							
	KNOTTY PINE DR	CULVERTS	6'x3.5'	*Constructed Concrete Box culvert							
	SILVERTIP	CULVERTS	3'	*Constructed 2-CMPs							
	PONDEROSA AVE.	CULVERTS	4'	*Constructed CMP			$555	$455	$495	$1,505	Culverts in this group
		CHANNELS		**Not Constructed**			$490	$402	$437	$1,329	
A9-20 ~ A9-27	WOOD CREEK	DEBRIS BSN		**Not Constructed**			$865	$709	$771	$2,346	
		CHANNELS		**Not Constructed**			$735	$603	$655	$1,993	
		DEBRIS BSN		**Not Constructed**			$840	$689	$749	$2,278	
A9-28 ~ A9-42	W. FORK THIRD CREEK	CULVERTS		**Not Constructed**			$865	$709	$771	$2,346	
	COLLEGE DR.	CULVERTS	3'x1.5'	*Constructed Camps, 1.5' is approx. 5' higher			$2,920	$2,394	$2,604	$7,918	Culverts in this group
		CULVERTS	3'	*Constructed 120' long CMP							

ELEMENT	LOCATION			TOTAL COST DESCRIPTION							
		IMPROVEMENT TYPE	SIZE	DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
	DONNA DR	CULVERTS	3'	*Constructed CMP							
	VILLAGE BLVD	CULVERTS	3'	*Constructed CMP							
	HAROLD DR	CULVERTS	3'	*Constructed 1/5' Debris Dam							
	NORTHWOOD BLVD	CULVERTS	4'	*Constructed CMP							
	NORTHWOOD BLVD	CULVERTS	4.5'x2.7'	*Constructed Arch CMP							
	LAKESHORE BLVD	CULVERTS	7'x4/7'	*Constructed Arch CMP							
		CHANNELS		**Not Constructed**			$2,695	$2,210	$2,403	$7,308	
A9-43 ~A9-58	THIRD CREEK	DEBRIS BSN		**Not Constructed**			$865	$709	$771	$2,346	
	VILLAGE BLVD	CULVERTS	5.5'	*Constructed CMP			$2,650	$2,173	$2,363	$7,186	Culverts in this group
	DRIVER WAY	CULVERTS	5.5'	*Constructed CMP							
	FAIRWAY BLVD	CULVERTS	6'x3.5'	*Constructed 2 Arch CMPs							
	GOLF CART RD U/S OF TAHOE	CULVERTS	5'	*Constructed CMP							
	TAHOE BLVD	CULVERTS	12'x6'	*Constructed Concrete Box culvert							
		CULVERTS	6'x3.5'	*Constructed 2 Arch CMPs							
	LAKESHORE BLVD	CULVERTS	10'x6'	*Constructed 2 concrete box culverts							
	MOUNT ROSE HWY	CHANNELS	T48', B20', D15'	*Constructed Concrete Trapz. Channel							
		CHANNELS	T25', B6', D20'	*Constructed Trapz. Wooden channel							
A9-59 ~ A9-82	W. FORK INCLINE CREEK	DEBRIS BSN		**Not Constructed**			$860	$705	$767	$2,332	
	JUPITER DRIVE	CULVERTS	2'	*Constructed CMP			$2,600	$2,132	$2,319	$7,051	Culverts in this group
	MT ROSE HWY	CULVERTS	2'	*Constructed CMP-Not Main Channel							
	MT ROSE HWY	CULVERTS	4'	*Constructed CMP-Main Channel							
	DANA DR	CULVERTS	5'	*Constructed CMP							
	COUNTRY CLUB	CULVERTS	5'x3'	*Constructed Arch CMP							
	VILLAGE BLVD	CULVERTS	5'x3'	*Constructed Arch CMP							
	DRIVER WAY	CULVERTS	2.5'x2'	*Constructed Side by side CMPs							
	FAIRWAY BLVD	CULVERTS	6'x4'	*Constructed Arch CMP							
	UNNAMED DRIVEWAY	CULVERTS	3'	*Constructed CMP							
	WEDGE PLACE	CULVERTS	5'x3'	*Constructed Arch CMP							
	FOURTH GREEN DR	CULVERTS	5'x3'	*Constructed Arch CMP							
	GOLF CART RD U/S OF TAHOE	CULVERTS	5'x3'	*Constructed Arch CMP							
	TAHOE BLVD	CULVERTS	6'x3.25'	*Constructed Arch CMP							
	INCLINE WAY	CULVERTS	3'	*Constructed CMP							
		CHANNELS		**Not Constructed**			$8,375	$6,868	$7,469	$22,711	
A9-83 ~ A9-92	INCLINE CREEK	DEBRIS BSN		**Not Constructed**			$865	$709	$771	$2,346	
	COUNTRY CLUB DR	CULVERTS	6'x4'	*Constructed 2 - Elliptical CMP			$1,410	$1,156	$1,257	$3,824	Culverts in this group
	COUNTRY CLUB DR	CULVERTS	2'	*Constructed CMP							
	GOLF CART RD U/S OF TAHOE	CULVERTS	5'	*Constructed CMP							
	TAHOE BLVD	CULVERTS	5'	*Constructed 2-CMPs w/4' outlet drop							
	INCLINE WAY	CULVERTS	5.4'	*Constructed 2-CMPs, no headwall							
	LAKESHORE BLVD	CULVERTS	5'x4'	*Constructed 2'x1' energy diss. Pairs @ 10' intervals inside culvert							
	D/S of LAKESHORE BLVD	CHANNELS	T35', B20', D6	*Constructed Trapz. Natural channel							
A9-93	MILL CREEK	DEBRIS BSN									
		CULVERTS	10'x4.4'	*Constructed at the Dam-concrete box culvert			$995	$816	$887	$2,698	Culverts in this group
	PUBLIC WORKS RD	CULVERTS	3'	*Constructed CMP							
	TAHOE BLVD	CULVERTS	4.5'	*Constructed CMP							
	SWEETWATER RD	CULVERTS	4'	*Constructed CMP							

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
				TOTAL COST DESCRIPTION							
	TAHOE BLVD	CULVERTS	4.5'	*Constricted CMP							
	TRAMWAY RD	CULVERTS	3'	*Constructed 2-CMPs							
	LAKESHORE BLVD	CULVERTS	3'	*Constructed 2-CMPs w/headwall							
	LAKESHORE BLVD	CULVERTS	3'	*Constructed secondary channel culvert NW of main							
	LAKESHORE BLVD	CULVERTS	2'	*Constructed CMP							
		CHANNELS		**Not Constructed**			$1,480	$1,214	$1,320	$4,013	
B1-1 ~ B2-25	IDAHO DRIVE CHANNEL	CHANNEL		*Constructed Natural Channels			$2,855				
B1-1 ~ B2-25	IDAHO DRIVE CHANNEL	CULVERTS		*Constructed Culverts			$2,020				
B1-26	CHACKADEE DR CHANNEL	CHANNEL		**Not Constructed**			$2,370	$1,943	$2,114	$6,427	
B1-27	LEMMON VALLEY DR	CULVERT		**Not Constructed**			$415	$340	$370	$370	
B1-28	CHACKADEE DR CHANNEL	CHANNEL		**Not Constructed**			$2,880	$2,362	$2,568	$2,568	
B2-1	OLD 395	CULVERT	3'	*Constructed 2-3' circ. Metal pipes			$130				
B2-2	US 395	CULVERT		*Constructed Bride under RR and US 395			$440				
B2-3 ~ B2-7	US 395 - SILVER LAKE	CULVERTS	H6', D4'	*Constructed 3 Arch steel pipes			$540				
B2-3 ~ B2-7	US 395 - SILVER LAKE	CHANNEL	T50', B20', D5'	*Constructed Trapz. Ditch			$1,370				
B2-8	OLD 395	CULVERT	4'	***Constructed 4' Circ. Steel pipe**			$85				
B2-9	US 395	CULVERT	6'x6'	*Constructed box culvert under US 395			$385				
B2-10	SILVER LAKE DRIVE	CULVERT	2'	*Constructed 2 - 2' Steel pipes			$70				
B2-11 ~ B2-19	CASSILIS DR TO MILITARY DR	CULVERTS	Variable	*Constructed Arch steel pipes			$415				
B2-11 ~ B2-19	CASSILIS DR TO MILITARY DR	CHANNEL	Variable	*Constructed natural small channels			$885				
B2-20	MILITARY RD TO LAKE	CHANNEL	T50', B25', D8'	*Constructed Trapz. Concrete lined perpend. To Military Rd.			$1,200				
B2-21	UNNAMED ROAD	CULVERT		**Not constructed**			$90	$74	$80	$244	
B2-22	US 395	CULVERT		*Constructed under the Lemon Dr. Underpass			$415				
B2-23 ~ B2-38	LEMMON VALLEY DRIVE	CULVERTS	Variable				$2,490				
B2-23 ~ B2-38	LEMMON VALLEY DRIVE	CHANNEL	T30', B8', D5'	*Constructed soil w/riprap at culvert/bridge crossings			$5,745				
B2-39	DEODAR - LEMMON VAL DR	CHANNEL		**Not constructed**			$1,015	$832	$905	$2,752	
B2-40	LEMMON VALLEY DRIVE	CULVERT		**Not constructed**			$160	$131	$143	$434	
B2-41	LEMMON VALLEY DR - LAKE	CHANNEL		**Not constructed**			$420	$344	$375	$1,139	
B3-1	LEMMON VAL W @ OLD 395	CULVERT	4'	*Constructed CSP			$110				
B3-2	BLOCK N WASH DAM SITE	DET BASIN		**Not constructed**			$2,600	$2,132	$2,319	$7,051	
B3-3	OLD 395	CULVERT	10'x4'	*Constructed - 2 boxes w/heavy sediment			$295				
B4-1	UPPER PEAVINE CREEK DAM	DET BASIN		Constructed			$440				
B4-2	WEST WASH DAM	DET BASIN		Constructed			$700				
B4-3	DANDINI WASH @ COMSTOCK	CULVERT	4'	4' circular pipe			$75				
B4-4	McQUEEN WASH @ W 4TH ST	CULVERT	H8'xD10'	Bridge			$250				
B4-5	ALUM CREEK U/S OF MAYBERRY	CHANNEL	T50', B25', D5'	Ditch or natural channel			$495				
B4-6	ROSEWOOD CREEK US ARLINGTON	CHANNEL		Ditch or natural channel			$215				
B4-7	McCARRAN BLVD	CULVERT	H6', D6.5'	Elliptical pipe under McCarran			$150				
B5-1b	DANT BLVD OUTFALL	CULVERT	2'	2' Circular	EA	1					
B5-1c	DANT BLVD	DET POND	Tri 2300'x450'	Earthen Dam							
B5-1	PHEASANT LN	CULVERT	2'	2' Circular CMP	EA	1	$70	$57	$62	$190	

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	TOTAL COST DESCRIPTION							
				DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
B5-2	EVANS CREEK DAM SITE	DET BASIN		Weir footing, approx. 1.5' drop.			$3,260	$2,673	$2,907	$8,840	
B5-2b		DAM/CHANNEL	21'X7'	Earthen V channel							
B5-2c		CULVERT	8'R, 3' Base	View Ln due south of Copper Creek Ct.							
B5-2d		CULVERT	W24', H9.5'	Concrete arch bridge							
B5-2e		CULVERT	10.2'x3.75'	Concrete box culvert							
B5-2f		CULVERT	W25', H8'	Concrete arch bridge							
B5-2g		POND		Ponds behind apt SW of Plumas on main channel							
B7-1	GALENA CR U/S OF SR431	CHANNEL		**Not constructed - natural channel**			$110	$90	$98	$298	
B7-2	MT. ROSE HWY	CULVERT	2'	*Constructed circular CMP			$310	$254	$276	$841	
B7-3	GALENA CR D/S OF SR431	DET. BASIN	120'x120'	*Constructed square earthen w/4' berm			$110	$90	$98	$298	
B7-4	JONES CR @ MT MEADOW LN	CULVERT	3'	*Constructed circular RCP			$190	$156	$169	$515	
B9-1	FRANKTOWN CK FRANTOWN RD	BRIDGE	1.5'	CMP			$600				
B9-2	MUSGROVE CK FRANTOWN RD	CULVERT	3'	CMP			$170				
B9-3a	OLD US 395	CULVERT	8'x8'	Concrete box culvert							
B9-3	MUSGRAVE CR @ OLD US 395	CULVERT	7'x6'	Concrete box culvert			$270				
C1-1	U/S DEODAR DRIVE	CHANNEL		**Not constructed**			$1,760	$1,443	$1,570	$4,773	
C1-2	U/S DEODAR DRIVE	CHANNEL		**Not constructed**			$625	$513	$557	$1,595	
C1-3	DEODAR DRIVE	CULVERT		**Not constructed**			$230	$189	$205	$624	
C2-1	DEBRIS BASIN SITE	DEBRIS BASIN		**Not constructed**			$500	$410	$446	$1,356	
C2-2	U/S OF DEODAR WAY	CHANNEL		**Not constructed**			$410	$336	$366	$1,112	
C2-3	DEODAR WAY	CULVERT		**Not constructed**			$100	$82	$89	$271	
C2-4	U/S ERIN DR	CHANNEL	T15', D5'	*Constructed small ditch			$220				
C3-1	AMARAGOSA ST TO GRAVEL PIT	CHANNEL SYS	2'	Circular steel pipe			$1,040				
C3-2	5TH AVE - GRAVEL PIT	CHANNEL SYS	2'	Circular steel pipe			$445				
C3-3	GRAVEL PIT	DET BASIN		Deten. And skating ring			$1,935				
C3-4	LEON DRIVE - 1ST AVE	CHANNEL SYS		Naturally vegetated channel			$470				
C3-5	1ST AVE	CULVERT	3'	Circular steel pipe			$155				
C3-6	1ST AVE - FRANKLIN	CHANNEL SYS		Naturally vegetated channel			$280				
C3-7	FRANKS LANE	CULVERT	H5', D3'	2 - arch steel pipes			$170				
C3-8	FRANKS LANE-RAMPION WAY	CHANNEL		Naturally vegetated channel			$280				
C3-9	RAMPION WAY	CULVERT	3'	2 - circular steel pipes			$285				
C4-1	SOCRATES DR & WPRR SITE	DET BASIN		*Constructed			(IN PROG)				
C4-2	ROSEWOOD CREEK @ ARLINGTON	CULVERT		**Not constructed**			$60	$48	$54	$163	
C4-3	ROSEWOOD CREEK DAM SITE	DET BASIN		**Not constructed**			$755	$619	$673	$2,047	
C5-1d	MOANA PRIVATE DRIVEWAY	CULVERT	2'	*Constructed 2' CMP just u/s of Moana Ln xing			$10	$8	$9	$27	
C5-1c	MOANA RD	CULVERT	10'x4'	*Constructed 2 concrete box culverts							
C5-1a	CLASSIC RES PARKING LT	CULVERT	7'x5'	*Constructed Very long concrete box culvert							
C5-1b	PLUMAS RD	CULVERT	5'x5'	*Constructed concrete box culvert							
C5-2	EVANS CK U/S OF LAKESIDE	CHANNEL		**Not Constructed**			$275	$226	$245	$746	
C5-3	EVANS CK @ LAKESIDE	CULVERT	10.5'x4.6'	*Constructed concrete box culvert			$85				

Washoe County Flood Control Improvements Cost Estimates

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
C5-3b	PARK COVERED BRIDGE	CULVERT	12'x6	*Constructed concrete box culvert							
C5-4	EVANS CK LKSIDE - DELMONTE	CHANNEL		**Not constructed**			$610	$500	$544	$1,654	
C5-5	EVANS CK DEL MONTE	CULVERT	12'x3.5'	*Constructed concrete box culvert			$75				
C5-6b	TALBOT LANE	CULVERT	4'x2.7'	*Constructed Elliptical CMP							
C5-6c	S END OF TALBOT LN	CULVERT	2.6'	*Constructed Circular plate steel							
C5-6a	DEL MONTE TO I-395	CHANNEL		**Not constructed**			$1,400	$1,148	$1,249	$3,797	
C5-7	N. FK DRY CRK, FROST LANE	CULVERT	2.5'	*Constructed Circular CMP			$95	$78	$85	$258	
C5-7b	LAKESIDE DR	CULVERT	7'x6'	*Constructed concrete box culvert							
C5-7c	CATALPA LN	CULVERT	5'x3.8'	*Constructed 2 elliptical CMPs							
C5-8	DRY CRK LAKESIDE	CULVERT	3'	*Constructed Circular CMP			$195	$160	$174	$529	
C5-8b	TIMOTHY LN	CULVERT	6'x5.2'	*Constructed concrete box culvert							
C5-9	DRY CREEK DERRINGER	CULVERT	10'x7'	*Constructed 2 box culverts			$175				
C5-10	DRY CREEK PANORAMA	CULVERT	6'	*Constructed 2 CMPs			$155				
C5-11	DRY CREEK DAM SITE	CHANNEL		**Not constructed**			$3,605	$2,956	$3,215	$9,776	
C5-11b	HUFFAKER LN	CULVERT	12'x5'	*Constructed 3 Concrete box culverts							
C5-11c	COUNTRY ESTATES CIR.	CULVERT									
C5-11d	I-395	CULVERT	10'x5'	*Constructed 4 concrete box culverts							
C5-11e	HUFFAKER PLACE	CULVERT	REMOVED	**Not to be Constructed**							
C6-1	DRY CREEK @ HOLCOMB	CULVERT	6'x6	*Constructed concrete Box culvert			$165				
C6-2d	VENTURA PKWY	CULVERT	35'x3.5'	*Constructed concrete Arch pipe							
C6-2	VENTURA PKWY	DET BASIN		**Not Constructed**			$3,100	$2,542	$2,765	$8,407	
C6-2c		DET BASIN	150'x150'~	*Constructed for subdivision n. of channel w/spillway @ +12'							
C6-2b		BRIDGE		60' steel span 20' above natural channel							
C6-3	THOMAS CK DIXON LN - VIRG	CHANNEL		**Not Constructed (natural channel)**			$490	$402	$437	$1,329	
C6-4	THOMAS CK SIERRA MANOR	CULVERT	3'	*Constructed circular CMP			$75	$625	$67	$203	
C6-5	THOMAS CK SOUTH VIRGINIA	CULVERT	10'x3.5'	*Constructed Concrete box culvert w/gravel bottom			$210				
C6-5b	SOUTH VIRGINIA	CULVERT	8'x4'	*Constructed 2 concrete box culverts							
C6-5c		WEIR	W5', D3'	*Constructed concrete weir control structure							
C6-5d		CULVERT	1.5'	*Constructed 2 circular CMPs							
C6-5e	S MEADOWS PKWY/I-395	WEIR	W6'x1.5'	*Constructed -3 concrete spreader weirs							
C6-6	THOMAS CK PKWY	DET FACILITY					$4,630	$3,797	$4,129	$12,556	
C6-6b		CULVERT	24'x9'	*Constructed concrete Arch Pipe							
C6-7	SILVER WOLF XING	CULVERT	21'x4'	*Constructed concrete Arch pipe			$125				
C6-8a	THUNDERBOLT	CULVERT	8'x4'	*Constructed -2 box culverts							
C6-8b	WHITES CK LA GUARDIA RD	CULVERT	10'x4.5'	*Constructed -2 box culverts			$125				
C6-9	WHITES CK ZOLEZZI	CULVERT	6'x3'	*Constructed -concrete box culvert			$125	$103	$111	$339	
C6-9b	ZOLEZZI LN	WEIR	35'	*Constructed 30" CMP from diagonal weir							
C6-10	S VIRGINIA	CULVERT	6'x2.25'	*Constructed concrete box culvert			$150	$123	$134	$407	
C6-10b	S VIRGINIA	CULVERT	1.5'	*Constructed circular RCP, flow is split in U/S structure							
C6-11a	WHITES CK OLD VIRG RD	CULVERT	3'	*Constructed circular RCP			$70	$57	$62	$190	
C6-11b	OLD VIRGINIA RD	CULVERT	4'	*Constructed circular RCP							
C6-11c	OLD VIRGINIA RD	CULVERT	3'	*Constructed circular CMP							
C6-12	BAILEY CK KIEVETT - TOLL RD	CHANNEL	T25', B11', D4'	*Constructed trapz. Channel			$1,700				
C6-13	BAILEY CK TOLL RD	CULVERT	12'x4'	*Constructed concrete box culvert			$125				
C6-14	BAILEY CK TOLL RD - STMBOAT	CHANNEL		***Not Constructed (natural Channel)**			$480	$394	$428	$1,302	

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
				TOTAL COST DESCRIPTION							
C6-15a	STEAMBOAT CK SR 341	WEIR	10'X10' high	*Constructed rock & Concrete			$405				
C6-15a		BRIDGE	T100', B30', D25'	*Constructed trapz. Concrete channel							
C7-1	JONES CK CALLAHAN RANCH RD	CULVERT	3'	*Constructed circular RCP			$220				
C7-2	GALENA CK CALLAHAN RANCH RD	CULVERT	3'x3'	*Constructed Arch metal pipe			$310				
C7-3	GALENA CK GALENA NARROWS	DET BASIN		**Not Constructed**			$2,505	$2,054	$2,234	$6,793	
C7-3a		CHANNEL		**Not Constructed**							
C7-4	STEAMBOAT CK BLACK WILLOW	CHANNEL	T35', B12', D7'	*Constructed Steel trapz. Channel			$115				
C7-5	STEAMBOAT CK CONESTOGA	CHANNEL	T55', B10', D6.5'	*Constructed Steel trapz. Channel			$115				
C7-6	STEAMBOAT CK LARAMIE	CULVERT	12'x6'	*Constructed Concrete box culvert			$115				
C7-7	STEAMBOAT CK CONCHO	CULVERT	12'x6'	*Constructed Concrete box culvert			$145				
C7-8	STEAMBOAT CK TOWNE	CULVERT	6'x5'	*Constructed 3 Concrete boxes			$230				
	ANDREWS LN	CHANNEL	T29', B29', D4.5-5.5'	*Constructed Concrete bridge, cobble bottom							
	RHODES RD	CHANNEL	T14', B12', D8'	*Constructed trapz. Wooden beam bridge							
	HOT SPRINGS			Bridge removed							
C8-1	ESMERALDA WASH U/S E. LAKE	CHANNEL					$350				
C8-2	ESMERALDA WASH @ E. LAKE BLVD	CULVERT					$70				
C8-3	ESMERALDA WASH E. LAKE - ESM	CHANNEL					$470				
C8-4	ESMERALDA WASH @ PERSHING	CULVERT					$210				
C8-5	ESM WASH @ LAKESIDE	CHANNEL					$595				
C8-6	ESMERALDA WASH @ WT PINE DR	CULVERT					$110				
C8-7	ESMERALDA WASH @ LYON DR	CULVERT					$110				
C8-8	ESMERALDA WASH @ LAKESIDE DR	CULVERT					$110				
C8-9	JUMBO GRADE @ DRAKE WAY	CULVERT					$150				
C8-10	JUMBO GRADE @ PINTAIL DR	BASIN					$980				
C8-11	JUMBO GRADE GANDER - E LAKE	CHANNEL					$440				
C8-12	JUMBO GRADE @ EASTLAKE	CULVERT					$95				
C8-13	JUMBO CK EASTLAKE -ORMSBY	CHANNEL					$1,950				
C9-1	MUSGROVE CREEK @ US 395	CULVERT	10'x2.5'	Concrete box culver			$650				
D1-1	GRIFFITH CAN CALLE LAPLATA	CULVERT		**Not Constructed**			$130	$107	$116	$353	
D1-2	GRIFFITH CAN	CHANNEL		**Not Constructed**			$420	$344	$375	$1,139	
D1-3	GRIFFITH CAN	CHANNEL		**Not Constructed**			$1,310	$1,074	$1,168	$3,552	
D1-4	GRIFFITH CAN @ SR445	CULVERT		**Not Constructed**			$225	$185	$201	$610	
D1-5	SR445 - BONEYARD FLAT	CHANNEL		**Not Constructed**			$1,300	$1,066	$1,159	$3,525	
D2-1	WATER TANK RD - SR445	CHANNEL		*Constructed natural Drainageway			$2,080				
D2-2	SR 445	CULVERT	3'	*Constructed 4- circular pipes			$115				
D2-3	ERIN DRIVE	CULVERT	3'	*Constructed 3- circular pipes			$80				
D2-4	ERIN DRIVE - DOLORES DRIVE	CHANNEL		*Constructed			$240				
D2-5	DOLORES DRIVE	CULVERT	T20', D5'	*Constructed ditch leads to a small pond w. of SR445			$80				
D2-6	SR 445	CULVERT		**Not Constructed**			$130	$107	$116	$353	
D2-7	SR 445 - ORR DITCH	CHANNEL		**Not Constructed**			$315	$258	$281	$854	
D2-8	SPANISH SP RD - ORR DITCH	CHANNEL		**Not Constructed**			$485	$398	$433	$1,315	

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	TOTAL COST DESCRIPTION DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
D3-1	DETENTION SITE	DET BASIN		**Not Constructed**			$585	$480	$522	$1,586	
D3-2	VISTA BLVD - SHADOW LN	CHANNEL		*Constructed natural channel			$230				
D3-2A		CHANNEL	T30', B7', D6'	*Constructed channel lined w/ rip rap							
D3-2B	VISTA BLVD	CULVERT	12'x4' & 6'x4'	*Constructed 2 box culverts							
D5-1	N HIDDEN VAL DET SITE	DET BASIN		New subdivision under construction and no detention on plans. Not constructed			$1,680	$1,378	$1,498	$4,556	
D5-2	S HIDDEN VAL DET SITE	DET BASIN					$600	$492	$535	$1,627	
D6-1		DET BASIN		**Not Constructed**			$450	$369	$401	$1,220	
D6-1b	KENNETH WAY	CULVERT		**Not Constructed**							
D6-2	KENNETH WAY/RANCHO VERDE DR.	CHANNEL	T25', B5', D5'	*Partially Constructed trapz. Natural channel							
D6-2b	RANCHO VERDE DR.	CULVERT		**Not Constructed**			$765	$627	$682	$2,075	
D6-3	MIRA LOMA RD	CULVERT		**Not Constructed**			$70	$57	$62	$190	
D6-4	MIRALOMA RD - TOE OF FAN	CHANNEL	T5', D2'	*Constructed Irrigation V-ditch			$805	$660	$718	$2,183	
D7-1	BAILEY CRK DAM SITE	DET BASIN		**Not Constructed - natural channel**			$5,360	$4,395	$4,780	$14,535	
D7-2	BAILEY CK DAM - TOLL RD	CHANNEL	T25', B10', D5'	*Constructed trapz. Natural channel			$280				
D7-3	BAILEY CK TOLL RD	CULVERT	8'x4.5'	*Constructed 2-concrete box culverts			$20				
D7-3b	TOLL RD	CULVERT	8'	*Constructed circular CMP							
D7-4	BAILEY CK TOLL RD - T HILL	CHANNEL	T25, B10', D4'	*Constructed native trapz. Channel			$340				
D7-5	BAILEY CRK PVT DRVWY	CULVERT	8'	*Constructed circular CMP			$20				
D7-6	BAILEY CRK TEMPLE HILL	CULVERT	10'	*Constructed circular CMP			$20				
D7-7	BAILEY CK T HILL - KIVETT	CHANNEL	T25, B10', D5'	*Constructed trapz. Natural channel			$365				
D7-7b	KIVETT LN	CULVERT	10'x6'	*Constructed concrete box culvert							
D7-7c	PINON DR	CHANNEL	T25', B10', D5'	*Constructed native trapz. Channel, needs culvert			$50	$41	$45	$136	
D7-8	GEIGER FK BLY CK SR 341	CULVERT	4'x4'	*Constructed concrete box culvert			$50				
D7-9	GEIGER FK SR 341 - PINON DR	CHANNEL		**Not Constructed**			$390	$320	$348	$1,058	
D7-10	GEIGER FK BLY CK PINION DR	CULVERT		**Not Constructed**			$50	$41	$45	$136	
D7-11	GEIGER FK PINION - KIVETT	CHANNEL		**Not Constructed**			$95	$78	$85	$258	
D7-12	GEIGER FK BLY CK KIVETT LN	CULVERT	16"	*Constructed parallel CMPs			$50	$41	$45	$136	
D7-12b	GEIGER FK BLY CK KIVETT LN	CULVERT	18"	*Constructed parallel CMPs							
D7-13	GEIGER FK KIVETT - BAILEY	CHANNEL					$150	$123	$134	$407	
				Not Constructed							
ST-1	MOYA BLVD	CULVERT									
		CHANNEL									
ST-3		CULVERT									
		CHANNEL									
ST-3		CULVERT									
		CHANNEL									
ST-4		CULVERT									
ST-5		CULVERT									

ELEMENT	LOCATION	IMPROVEMENT TYPE	SIZE	DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
				TOTAL COST DESCRIPTION							
ST-6		CULVERT									
ST-7		CULVERT									
		CHANNEL									
ST-8		CULVERT									
		CHANNEL									
ST-9		CULVERT									
		CHANNEL									
ST-10		CULVERT									
ST-11		CHANNEL								$8,369	Total for ST-1 ~ ST-11
A-1	EAST LAKE BLVD	CULVERT									
		CHANNEL									
A-2		CHANNEL								$301	Total for A-1 ~ A-2
B-1	BRENDA WAY	CULVERT									
B-2	DUNBAR DRIVE	CULVERT									
		CHANNEL									
B-3	EAST LAKE BLVD	CHANNEL									
B-4	EAST LAKE BLVD	CULVERT									
		CHANNEL								$313	Total for B-1 ~ B-4
C-1	EUNICE WAY	CULVERT									
		CHANNEL									
C-2	EAST LAKE BLVD	CULVERT									
		CHANNEL									
C-3		CHANNEL								$469	Total for C-1 ~ C4
D-1	GUFFY DRIVE	CULVERT									
		CHANNEL									
D-2	GUFFY DRIVE	CULVERT									
		CHANNEL									
D-3	GUFFY DRIVE	CHANNEL								$597	Total for C-1 ~ C4
E-1		CHANNEL									
E-2	COYOTE DRIVE	CULVERTS									
		CHANNEL									
E-3	COYOTE DRIVE	CULVERTS									
		CHANNEL									
E-4	COYOTE DRIVE	CHANNEL								$1,952	Total for E-1 ~ E-4
F-1		CULVERT									
		CHANNEL									

ELEMENT	LOCATION			TOTAL COST DESCRIPTION							
		IMPROVEMENT TYPE	SIZE	DESCRIPTION	UNIT	QUANTITY	1990 TOTAL (THOUSANDS)	1990 OTHER COSTS (82%)	INFLATION (49%)	2004 TOTAL (THOUSANDS)	Notes
F-2	ESMERALDA DRIVE	CULVERT									
		CHANNEL									
F-3	ESMERELDA DRIVE	CHANNEL								$424	Total for F-1 ~ F-3
G-3	CLARK DRIVE	CHANNEL									
G-4	CLARK DRIVE	CULVERT									
		CHANNEL									
G-5	CLARK DRIVE	CHANNEL									
G-9	ORMSBY LN	CHANNEL									
G-10	ORMSBY LN	CHANNEL									Total for G-3 ~ G-5 and
G-11		CHANNEL								$2,983	G-9 ~ G11
G-1	JUMBO GRADE	CULVERT									
		CHANNEL									
G-2	JUMBO GRADE	CULVERT									
		CHANNEL									
G-6		CHANNEL									
G-7		CULVERT									
		CHANNEL									Total for G-1, G-2 and
G-8	ORMSBY LANE	CHANNEL								$1,027	G-6 ~ G8
SP-1	PYRAMID HIGHWAY	CHANNEL									
SP-2		CHANNEL									
SP-3		RAISE DETENTION FACILITY									
SP-4		DETENTION FACILITY									
SP-5		DETENTION FACILITY								$6,030	Total for SP-1 ~SP-5