Effects of diversions for the Comanche Peak Nuclear Project on the ecological health of the Brazos River

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The Comanche Peak application fails to adequately address the instream flow water needs necessary for the protection the ecological health of the Brazos River. The proposed diversion would result in an increase in the severity, frequency and duration of "man made" drought conditions, potentially leading to an alteration in the ecosystem structure by either reducing overall fisheries abundance or by favoring one fisheries species at the expense of others, thereby reducing biodiversity. Specifically, the increased diversion could result in a decrease in suitable habitat conditions for the aquatic organisms that depend on the natural variability of the flows in the Brazos River to provide instream habitat, transport sediments and nutrients and maintain water quality to support diverse plant and wildlife assemblages. (SAC 2004)

This conclusion is based on a comparison between the instream flow needs for the Brazos River at Glen Rose recently determined as part of the Brazos River Authorities Systems Operation (SysOps) Permit and the flows that would result under future management plans including the Comanche Peak Nuclear Plant water diversions. Flows were simulated using a Water Availability Model (WAM) developed by the Texas Commission on Environmental Quality (TCEQ) and employed by the Brazos G Regional Water Planning Group (Region G) and the Brazos River Authority (BRA) to support long term water planning in the Basin. As indicated in Comanche Peak Nuclear Power Plant, Units 3 & 4 COL Application. Section 5.2.2.3.1 future water supply for this project is dependent on the approval by TCEQ of BRA's SysOps water right application. The statement in section 5.2.2.1 that impacts are "small" is not based on a quantitative assessment of the effect of a new consumptive use of 61,617 acre feet per year. As the following quantitative analysis will demonstrate, the proposed operations needed to supply water for the Comanche Peak Project would result a significant increase in the failure to maintain flow necessary to protect the health of the Brazos River. While it is true that naturally occurring periods of low flows in the Brazos result in events in which target flow are not satisfied, there is substantial evidence in scientific literature (Annear, et al 2004,. Arthington, et al 2006, BIO-WEST. 2008 NRC 2005 Poff, et al 1997, Poff, et al 1989, Richter, et al 1997) to conclude that there are ecological limits to hydrologic alteration beyond which an increase in the severity, frequency, or duration of drought flows will alter the ecosystem structure by either reducing overall fisheries production or by favoring one fisheries species production at the expense of others, thereby reducing biodiversity. The operations of the Comanche Peak project would result in a significant increase in the severity, frequency and duration of these "man made" drought conditions.

1. Operations of the Comanche Peak Project will result in significant decrease in instream inflows as compared to the natural and current conditions.

As part of the Brazos River System Operations permit application preliminary instream flow recommendations to protect the sound ecological health of the Brazos River have been determined. (TQEC 2009) Instream flows are considered "master" variable in their role in maintaining ecosystem health. Their primary functions are to provide instream habitat, transport sediments and nutrients and maintain water quality to support diverse plant and wildlife assemblages. Quantification of the magnitudes, frequencies, durations, timing and variability of the flow needed to protect instream uses is a complex undertaking requiring the expertise of multiple disciplines including hydrology, hydraulics, aquatic and riparian biology, geomorphology and water chemistry among others. Decades of research in the science of instream flows has arrived at a generally accepted principle that maintenance of critical components of a natural flow regime encompassing a full range of flows including subsistence low flows, normal base flow, and occasional high flow pulses and bankfull events, all of which should include appropriate inter and intra annual variability are needed to maintain a sound ecological environment. Based on this understanding the state of Texas has developed an approach (TIFP 2008) which has been approved by the National Academy of Sciences (NRC 2005) to conduct instream flow studies on Texas Rivers. The Brazos River was selected as one of the top priority streams for study, largely in response to the number of large water development projects proposed in the basin that have been identified as being needed to meet the long term demands for water. State agencies have conducted a stakeholder process and are currently developing a study design for

the Brazos that will, within the next several years, develop a flow recommendation based on the principles described above. The 77th Texas Legislature recognizing the significant time and resources necessary to conduct these types of evaluations passed SB3; (which creates a process to convene bay and basin expert science teams to develop instream and freshwater inflow targets based on readily available data), that will guild permitting and planning until the more detailed studies are completed. The approach developed for the BRA systems operation permit is currently serving as one of the more significant models guiding the SB3 process. The BRA working with water resource agencies developed flow recommendations based primarily on pre-development flow records and expert opinion for six locations in the Brazos Basin including the Brazos River at Glen Rose a site immediately downstream of the proposed diversion for the Comanche Peak project. The draft permit for this application is very complex. It includes targets for the full range of flows as well as an accounting plan to be used for its implementation. A full review and critique of this permit and the special conditions presented within is beyond the scope of this analysis. Rather it is presented as the best available evaluation of the instream needs for this location. The evaluation of the impacts of new diversions including the Comanche Peak project is presented in the following sections based on the effect that these diversions will have on severity, duration and frequency of not meeting these target base flows. This evaluation considers just one part of the flow recommendation; that is the base flow requirement which includes daily flow targets for dry, average and wet conditions (Table 1). A more complex analysis would be required to assess the projects potential impact on the high flow part of the regime. The reader should be aware that that the results presented herein are based on model simulations and a management plan that ties target conditions to overall storage in the basin so as to provide the recommended flow at desired frequencies. The details regarding the implementation of this systems operation plan have yet to be determined. These results should be viewed relative to one another rather than as predictions of future conditions in an absolute sense.

Table 1 Low flow instream flow requirements for the Brazos River at Glen Rose

Instream Flow (cfs)	BRAZOS RIVER NEAR GLEN ROSE - USGS #08091000			
	Winter	Spring	Summer	Fall
Subsistence (7Q2)	15.3	15.3	15.3	15.3
Dry	39.0	45.0	33.3	62.0
Average	92.0	138.0	101.5	150.0
Wet	234.0	292.8	249.5	332.0

Given the above flow targets the first step in assessing the potential impacts of the new water diversion on the ecological health of the Brazos River is to develop estimates of flows under a range a management scenarios. These include estimates of natural, current and future conditions. Estimates of natural conditions serve as a baseline against which to evaluate existing and proposed alterations. Natural systems have evolved in response to the magnitude, duration, frequency of inter and intra annual variations in inflow conditions. Alteration of these conditions beyond some point will likely lead to a shift in ecosystem structure. Therefore some understanding of these conditions is an important starting point in any evaluation. Unfortunately there is rarely data available to evaluate how species responded to conditions prior to human alteration of natural systems; therefore evaluation of the ecosystem response to changing conditions also requires an evaluation of existing conditions. Finally, responsible planning requires that some effort be made to predict the instream flow conditions based on reasonable estimates of proposed future diversions.

Estimates of instream flows under natural, current and future water use scenarios are determined through the application a Water Availability Model (WAM). WAMs have been developed for each of the 23 river basins in Texas at the direction of the 75th Texas Legislature (SB1). The primary purpose of these models is to apply water use scenarios to historic flow conditions to predict water availability for existing and future water rights permits. WAMs are essentially accounting models that track stream flow and diversions throughout a river basin. The Brazos WAM has also been modified and used for long term water planning by the Senate Bill 1 Brazos G Water Planning Group (Region G). Most recently it has be used to evaluate a new water right application submitted to the TCEQ in October, 2004 by the BRA which would allow the

BRA to divert almost 1 million additional acre feet of water to meet future water needs in the basin. Water made available under this permit will used for the Comanche Peak Project.

Naturalized inflows are flows for which the effects of human alterations have been removed. These include surface water diversions, wastewater return flows and water impounded in reservoirs and the evaporation associated with these impoundments. Current conditions is the description used to define TCEQs WAM that includes existing water use and return flow rates. So the current conditions runs for 1940, simulates the status of the system assuming a repeat of 1940 hydrology but with present water use. Model simulations for the recent past suggest that under current conditions water uses represent an annual average reduction from natural to current of about 250,000 acre feet per year and a maximum of over 500,000 acre feet per year in the Brazos River downstream of Lake Granbury.

Proposed water management strategies needed to supply water for the Comanche Peak project will result in additional reductions in instream flows. It is unclear whether special conditions requiring pass through for instream flow needs would be required as a condition in these diversions but commitment of water for the Comanche Peak project and other future demands has made it necessary for BRA to seek an application for additional diversions under the Systems Operation Permit. The present analysis utilizes the WAM developed by BRA and the TCEQ to simulate flows resulting from this new water right. Average annual flow would be reduced over 300,000 acre feet per year from current to proposed conditions. A total average reduction from natural on the order of a half a million acre feet and a maximum of over 1 million acre feet.

2. These decreases will result in significant increased in the severity, frequency and duration of drought conditions.

Time series analysis of flows under natural, current and proposed conditions demonstrates marked increase in the severity, frequency and duration of drought resulting from human alterations of flows in the Brazos River.

Severity of failing to meet targets is defined as the shortfall or magnitude by which flows fall below the level that has been determined to be necessary to protect the sound ecological environment. Table 2 shows the average and maximum shortfalls under the three flow scenarios. The average shortfalls under natural conditions range from 79 cfs to 2,206 cfs. Under the proposed diversions these shortfall increase to between 3,765 to 7,543. A similar pattern is seem with respect to the maximum shortfalls, if fact in many of the most sever months, the Brazos River could be effectively dewatered. These results clearly demonstrate an increase in the severity of drought conditions beyond those that would be expected under natural conditions.

Table 2 Severity of failing to meet targets under natural, current and proposed flow conditions

	Average			Maximum		
Month	Natural	Current	Proposed	Natural	Current	Proposed
JAN	534	2,670	4,346	5,657	13,448	14,031
FEB	253	2,452	3,763	6,240	12,936	12,948
MAR	485	5,017	5,717	5,259	8,485	9,908
APR	600	4,442	6,250	4,473	17,117	17,132
MAY	268	2,613	6,245	4,090	8,485	16,156
JUN	68	1,370	4,696	910	14,846	14,846
JUL	461	3,946	5,287	6,241	14,951	14,676
AUG	1,122	3,862	5,056	6,241	15,141	15,239
SEP	1,368	3,399	6,350	7,921	8,926	18,198
OCT	1,336	4,083	6,998	8,509	9,223	9,223
NOV	1,765	4,818	7,130	8,926	13,760	16,624
DEC	335	2,315	4,180	4,290	5,657	14,064
All Months	747	3,475	5,446	8,926	17,117	18,198

The duration of drought events would also be expected to substantially increase under the water management plan that includes the proposed Comanche Peak project. A drought event is defined as the continuous period of time during which flows remain below recommended targets. Table 2 shows the duration of individual periods when flows fail to meet targets. While it is true that the number of events when the flow target are not meet would increase significantly from natural to proposed conditions, what is perhaps more striking is the duration of these event. Under natural conditions only two drought events lasted more than 3 months and none any longer than 4 months. Under the proposed plans there are more than 20 events in which flows fails to meet the targets for more than 4 continuous months and one event that lasts for 17 continuous months.

Table 3 Duration of failing to meet targets conditions under natural, current and proposed flow conditions

Duration (months)	Natural	Current	Proposed
1	47	47	40
2	7	21	20
3	4	15	16
4	2	6	5
5		5	6
6		2	4
7		1	3
8		4	6
9		1	
10		1	5
11			1
12			1
13			
14			
15			
16			
17			2
Total	60	103	109

Finally the frequency of failing to meet the necessary flow conditions would be substantially increased with the implementation of the proposed water development plans need to supply water for the Comanche Peak project. Frequency of drought conditions is defined as the number of months in which the target flows are not meet. These frequencies are presented in Figure 1 as the percent of months over the 56 year WAM simulation period during which the flows would be expected to be below recommended levels. Clearly there are times when even under natural conditions the targets would not be satisfied, however these occurrence which would have been relatively infrequent (about 10% of the time) under the natural flows will become the dominate condition under the proposed plans.

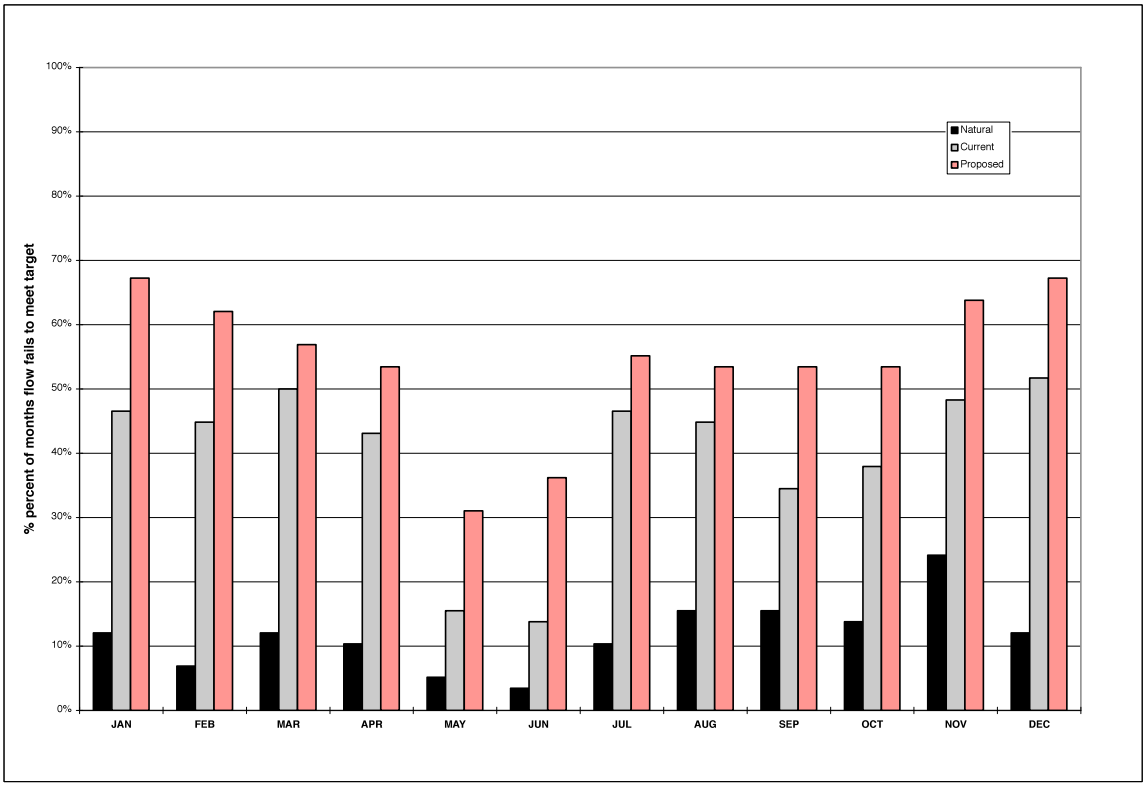

Figure 1 Frequency of failing to meet targets under natural, current and proposed flow conditions

Conclusion

As the preceding analysis demonstrates, the consumptive water use needed to expand the Comanche Peak project will result substantial increases in the frequency, duration and severity of failing to meet target environmental flow needs. Rather than resulting in a small impact as the applicant contends, increase diversions have the potential to have significant, negative impacts on the ecological health of the Brazos River.

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