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Incline Creek and Third Creek Watershed Assessment Memorandum

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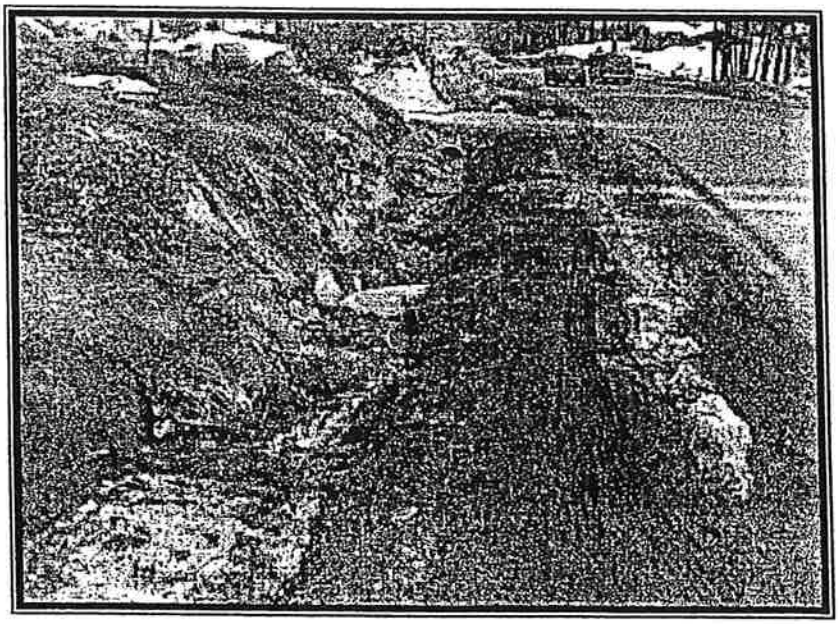


Ecological Restoration/Geomorphology/Water Quality/ Hydrology/ Construction Planning and Supervision/Applied Research

Incline Creek and Third Creek Watershed Assessment Memorandum

Table of Contents

Incline Creek and Third Creek
Watershed Assessment Memorandum

INTRODUCTION

The Incline Village General Improvement District (IVGID) contracted Watershed Restoration Associates (WRA) in 1998 to complete a Watershed Assessment (WA) for Third Creek and Incline Creek basins and to identify and complete Stream Environment Zone (SEZ) restoration projects. The primary purpose of the WA was to identify water quality problems and prepare a prioritized list of improvement projects. The proposed work included developing a drainage map, conducting a channel stability survey of stream channels below Mount Rose Highway, collecting water and sediment samples during snowmelt runoff and mapping the stability of road shoulders and road-side drainage ditches. Fieldwork occurred during the snowmelt runoff of March 1999 but was halted in late April due to lack of funding.

The limited data collected in April provides extensive insight into sediment generation and drainage problems in the two watersheds. WRA believes that this limited data set and the preliminary geomorphic analysis of the watersheds provide adequate data to prioritize pollutant source control and SEZ restoration projects. Accordingly, WRA has produced the following memorandum, at its own initiative, to describe the data collected and to provide recommendations for a prioritized water quality improvement and SEZ restoration program.

OBJECTIVES AND STRATEGIES OF WATERSHED ASSESSMENT (WA), POLLUTION SOURCE CONTROL AND STREAM ENVIRONMENT ZONE (SEZ) PROGRAMS

WRA strongly believes that WA projects must be objective-driven in order to set priorities and design projects. For watershed planning purposes, the objectives of a WA typically are broad. They usually cover not only water quality, but also flood control, fisheries, riparian habitat, forestry, urbanization effects and resource extraction (water diversion, logging, mining, etc.). We have developed a set of objectives for Incline and Third Creeks that

incorporate programmatic as well as regulatory issues that have emerged from our work to date. The primary WA objectives are:

- To improve the quality of water flowing into Lake Tahoe, especially components that affect lake clarity and aquatic habitat (dissolved nutrients and wash load sediment); and
- To improve SEZ functions related to riparian habitat and fisheries resources per TRPA policies.

Secondary objectives include:

- To implement project designs that mimic as closely as possible natural ecosystem function, minimize long-term maintenance and ensure that habitat and water quality benefits improve over time;
- To implement feasible (from an engineering perspective) and cost-effective projects; and
- To minimize impacts to water rights, private lands and infrastructure.

Introduction

The goal of the WA programs is to implement projects that meet the two primary objectives: improve water quality and SEZ habitat functions. Projects to improve water quality may take one of two forms: pollution source control involving erosion control, or use of SEZ wetlands to filter runoff from urban and disturbed land. Source control projects may be located well away from stream channels (e.g. stabilization of road fill) or directly in the stream (e.g. stabilization of streambanks). SEZ restoration projects may be implemented to either control erosion and the source of sediment or to filter sediment-laden water in wetlands or riparian areas.

The ability of a restored SEZ to filter water is related to the extent of significant flood plain or other densely vegetated riparian wetland areas (existing, created or restored) where out-of-channel flows can be filtered. SEZ restoration implies the reestablishment of natural processes and functions, thus the filtering function of flood plain areas is highly dependent on the unique geology and geomorphology of the watershed. WRA recognized at the

beginning of the IVGID project (see original scope of work dated December 1998) that due to the steepness of the Third and Incline Creeks watersheds and streams, SEZ restoration of flood plains along streams would be limited to small, lower gradient areas below Highway 28. The natural potential of both Third and Incline Creeks to create large areas of flood plain is limited because the stream systems have moderate gradient (two to five percent) and are naturally incised and confined. This limits the flood plain areas for water treatment capability are limited. Natural gradient streams with moderate gradient (Rosgen type A and B channels) tend to be confined with a low "entrenchment" ratio of bankfull width to food plain width. Consequently, in Incline and Third Creeks the greater benefit in terms of water quality will be achieved by control of pollutant sources. The same gradient limitation applies to artificial wetlands constructed primarily for water quality benefits because these types of improvements require large flat areas.

The appropriate strategies above Highway 28 is pollution source control through: 1) stream channel stabilization (which might consist of SEZ restoration); 2) control and filtration of urban runoff prior to its discharge to natural streams; 3) stabilization of eroding road shoulders and ditches; and/or 4) a combination of some or all of these measures. SEZ restoration projects may be more effective at stabilizing sediment sources and meeting habitat objectives than filtering sediment-laden discharge.

Pollution Source Control Projects

Pollution source control projects are aimed at reducing pollutant loading into waterways that discharge into Lake Tahoe and at reducing pollutant loading into stream-zone aquatic habitats. Pollutants potentially harmful to the water quality of Lake Tahoe include the following:

- dissolved nutrients
- fine particulates
- clastic sediment

Each of these pollutant types is described in more detail in the following sections, including their potential origin in the Third and Incline Creek watersheds and the appropriate treatment strategies.

Dissolved Nutrients

Dissolved nutrients accelerate algae growth in Lake Tahoe that in turn reduces optical clarity. Nitrate and phosphorous are dissolved nutrients that occur naturally but can be augmented by applied fertilizers, untreated sewage (either illegally dumped or leaking from nearby buried sewer lines), organic matter (e.g. leaves, pine needles, turf grass) and urban runoff. A major source of nitrates in the Lake Tahoe basin is atmospheric loading from smog, including deposits in snow and watershed surfaces that are entrained in urban runoff.

Treatment Strategies for Dissolved Nutrients

Theoretically, dissolved nutrients can be stripped from streamflow through contact with wetland soils and biouptake through plants. This is the primary strategy behind using SEZ restoration projects for runoff treatment. However, the effectiveness of this method in the Tahoe Basin is unproven due to a lack of appropriate water quality data (collection periods and frequency). Evidence drawn from available data suggests that most dissolved nitrate in streamflow that is attributable to pollutant sources passes during winter months outside of the plant-growing season. In Third Creek and Incline Creek watersheds, there are no expansive low gradient (flat) areas to generate the theoretically necessary residence times for treatment. There may be some small-scale wetlands available to treat runoff prior to its discharge to a watercourse, but it is unknown whether these would generate significant water quality benefits.

The best strategy is to avoid generation of dissolved nutrients at the source and prevent contaminated runoff from entering the watercourses that discharge into Lake Tahoe. Separation and direct treatment of urban runoff should be considered seriously.

Fine Particulates

Particulates are sediment or organic particles often ranging in size between 2 and 50 microns. They are a factor in the reduction of optical clarity in Lake Tahoe and may originate from natural sources such as eroding streambanks or hillslopes or from soils weathered from volcanic parent rocks. In the Tahoe Basin, there appears to be significant sources associated with urban runoff, particularly in road de-icing sand and salt mixes that are applied to roads in winter. These mixes often include volcanic cinders that often weather to "dispersive" clays. Dispersive clay particles held by sodium or other monovalent cations "disperse" into colloidal suspension in fresh water. Conditions highly favorable for significant loading of dispersive clay particulates into waterways are present in the Third and Incline Creek watersheds. Road de-icing mixtures applied in winter are pulverized by vehicle tires and deposited on road shoulders and in drainage ditches. These drainage ditches either lead directly to a watercourse or have diverted watercourses within them. In snowmelt runoff events that occur during winter, nearly all road runoff flows from road to road shoulder to drainage ditch to stream. During rainfall events, the loading is probably very significant as all road shoulders are subject to raindrop impact erosion and excessive runoff from impervious roadways

Treatment Strategies for Particulates

The strategies available for treatment of particulates are to stabilize streambanks, road shoulders and ditches and separate road runoff from streams that discharge into Lake Tahoe.

Excessive Clastic Sediment

Clastic sediments are pieces of rock weathered into sizes ranging from fine sediment (suspended sands, silts and clays) to coarse sediment (bedload sands and gravel). A certain level of clastic sediment load is natural. Excessive loads occur as a result of disturbance such as channel modification, removal of stabilizing vegetation, urbanization or increased runoff

disrupting geomorphic stability. The finest sizes of suspended load may contribute to loss of lake clarity. Larger sizes may indirectly reduce lake clarity when excessive bedload induces channel instability and erodes streambanks containing fine sediments. Clastic sediments can impact aquatic habitats significantly by filling pools and smothering spawning gravels.

Treatment Strategies for Clastic Sediments

The best treatment strategy for clastic sediment is source control through channel, streambank and hillslope stabilization and other erosion control measures. Small-scale sediment retention basins in ephemeral watercourses (i.e. tributaries to perennial streams) can be very effective in removing clastic sediments if basin and outlet works are sized properly (basin volume and flows) and care is taken to avoid channel instability.

In low gradient natural perennial watercourses, SEZ flood plains and wetlands can trap significant quantities of fine and coarse sediment. However, a high level of sediment loading can disrupt geomorphic stability and cause channel adjustments in width, depth and/or alignment. Sediment retention basins are designed to trap all clastic sediments and as a result they often require intensive maintenance. Channel stability problems may arise with fluctuations in sediment loads above and below the basin.

METHODS AND RESULTS OF POLLUTANT SOURCE DATA COLLECTION IN THIRD AND INCLINE CREEKS

A limited data set documenting erosion and sediment generation was collected in April 1999. This included a visual survey of the roads and drainage ditches during low elevation snowmelt (April 15-16, 1999), collection of water quality grab samples and photo and video documentation. In addition, an initial assessment was conducted of the watershed's geomorphology, impacts related to Comstock-era and post-Boise Cascade Incline Village development and urban drainage systems.

Third Creek and Rosewood Creek

The Incline and Third Creek watersheds occur within the Carson Range of the Sierra Nevada and are underlain by granitic and volcanic rocks and associated alluvial sediments. Third Creek originates below the Mount Rose "Sheep Flats" meadow and drains the area below the south side of Rose Nob Peaks. The terrain above Mount Rose Highway is very steep with a combination of forested cover, areas of sparse shrubs and minor areas of residential development. Below Mount Rose Highway, Third Creek flows onto a large alluvial fan collecting drainage from numerous tributaries in the urban areas. These watercourses have been greatly impacted by road and bridge construction, diversion and realignment for development. Third Creek flows within the Incline Village golf courses and has been realigned within several residential subdivisions. Loading of dissolved nutrients is possible given the large coverages of turf grass. Excessive clastic sediment loading primarily from road erosion appears probable.

A major tributary to Third Creek is Rosewood Creek, which drains the western side of the Third Creek watershed. It originates at a spring above Mount Rose Highway and flows through densely urbanized areas along Village Boulevard and Northwood Drive. Rosewood Creek is steep with most reaches exceeding 5 percent grade. Between Mount Rose Highway and the Village/McDonald Drive intersection, Rosewood Creek is confined in a narrow corridor bounded by dense urban developments consisting of a mobile home park and Sierra College. Although channel stability is fairly good in this area, urban stormwater pollutant sources are abundant and run directly into the creek. Below Village/McDonald Drive, Rosewood Creek is highly disturbed and channelized into eroding roadside ditches. Tributary road ditches along the east side of Village Boulevard are also deeply eroded and road shoulders and road cuts are actively eroding.

Rosewood Creek flows alongside upper Village Boulevard then westward past Incline High School to Northwood Way. From Northwood Way to Highway 28, Rosewood Creek flows through a highly unstable reach within a recently incised gully channel and numerous headcuts. This reach has incised 4-12 feet over the past several years. Overall, Rosewood

Creek above Highway 28 is a significant sediment source that will continue o supply sediment to Lower Third Creek and Lake Tahoe for years to come until geomorphic stability is reached in channels and source control and drainage projects on roads are implemented.

Another significant sediment source is an unnamed tributary to Rosewood Creek that originates along Harold Drive above Highway 28. This tributary includes an intermittent stream that flows into an eroding road ditch along Helen Way. It merges with ephemeral flows from Harold Way and Fairway Drive, and then flows into a ditch along Northwood Drive. All this flow is concentrated into the eroding ditch as it descends a steep hill to Highway 28. The natural watercourse originally flowed along the south side of Northwood Drive, an area now filled with houses. Just above the Northwood Way and Highway 28 intersection, the flow is collected into a culvert and sent east to a water quality treatment system that occurs along the upstream side of Highway 28. This system was constructed in 1997 and begins with a vegetated swale below the culvert outlet, then flows into a detention basin that uses Highway 28 as a dam. A riser connected to a culvert under Highway 28 detains flow until pond depth reaches about three to four feet. The overflow is discharged into a broad grassy swale downstream of Highway 28 before flowing into Rosewood Creek approximately 300 feet upstream of the Rosewood Creek confluence with Third Creek. The system appears to be very effective: Measured turbidity decreased from 99 NTU on inflow to 1 NTU at outflow. The system appears to be sized well for the flows of this tributary

Incline Creek

Incline Creek originates south of Mount Rose Highway and east of Incline Village above the Diamond Peak Ski Area. Streamflow is routed under the Diamond Peak parking lot in a culvert then discharged below the Fairview/Diamond Peak Parking Lot intersection. From this point Incline Creek flows under Lower Country Club Drive, Highway 28 and Incline Way.

Incline Creek flows through a steep alluvial valley within a moderately unstable channel in the Tyrolean Village development. Visual evidence of road shoulder and road cut erosion

suggests possible significant sediment loading into Incline Creek. Below Tyrolean Village, Incline Creek enters the long culvert that seems to protect its flow from the runoff of the ski area and parking lot. The ski area and parking lot runoff is routed down the parking lot access road to an off-stream detention pond that appears to be effective in trapping sediment before discharging back into Incline Creek just above Highway 28.

Significant sediment sources in Incline Creek occur in the intermittent ephemeral tributaries above Highway 28 between Country Club Drive and Mount Rose Highway. Nearly all of the natural drainage from Fairview Drive to Country Club Way has been diverted into eroding roadside ditches. In addition, sediment detached by erosion of road shoulders and road cuts flow directly into diverted and natural watercourses. This characteristic encompasses many miles of roads and ditches between Fairview and Country Club Way.

Aside from road ditches, stream channels in the Incline Creek watershed may be a source of clastic sediments. This is not well known because data collection was halted before channel surveys could be completed.

Pollutant Source Control Projects

Based upon the limited surveys conducted in 1999, it is apparent that a variety of watershed source control projects are warranted to reduce sediment loading into Third and Incline Creeks and discharging into Lake Tahoe. Treatment will likely include erosion control projects to install curbs, gutters and other drainage facilities along eroding roads and, where opportunities exist, dispersion of runoff into small-scale detention basins. In addition, stream channels should be stabilized or, if untreatable, measures should be taken downstream to filter flows to the extent possible.

With respect to dissolved nutrients, currently available data is not sufficient to identify loading events let alone the design and possible effectiveness of projects. While there are abundant potential source areas, it will not be possible to develop technically and economically effective treatments without sufficient data. A proposal has been submitted to

TRPA to collect such data on Rosewood and Third Creeks. A possible option is to retain and actively treat first flush and other small-scale runoff events that may contain high concentrations of dissolved nutrients.

RECOMMENDED PROJECTS

Introduction

Table 1 shows a comprehensive list of projects identified for implementation of pollution source control, SEZ restoration and fisheries passage improvements. The intent of the matrix is to encapsulate the projects identified by WRA that address the broader watershed needs and their timelines. Some key conclusions drawn from the information are:

1) Restoration of Lower Rosewood Creek SEZ should be a priority for immediate implementation. It would filter out clastic and perhaps some particulate sediment prior to the implementation of watershed stabilization projects whose timing is unknown.
2) The sediment source survey of the watersheds should be completed in order to prioritize watershed stabilization projects along roads and in streams. This project is now underway through TRPA's administration.

SEZ RESTORATION PROJECTS

SEZ restoration projects are aimed at providing major benefits for water quality treatment by filtration, sediment source erosion control and riparian and aquatic habitat restoration or improvement.

Water Quality Treatment Projects

WRA has identified two potential SEZ restoration projects below Highway 28 that could filter runoff in Rosewood Creek and lower Third Creek. These two projects are:

- Restore Rosewood Creek to its original, pre-Comstock era alignment west of Third Creek from their present confluence to a point just above Lakeshore Boulevard.

- Create new "pocket flood plains" on Third Creek between Lakeshore Boulevard and Highway 28.

There is concern that over-implementing SEZ projects prior to stabilizing sediment sources upstream could be disadvantageous. However, WRA's recommendation is to proceed with SEZ restoration on Rosewood Creek and Third Creek because: a) The volume of sediment is not significant enough to cause failure on the moderate grade channels; b) Needed source control projects upstream are in many cases on private lands and are not in any state of advanced planning, therefore, it is unknown when or if these projects will be implemented; and c) SEZ restoration in Rosewood Creek can provide some filtering treatment in the interim period while restoring 3,000 feet of functional SEZ and improving aquatic habitat in Third Creek.

Rosewood Creek Restoration Project

WRA has concluded that restoration of Rosewood Creek is the most beneficial SEZ restoration project in the Third and Incline Creek watersheds. It provides the most significant opportunity for treatment of poor quality water in wetlands and a major increase in stream and riparian habitat. The significant advantages and benefits are:

- Separation of high sediment loads in Rosewood Creek from Third Creek would improve stream habitat and channel stability to over 2,000 feet of Third Creek.
- The restored alignment of Rosewood Creek includes a relatively large treatment wetland at the downstream end. This would: 1) filter sediments by increasing hydraulic residence time and coursing runoff through densely vegetated flood plain areas; 2) provide a water quality buffer between the highly disturbed Rosewood Creek watershed and Lake Tahoe until source control projects are completed (in unknown future timeframe); 3) provide a

safe diversion for Third Creek flows in the event of a major Third Creek SEZ restoration project in the future; and 4) provide a treatment wetlands for future construction of source control projects in the Rosewood Creek watershed.

- IVGID owns all of the property along the Rosewood Creek alignment and is a willing landowner participant in its restoration, a very important factor.
- The project has no apparent major permitting problems.

After considering the WA to date, available SEZ projects and the reasons described above, TRPA staff support the immediate design and implementation of the Rosewood Creek SEZ project for construction in 2000. Furthermore, using methodologies developed from TRPA's SEZ Restoration Priorities Study, Rosewood Creek rates the highest of all SEZ projects on the Nevada side of Lake Tahoe given its high degree of watershed disturbance and the relative availability of low gradient and restorable flood plain areas.

Third Creek Pocket Flood Plains Project

Aside from Rosewood Creek restoration projects, this project would create large pocket flood plain areas along Third Creek between Incline Way and Lakeshore Boulevard similar to the project recently completed on Incline Creek. Pocket flood plains would be created on alternate sides of Third Creek to promote channel stability and reduce sediment supplies. Both the duration of overbank flow and the area of the flood plain would be increased, resulting in expanded riparian forest. Instream aquatic habitat would also be significantly improved. The sediment source control benefits of this project would be significant because there are extensive eroding banks throughout the project area.

This is the only other SEZ project identified in the watersheds that can be expected to provide improved water quality treatment. However, due to the geomorphic nature of the Third Creek stream channel, the amount of flood plain created by this project will be less than the Rosewood project, even though flows are significantly greater. Therefore, Rosewood will have greater treatment potential.

This project could be completed as early as late summer/fall 2002. Flow could be temporarily diverted into a restored Rosewood Creek during the construction period and re-introduced immediately after.

Sediment Source Reduction SEZ Projects

SEZ restoration projects that stabilize streambanks and channels are effective in reducing erosion in moderate and high gradient streams. The major benefit of the following SEZ projects would be the control of sediment sources.

- Stabilize Rosewood Creek in the disturbed reach upstream of Highway 28.
- Stabilize banks in limited reaches of lower Third Creek, between Lakeshore Boulevard and Highway 28.
- Potential stream channel stabilization projects in the Incline Creek watershed.

Stabilize Upper Rosewood Creek

The reach of Rosewood Creek, from Highway 28 to Northwood Way, is extremely unstable. The stream has been diverted from its original alignment, particularly in the lower end near Highway 28. It is actively headcutting and producing large quantities of sediment. To address this, the design of this project should include a restored channel for several hundred feet, as well as valley-wide grade controls to ensure that a restored channel remains in the same stable location.

Due to the high slope of the flood plain in this area, a restored channel will have little benefit in terms of water quality filtering treatment on the flood plain. However significant benefits may be realized in terms of sediment source controls and improvement of instream and riparian habitat. The main drawback of this project is extremely high cost due to limited construction access and the need for valley-wide grade controls.

Third Creek Bank Stabilization

The area of this project would be the same as that of the "pocket flood plain" project noted above. In this project, however, only eroding banks would be addressed and no pocket flood plain would be created. The purpose of this project would be to reduce sediment inputs while minimizing impacts due to construction. The project would be designed with limited use of heavy equipment in mind and would rely on biotechnical methods of bank stabilization.

In general, this project fails to address long-term problems in lower Third Creek. While banks are stabilized, the main issues causing bank instability (channel incision) are not addressed. On a short–term basis, the reduction of sediment loading from this reach may be an appropriate goal. The best context for this project, however, may be to consider it a short-term solution while maintaining the goal of a more comprehensive Third Creek project in the future.

Incline Creek Watershed Channel Stabilization Projects

Surveys of stream channel conditions in the Incline Creek watershed have not yet been completed. It is likely that some SEZ projects focusing on bank stabilization will be located during this assessment.

HABITAT RESTORATION PROJECTS

The major benefit of the following SEZ projects would be the improvement and restoration of fish and riparian habitat.

- Restore Third and Incline Creek SEZ's through the Lakeshore Boulevard road crossing.
- Restore lagoons at the mouths of Third and Incline Creeks

Lakeshore Boulevard Stream Crossings

The culverts under Lakeshore Boulevard on both Third and Incline Creeks are barriers to fish migration. They are likely a complete barrier to fall spawning fish, and at least a partial barrier to salmonids that migrate at other times of the year, or to other species and life-stages. This fall, Kokanee salmon were abundant downstream of Lakeshore Boulevard in Third Creek but were not seen upstream. Also, electrofishing surveys in Incline Creek conducted in spring of 1999 indicate that native fish species found in the lakeshore area are not migrating upstream past Lakeshore Boulevard. They are found extensively between the lake and the road crossing.

The crossings are similar in hydraulic configuration and problems with fish passage. They consist of concrete bos culverts placed well above downstream streambed grade. A concrete apron at the downstream end of the culverts allows water to drop to the downstream streambed, but produces low depth and high water velocity. Providing fish passage conditions similar to adjacent reaches of the natural channel at the crossings would require complete replacement of the existing culverts with bridges. Passage conditions could be improved somewhat with more limited projects, such as baffles and backwater weirs, but these limited projects would not eliminate fish passage concerns.

The main benefit of this project would be fish passage. Some limited restoration of riparian habitat may be realized. Also, the road fill at the Incline Creek culvert is eroding. The replacement of this crossing may have some limited water quality benefits in terms of sediment source control. Drawbacks of this project include high cost, disruption of Lakeshore Boulevard traffic and potential lack of funding given the limited objectives of fish habitat restoration.

Third and Incline Creeks Lagoon Restoration

The mouths of both Third and Incline Creeks have been straightened to protect beach habitat, reduce flooding and provide year-round access by fish. Historically, the mouths of

these streams were almost certainly small lagoons behind a barrier beach. This was likely a very dynamic area: increasing in size during wet years and decreasing in times of drought. During low lake stands, the streams would incise through the barrier beach, while at high lake stands very little channel might be present between the lagoon and the lake. A current example of this geomorphic configuration can be seen at the mouth of Taylor Creek on the south shore.

This project would consist of recreating the lagoons at the mouth of the creeks. A limited amount of meandering channel might also be created from the Lakeshore Boulevard crossings downstream to the lagoons. Because the lagoons would be relatively small and dynamic, it is not anticipated that water quality treatment function of the lagoons would be significant, nor would the treatment potential of the meandering channels be especially important due to their limited length. However, this project would have significant benefits to fish and wildlife habitat through the restoration of a habitat type that is quite rare on the lake.

Drawbacks of this project include high cost, uncertainties in design and the potential loss of passage for fish species currently the focus of management policy, particularly kokanee salmon. Lagoons are dynamic environments; the behavior of constructed lagoons would be extremely difficult to predict.

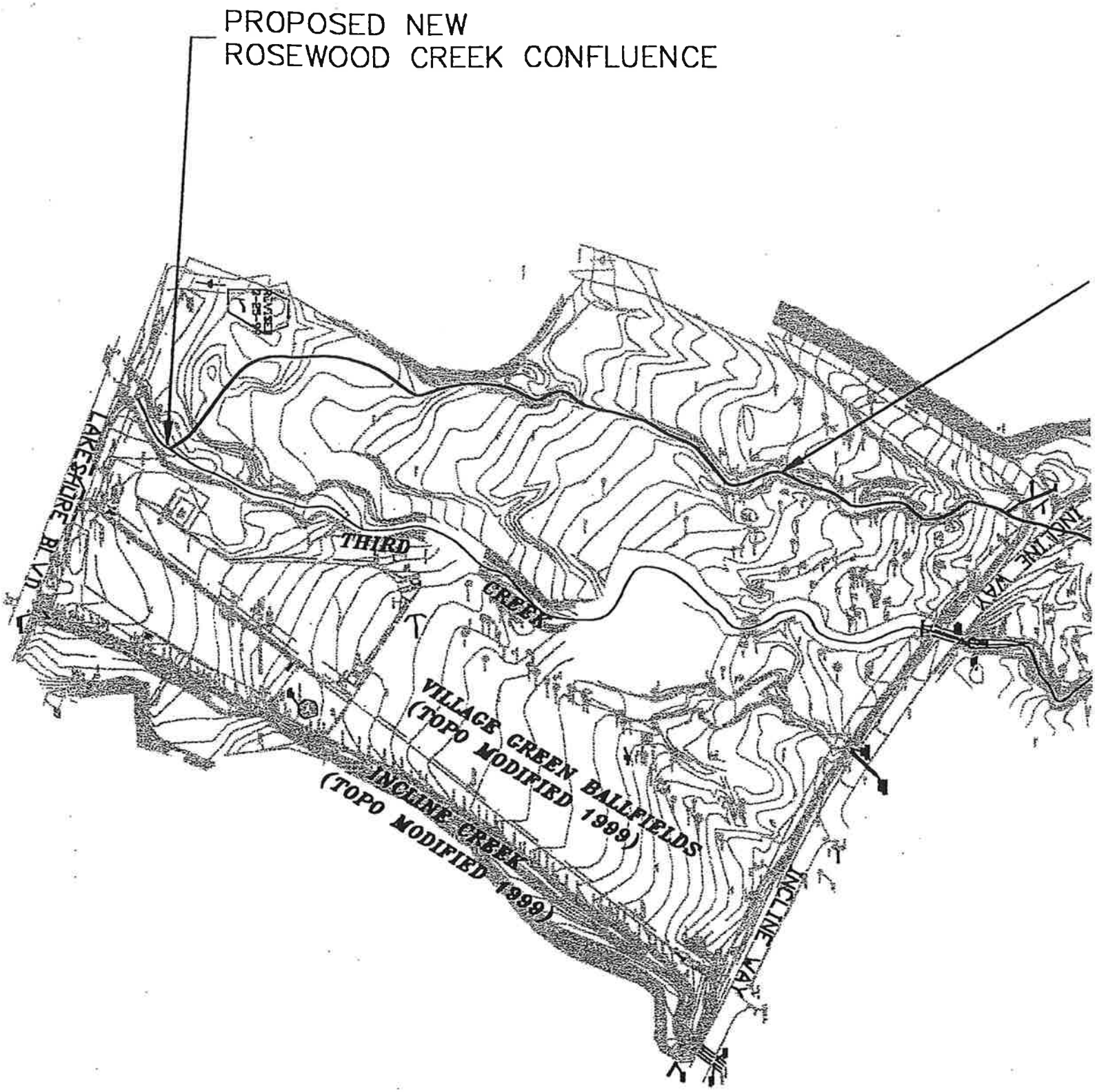
CONCLUSIONS AND RECOMMENDATIONS

1) A combination of SEZ restoration projects and pollutant source control projects should be implemented in the Third and Incline Creek watersheds to achieve improved water quality and other objectives.
2) The SEZ projects for flood plain restoration and pollutant filtration should occur below Highway 28 in relatively low gradient reaches in Rosewood Creek and Third Creek. Rosewood Creek is a Phase 1 priority project because: 1) it is the most visibly polluted water course; 2) the project is highly feasible from a permitting and land ownership perspective; and 3) the project will have a measurable benefit to water quality. It is the

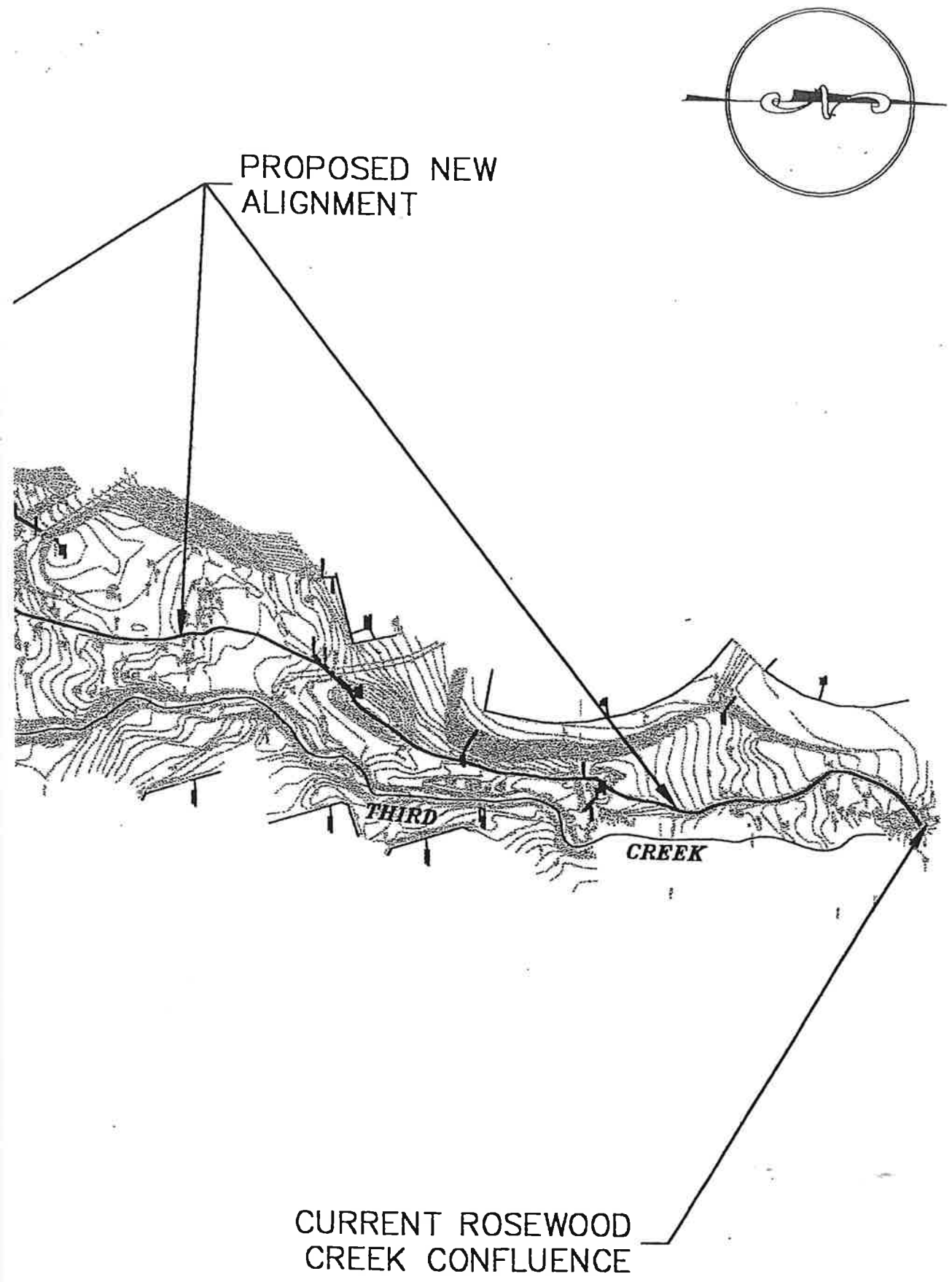
opinion of WRA and TRPA staff that it should be designed and implemented immediately. Third Creek has some opportunities for SEZ improvements, but less so for water quality treatment.

3) The majority of water quality benefits will occur with source control projects on roads in Rosewood and Incline Creeks. These projects should include: 1) curb and gutter construction to stabilize ditches and separate road runoff from water courses; 2) development of urban water detention basins for onsite treatment and possibly active treatment after collection of first flush runoff; and 3) SEZ restoration for channel stabilization and separation from road ditch sources.

It is difficult to determine which specific areas should have priority without completing the Watershed Assessment, which envisioned quantitative road and stream channel stability surveys. Also, a hand-drawn drainage system map completed by Washoe County Roads Department in 1981 needs to be digitized, enhanced and incorporated into the road survey database. It is anticipated that road drainage improvements costing millions of dollars will be needed to reduce and eliminate pollution input to waterways and the lake. Completion of the Watershed Assessment and these stream and road surveys will be a major step forward in this regard.


PROPOSED NEW
ROSEWOOD CREEK CONFLUENCE
LAKESHORE BLVD
THIRD
CREEK
VILLAGE GREEN BALLFIELDS
(TOPO MODIFIED 1999)
INCLINE CREEK
(TOPO MODIFIED 1999)
INCLINE WAY
INCLINE WAY

SCALE: 1"=200'



Rev	Date	Description

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ROSEWOOD CREEK RESTORATION PLAN

PROPOSED AND
EXISTING CHANNELS

Date	12-8-99
Scale	AS SHOWN
Project	98-131

FIG 1