Lake Davis Northern Pike Eradication Project 2007
Draft Water Quality Monitoring Plan
Preliminary Draft: Subject to Revision
April 24, 2007

The Department of Fish and Game has approved a project to eradicate pike, a non-native invasive species, with a chemical treatment of Lake Davis and its tributaries in September and/or October 2007. Lake Davis is a reservoir located on Big Grizzly Creek, a tributary to the Middle Fork Feather River. The reservoir contains 84,371 acre feet at capacity. Pike, a predaceous non-native fish, were illegally introduced into the reservoir and threaten fisheries resources in Lake Davis, downstream watersheds, and watershed throughout California.

The approved project calls for treating the reservoir at 45,000-48,000 acre-feet, and using predominantly the rotenone formulation CFT Legumine with the use of some Noxfish, and powdered rotenone in the form of gel-balls, if needed. There is also a contingency plan for treating the reservoir at a lower level, down to 38,000 acre-feet, if needed. Project plans specify treating the reservoir with CFT Legumine and some Noxfish at a resultant concentration of 1 mg/L (50 µg/L rotenone.). Tributaries to Lake Davis will also be treated before and during the reservoir treatment.

There are three options for neutralization of the rotenone. The preferred option is to shut off the dam and allow the rotenone to degrade naturally, while returning any uncontrolled leakage to the reservoir. A second option is to conduct off-stream neutralization using potassium permanganate. The third option is to conduct instream neutralization in Big Grizzly Creek below the dam using potassium permanganate. Monitoring plans have been developed for Big Grizzly Creek Options 1 and (Appendix A). In addition, DFG is working the the Department of Water Resources and Plumas County Environmental Health Department to monitor area wells to confirm that groundwater is not contaminated (Appendix B).

This monitoring plan consists of two elements: a chemical monitoring plan (Table A) and a toxicological monitoring plan.

I. Chemical Monitoring

A. Objectives

(1) Confirmation that the rotenone concentrations present in the reservoir and tributaries are sufficient to eliminate the target species;

(2) Confirmation that degradation of rotenone and other chemicals in or components of Noxfish^{R} and/or CFT Legumine^{R} has occurred in the reservoir and tributaries;

(3) Confirmation that toxic concentrations of rotenone or other project chemicals do not

impact Big Grizzly Creek downstream of Big Grizzly Dam; and

(4) Fulfillment of monitoring requirements specified by the Department of Health Services (DHS) and the Central Valley Regional Water Quality Control Board (RWQCB).

B. Materials and Methods

Water samples will be collected using the methods of Siepmann and Finlayson (1999) for water and sediment. Analysis for rotenone and rotenolone concentrations in water will be performed by DHS laboratory using methods described in Dawson et al. (1983). Analysis for the other organic constituents and potential contaminants of the formulation will be performed by DHS laboratory using U.S. Environmental Protection Agency approved methods. DFG Water Pollution Control Laboratory will analyze splits of 15% of the water samples for rotenone and other organic constituents. DFG will also analyze sediment samples for rotenone and other organic constituents. The numbers of samples are given in Tables B and C.

Preproject monitoring will occur about one week prior to the project. Post-project monitoring will occur as described below with the first day of treatment being Day 0.

1. Sample Collection and Storage

a. Water samples: Grab samples will be collected from the reservoir and tributaries. Subsurface water samples will be collected using a 4.2-liter Kemmerer bottle from mid-depth and one foot above the bottom in Lake Davis. Sample collection and handling will conform to both EPA 500 series and EPA 8000 series method requirements.

1) Rotenone: Water sampling for rotenone and rotenolone will utilize 500-ml amber glass bottles filled to capacity and sealed with teflon-lined caps.

2) Other organic constituents: Water samples for other organic constituents of the formulated rotenone product will be collected in two 1,000-ml amber glass bottles (semi-VOC analysis) and in two 40-ml glass vials with septa caps (VOC analysis).

3) Water Quality: Dissolved oxygen content of water will be recorded at the time of sample collection using a YSI^{R} model 57 oxygen meter. Temperature of water column will be determined

using an electronic temperature profiler. Water samples for pH, hardness, total organic carbon, conductivity, and alkalinity determinations will be collected in 1-L high density polyethylene bottles. Samples collected for Biochemical Oxygen Demand (BOD) will be collected in 1-L high density polyethylene jars.

b. Sediment samples
Sediment samples will be collected using a sediment core sampler with butyrate plastic liner sleeves. The top 6 inches of hydrosoil will be analyzed for project chemicals.

c. Storage
Following collection, all samples will be stored on ice at a temperature of 4^{o}C. DHS water samples will be transported to the DHS laboratory in Berkeley. DFG sediment samples and split water samples will be transported to the DFG in Rancho Cordova. Sediment samples will be frozen pending analysis.

d. Quality Analysis/Quality Control
For water analyses, a travel blank, lab reagent blank, lab fortified blank, and field duplicate will analyzed for each constituent for each sampling event. A lab fortified matrix sample will be analyzed for methyl pyrrolidone (MP), diethylene glycol ethyl ether (DGEE), and rotenone/rotenolone for each sampling event. A quality control sample will also be collected and analyzed for each sampling event. DFG will analyze rotenone and rotenolone, VOC, and semi-VOC on splits for 15% of all water samples collected in the reservoir. The purpose of these samples is to ensure accuracy, precision, and lack of contamination of the monitoring.

For sediment analyses, matrix spikes and matrix spike duplicates (5%), laboratory control spikes and laboratory control spike duplicates (5%), method blanks (5%), laboratory duplicates (5%), and field splits (5%) will be utilized.

2. Analyses: Reporting Limits (RLs) for all parameters measured are given in Table C.

a. Rotenone and Rotenolone: Samples will be analyzed using high-performance liquid chromatography according the method of Dawson et al. (1983).

b. Other organic constituents – The DHS laboratory will analyze volatile and semi-volatile organic compounds using EPA methods 524 and 525 (USEPA 1995a, 1995b). A subset of samples will be splits and splits analyzed by DFG using EPA methods 8260, 8015, and 8270 for water (USEPA 1994a, 1994b, 1996. Sediment samples will be analyzed by DFG using EPA methods 8260, 8015, and 8270 (USEPA 1994a, 1994b, 1996).

c. Water Quality: Samples for pH, hardness, total organic carbon, conductivity and alkalinity will be analyzed by DFG using standard APHA methods. BOD samples will be analyzed by a State of California certified laboratory using Standard Methods 5210 (APHA 1998). Bacteriological analysis samples will be analyzed by a private laboratory following sampling protocol specified by DHS.

3. Sample Security and Data Handling

Each sample collected will be accompanied by a Chain of Custody form documenting the sequence of transfer from sample generation to the analytical laboratory.

The form will include locations (GPS coordinates), sampling dates and times, and sample description.

4. Monitoring Locations: Water

The approximate locations of ten sites have been determined for monitoring (Figure 1). At least one week before the project, exact sites in Lake Davis will be marked with a buoy and GPS coordinates recorded using a Garmin GPSmap 76s. Sites on the tributaries will be marked with flagging and GPS coordinated noted.

a. Reservoir: Ten sites have been selected for water and sediment sampling in the reservoir. Five of these are limnetic (deeper) sites and five are littoral (shallower) sites. Water samples will be collected at three depths at each limnetic site (surface, mid-depth, and bottom) and two depths at each littoral site (surface, bottom).

b. Tributaries: Tributaries to Lake Davis will be sampled upstream of approximately 30 drip stations during the treatment for rotenone and rotenolone residues. A number of tributary sites (approximately three) will be monitored for project chemicals before the area is opened for public contact. The initial samples will be for rotenone. Once rotenone is not detected, other organic constituents will be monitored. Non-flowing side channels will be monitored for efficacy if deemed necessary. The location and number of these sites are dependent on the treatment plan in the tributaries (Table E).

5. Monitoring Location: Sediment Sites

Each of the littoral sites will be sampled for sediment. DFG will collect sediment samples at approximately three sites on the tributaries prior to DHS allowing public access.

6. Sampling Frequency

Sampling of the reservoir will occur approximately one week prior to the project and then two days after the project. Other sampling events will occur weekly. To accommodate laboratory schedules, sampling events will occur early in the week, typically on Mondays.

Sampling of the tributaries and nonflowing side channels will occur during the treatment to ensure that desired concentrations were attained. Sampling of the tributaries will occur again prior to re-opening the surrounding land to public contact. The land will not be opened to the public until no project chemicals are present in detectable levels.

A Sampling schedule has been developed for sampling water and sediment in Lake Davis (Table F).

Table A. Overview of Monitoring for Lake Davis Project (Water and sediment)

	Tributaries	Lake Davis	Big Grizzly Crk[1]	Groundwater (Wells)
Water:				
Entity	DFG	DHS	DFG	PCEHD
# Sites	30	25		TBD[2]
Rotenone	4 X	Weekly		~ Biweekly
Inerts	1 X	Weekly		~ Biweekly
Water quality		Biweekly (DFG)		
Sediment:				
Entity	DFG	DFG		
Rotenone	1 X	Biweekly		
Inerts	1 X	Biweekly		

[1]Monitoring plan will be determined when detoxification option is chosen.
[2]To Be Determined: Number and location of wells to be tested will be determined by isotope monitoring.

Table B – Sampling Plan for Lake Davis water. Sampling will continue on a weekly (chemical constituents) and biweekly (water quality) basis until three samples yield no detectable residues of project chemicals.

		DHS				DFG (split samples)	
	Number of weeks	Number of Sampling Sites	QA samples	Samples per site	Total samples: DHS	Number of samples	Total samples: DFG
Rotenone/ Rotenolone	8[2]	25	5	1	240	4	32
VOC	8	25	5	1	240	4	32
Semi-VOC (incl. MP and DEGME)[1]	8	25	5	2	480	4	32
Water quality	4	0	0	0	0	6	24

[1]DHS analyzes separate samples for MP and DEGME.
[2]One pre-project week and seven post-project weeks.

Table C. Reporting Limits in Surfacewater and Sediment

Analyte	Media	Method	Reporting Limit
Rotenone	Water	Dawson et al. 1983	2 µg/L[1]
Rotenolone	Water	Dawson et al. 1983	2 µg/L[1]
1,3,5-Trimethylbenzene	Water	EPA 524	0.5µg/L
sec-Butylbenzene	Water	EPA 524	0.5µg/L
n-Butylbenzene	Water	EPA 524	0.5µg/L
p-Isopropyltoluene	Water	EPA 524	0.5µg/L
Naphthalene	Water	EPA 524	0.5µg/L
Toluene	Water	EPA 524	0.5µg/L
m/p-Xylene	Water	EPA 524	0.5µg/L
o-Xylene	Water	EPA 524	0.5µg/L
Isopropylbenzene	Water	EPA 524	0.5µg/L
n-Propylbenzene	Water	EPA 524	0.5µg/L
1,2,4-Trimethylbenzene	Water	EPA 524	0.5µg/L
Trichloroethylene	Water	EPA 524	0.5µg/L
2-Methylnaphthalene	Water	EPA 524	0.5µg/L
Naphthalene	Water	EPA 524	0.5µg/L
n-Methyl-2-pyrrolidone	Water	EPA 524	5 - 10 µg/L[1]
Diethylene glycol ethyl ether	Water	EPA 524	5 - 10µg/L[1]
Rotenone	Sediment	Dawson et al. 1983	30 ng/g (dry weight)
Rotenolone	Sediment	Dawson et al. 1983	30 ng/g(dry weight)
1,3,5-Trimethylbenzene	Sediment	EPA 8260	10 ng/g
sec-Butylbenzene	Sediment	EPA 8260	30 ng/g
n-Butylbenzene	Sediment	EPA 8260	30 ng/g
p-Isopropyltoluene	Sediment	EPA 8260	30 ng/g
Naphthalene	Sediment	EPA 8260	40 ng/g
Toluene	Sediment	EPA 8260	20 ng/g
m/p-Xylene	Sediment	EPA 8260	30 ng/g
o-Xylene	Sediment	EPA 8260	30 ng/g
Isopropylbenzene	Sediment	EPA 8260	10 ng/g
n-Propylbenzene	Sediment	EPA 8260	20 ng/g
1,2,4-Trimethylbenzene	Sediment	EPA 8260	20 ng/g
Trichloroethylene	Sediment	EPA 8260	30 ng/g
2-Methylnaphthalene	Sediment	EPA 8270	500 ng/g
Naphthalene	Sediment	EPA 8270	500 ng/g
n-Methyl-2-pyrrolidone	Sediment	EPA 8015b	1.2µg/g
Diethylene glycol ethyl ether	Sediment	EPA 8015b	1.1µg/g

[1]Final reporting limit to be determined after method development and validation.

Table D - Sampling Plan for Lake Davis sediment. Sampling will continue on a biweekly basis until three samples yield no detectable residues of project chemicals.

	Number of sample sites	Number of weeks	QA/QC samples	Total number of samples
Rotenone/ Rotenolone	5	4	5	25
VOC	5	4	5	25
Semi-VOC	5	4	5	25

Table E – Sampling Plan for Tributaries to Lake Davis

	Treatment 1	**Treatment 2**	**Before public contact**
Water			
Rotenone/Rotenolone	30 sites	30 sites	3 + sites
VOC			3 + sites
Semi-VOC			3 + sites
Sediment			
Rotenone/Rotenolone			3 + sites
VOC			3 + sites
Semi-VOC			3 + sites

Table F – Sampling Schedule for Lake Davis water and sediment.

	Day -7	**Day 2**	**Day 7**	**Day 14**	**Day 21**	**Day 28**	**Day 35**	**Day 42**
Water:								
Rotenone/Rotenolone	X	X	X	X	X	X	X	X
VOC	X	X	X	X	X	X	X	X
Semi-VOC	X	X	X	X	X	X	X	X
Water Quality	X		X		X		X	
Sediment:								
Rotenone/Rotenolone	X		X		X		X	
VOC	X		X		X		X	
Semi-VOC	X		X		X		X	

B. Information Disclosure

Monitoring results required by the RWQCB will be submitted to them by the first day of the second week following sample collection. A final report on the monitoring will be supplied to the RWQCB, DHS, the Plumas County Health Department, and other interested parties within 60 days after the completion of monitoring.

C. References

American Public Health Association. 1998. Standard Methods for the Examination of Water and Wastewater.

Dawson, V., P. Harmon, D. Schultz, and J. Allen. 1983. Rapid method for measuring rotenone in water at piscicidal concentration. Trans. Amer. Fish. Soc. 112:725-728.

U.S. Environmental Protection Agency (USEPA). 1996. Method 8015B. Non-halogenated organics using GC/FID, Revision 2.

USEPA. 1995a. Method 524: Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry - Revision 4.1.

USEPA. 1995b. Method 525: Determination of Organic Compounds in Drinking Water by Liquids-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry, Revision 2.2.

USEPA. 1994a. Method 8260: Volatile organic compounds by gas chromatography/mass spectrometry (GC/MS): capillary column technique.

USEPA. 1994b. Method 8270: Semi-volatile organic compounds by gas chromatography/mass spectrometry (GC/MS): capillary column technique.

Harrington, J. and B. Finlayson. 1988. Rotenone residues in water following application to Kaweah River and Tulare Lake Basin, California. California Department of Fish and Game Environmental Services Division Administrative Report 88-1. Sacramento, California.

Siepmann, S., and B. Finlayson. 1999. Chemical residues in water and sediment

following rotenone application to Lake Davis, California. California Department of Fish and Game Office of Spill Prevention and Response Administrative Report 99-2. Sacramento, California.

II. Toxicological Monitoring

The purpose of toxicological monitoring is to confirm the efficacy of the chemical treatment in the reservoir and tributaries. These objectives will be accomplished by the placement of live rainbow trout at various locations within the reservoir and tributaries. Rainbow trout are less sensitive to rotenone than are northern pike and can serve as sentinels to test the efficacy of the treatment.

A. Materials and Methods: Reservoir

1. Live cars will be placed at each of the ten of the chemical monitoring sites and at each of the two or three sampling depths in Lake Davis. Each live car set in the reservoir will consist of two to three net cages attached to a weighted line suspended from a buoy. The highest cage will be suspended 1 foot from the surface, a cage will be at mid-depth, and the lowest cage will be approximately 1 foot from the bottom of the reservoir. Five rainbow trout will be placed in each cage.

2. Live cars will be set up immediately prior to treatment. Fish will be checked daily, beginning two days after treatment. The live cars will be removed and will not be restocked when the fish die.

B. Materials and Methods: Tributaries

1. In the tributaries, live cars will be set up above every drip station except the highest one. Live cars will consist of a single net cage attached to a weighted line. Five rainbow trout will be placed in this cage.

2. Fish will be checked by the dripcan operator at least three times daily during the treatment and dead fish will be removed. Fish survival will be noted along with drip station data.

3. Fish will be placed in some of the nonflowing side channels to monitor the efficacy of the treatment.

APPENDIX A. MONITORING PLAN FOR BIG GRIZZLY CREEK

There are three neutralization options. The preferred neutralization option is to shut off the dam and allow the rotenone in the reservoir to degrade naturally, returning the uncontrolled leakage to Lake Davis (Option 1). . Option 2 is offstream neutralization using potassium permanganate and Option 3 is instream treatment with potassium permanganate. Monitoring plans for Option 1 and Option 2 are described below. A sampling plan for Option 3 may be developed at a later date. The monitoring will include chemical and toxicological monitoring. Monitoring locations are listed in Table G.

A. Objectives

(1) Determination of extent of movement of project chemicals in Big Grizzly Creek;

(2) Confirmation that concentrations of potassium permanganate are sufficient to neutralize rotenone in Big Grizzly Creek;

(3) Determination of duration of project chemicals in water in Big Grizzly Creek; and

(4) Fulfillment of any monitoring requirements set by the State Water Resources Control Board or the Regional Water Quality Control Board.

B. Descriptions of Monitoring by Option – Options correspond with options described in NPDES permit.

1. Option 1 will require the Grizzly Valley Dam be closed for a period of up to 45 days to allow the project constituents to fully degrade. The seepage from the reservoir (estimated at 4 gallons per minute) will be collected and returned to the reservoir. For this option, monitoring will include sampling at SEEP-001 (daily for rotenone and weekly for inerts) and BGC1 (weekly for rotenone and inerts. A live car at BGC1.5b will be checked four times daily (Table H).

2. Option 2 consists of off-stream treatment of Lake Davis water and its discharge into Big Grizzly Creek to allow for increased stream flows. A maximum of 0.5 cfs of water from Lake Davis that has been treated with potassium permanganate will be released into Big Grizzly Creek at Eff-001. Monitoring will sampling for rotenone at INF-001, EFF-001, and BGC1.5a. Other organic constituents will be sampled at INF-001, Eff-001, BGC1.5a, and BGC1.5b until there are three non-detects. Potassium permanganate will be sampled hourly or continuously at Eff-

001. Dissolved oxygen and pH will be sampled daily at Eff-001. Biological Oxygen Demand (BOD) will be monitored weekly at Eff-001. Color will be monitored at BGC3. Toxicological monitoring will occur at Eff-001, BGC1.5a, and BGC1.5b, BGC2, and BGC3 (Table I).

3. Option 3 includes both Options 3 and 4 described in the NPDES permit. This option consists of using Big Grizzly Creek for neutralizing the rotenone. Potassium permanganate will be added at BGC1 and will neutralize the rotenone, most likely upstream of BGC2. Option 3 will allow up to 2 cfs of water to be released from Grizzly Valley Dam and Option 4 will allow up to 5 cfs. A sampling plan will be developed for Option 3 at a later date.

C. Materials and Methods

Water samples will be collected using the methods of Siepmann and Finlayson (1999). Analysis for rotenone and rotenolone concentrations will be performed by DFG laboratory using methods described in Dawson et al. (1983). Analysis for the other organic constituents, and potential contaminants, of the formulation will be performed by DFG laboratory or a private laboratory using U.S. Environmental Protection Agency approved methods.

Live cars will be set up on Day 0. Dead fish will be replaced. Toxicity will be defined as death of a majority of fish in a live car.

Preproject monitoring will occur about one week prior to the project. Post-project monitoring will occur as described below with the first day of treatment being Day 0.

1. Sample Collection and Storage

a. Water samples: Project chemicals
Water sampling for rotenone and rotenolone will utilize 500-ml amber glass bottles filled to capacity and sealed with teflon-lined caps. Water samples for other organic constituents of the formulated rotenone product will be collected in 1-L amber glass bottles (non-VOC analysis) and 40-ml glass vials with septa caps (VOC analysis). Grab samples will be collected from creek.

b. Water samples: Potassium permanganate
Water samples will be collected hourly or continuously for potassium permanganate using modified Standard Methods 4500 (APHA 1998). The

target residual of potassium permanganate at BGC2 is 0.5 to 1.0 mg/L.

c. Storage
Following collection, all samples will be stored on ice at a temperature of 4°C and transported to the Pesticide Investigations Unit (PIU). The samples will be transferred to the DFG Water Pollution Control Laboratory in Rancho Cordova for analysis.

d. Quality Analysis/Quality Control
Laboratory matrix spikes (5%), field (10%) duplicate samples, laboratory duplicate analyses (5%) and fresh travel blanks will be utilized to ensure accuracy, precision, and lack of contamination of the monitoring.

2. Analyses: Reporting Limits (RLs) for all parameters measured are given in Table C.

a. Rotenone and Rotenolone - A 500-ml aliquot of a water sample, buffered to pH 5 will be filtered through a preconditioned Sep Pak^R at a rate not to exceed 40 ml/min using a vacuum pump according to the method of Dawson et al. (1983). Rotenone and rotenolone will be extracted from the Sep Pak^R with methanol and analyzed on a Varian^R model 500 high-performance liquid chromatograph on a MCH 10 reverse-phase column with methanol:water (75:25) mobile phase and wavelength of 275 nm.

b. Other organic compounds - These samples will be analyzed by a State of California certified laboratory using EPA methods 8260, 8015, and 8270 for water and sediment (USEPA 1994a, 1994b, 1996).

3. Sample Security and Data Handling

Each sample collected will be accompanied by a Chain of Custody form documenting the sequence of transfer from sample generation to analytical laboratory. The form will include location codes, sampling dates and times, and sample description. Fish survival data from toxicological monitoring also be recorded.

Table G. Monitoring Locations on Big Grizzly Creek

Site Name	Site Description
SEEP-001	Grizzly Valley Dam Toe Drains
INF-001	Influent to Rotenone Neutralization Station
EFF-001	Effluent from Rotenone Neutralization Station.
BGC1	Big Grizzly Creek 0 – Discharge from Lake Davis Dam to Big Grizzly Creek
BGC1.5a	Big Grizzly Creek below spring tributary flows – 100 ft downstream of BGC1.
BGC1.5b	Big Grizzly Creek immediately below spring tributary flows 400 yds downstream of Eff-001
BGC2	Big Grizzly Creek at the 30 minute travel time downstream of BGC1.
BGC3	Big Grizzly Creek at the 60 minute travel time downstream of BGC1.

Table H. Sampling schedule for Big Grizzly Creek for Option1.

Site	Rotenone	VOC	Semi-VOC	Toxicological
SEEP-001	Daily	Weekly	Weekly	
BGC1	Weekly	Weekly	Weekly	
BGC1.5				4x/day

Table I. Sampling schedule for Big Grizzly Creek Option 2.

Site	Rotenone	VOC	Semi-VOC	Potassium permanganate	Water Quality[1]	BOD	Toxicological	Color
INF-001	4x/day	Every 2 days	Every 2 days					
EFF-001	2X/day	Every 2 days	Every 2 days	Hourly (or continuously)	Daily	Weekly	Hourly	
BGC1.5a	Daily		Daily[2]				4x daily	
BGC1.5b		Weekly	Daily[3] Weekly				4x daily	
BGC2							4x daily	
BGC3							4x daily	Daily

[1]4x/day for first week, 3x/day for second week, 2x/day until 3 non-detects.
[2]Methyl pyrrolidone only
[3]Naphthalene and DGEE only, all others weekly.

APPENDIX B. PLUMAS COUNTY ENVIRONMENTAL HEALTH DEPARTMENT GROUNDWATER MONITORING PLAN

Groundwater level and groundwater quality monitoring will occur before and during the Lake Davis Pike Eradication Project. Department of Water Resources (DWR) is conducting groundwater level monitoring and Plumas County Environmental Health Department (PCEH) is conducting groundwater quality monitoring.

I. GROUNDWATER LEVEL MONITORING:

DWR will conduct the following groundwater level monitoring activities.

- locate and map wells in the watershed;
- characterize groundwater movement, identify influences on groundwater levels and flow in the area, and map the hydraulic elevations and gradient in the Big Grizzly Creek watershed;
- determine if there are any wells in the watershed which may be hydraulically influenced by potential reservoir drawdown or temporarily reduced flows in Big Grizzly Creek;
- compile into a single database existing well information including well locations, construction details;
- visually portray groundwater characteristics in the watershed so that scientists, agency personnel, technical workers, and the public can better understand the groundwater system;
- participate in agency and well owner workshops to improve understanding of the groundwater system, and;

Well water level monitoring: Well locations will be plotted with Global Positioning System (GPS) devices. Database and maps will be developed into a Global Information System (GIS) format. Well heads will be surveyed to determine elevation in reference to sea level. Groundwater hydrology monitoring and evaluation will occur before, during, and after the pike eradication project. Information regarding groundwater hydrology will be monitored and updated continuously to assist with project operations. Information will be presented to the public during outreach meetings and public concerns will be addressed.

In consultation with PCEH and California Department of Health Services (DHS) DWR has equipped specific wells with pressure transducer-data loggers (data loggers) to monitor static groundwater level. Three data loggers installed in the study area and have been collecting data since November, 2005. DWR may install loggers on up to two additional water wells, if needed, by July 10, 2006. Program probes to record groundwater level measurements at a frequency appropriate for providing data for future contour mapping and groundwater information.

DWR will collect static and pumping groundwater level information from loggers. Data will be collected and downloaded to create a spreadsheet and/or graph for determination of seasonal groundwater level

variation in wells. Collection of data, downloading and servicing data loggers as necessary and as permitted by weather and access conditions.

Well location mapping:

In coordination with PCEH and DHS, DWR will identify and map the location of the 78 wells currently in the 1997 PCEH water quality testing program. DWR will obtain information regarding locations of the estimated additional 50 to 100 wells in the project area and any new wells installed since 1997. Information regarding wells, if available, will include water quality analytical data, owner and parcel information, well structural details, well level monitoring data and well GPS coordinates. To the extent possible, wells will be plotted on a topographic map.

Monitoring Data:

Monitoring information will be evaluated to assist in determining the number and location of additional wells to be included in the water level monitoring grid.

Well data logger locations will be monitored, maintained, evaluated, and adjusted as necessary. Manual measurements of wells without automatic data loggers will occur as well. Automatic logger information will be downloaded, and manual measurements will be collected monthly as weather permits. Measurement information will be entered into a database and compiled to construct a groundwater level time history (hydrograph) for each well in the monitoring network. This will provide baseline and ongoing groundwater hydrological information.

This information will allow groundwater level contour and flow vector maps to be developed for the lake Davis vicinity. Monitoring will also provide information regarding well water levels, groundwater flow direction, and pumping or drawdown influences in the region before and after the pike eradication project.

DWR will present monitoring information in public well owner and well user workshops.

II. GROUNDWATER QUALITY MONITORING:

Groundwater quality monitoring conducted by PCEH for the 1997 Lake Davis rotenone treatment will continue. In addition, PCEH will conduct groundwater quality monitoring before, during, and after the 2007 Pike Eradication project required by DHS, the Regional Water Quality Control Board (RWQCB), and as recommended by PCEH and LLNL. Monitoring will include the following activities:

- Collect background surface water samples in the Lake Davis vicinity for isotopic analysis by LLNL.
- Collect groundwater samples in approximately 200 wells for isotopic analysis

- Surface and groundwater isotope samples will be analyzed by LLNL
- Identify wells for future sampling (revised grid).
- Collect water samples from wells in the revised grid before treatment, 48 hours post-treatment and weekly thereafter until 3 consecutive samples are non-detect for compounds associated with the 2007 treatment..
- Collect well water samples from wells in the 2007 grid annually for 10 years; analyze water for 2007 rotenone chemicals.
- Observe DFG reservoir water quality sample collection and implement independent laboratory confirmation sampling of third consecutive non-detect DHS water sample.

1997 Lake Davis Groundwater Monitoring Program:

PCEH has been monitoring groundwater quality in approximately 80 wells (currently 78 wells) in the area as part of a 10-year monitoring agreement resulting from the 1997 Lake Davis rotenone application. The wells in this monitoring network or *grid* are currently tested for rotenone formulation constituents that were part of the 1997 Lake Davis rotenone treatment. Seventy-six wells are tested annually and two are tested semi-annually. This is the ninth year of the PCEH 10-year well water quality testing program in the 1997 well grid, to be completed in 2008. Tests conducted as part of this program to date show no contaminants related to the 1997 treatment in any of the wells. PCEH well water samples are currently analyzed by North Coast Laboratory, in Arcata, California.

Isotopic Analysis of Groundwater for the 2007 Pike Eradication project:

PCEH contracted LLNL to conduct a review and assessment of Plumas County's Groundwater Quality Monitoring at Lake Davis. LLNL recommended that the most effective way to monitor the local groundwater was to clarify the source of the groundwater in the wells through the use of isotopic analysis.

Well water samples will be collected by PCEH for isotopic analysis by LLNL. Isotopic analysis will include the collection of baseline surface and groundwater samples in approximately 200 wells (including the current 78-well grid) prior to the 2007 Lake Davis rotenone treatment. Isotopic testing will determine if wells in the current monitoring grid contain water that originates from a surface water source, such as Lake Davis or Grizzly Creek; likewise, the testing will identify wells that do not have evidence of surface water connection.

PCEH staff will first collect background surface water samples for isotopic analysis in Lake Davis, Grizzly Creek, and specific tributaries. These samples will be analyzed for isotopic signatures by LLNL. Later they will be compared to well water isotope sample results. The well water samples will be collected by PCEH approximately May/June 2007. Samples will be transported by PCEH to LLNL for the isotopic analysis prior to the 2007 Lake Davis treatment. Isotopic analytical results will be evaluated by LLNL in the context of other groundwater monitoring information to determine potential vulnerability

of groundwater quality from pike eradication activities. Other groundwater evaluation criteria includes historical groundwater quality monitoring data, past and current DWR groundwater level monitoring, well location and geology, casing depth, screen intervals, and well log information, if available. Based on the LLNL isotopic evaluation and recommendation, the well monitoring grid will be revised to include the set of wells that contain water originating from a surface water source.

Water quality monitoring in the 2007 well grid:

Wells in the revised grid will be monitored by PCEH for the 2007 rotenone treatment chemicals in conjunction with DHS surface water sampling as follows: baseline testing one week prior to treatment, 48 hours post-treatment, and weekly thereafter until 3 consecutive samples result in no detection of compounds associated with the 2007 treatment. PCEH will also implement independent laboratory confirmation analysis of the third consecutive non-detect DHS water sample. After 3 non-detectable sample results are confirmed in surface water by DHS and an independent laboratory, and groundwater by PCEH, PCEH will begin annual testing for 2007 formulation chemicals in the new well grid starting summer of 2008 for up to 10 additional years.

All well water samples will be collected by PCEH according to the Henrici Method and as recommended by LLNL (Ridley 2006), and transported to the appropriate independent laboratory via chain-of-custody. Isotope samples will be transported to LLNL and well water samples to be analyzed for rotenone, rotenone breakdown products, and rotenone formulation chemicals will be analyzed for PCEH by North Coast Laboratories in Arcata, California. Constituents to be analyzed are shown in table below:

2007 Groundwater Constituents and Reporting Limits:

Analyte	Media	Method	Reporting Limit
Rotenone	Water	A LC/MS method to be developed, or based on previous data/studies	To be determined by methods evaluation work; or 2 mg/L
Rotenolone	Water	A LC/MS method to be developed, or based on previous data/studies	To be determined by methods evaluation work; or 2 mg/L
1,3,5-Trimethylbenzene	Water	EPA 502.2	.10mg/L
sec-Butylbenzene	Water	EPA 502.2	10 mg/L
n-Butylbenzene	Water	EPA 502	10 mg/L
p-Isopropyltoluene	Water	EPA 502.2	.10mg/L
Naphthalene	Water	EPA 502.2	.10mg/L
Toluene	Water	EPA 502.2	.10mg/L
m/p-Xylene	Water	EPA 502.2	.10mg/L
o-Xylene	Water	EPA 502.2	.10mg/L
Isopropylbenzene	Water	EPA 502.2	.10mg/L
n-Propylbenzene	Water	EPA 502.2	.10mg/L
1,2,4-	Water	EPA 502.2	.10mg/L

Trimethylbenzene			
Trichloroethylene	Water	EPA 502.2	10mg/L
2-Methylnaphthalene	Water	To be determined during methods evaluation work	To be determined during methods evaluation work
N-Methyl-2-pyrrolidone	Water	To be determined during methods evaluation work	To be determined during methods evaluation work
Diethylene glycol ethyl ether	Water	To be determined during methods evaluation work	To be determined during methods evaluation work

PCEH Observation of DFG Lake Water Sampling:

In addition to groundwater monitoring, PCEH will monitor DFG sampling activities. PCEH will observe a portion of the DFG surface water sample collection activities on Lake Davis pertaining to DHS requirements. PCEH will observe both baseline surface water sampling and final non-detect confirmation sampling. DHS post-treatment surface water quality sampling will begin approximately 48 hours after rotenone treatment of the reservoir is completed, and weekly thereafter until 3 consecutive sample results indicate non-detectable levels for rotenone, rotenone breakdown products, and rotenone formulation chemicals in the water column and sediment. PCEH well water samples will be collected at the same schedule as DHS-required surface water samples.