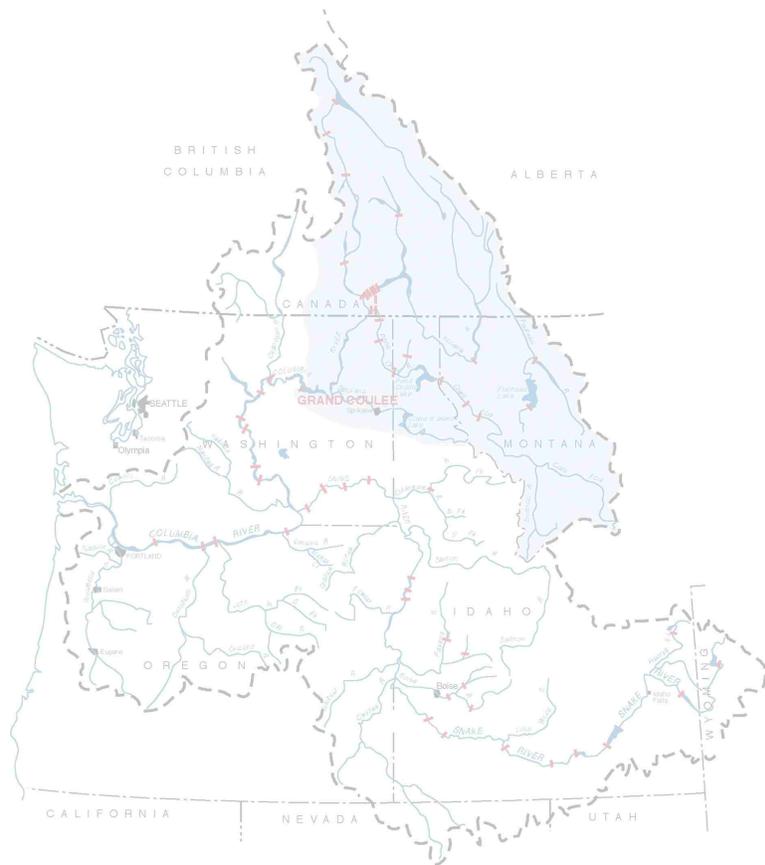

Draft

Framework Plan for Coordinating Activities of the Columbia River Transboundary Gas Group Phase 1



Prepared for:

*The Columbia River
Transboundary Gas Group*

*by the
U. S. Department of the Interior
Bureau of Reclamation*

February 11, 2000

Framework Plan - Phase 1

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Framework Plan Description

- ◆ ***Background***
- ◆ ***Goals and Objectives***

1

Framework Plan Description



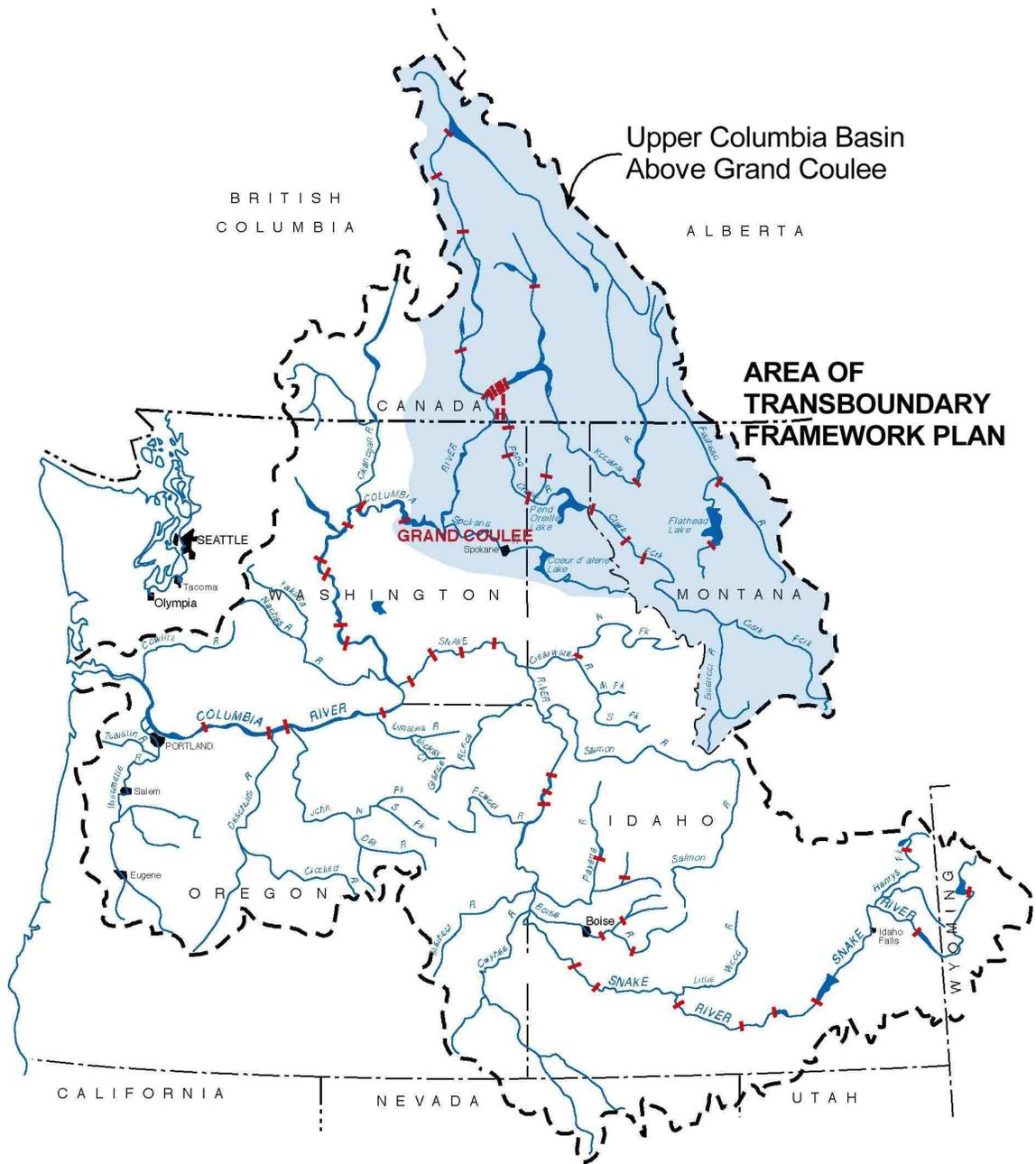
This framework plan was prepared to facilitate the cooperative efforts that are underway to evaluate and mitigate problems associated with excessive air entrainment in waters of the Columbia River system upstream of Grand Coulee Dam. The geographic scope is within the upper Columbia River basin in the northwestern United States and British Columbia, Canada including the Columbia River mainstem and major tributaries of the Kootenai and Pend d'Oreille Rivers. This framework plan will also coordinate with similar efforts that are in progress to manage dissolved gas problems in the lower Columbia River basin.

In early 1998, the Transboundary Gas Group (TGG) was organized to help coordinate the investigations and dissolved gas management efforts in the transboundary region of the Columbia River basin. The following United States and Canadian agencies and interest groups have participated in the TGG activities:

U.S. Environmental Protection Agency	Environment Canada
Idaho Department of Environmental Quality	B.C. Ministry of Environment
Oregon Department of Environmental Quality	Fisheries and Oceans Canada
Washington Department of Ecology	B.C. Hydro
U.S. Bureau of Reclamation	Columbia Power Corporation
U.S. Army Corps of Engineers	Cominco Ltd.
Bonneville Power Administration	West Kootenay Power
U.S. National Marine Fisheries Service	RL&L Environmental Services
Chelan County P.U.D.	Aspen Applied Sciences
Grant County P.U.D.	AVISTA
Seattle City Light	Colville Confederated Tribes
Northwest Power Planning Council	Spokane Tribe of Indians
Battelle Pacific Northwest Division	International Joint Commission

The TGG has organized five topical workgroups to focus on the various investigations and actions relevant to address gas problems in the transboundary area. This framework plan is based on current information available in TGG planning papers and reports, and is intended to support the further investigations and efforts of the TGG participants.

Figure 1. Columbia River Watershed



Background

Air entrainment occurs as water passes over and through the large hydroelectric facilities in the Columbia River system. Excessive entrainment of air can cause elevated saturation of dissolved gases and produce health hazards, collectively described as “gas-bubble disease” for resident and migratory fishes and other aquatic organisms. The potential for harmful effects can depend on a number of variables such as gas concentration, exposure, species characteristics, migration patterns, life cycle stage, and environmental conditions.

Gas-bubble disease is a concern for fish populations in the Columbia River basin including anadromous migratory fish, species indigenous to the river, and the fisheries established in reservoir backwaters. The hazard risks are accentuated during times of higher than normal runoff, when there is less flexibility in operating facilities to reduce air entrainment.

The extent of gas supersaturation can depend on facility structural characteristics, inflow conditions, operating constraints, and the river environment. Previous investigations have indicated voluntary and involuntary spill over dams, as opposed to passing water through hydroelectric turbines, is a major factor in supersaturation. As a result, supersaturation problems are often more severe and difficult to manage during times of high runoff when more water is spilled over the major hydroelectric dams throughout the Columbia system.

Investigations have also indicated the dissolved gas can persist for significant distances to accumulate in the river and pass through to downstream fisheries. Consequently, a system wide management approach is considered essential since conditions at one dam can affect downstream operations. An effective management plan might incorporate both structural and operational measures that are feasible to reduce hazard risks in critical areas.

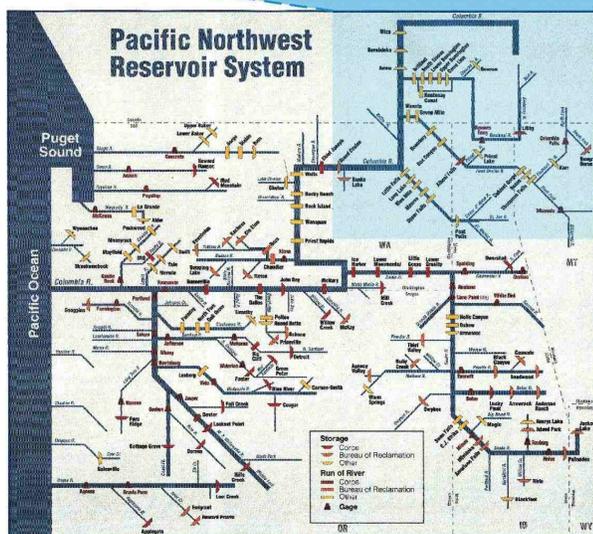
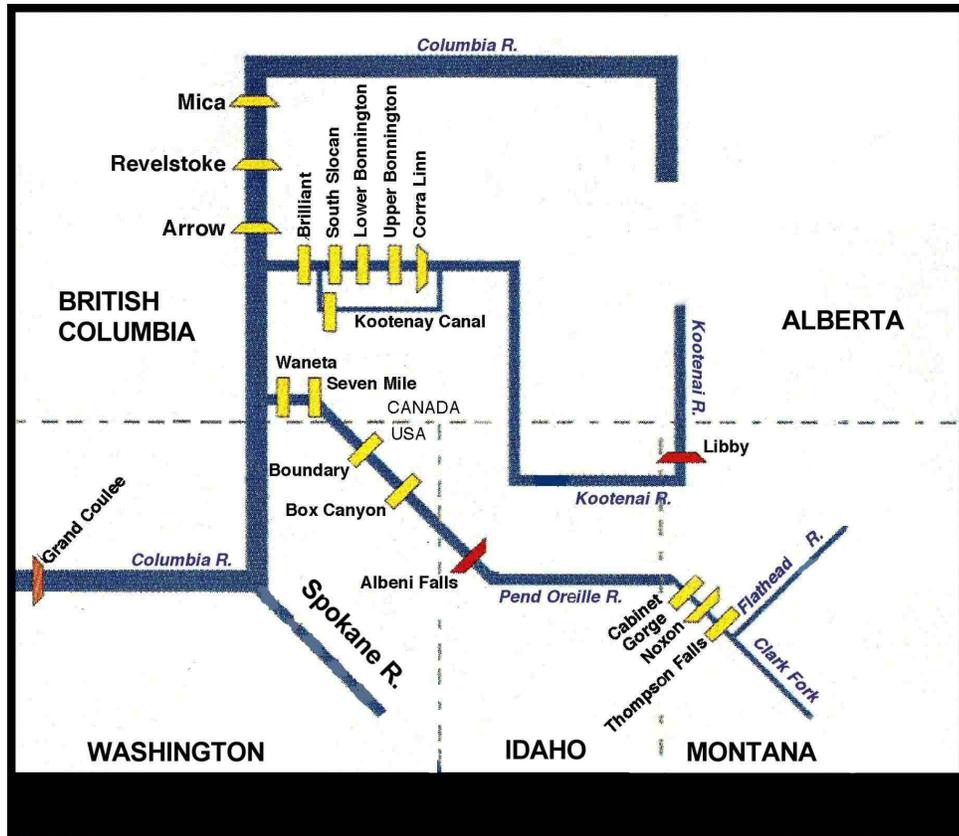
Transboundary Area

The Columbia River watershed and upper basin (shaded area) above Grand Coulee dam are shown in Figure 1. The transboundary area refers specifically to the Columbia River and principal tributaries within British Columbia, Canada and the northwestern United States. Figure 2 is a schematic diagram that shows the major dam facilities in the Columbia River system, and an expanded view of the tributaries and dams in the transboundary area.

Historical Perspective

Periods of high flow in the Columbia River system have resulted in greater supersaturation levels that are conveyed to the next downstream facility. In some cases total dissolved gas levels have exceeded Federal, provincial, state, and tribal water quality standards in both the United States and Canada. In response to concerns raised in the 1960's regarding gas supersaturation problems, extensive monitoring, biological effects research investigations, and efforts to promulgate more effective water quality standards and criteria were initiated to address the potential gas supersaturation problems in the Columbia River system.

Figure 2. Transboundary Area Schematic



(Adapted from U.S. Army Corps of Engineers publications)

Dissolved gas supersaturation is a major issue in the implementation of the U. S. National Marine Fisheries (NMFS) Biological Opinion for Endangered Species Act (ESA) listed Snake River salmon stocks. The major intent of the Biological Opinion was to aid salmon recovery efforts by utilizing increased voluntary spills to accommodate fish passage through reservoir facilities on the Columbia and Snake Rivers.

Total dissolved gas management in the Columbia and Lower Snake Rivers in the United States is coordinated through the NMFS Regional Forum. Extensive efforts are underway in the United States to address dissolved gas problems in the Columbia River downstream of Grand Coulee Dam, as indicated in the NMFS "*Biological Opinion for Operation of the Columbia River Hydro System*" (NMFS, 1995; 1998). A gas monitoring program is currently managed by the U.S. Army Corps of Engineers (COE) in cooperation with the U.S. Bureau of Reclamation (Reclamation) and the mid-Columbia River public utility districts (COE, 1999a). During periods of high spill operations, dissolved gas is managed throughout the Federal Columbia River Power System (FCRPS) according to spill caps and spill priorities adopted by the NMFS Regional Forum (COE, 1999b).

In March 1998, the System Configuration Team (SCT) and the Dissolved Gas Team (DGT), two coordination groups of the NMFS Regional Forum, were given the task to begin developing a systemwide approach to dissolved gas management and abatement for the entire Columbia Basin. Previous and ongoing efforts have concentrated on reducing dissolved gas levels at individual dams or through particular river reaches, such as the lower Snake and lower Columbia Rivers. A proposed NMFS effort would characterize the locations and extent of dissolved gas levels produced by dams on the main river channels and major tributaries of the entire Columbia and Snake River systems. The geographic scope of the cooperative systemwide effort includes river basins in British Columbia, Canada, and the states of Oregon, Washington, Idaho and Montana.

Transboundary Gas Group

A second and closely related basin-wide dissolved gas planning effort was recently initiated in Castlegar, British Columbia. On April 27-29, 1998, an international conference and workshop entitled "*Towards Ecosystem-Based Management in the Upper Columbia River Basin*" was held. This conference was attended by scientists, planners and policy-makers from federal and provincial Canadian agencies, U.S. federal and state agencies, Indian tribes from the U.S. and Canadian first nations, utilities and private industry.

The need to develop: (1) a transboundary total dissolved gas management plan and (2) the capability to evaluate affects of gas abatement measures within a systemwide context were identified as priority concerns in the meeting discussions of this conference.

As a result of this discussion, the Transboundary Gas Group (TGG), with membership from a broad range of federal, provincial, and state agencies from the U.S. and Canada, Indian tribes from the U.S., Canadian first nations, utilities, and private industry, was formed at the Castlegar conference to facilitate systemwide dissolved gas management planning.

During subsequent TGG meeting discussions, co-chairs of the TGG were selected to assist in coordinating future TGG efforts, and the Systemwide Dissolved Gas Abatement Steering Committee was formed. In addition, four technical sub-groups were formed to undertake and coordinate technical activities of the TGG. The four technical workgroups are:

- ◆ Biological Effects and Research
- ◆ Monitoring and Information Sharing
- ◆ Modeling (Computer Simulations)
- ◆ Operational and Structural Abatement

The investigations of these workgroups are coordinated through the meetings of the TGG and the steering committee. The steering committee has responsibility to develop a study plan to direct the transboundary gas management efforts, and to coordinate the efforts of four workgroups formed to address technical aspects of gas management. For the most part, these groups are jointly co-chaired by U.S. and Canada representatives.

Lower Columbia River Activities

Evaluation of potential new operational and structural measures for gas abatement are also under investigation in the hydro power system from Grand Coulee Dam downstream. For example, the COE is conducting the Dissolved Gas Abatement Study to address structural and operational changes at eight hydroelectric facilities on the lower Snake and Columbia Rivers, and has identified a number of actions for short and long-term implementation.

The COE and Reclamation are also engaged in cooperative studies to evaluate operational and structural measures to reduce gas generation at the Chief Joseph and Grand Coulee Dam complex; resolution of transboundary gas problems would greatly reduce background dissolved gas problems at these facilities.

Basin-wide dissolved gas characterization could be followed by more in-depth analyses and modeling efforts to determine a systemwide approach to reduction in dissolved gas levels throughout the Columbia River. This approach may be more cost-effective than proceeding on the present dam-by-dam course of action. For example, the Bureau of Reclamation is presently evaluating the feasibility of several costly structural alternatives to reduce gas entrainment attributed to spill operations at Grand Coulee Dam..

A systemwide approach to gas management and abatement may also find that operational changes or structural modifications at specific locations are less costly and result in greater overall dissolved gas reduction throughout the Columbia River. For example, systemwide planning may find that dissolved gas at Grand Coulee could be reduced at less overall cost by implementing more effective structural and operational changes at other facilities in the Columbia River system.

Goals and Objectives

This framework plan is intended to serve the goals and objectives of the Columbia River Transboundary Gas Group. In the initial planning stages, the TGG adopted the following statement as the overall long-term goal:

"Reduce system-wide total dissolved gas (TDG) to levels safe for all aquatic life in the most cost-effective manner possible."

This ultimate goal presents significant challenges given the physical scope and scale of the watershed and facilities involved, the number of potentially effected or concerned entities, and the array of different administrative and political jurisdictions that are associated with the transboundary issues. It is clear that effective coordination of the various investigations and activities of the TGG is essential to advance this comprehensive goal.

The investigations and planning efforts necessary to accomplish this ultimate goal will vary in complexity and duration. Consequently the TGG must accommodate long term activities and still support appropriate short term actions to alleviate gas supersaturation problems in the river in the most efficient and cost-effective manner possible.

Framework Plan Goals

This framework plan is intended to facilitate activities identified by the TGG workgroups to promote efficient use of resources and to help focus these efforts toward improved water quality management throughout the Columbia River system. Accordingly, the overall goals of this framework plan are twofold:

- ◆ Provide a framework to facilitate short and long term investigations and dissolved gas management planning efforts for the United States and Canada transboundary area of the Columbia River system.
- ◆ Provide for systemwide management of dissolved gas problems through modeling, monitoring, and operational links between the transboundary and lower Columbia River management efforts.

The framework plan is intentionally simple to minimize the amount of effort required to organize and coordinate activities. It has an open-format to allow for periodic update and tracking. It is designed to help define tasks and transfer the products needed by different workgroups. The framework is intended to accommodate short and long term activities, and to help integrate local and large scale considerations. Although the main focus is on the transboundary activities, the framework also identifies interaction with the lower basin gas management programs at appropriate points to allow systemwide integration.

Phase 1 Objectives

A number of specific objectives are identified for Phase 1 of the framework. The Phase 1 activities are a combination of investigations that will provide information to characterize the conditions and problems in the transboundary area and develop basic computer model capabilities to support an initial series of simulation modeling evaluations. Objectives for Phase 1 of the framework plan include:

- ◆ Complete an inventory of major facilities characteristics in the transboundary area and identify potential structural and operational gas abatement measures.
- ◆ Develop a dissolved gas database to compile monitoring data and research results for the transboundary area to support modeling and future investigations.
- ◆ Develop screening-level computer simulation models to evaluate basic dissolved gas saturation conditions and potential gas abatement alternatives.
- ◆ Define and complete an initial series of screening model scenarios to help identify predominant "hot spots" or critical areas of transboundary concern.
- ◆ Evaluate and make recommendations regarding implementation of operational measures for individual facilities to produce short-term improvement.
- ◆ Evaluate and make recommendations on the potential to expand the lower river system spill management priorities to include the transboundary area.
- ◆ Evaluate and make recommendations on structural modifications to reduce gas entrainment for further consideration and planning in Phase 2 studies.

For the most part these Phase 1 objectives focus on short term activities that could lead to immediate results and direct improvement. There are also other research investigations and planning efforts underway that contribute to the longer term TGG goals. Future framework phases are expected to incorporate additional activities as they become eminent.

Systemwide Coordination

The goals and objectives of this framework plan are based on the objectives outlined in the TGG draft study plan (TGG, 1999). The draft plan emphasized *system-wide* dissolved gas management. Although the Phase 1 objectives focus on transboundary attributes and short term activities, coordination with the lower basin planning efforts is essential to the overall systemwide goals. The Phase 1 activities are intended to support interactions between the modeling, monitoring, and modification efforts for the transboundary and lower basin and ultimately promote systemwide guidance and effective use of resources to improve water quality throughout the Columbia River system.

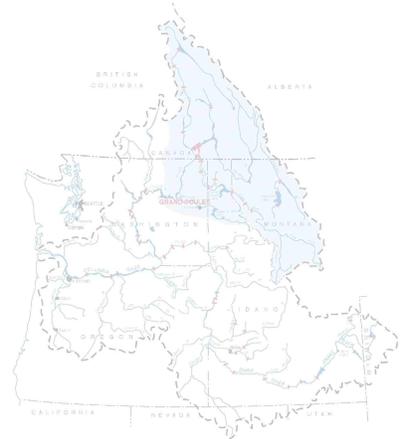
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Cooperative Mechanisms

- ◆ ***Plan Formulation***
- ◆ ***Review and Coordination***
- ◆ ***Funding and Cost Allocation***

2

Cooperative Mechanisms



This section describes mechanisms and principles that are employed in the framework plan to help accomplish the goals of the Transboundary Gas Group. Successful completion of the technical activities that are included in Phase 1 of the framework plan will rely heavily on the cooperative efforts of the TGG workgroups and participants.

Continued funding including budgets to support participation in the TGG and co-sponsored investigations is essential to accomplish the Phase 1 framework plan activities and achieve further progress toward the TGG goals and objectives.

Phase 1 of the framework plan is defined as a two-year effort. Phase 1 includes a variety of activities that will be undertaken by different groups that will require some coordination to ensure critical products are transferred between groups and to effectively integrate results into revised guidance for gas management in the transboundary area.

The need for effective mechanisms to coordinate and track the progress of short and longer term activities was recognized in the initial TGG planning discussions. The cooperative mechanisms outlined in this framework plan are intended to facilitate tracking of both the short term activities included in Phase 1 and relevant longer term efforts.

Implementation of these mechanisms may also help to define needs for subsequent phases and help to break down short term actions to advance long term objectives. This includes coordination to anticipate future linkages with lower Columbia River planning efforts.

This section describes how the framework mechanisms are formulated to help accomplish the Phase 1 activities and how the framework review and coordination processes fit within the existing TGG cooperative mechanisms. The last part of this section describes current cooperative cost-share and voluntary funding mechanisms, and includes a brief discussion of possible funding considerations that may be considered to accommodate future activities of the TGG and systemwide Columbia River water quality improvement efforts.

Figure 3. Workgroup Interactions

		Short Term		Long Term	
◆	Biological Investigations	→	1. activity 2. activity 3. activity	→ →	→ product ✓ ↕ goal ←
			↕		
◆	Structural Characteristics	→	1. activity 2. activity 3. activity	→ →	→ product ✓ ↕ goal ←
			↕		
◆	Facility Operations	→	1. activity 2. activity 3. activity	→ →	→ product ✓ ↕ goal ←
			↕		
◆	Monitoring Information	→	1. activity 2. activity 3. activity	→ →	→ product ✓ ↕ goal ←
			↕		
◆	Computer Modeling	→	1. activity 2. activity 3. activity	→ →	→ product ✓ ↕ goal ←
			↕		
◆	Framework Plan Integration		↕	↕	↕

- ➔ Facilitate Technical Group Activity Interactions
- ➔ Transboundary Gas Management Status Report
- ➔ Coordinate with Lower Columbia River Planning

Plan Formulation

The framework plan has two main components. One component consists of specific tasks or activities that comprise the scope of work for a given time period, such as Phase 1 of the TGG efforts. The second component is an ongoing report that documents the conditions and status of dissolved gas management in the transboundary area. These components are the topics of Section 3 and Section 4 respectively of this framework plan.

Framework plan activities are accomplished by technical workgroups, the TGG committee chair representatives, and members of the Systemwide Dissolved Gas Abatement Steering Committee. In addition, consultants, contractors, willing participants, and other interested entities also provide assistance with certain TGG activities.

Phase 1 Technical Activities

Phase 1 activities are organized into six topic areas that are consistent with the four TGG technical workgroups. Structural and operational activities are separated into two activity topics and a new activity area of “Framework Plan Integration” is added to define specific review and coordination needs to accomplish the framework plan objectives. This results in the following six activity areas included in the Phase 1 framework plan.

- ◆ Biological Investigations
- ◆ Structural Characteristics
- ◆ Facility Operations
- ◆ Monitoring Information
- ◆ Computer Modeling
- ◆ Framework Plan Integration

These six activity areas are shown in Figure 3. Phase 1 is comprised of short term activities including high priority investigations and actions that lead to the Phase 1 initial assessment and screening analysis objectives. Specific activities included in the Phase 1 scope of work are described in more detail in Section 3.

Plan Implementation

Basic functional relationships and interactions between the framework technical areas and the TGG are illustrated in Figure 3. For each topical area there are one or more activities that are coordinated by the principal TGG group contacts. Activities may lead to a product intended for use by another group, or may contribute toward longer term goals.

A key element in framework implementation is the “Framework Plan Integration” activity area. The systemwide steering committee and TGG committee co-chairs are the principal contacts for framework integration. This activity is an important function to facilitate the communication and information transfer between workgroups, carry results forward and document progress, and to coordinate with lower basin management efforts.

The five technical activity areas shown in Figure 3 correlate directly with the existing TGG workgroups and the activities identified in each area are coordinated through the respective technical workgroup co-chairs. Framework integration is intended to be administrative and supporting in nature, to facilitate funding, reporting, and workgroup coordination. As a result, open communication and cooperative interaction between these groups are expected to occur without framework integration involvement. The three most prominent framework integration activities are indicated at the lower section of Figure 3.

The Transboundary Gas Management Status Report is a working document that reflects the recent activities undertaken by the TGG, upcoming events, the current gas management criteria, and updated reports on conditions in the transboundary area. A status report of this type could also be distributed separately as an ongoing product of the TGG. Further details of the status report are provided in Section 4.

Review and Coordination

Effective framework coordination and integration is needed in planning to help break down long term goals into feasible shorter term activities, and to ensure that critical activities are completed and products are transferred between workgroups. An efficient review process is also important to evaluate results that could change applied gas management principles.

For example, the modeling group will define the monitoring needs to support the screening model. The monitoring group later provides monitoring data to the modeling group, which is then used to refine an operating model scenario. These activities could eventually lead to implementation of revised operating procedures and longer term monitoring plans that are documented in updated versions of the Transboundary Gas Management Status Report.

The framework plan is designed to be easily updated to incorporate changes and workgroup products. Results and new information will be reviewed continuously through the steering committee, co-chairs, and TGG participants.

In the long term, the implications of results and findings relevant to the transboundary area will require comprehensive review and systemwide coordination with lower basin planning efforts, the power operations treaty, and other legal and institutional authorities.

Framework Review Process

The framework plan review process is directed by the steering committee. An interim review and progress reporting is expected to occur approximately every six months at the TGG meetings. This could include an update on the workgroup activities and discussion of appropriate modifications to the framework Phase 1 activities. Updates or revisions to the Transboundary Gas Management Status Report could also be raised at these meetings. The overall framework plan itself is tentatively planned for review in two years to coincide with the completion of the Phase 1 activities. These framework plan review cycles may be modified at any time to accommodate needs identified by the TGG.

Summary of Framework Review Cycles

◆	Workgroup progress	→	6 months at TGG meeting
◆	Framework activities	→	6 months at TGG meeting
◆	Status report review	→	6 months at TGG meeting
◆	Framework plan	→	2 years depending on phase

The goal is to implement changes, distribute meeting notes, and produce a revised status report (if applicable) shortly after each TGG meeting. The steering committee and TGG technical workgroups will work together to focus on short and long term needs.

Short and Long Term Coordination

The relationships between short and long term activities are directly tied to the interactions between workgroup activities and the ultimate goals of the TGG. These overall functions and framework concepts are illustrated graphically by the flow diagram in Figure 4.

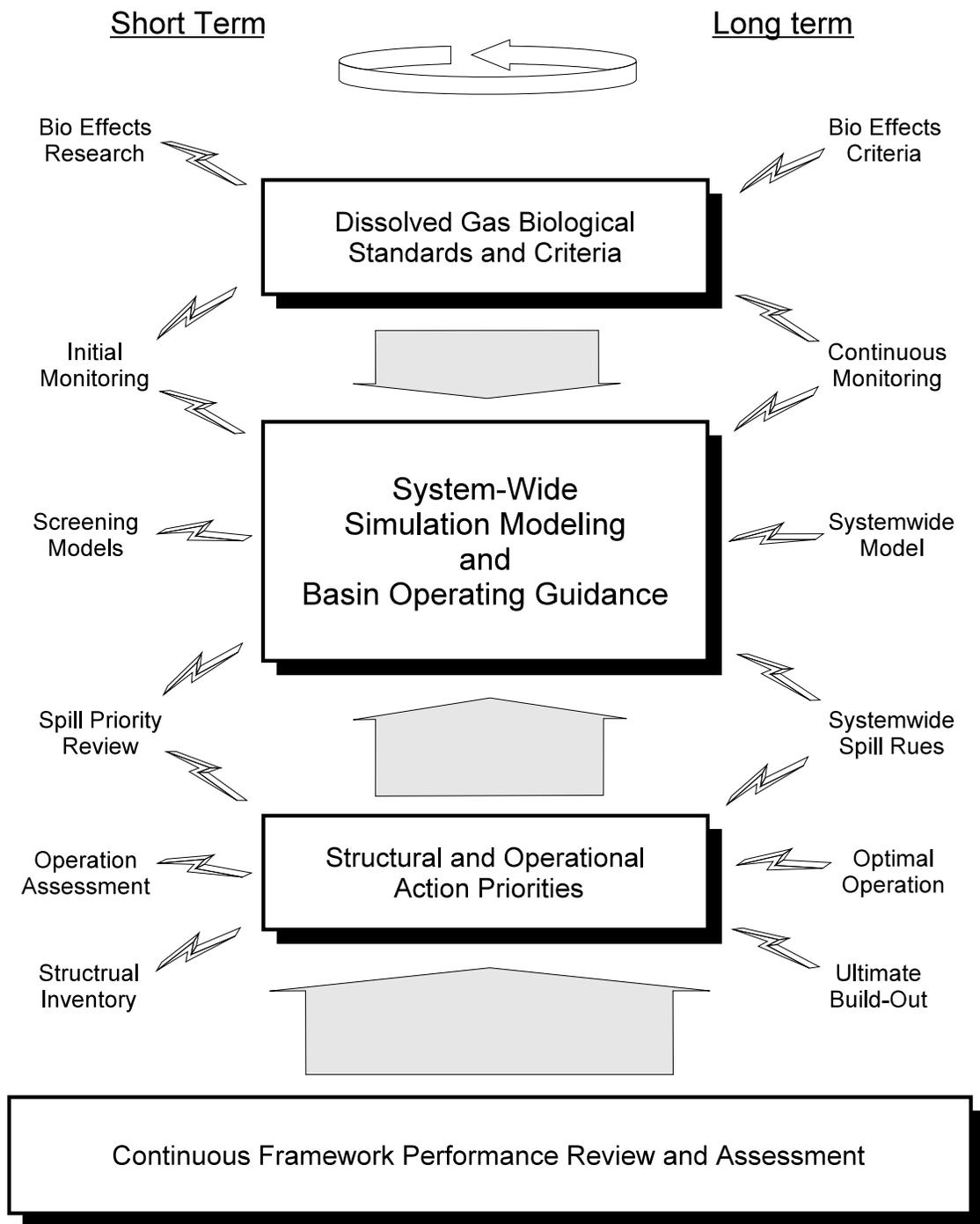
The center of the flow diagram shows the ultimate long term objective of gas management planning as a systemwide model program (with support monitoring) that is used to prepare effective basin guidance for conditions at a given time or water year. This outcome also assumes that the high priority feasible structural and operational modifications at individual facilities are in place. Short term activities that contribute to this goal are indicated on the left and the shift toward longer term products or actions is shown on the right.

For these purposes, short and long term objectives are defined operationally. A short term activity is defined as an action that can be undertaken immediately. A short term activity has a distinct approach, workgroup, product, primary contact, and funding mechanisms, that can be summarized in an activity description sheet. Long term actions are generally more goal oriented or may have several short term tasks that are pursued in sequence.

As better information is derived and improvements are implemented the topics indicated in the center boxes shift from short term objectives toward the longer term goal. For example, biological effects research might ultimately lead to more accurate dissolved gas criteria that accounts for critical river locations, migration factors or environmental conditions. Ideally, this information is integrated to refine simulation model analysis and develop appropriate systemwide guidance. Similarly, information derived from assessments of structural and operational conditions are used in conjunction with early modeling tests to determine the priorities for undertaking facility modifications. These actions directly improve dissolved gas conditions and eventually lead to optimization of the continuous operating criteria.

The Phase 1 framework activities focus on an interim step in this process, the development of “screening” models that are applied to identify critical hot spots and narrow the range of conditions for subsequent analyses. The short term results of Phase 1 will help to evaluate and define further activities, and work toward breaking down the other long term objectives into a sequence of short term projects and tasks.

Figure 4. Framework Flow Diagram



Funding and Cost Allocation

There are two main funding mechanisms that have been employed to date or considered to accomplish the TGG activities. The principle mechanism to date is strictly a cooperative basis, in which participants contribute in-kind services, and in some cases have agreed to provide funds on a direct cost-share basis to accomplish certain tasks. Another mechanism not yet employed by the TGG involves developing a pooled fund resource for funding actions that are too expensive to be accomplished by a single entity, or to allocate the costs of actions at one location that have widespread benefits.

Thus far the TGG participants from government agencies, private utilities, facility owners, and other interested entities have acted on a strictly cooperative basis with co-sponsorship of funding or voluntary efforts. This funding mechanism has proven effective for meeting attendance, literature compilation, and relatively lower cost actions. As the tasks become more involved and potentially beyond the ability to perform tasks within these cooperative funding sources, the TGG may have to explore alternative funding mechanisms.

One function of the framework plan is to identify and compile short-term tasks of the TGG so that activities are sufficiently well-defined that both the personnel and funding resources needed can be determined. Some activities are already funded, others may require further cooperative and cost-sharing with the TGG members requesting funding through respective management and administrative mechanisms. Some tasks may require combined funding sources from several interested parties.

Phase 1 activities and an expected range of costs for contract activities are summarized in Section 3. This information is intended to help to define the cost needs and locate funding sources. The Steering Committee, with input from technical groups and co-chairs, will ask for volunteers to undertake activities with funding from respective agencies or employers. The Steering Committee and TGG co-chairs will also coordinate the funding requests and proposals to perform tasks that cannot be done through voluntary means.

Interagency agreements or memoranda of understanding may also be pursued to facilitate the continued support of the TGG participants. This approach will probably only be done if necessary to minimize the time and effort spent on administrative arrangements.

Obviously, as more long term commitments are made and potential structural modifications are identified, much larger funding requirements can be expected. More substantial funding sources and pooled mechanisms might be considered to accommodate larger project needs and to develop an equitable means to allocate costs between beneficiaries. These issues are not next anticipated until the subsequent framework phases.

3

Technical Group Activities

- ◆ ***Biological Investigations***
- ◆ ***Structural Characteristics***
- ◆ ***Facility Operations***
- ◆ ***Monitoring Information***
- ◆ ***Computer Modeling***
- ◆ ***Framework Plan Integration***
- ◆ ***Phase 1 Summary and Costs***

3

Technical Activities



This section describes activities included in Phase 1. This section is organized into topical activity areas that are separated by divider sheets so that the activities within a given topic can be easily found. There are five subsections for the technical workgroup activities and one subsection for the Framework Integration activities. The last subsection is a summary of the critical products and expected costs for all of the Phase 1 activities.

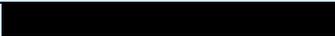
Information concerning the scope and participants involved in each activity (or project) are summarized in one-page activity description sheets. An example of the activity description sheet format is shown in Figure 5. These description sheets only provide basic information such as project title, participants, workgroup for coordination, and a brief summary of the scope and products. References to detailed project information are also indicated.

The activity description sheets are only intended to help in planning and coordinating the various TGG efforts undertaken by different workgroups. These description sheets do not replace other working project documents, technical abstracts, or proposals.

The activity description sheets focus on single actions and allow a quick view of activities and products in a given area. The sections can be readily updated to include descriptions of new activities or to modify the scope as projects change. The topical areas and description sheets may also help to identify new activities, break down activities into manageable short term tasks, and target results to focus on the long term goals and critical products.

Figure 5. Example - TGG Activity Description Sheet

Project Title:	Title of Project or Activity	Identity:	XX-YR.01
		Started:	
Workgroup:	(One of the workgroups or steering committee)		
Contact:	(Name and agency of primary project contacts)		
Participants:	(Names of major participating groups - not individuals)		
Purpose:	(Intent from standpoint of contributions to TGG objectives)		
Description:			Update: 1/07/00
1	(Brief description of the project, investigation or tasks) (Note: intended for identity in framework coordination - the more detailed project proposals, scope of work, or research abstracts and reports are independent of this - contact person could direct inquiries to additional project information as appropriate) (Target completion duration and products anticipated) (Possible reference to additional information available)		
2			
3			
4			
5			
6			
7			
8			
Short Term Products:	(This refers to the use or routing of information to other workgroups or to modify and incorporate into the updated management status report)		
Long Term Application:	(This refers to the overall objectives or implications of the activity within the short term task and long term framework plan approach)		



◆ ***Biological Investigations***

Biological Investigations

The primary technical responsibility for addressing biological investigations needs of the Transboundary Gas Group lies with the Biological Effects and Research Workgroup. The workgroup conducted a detailed review of existing information relating to biological effects of total dissolved gas supersaturation and a summary of outstanding research needs in initial phases of transboundary gas planning. Findings (Fidler, Antcliffe, Birtwell, and Pinney; 1999) were presented to the entire TGG and steering committee for consideration.

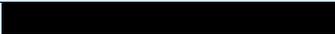
The workgroup report recommended that a comprehensive research plan be prepared to address the biological knowledge gaps which limit existing gas modeling efforts. Under the approach developed by the workgroup, additions and improvements to biological components of gas modeling efforts were to be developed. Biological components would be used to assist in management of spill, establish site specific water quality objectives, and assess and prioritize gas abatement alternatives. The workgroup strategy called for enhancement of predictive tools for optimizing spill and dollars spent on gas abatement before initiation of transboundary and systemwide gas abatement planning.

Discussions on biological risk assessment within the entire TGG and the steering committee focused on the planning nature of TGG goals, rather than the research based approach to development of biological effects modeling tools that was brought forward by the Biological Effects and Research Workgroup. The need for a short term initiative to reduce dissolved gas levels in the transboundary area was stressed. Representatives of Canada chose to conduct biological risk assessments based on existing biological information in transboundary reaches of the Columbia, Kootenai, and Pend d'Oreille Rivers. U.S. representatives chose to assume a direct relationship between the amount of gas produced and the risk to fish and aquatic resources.

Because of the over riding need to initiate gas abatement planning and implementation immediately, based on existing tools and information, the short term biological investigations needs defined in this framework plan are limited to the biological risk assessment proposed by representatives from Canada. However, it is generally recognized that additional goal oriented research and site specific biological information needs may be defined in later, more detailed studies of gas abatement alternatives.

TGG Activity Description Sheet

Project Title:	Transboundary Total Gas Pressure (TGP) Biological Risk Assessment	Identity:	BI-99.01
		Started:	12/01/99
Workgroup:	Biological Effects and Research		
Contact:	Bonnie Antcliffe, Department of Fisheries and Oceans Julia Beatty, B.C. Ministry of Environment, Lands, and Parks; CRIEMP		
Participants:	Columbia River Integrated Environmental Effects Monitoring Committee (CRIEMP)		
Purpose:	Identify key biological resources at risk due to elevated TGP in the transboundary reaches of the Columbia, Kootenai, and Pend d’Oreille Rivers.		
Description:			Update: 1/20/00
	1		
	2	This project will inventory the fisheries resources and relate to TGP in Canadian reaches of	
	3	the Columbia River from Keenleyside Dam to the international boundary, the Kootenai River	
	4	downstream of Kootenay Lake, and the Pend d’Oreille River from Boundary Dam	
	5	downstream. A summary of TGP data in the transboundary area will be prepared to describe	
	6	the location, frequency, and duration of elevated gas levels. The biological inventory will	
	7	include fish species distribution, relative abundance, life history phases, habitat utilization,	
	8	and behavioral patterns which could influence vulnerability to TGP. Information such as	
	9	horizontal and vertical distribution in the water column, daily patterns, migratory patterns,	
	0	location and depth of spawning areas, vertical distribution after emergence, location and	
	1	depth of larval and juvenile rearing habitat, and adult behavior patterns will be evaluated	
	2	relative to the summarized TGP data. Key fishery resources and life history phases at risk to	
	3	elevated TGP and any periods of reduced biological risk for spill will be identified.	
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Short Term Products:	Results of this study will go to the TGG for review and evaluation of possible implications to transboundary planning guidelines and criteria.		
Long Term Application:	In the long term these types of analyses will support reevaluation of applicable standards and criteria for management of total dissolved gas in the transboundary area.		



◆ ***Structural Characteristics***

Structural Characteristics

The Operational and Structural Abatement Workgroup was formed to investigate the gas generation characteristics of hydroelectric facilities and dams in the transboundary area, and to take the lead in identifying structural abatement measures for evaluation in systemwide analyses. The workgroup membership has close ties to project owners and operators in the transboundary area, and will serve to gather structural information and gas abatement alternatives developed for the individual projects and compile data for use in systemwide planning. This effort will also coordinate with other efforts such as the U.S. Army Corps of Engineers (USACE) Dissolved Gas Abatement Study (DGAS) program, as appropriate.

An initial product of the workgroup involved compilation of an inventory and preliminary ranking of storage and hydroelectric dams for gas abatement studies, based on estimated gas generation potential (Operational and Structural workgroup, 1999). Gas generation potential of facilities was estimated from the structure physical characteristics, hydraulics, experience reported by project owners, and dissolved gas monitoring, where available.

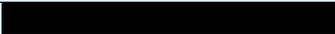
Additional Framework Plan activities related to structural characteristics and gas abatement options include (1) compilation of detailed information on flow and structural hydraulic characteristics, and (2) identification of structural gas abatement alternatives under consideration by owners of major dams and hydroelectric facilities in transboundary reaches of the Columbia, Kootenai, and Pend d'Oreille Rivers. Structural gas abatement alternatives would be screened in systemwide modeling evaluations to determine those options which should be studied in more detail as part of further advanced phases of gas abatement planning.

TGG Activity Description Sheet

Project Title:	Systemwide Inventory of Dams and Gas Generation Characteristics	Identity:	ST-99.01
		Started:	11/01/98
Workgroup:	Operational and Structural Abatement		
Contact:	Bijou Kartha, B.C. Ministry of Environment Keith Binkley, Seattle City Light		
Participants:	Project Owners/Operators and the Operational and Structural Abatement Workgroup		
Purpose:	The purpose of this project is to compile physical data related to gas generation for major dams in the Columbia River basin and rank facilities for further study.		
Description:			Update: 1/20/00
	1		
	2	Under this activity, an inventory of all major dams in the Columbia River was compiled,	
	3	along with information on the physical characteristics of the facility, project ownership,	
	4	purpose, location, occurrence of upstream and downstream projects, and dissolved gas data	
	5	or best professional judgement on gas generation potential. A ranking of dams for	
	6	systemwide gas abatement studies was completed, based on the size of the facilities, position	
	7	within the system, and the best available estimate of gas generation potential.	
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Short Term Products:	The inventory was provided to the Systemwide Dissolved Gas Abatement Steering Committee to assist in study plan development and formulation of systemwide alternatives.		
Long Term Application:	The focus of plan formulation efforts will narrow further as more data and site specific studies become available.		

TGG Activity Description Sheet

Project Title:	Identification of Structural Alternatives for Transboundary Gas Abatement	Identity:	ST-00.02
		Started:	
Workgroup:	Operational and Structural Abatement		
Contact:	Bijou Kartha, B.C. Ministry of Environment Keith Binkley, Seattle City Light		
Participants:	Project Owner/Operators and the Operational and Structural Workgroup with technical assistance for the U. S. Army Corps of Engineers Program staff		
Purpose:	The purpose of this activity is to identify and describe the full range of structural gas abatement alternatives available at transboundary facilities.		
Description:			Update: 1/07/00
	<p>1</p> <p>2 B.C. Hydro, the Columbia Power Corporation, West Kootenay Power, and public utility</p> <p>3 districts in the United States are involved in planning and investigations related to structural</p> <p>4 gas abatement measures, expansion/upgrade of power plant facilities, maintenance or</p> <p>5 replacement of outlet works, and other actions which might partially mitigate dissolved gas</p> <p>6 problems at the project level. This activity would compile and summarize the costs and gas</p> <p>7 reduction benefits ongoing project-level structural gas abatement planning activities, and</p> <p>8 identify further options needing consideration in systemwide evaluations. The Operational</p> <p>9 and Structural Abatement Workgroup will coordinate with U.S. Army Corps of Engineers</p> <p>0 Dissolved Gas Abatement Study program staff on technical aspects of defining short term</p> <p>1 alternatives and priorities.</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	Results will go to the Systemwide Dissolved Gas Abatement Steering Committee for use in prioritizing projects on a systemwide basis.		
Long Term Application:	Based on systemwide modeling results, projects would be incorporated into a plan to achieve system gas abatement objectives at the least possible cost.		



◆ **Facility Operations**

Facility Operations

The Operational and Structural Abatement Workgroup has primary responsibility for identifying and describing the potential operational measures for dissolved gas abatement under the framework plan. The workgroup will provide liaison with the project owners, provide technical assistance in identifying operational gas abatement measures, and help facilitate technical assistance from other efforts including U.S. Army Corps of Engineers Dissolved Gas Abatement Study (DGAS) program, as appropriate.

The Framework Plan strategies for operational considerations under Phase I are two-fold. The first short-term objective is to identify project specific operational gas abatement criteria for transboundary facilities for possible early implementation. The second focus is to explore and evaluate the option of expanding the Federal Columbia River Power System (FCRPS) spill and dissolved gas management program to include transboundary facilities.

Framework plan activities include working with project owners to identify short-term project specific operational measures to abate gas at facilities on the Columbia, Kootenai, and Pend d'Oreille Rivers in the transboundary area. The workgroup will also provide oversight of a project to formulate systemwide operational strategies which would expand the scope of current gas management operating criteria on the lower river. Operational gas abatement strategies will be evaluated using systemwide modeling tools developed by the Modeling Workgroup.

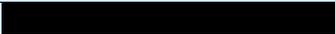
The Evaluations of operational alternatives will address concerns of transboundary project owners and action agencies of the FCRPS. If a decision is made to expand the current criteria for spill and gas management in the lower river to include transboundary facilities, later phases of study may focus on development of institutional arrangements for managing spill on a systemwide basis.

TGG Activity Description Sheet

Project Title:	Identification of Short-Term Operational Measures for Transboundary Gas Abatement	Identity:	OP-00.01
		Started:	
Workgroup:	Operational and Structural Abatement		
Contact:	Bijou Kartha, B.C. Ministry of Environment, Lands, and Parks Keith Binkley, Seattle City Light		
Participants:	Project Owners/Operators and the Operational and Structural Abatement Workgroup, with technical assistance from US Army Corps of Engineers DGAS program staff		
Purpose:	To identify, assess, and facilitate implementation of short-term operational measures to reduce gas production in the transboundary area.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 It is recognized that there are a number of operational gas abatement measures which might</p> <p>3 be implemented in the short-term on a project-specific basis by owners and operators of</p> <p>4 hydroelectric facilities in the transboundary area. Operational measures include optimization</p> <p>5 of spill configurations, preferential use of those outlet conduits which generate the smallest</p> <p>6 amounts of gas, maximizing generation, and operation of turbines at speed-no-load when</p> <p>7 system power loads do not permit full use of power plan hydraulic capacities. This activity</p> <p>8 would compile and summarize the structural and hydraulic characteristics and operating</p> <p>9 criteria of transboundary facilities, and recommend short-term operational measures to</p> <p>0 reduce gas production. The Operational and structural workgroup will coordinate with the</p> <p>1 U.S. Army Corps of Engineers Dissolved Gas Abatement Study program staff on technical</p> <p>2 aspects in defining short term alternatives and priorities.</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	Results of this activity will go to the Systemwide Dissolved Gas Abatement Steering Committee for recommendation of short term implementation actions by project owners/operators in the transboundary area.		
Long Term Application:	As system modeling capability improves emphasis will likely shift from project specific to system operations strategies for gas abatement.		

TGG Activity Description Sheet

Project Title:	Formulation of Cooperative Systemwide Operational Strategies	Identity:	OP-00.02
		Started:	
Workgroup:	Operational and Structural Abatement		
Contact:	Mark Schneider, US National Marine Fisheries Service Dave Wilson, B.C. Hydro		
Participants:	Facilitated by NMFS and B.C. Hydro, with participation by project owners/operators and other appropriate entities		
Purpose:	Develop and analyze systemwide operational strategies for reducing gas production in the transboundary area of the Columbia River basin.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 This project will focus on formulation of cooperative operational strategies to reduce gas</p> <p>3 production in the Columbia River system. Initial efforts will focus on expansion of the Gas</p> <p>4 Management Plan for the Federal Columbia River Power System (FCRPS) to Canadian</p> <p>5 facilities and US non-Federal dams in transboundary reaches of the Columbia, Kootenai, and</p> <p>6 Pend d’Oreille Rivers. During periods of voluntary and involuntary spill, dissolved gas is</p> <p>7 managed throughout the Federal Columbia River Power System and at Mid-Columbia public</p> <p>8 utility district facilities according to spill caps and spill priorities adopted by the NMFS</p> <p>9 Regional Forum. Appropriate participating agencies and private entities will be identified by</p> <p>0 co-facilitators, and an expanded spill priority list based on existing information and a coarse</p> <p>1 level of analysis will be prepared.</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	Results of the study will be presented to the Systemwide Dissolved Gas Abatement Steering Committee to consider implementation actions.		
Long Term Application:	Implementation of spill management beyond the FCRPS would require development of an institutional framework.		



◆ **Monitoring Information**

Monitoring Information

The Monitoring and Information Sharing Workgroup has primary technical responsibility for managing framework plan tasks associated with planning and implementing total dissolved gas monitoring activities, including development of protocols, coordination of system monitoring, data management, and summary reporting. Project owners will have responsibility for installation and maintenance of monitoring equipment, conducting necessary transects and near-field studies, and making information available to the other TGG workgroups.

The workgroup has identified available total dissolved gas data in Canada and the United States, prioritized projects according to the relative need for further monitoring, and estimated costs for several expanded monitoring options (Monitoring and Information Sharing Workgroup, 1999). The workgroup found that some total dissolved gas data is available for most major dams and hydroelectric facilities in the transboundary area. The Framework Plan monitoring strategy provides for a focused effort to assure availability of adequate data for model development, calibration, and verification in the transboundary reaches of the Columbia, Kootenai, and Pend d'Oreille Rivers.

Framework Plan activities identified for the Monitoring and Information Sharing workgroup include implementation of a Phase I Monitoring program, based on data needs identified by the Modeling Workgroup. Implementation of monitoring would be conducted in coordination with project owners. The Monitoring and Information Workgroup is also tasked with providing technical oversight for a project to describe existing dissolved gas conditions in the transboundary area, based on summary and evaluation of existing data. This evaluation would expand on previous summaries of data from projects in Canada (Columbia River Integrated Environmental Monitoring Program Committee, 1999).

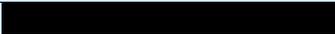
Monitoring strategies during Phase II and beyond will likely shift to establishment of fixed station monitors to support real-time spill management, and additional site specific studies to meet data needs for detailed evaluations of gas abatement alternatives.

TGG Activity Description Sheet

Project Title:	Phase I Monitoring for Screening Model	Identity:	MI-00.01
		Started:	
Workgroup:	Monitoring and Information Sharing		
Contact:	Andrea Ryan, Environment Canada Jack Gakstatter, US Environmental Protection Agency Faith Ruffing, Sun Mountain Reflections		
Participants:	Project owners/operators and the Monitoring Information Workgroup based on input from the Modeling Workgroup		
Purpose:	This activity would provide for collection of the initial data sets needed to apply existing dissolved gas models in the transboundary reaches of the Columbia, Kootenai, and Pend d'Oreille Rivers.		
Description:			Update: 1/20/00
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	2	The Phase I Monitoring activity would provide for collection of dissolved gas, flow, spill,	
	3	bathymetry, and topography data and any additional near field or transect studies needed by	
	4	the Modeling Workgroup to define relationships between spill and gas generation and	
	5	describe gas transport characteristics at facilities in the transboundary reaches of the	
	6	Columbia, Kootenai, and Pend d'Oreille Rivers. Hydroelectric project owners and operators	
	7	would have the primary responsibility for data gathering at transboundary facilities. The	
	8	Monitoring Information Workgroup will provide for coordination, technical assistance and	
	9	review of monitoring protocols and study plans.	
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Short Term Products:	Information developed under this activity will be provided to the Modeling Workgroup for use in initial screening model development.		
Long Term Application:	Gas generation curves and gas transport relationships developed with these data will provide a mechanism for system wide screening of gas abatement projects.		

TGG Activity Description Sheet

Project Title:	Description of Existing Dissolved Gas Conditions in the Transboundary Area	Identity:	MI-00.02
		Started:	
Workgroup:	Monitoring and Information Sharing		
Contact:	Andrea Ryan, Environment Canada Jack Gakstatter, US Environmental Protection Agency Faith Ruffing, Sun Mountain Reflections		
Participants:	Project Owners/Operators, the Monitoring and Information Sharing Workgroup, and Contractor		
Purpose:	This project would provide a description of dissolved gas conditions in the transboundary reaches of the Columbia, Kootenai, and Pend d’Oreille River, based on existing data.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 Under this activity, existing dissolved gas data in the transboundary area would be compiled</p> <p>3 and summarized. The magnitude, frequency, seasonal distribution, and duration of spills and</p> <p>4 exceedances of dissolved gas water quality standards and other planning criteria would be</p> <p>5 evaluated for each facility in the transboundary area. The project would recognize and build</p> <p>6 on the 1999 Columbia River Integrated Environmental Monitoring Program (CRIEMP)</p> <p>7 project conducted by RL&L Environmental Services at Canadian facilities for B.C. Hydro,</p> <p>8 the Columbia Power Corporation, COMINCO, West Kootenay Power, and the city of Nelson,</p> <p>9 B.C. This activity would expand on the CRIEMP project and extend the analysis to dams in</p> <p>0 the US. Project owners and operators would be responsible for providing project specific</p> <p>1 dissolved gas data to be included in the analysis.</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	The project will be used by the Systemwide Dissolved Gas Abatement Steering Committee to identify ‘hot spots’ and prioritize gas management planning activities.		
Long Term Application:	This activity will eventually provide a baseline for measuring progress in abating gas in the transboundary area.		



◆ ***Computer Modeling***

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Computer Modeling

The Modeling Workgroup has lead responsibility for managing technical aspects of total dissolved gas model development and use under the Framework Plan. The Modeling Workgroup will coordinate with project owners and the monitoring workgroup to compile existing data and define information gaps which must be filled to complete development of dissolved gas modeling capabilities for transboundary areas of the Columbia, Kootenai, and Pend d'Oreille Rivers. The workgroup will assure that dissolved gas model simulations developed for the transboundary area can be used in combination with existing models for spill optimization and gas abatement planning in the lower Columbia and Snake Rivers to provide for systemwide analytical capabilities.

The Modeling Workgroup has evaluated several types of models that are currently in use in the lower Snake and Columbia Rivers, and which appear to have potential for systemwide evaluation of gas management options (Modeling Workgroup,1999) . The workgroup provided estimated levels of effort and costs of applying the models on a systemwide and transboundary area level. Concurrently, the Federal Columbia River Power System (FCRPS) action agencies initiated development of a spread sheet dissolved gas model with capability to optimize spill and system power loads, and maintain dissolved gas below standards and guidelines.

The Framework Plan Phase I modeling strategy is to move ahead with development and calibration of two dissolved gas models, a one-dimension (1D) hydrodynamic temperature and dissolved gas transport model, and the spreadsheet model developed for the FCRPS by the U.S. Army Corps of Engineers Waterways Experiment Station. The development of dual modeling capabilities will keep future options for model application open, provide temperature modeling capability, maintain the option of adding a biological component to the planning model, provide for spill optimization, and assist system managers in meeting power loads and gas standards and guidelines.

Specific modeling activities included in the initial phase of the Framework Plan are (1) identification of data gaps for model development, (2) calibration and verification of the 1D gas transport and spread sheet models, and (3) application of the models in a coarse level evaluation of structural and operational gas abatement measures on a systemwide and transboundary level. More detailed evaluations of gas abatement alternative in later planning phases may require development of more data intensive 2D modeling capability or addition of biological effects criteria for specific river reaches.

TGG Activity Description Sheet

Project Title:	Identification of Screening Model Data Needs	Identity:	CM-00.01
		Started:	
Workgroup:	Modeling		
Contact:	Julia Beatty, B.C. Ministry of Environment, Lands, and Parks Marshall Richmond, Battelle NW		
Participants:	The Modeling Workgroup, with technical assistance from US Army Corps of Engineers Waterways Experiment Station modeling staff		
Purpose:	This activity would provide the scope of a data collection program to support development of dissolved gas screening models for the transboundary area.		
Description:			Update: 1/20/00
	1	<p>This activity will involve compiling the existing dissolved gas, flow, spill, bathymetry, and topography data for the Columbia, Kootenai, and Pend d’Oreille Rivers, and identifying additional data needed to configure, calibrate, and verify dissolved gas screening models for the transboundary area. Data needs of the Battelle NW gas transport model developed for the US Army Corps of Engineers (USACE) in the lower Snake and Columbia Rivers and a spreadsheet dissolved gas and power model currently under development at the USACE Waterways Experiment Station will be compiled and compared with existing information. An integrated description of data needs to develop and calibrate these two models will be prepared.</p>	
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Short Term Products:	The compilation of data needs will be provided to the Monitoring and Information Sharing Workgroup for early implementation of Phase I Monitoring.		
Long Term Application:	Results will facilitate development of systemwide dissolved gas screening models for evaluation of gas abatement options.		

TGG Activity Description Sheet

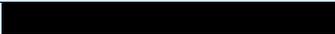
Project Title:	Operations Spreadsheet Model Development	Identity:	CM-00.02
		Started:	
Workgroup:	Modeling		
Contact:	Julia Beatty, B.C. Ministry of Environment, Lands, and Parks Marshall Richmond, Battelle NW		
Participants:	The Modeling Workgroup, and US Army Corps of Engineers (USACE) Waterways Experiment Station Staff		
Purpose:	To develop an operational model for use by system and facility managers to optimize systemwide power and dissolved gas generation effects of a range of gas abatement alternatives.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 A spreadsheet dissolved gas model would be developed to assist facility and system</p> <p>3 managers in evaluating effects of real-time operational decisions on gas levels and power</p> <p>4 generation. The model would predict total dissolved gas levels in the forebay and tailrace</p> <p>5 areas of all facilities in the system, provide for flow and spill optimization, account for</p> <p>6 transmission constraints, follow spill priorities and caps, meet system power loads, and</p> <p>7 maintain total dissolved gas below standards and guidelines. The geographic scope of the</p> <p>8 model would include the Columbia River upstream of the international boundary and the</p> <p>9 Kootenai and Pend d’Oreille Rivers in the US and Canada. The model will calculate</p> <p>0 required powerhouse and spill flows and predicts TDG, based on input data including total</p> <p>1 flows entering and leaving the project, pre-defined spill requirements, powerhouse hydraulic</p> <p>2 capacity, discharge-to-megawatt conversion factors, and spill-to TDG relationships. The</p> <p>3 model would be comparable to the USACE spreadsheet model currently under development</p> <p>4 for the Columbia River downstream of Grand Coulee Dam and the Snake River downstream</p> <p>5 of Lower Granite Dam.</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	This model would assist the Systemwide Dissolved Gas Abatement Steering Committee in screening and selecting gas abatement alternatives for advanced study.		
Long Term Application:	This model will facilitate evaluation and implementation of real-time spill management and operational gas management options including load sharing.		

TGG Activity Description Sheet

Project Title:	Screening/Planning Model Development	Identity:	CM-00.03
		Started:	
Workgroup:	Modeling		
Contact:	Julia Beatty, B.C. Ministry of Environment, Lands, and Parks Marshall Richmond, Battelle NW		
Participants:	Modeling Workgroup, Bonneville Power Administration, Battelle NW		
Purpose:	Development of a 1D gas transport model to facilitate screening and evaluation of transboundary gas abatement measures on a systemwide scale.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 Under this project, a hydrodynamic temperature and dissolved gas transport model, MASS1,</p> <p>3 developed for the US Army Corps of Engineers Dissolved Gas Abatement Program would be</p> <p>4 applied to transboundary reaches of the Columbia, Kootenai, and Pend d'Oreille Rivers.</p> <p>5 MASS1 is an unsteady river flow and water quality computer model that simulates a</p> <p>6 branched river channel system as a set of links and individual points along each link. The</p> <p>7 model is one-dimensional and only calculates cross-sectional average estimates of hydraulic</p> <p>8 and water quality conditions in the river or reservoir system. Standard model output includes</p> <p>9 discharge, water surface elevation, velocity, temperature, dissolved gas concentration, depth,</p> <p>0 area, hydraulic radius, channel top width, friction slope, and average travel time and bed</p> <p>1 shear stress. The model would be implemented in a phased approach, starting with the best</p> <p>2 available data and then refined in the future as additional data are collected and funds</p> <p>3 become available.</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	The model would be used to assist the Systemwide Dissolved Gas Abatement Steering Committee in evaluating existing conditions and ranking mitigation measures for advanced study and implementation.		
Long Term Application:	There may be a need to apply two or three dimensional models in specific areas as more information becomes available.		

TGG Activity Description Sheet

Project Title:	Screening Model Evaluation of Gas Abatement Alternatives	Identity:	CM-00.04
		Started:	
Workgroup:	Modeling		
Contact:	Julia Beatty, B.C. Ministry of Environment Lands and Parks Marshall Richmond, Battelle NW		
Participants:	The Modeling Workgroup, with technical assistance from U.S. Army Corps of Engineers and contractor staff		
Purpose:	The purpose of this activity is to determine the systemwide and transboundary level effectiveness of operational and structural gas abatement options available at facilities in the transboundary area.		
Description:		Update:	1/18/00
	<p>1</p> <p>2 The spread sheet and 1-dimensional gas transport models developed for systemwide</p> <p>3 screening of gas abatement alternatives would be used to simulate systemwide dissolved gas</p> <p>4 levels with various combinations of structural and operational abatement measures in place.</p> <p>5 Operational and structural gas abatement measures evaluated under this activity would be</p> <p>6 provided by the Operational and Structural Abatement Workgroup, in coordination with the</p> <p>7 Systemwide Dissolved Gas Abatement Steering Committee. The Modeling Workgroup</p> <p>8 would provide technical oversight of simulations and assure the most appropriate of the two</p> <p>9 available models are used for evaluation of each alternative.</p> <p>0</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	The simulations produced under this activity will be used by the Systemwide Dissolved Gas Abatement Steering Committee to formulate recommendations for advanced planning and implementation of gas abatement measures.		
Long Term Application:	More detailed evaluations may be needed on short river reaches during advanced planning of structural gas abatement measures		



◆ ***Framework Plan Integration***

Framework Plan Integration

These activities are accomplished or coordinated primarily by the TGG steering committee and TGG chairs with assistance by respective working groups and support staff. There are three major ongoing activities that are constant to implement this framework plan.

- 1) To track progress of TGG workgroup activities and facilitate and the transfer of critical products between workgroups.
- 2) To review and compile significant results of the TGG activities and incorporate results in the Transboundary Gas Management Status Report
- 3) To compile relevant information and coordinate major transboundary results with the lower Columbia River gas management efforts.

Integration Assistance and Support

The Systemwide Dissolved Gas Abatement Steering Committee has primary responsibility for implementing the Transboundary Gas Group Framework Plan. The steering committee will coordinate among the various technical workgroup activities and integrate workgroup and contractor products into planning reports which summarize results and recommend actions, including advanced gas abatement planning and implementation projects.

The Framework Plan management strategy involves oversight by the steering committee, coordination and management of planning activities, and preparation of interim and final reports. The steering committee would provide liaison with agencies, project owners, and the regional forum and other appropriate entities to secure regional endorsement and commitments of in-kind and financial resources needed to complete the planning and implementation of a systemwide gas management program.

An active steering committee with staff support will be critical to maintaining the focus of technical workgroups and assuring development and implementation of actions that will accomplish the overall goals of the Transboundary Gas Group. Periodic reconsideration of the steering committee membership may be necessary to assure representation of technical groups and project owners in Canada and the United States.

The two primary integration activities included in the Phase 1 scope are expected to be a constant need for this and future phases of the TGG efforts. Other important integration activities and support needs activities might be defined later once Phase 1 is underway.

TGG Activity Description Sheet

Project Title:	Coordination and Management of Transboundary Gas Abatement Planning	Identity:	PI-00.01
		Started:	
Workgroup:	Systemwide Dissolved Gas Abatement Steering Committee		
Contact:	Les Swain, British Columbia Ministry of Environment, Lands and Parks Jim Ruff, US National Marine Fisheries Service Mary Lou Soscia, US Environmental Protection Agency		
Participants:	Systemwide Dissolved Gas Abatement Steering Committee and agencies or a contracted study coordinator		
Purpose:	This activity would provide for over-all coordination and management of Transboundary Dissolved Gas Management Planning.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 This activity will involve coordination with technical workgroup leaders, participating</p> <p>3 agencies and project owners to secure staff and budget resources to complete work items,</p> <p>4 direct technical workgroup and contractor tasks, collate work products, provide oversight and</p> <p>5 management of study plan revisions, and prepare TGG status reports.</p> <p>6</p> <p>7 Program management would be conducted with guidance and direction from the Systemwide</p> <p>8 Dissolved Gas Abatement Steering Committee. Coordination with ongoing National Marine</p> <p>9 Fisheries Service Regional Forum dissolved gas planning programs in the United States will</p> <p>0 also be maintained. This study coordination function is expected to require about a quarter-</p> <p>1 time commitment of a staff person for the duration of the study.</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	This function will assist the steering committee in assuring that necessary commitments are in place to complete critical technical planning activities, and provide central direction to transboundary gas management planning.		
Long Term Application:	This function will likely shift to institutionalizing transboundary gas management programs in the long term.		

TGG Activity Description Sheet

Project Title:	Preparation of Transboundary Dissolved Gas Management Status Report	Identity:	PI-00.02
		Started:	
Workgroup:	Systemwide Dissolved Gas Abatement Steering Committee		
Contact:	Les Swain, B.C. Ministry of Environment, Lands, and Parks Jim Ruff, U.S. National Marine Fisheries Service Mary Lou Soscia, U.S. Environmental Protection Agency		
Participants:	Systemwide Dissolved Gas Abatement Steering Committee and agencies or other contracted staff		
Purpose:	The purpose of this activity is to provide an updated Transboundary Gas Management Plan Status Report at the end of an initial two year study period.		
Description:			Update: 1/20/00
	<p>1</p> <p>2 This activity would provide for completion of a status report describing total dissolved gas</p> <p>3 management in the transboundary area. Results of workgroup activities related to</p> <p>4 monitoring, biological risk assessment, modeling and screening tool development, spill</p> <p>5 management, and formulation of gas abatement plans will be integrated into a status report</p> <p>6 which will describe the state of gas management at the end of the first two years of planning.</p> <p>7 The report will recommend further planning needs defined through completion of preliminary</p> <p>8 coarse-level analyses conducted during the initial planning phase. The Systemwide</p> <p>9 Dissolved Gas Abatement Steering Committee will provide guidance and oversight of status</p> <p>0 report preparation and content.</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>		
Short Term Products:	The status report will be provided to the Transboundary Gas Group to provide a progress report and describe long-term advanced planning needs.		
Long Term Application:	The report will assist in integrating results of transboundary gas planning into a management plan, which includes monitoring, operations, and structural abatement components.		



◆ **Phase 1 Summary and Costs**

Phase 1 Summary and Costs

This section consists of a summary of the Phase 1 project activities that are defined in the previous activity description sheets. The summary tables included in this section provide a quick review of all of the projects currently included in the scope of Phase 1, and some of the important information for planning and tracking project activities. The tables identify projects by the Code ID and titles defined in the activity description sheets.

The project activities that have a product that is required by another group or is needed to undertake a series of activities are indicated in the column marked “Critical Products” in Table 1. This column shows the ID codes of any other activities that will need the products of that activity. This provides a simple view of the group interactions without going to the extent of developing a “critical path” management structure. As a result this approach will rely on the cooperative efforts and perseverance of the TGG workgroups.

The second table provides a brief summary of the approximate costs expected for the major project activities. Note that these costs are not necessarily all of the costs of an activity, and reflect only a rough range of costs for activities that are not undertaken through cooperative cost-share of voluntary mechanisms. The total costs may provide a basis for developing funding sources to accomplish the activities of Phase 1. A more accurate cost estimate may be developed in the future planning for each specific activity.

For these purposes, any in-kind services and other voluntary contributions are indicated as no cost. These working arrangements are considered indispensable to the ultimate success of the long term TGG goals and objectives. Hopefully continued involvement by the TGG participants can be supported by respective agency and industry budgets. Continuation of existing cooperative arrangements eliminates the need to develop complicated mechanisms and thereby allows efforts to be directed toward the tasks at hand.

Table 1. Phase 1 Activity Status Summary

Identity	Project Title	Status	Critical Products
BI-99.01	Transboundary Total Gas Pressure (TGP) Biological Risk Assessment	ongoing	Ongoing
ST-99.01	Systemwide Inventory of Dams and Gas Generation Characteristics	complete	Screening Model CM-00.03
ST-00.02	Identify Structural Alternatives for Transboundary Gas Abatement	proposed	Screening Alternatives CM-00.04
OP-00.01	Identify Short-Term Operation Measures for Transboundary Gas Abatement	proposed	Screening Model CM-00.03
OP-00.02	Formulate Cooperative Systemwide Operational Strategies	proposed	Screening Alternatives CM-00.04
MI-00.01	Phase I Monitoring for Screening Model	proposed	Screening Model CM-00.03
MI-00.02	Describe Existing Dissolved Gas Conditions in the Transboundary Area	proposed	Screening Alternatives CM-00.04
CM-00.01	Identify Screening Model Data Needs	proposed	Monitoring Plan MI-00.01
CM-00.02	Operations Spreadsheet Model Development	proposed	Screening Alternatives CM-00.04
CM-00.03	Screening/ Planning Model Development	proposed	Screening Alternatives CM-00.04
CM-00.04	Screening Model Evaluation of Gas Management Alternatives	proposed	★ Primary Focus of Framework Phase 1
PI-00.01	Coordinate and Manage Transboundary Gas Abatement Planning	proposed	Ongoing
PI-00.02	Prepare Transboundary Dissolved Gas Management Status Report	proposed	Ongoing

Table 2. Phase 1 Funding and Cost Summary

Identity	Project Title	Type	Expected Cost Range
BI-99.01	Transboundary Total Gas Pressure (TGP) Biological Risk Assessment	in-kind	---
ST-99.01	Systemwide Inventory of Dams and Gas Generation Characteristics	in-kind	---
ST-00.02	Identify Structural Alternatives for Transboundary Gas Abatement	in-kind	---
OP-00.01	Identify Short-Term Operation Measures for Transboundary Gas Abatement	in-kind	---
OP-00.02	Formulate Cooperative Systemwide Operational Strategies	in-kind	---
MI-00.01	Phase I Monitoring for Screening Model	in-kind	---
MI-00.02	Describe Existing Dissolved Gas Conditions in the Transboundary Area	contract	\$30-35K
CM-00.01	Identify Screening Model Data Needs	contract	\$15-20K
CM-00.02	Operations Spreadsheet Model Development	contract	\$75-90K
CM-00.03	1D Gas Transport Model Development	contract	\$75-100K
CM-00.04	Screening Model Evaluation of Gas Management Alternatives	contract	\$60-70K
PI-00.01	Coordinate and Manage Transboundary Gas Abatement Planning	contract	\$75-80K
PI-00.02	Prepare Transboundary Dissolved Gas Management Status Report	contract	\$35-40K

4

Transboundary Gas Management Status Report

- ◆ ***Management Status Update***
- ◆ ***Applicable Criteria and Standards***
- ◆ ***Current Individual Facility Conditions***
- ◆ ***Systemwide Operational Criteria***
- ◆ ***Reference Information***

4

Transboundary Gas Management Status Report



This is a working report that is intended to provide a fairly concise summary of the current conditions and management criteria applied in the transboundary area and related activities in the Columbia River system. The status report is reviewed periodically to incorporate the most recent information available pertaining to the following topics:

- Update of recent events and activities in progress.
- List of important meetings, conferences and upcoming events.
- Current standards and management criteria applied in the transboundary area.
- Current structural and operational conditions at major transboundary facilities.
- Current systemwide operations, including links to the lower basin activities.
- Reference information and a listing of TGG participants and contacts.

A first version of the Transboundary Gas Management Status Report is included in the Phase 1 framework plan. A similar status report could also be produced separately for distribution.

The Transboundary Gas Management Status Report is tentatively planned for review and update every 6 months upon the conclusion of the biannual TGG meetings. It is anticipated that the status of specific workgroup activities and possible revisions to the framework plan and status report could be presented and considered by the TGG.

Note that at the time of this writing the Phase 1 Framework Plan and status report have not been reviewed or adopted by the TGG. Review and discussion of the framework plan is expected to occur at the TGG meeting in March of 2000.

Management Status Update

This status report summarizes the results and actions undertaken over the last 17 months since the inception of the TGG in April 1998 until the September 1999 meeting in Nelson, British Columbia. This first status report includes brief summaries of the current conditions and criteria applied in the transboundary area. Notes from previous meetings, upcoming events, references and a list of contacts are also provided.

Current TGG Co-chairs

The members of the Systemwide Dissolved Gas Abatement Steering Committee are Les Swain from the British Columbia Ministry of the Environment, Land and Parks, Mary Lou Soscia of the U.S. Environmental Protection Agency, and Jim Ruff of the U. S. National Marine Fisheries Service. The co-chairs responsible for overall coordination of TGG activities are Bev Raymond from Environment Canada and Mark Schneider from the U. S. National Marine Fisheries Service.

Purpose of the Status Report

The status report is intended to report on recent activities of the TGG and to document the current gas management strategy applied in the transboundary area. This provides a forum to update criteria and record changes to gas management measures at sites as appropriate.

The status report is also a convenient method for tracking progress of the transboundary technical group activities. It does not replace technical documentation, but is a means to summarize results, findings, and references to other relevant work. In addition, the status report may also be useful to initiate proposals and obtain funding for the TGG activities.

As activities are accomplished, the status report will shift more toward final systemwide guidance and operating procedures applied for long term gas management. The status report of the transboundary efforts can be used to coordinate with the work currently completed or ongoing for the lower Columbia basin.

The short term products of Phase 1 activities including results of the initial screening model trials should be available to guide the TGG in developing the next phase of work.

TGG Framework Plan Activities

Phase 1 of the framework plan is defined as a two year effort, although two of the Phase 1 tasks are currently underway by the TGG workgroups. An inventory of the dam structural parameters and available TDG/TGP data in the transboundary area is complete. Long term biological risk assessments have also started under an established British Columbia program the Columbia River Integrated Environmental Effects Monitoring Committee (CRIEMP).

Transboundary Gas Group Meetings:

Formation of the TGG at the conference: April 27-30, 1998; Castlegar, B.C.
“Toward Ecosystem-Based Management
in the Upper Columbia River Basin”

Subsequent Meetings of the TGG: June 11, 1998; Spokane, WA
October 15, 1998; Vancouver, B.C.
February 18, 1999; Seattle, WA
April 29, 1999; Spokane, WA
September 30, 1999; Nelson, B.C.

Upcoming Meetings or Events:

TGG Biennial Meeting March 16, 2000 Spokane, WA
NMFS DGT meetings monthly contact Mark Schneider for information
NMFS SCT meetings monthly contact Bill Hevlin for information at
bill.hevlin@noaa.gov
BC/WA Environmental Cooperation Council Meetings contact Cassie Doyle, B.C. Ministry of
Environment Lands and Parks, or Tom
Fitzsimmons, Washington Department of
Ecology

Other Meetings or Conferences of Importance: ???

Summary of TGG Activities - April 1998 to September 1999

The need for a systemwide approach to total dissolved gas abatement was determined and the Transboundary Gas Group was formed to address these issues in Canada and the United States. The following notes summarize actions of the TGG as of September 1999:

- Co-chairs volunteered to provide coordination of the TGG.
- Goal of the TGG was developed as: *“Reduce systemwide total dissolved gas to levels safe for all aquatic life in the most cost-effective manner possible”*.
- The geographic area of the TGG was defined as the mainstem Columbia River upstream from Grand Coulee Dam including the Kootenai and Pend d’Oreille downstream of the confluence with the Flathead and Clark Fork Rivers.
- Systemwide Dissolved Gas Abatement Steering Committee was formed to provide direction to the TGG by developing an action plan for systemwide total dissolved gas abatement. The components of this action plan are:
 - develop, manage, and implement a study plan
 - coordinate efforts of technical workgroups performing the details studies
- General goals were formulated for short-term completion:
 - Provide a framework to facilitate short and long term investigations and dissolved gas management planning efforts in the transboundary area of the Columbia River basin.
 - Provide for systemwide management of dissolved gas problems in the Columbia River through modeling, monitoring, and operational links to the gas management programs in the lower Columbia River.
- Four technical workgroups were formed to address the major technical aspects of the TGG. The currently established technical groups are:
 - Biological Effects and Research
 - Structural and Operational Abatement
 - Monitoring and Information Sharing
 - Modeling (computer simulation)
- The technical groups have formulated draft work plans. Workgroup activities have been accomplished primarily by in-kind voluntary efforts of workgroup members.
- Extensive literature reviews have been compiled by all the workgroups and are complete. The workgroup study plans and other reference literature is accessed by visiting the TGG Internet web-site home page.

Applicable Criteria and Standards

This section describes the rules that will be applied to the evaluation of the transboundary area. The criteria and standards currently listed are taken from meeting minutes and are a result of a group consensus for acceptance of certain standards in order to move forward with Phase 1 or short term tasks. Currently, these criteria deal with the geographic area and the water quality criteria and standards applied with respect to dissolved gas and related fishery problems in the transboundary area. As more information becomes available these criteria may change and would be reported here. The criteria will be used to focus work areas and evaluate results from gas management screening tools developed during this Phase 1 period.

Geographical area includes the mainstem Columbia River upstream from Grand Coulee Dam including the Kootenai and Pend d'Oreille upstream of the confluence with the Flathead and Clark Fork Rivers. Other smaller tributaries are beyond the current scope of the TGG efforts.

The TGG has adopted an interim criteria of 110 percent saturation for Total Dissolved Gas (TDG) or the equivalent Total Gas Pressure (TGP). There is still ongoing discussion regarding appropriate TDG/TGP criteria for the transboundary area and this interim criteria may change as new information is available. Until new criteria are developed and accepted, the interim 110 percent saturation criteria will be assumed in gas management evaluations.

In Canada, 110 percent TGP is a guideline for water depths greater than 1 meter at sea level (Fidler and Miller, 1997). This standard would apply to most Columbia River sites where depths up to 30 meters exist, but not to projects near Vancouver Island, British Columbia where shallow depths are often encountered. The United States Environmental Protection Agency has adopted a TDG criteria of 110 percent saturation under the Clean Water Act. The National Marine Fisheries Service has written biological opinion documents that call for spill management to benefit migratory endangered aquatic species; however, waivers are periodically granted to allow for short term elevated TDG conditions.

The average 7-day high flow, 10-year recurrence interval hydrologic event will be applied as the flow standard for evaluation of operational and structural modifications. This criteria is consistent with the flow frequency and magnitude criteria used in dissolved gas planning in the lower Columbia River basin.

Current Individual Facility Conditions

This section is intended to provide an inventory and technical description of the dams and the dissolved gas characteristics in the transboundary area. This task has been completed by the Structural and Operational and the Monitoring and Information Sharing technical workgroups.

The major hydroelectric projects in the transboundary area are reflected in the schematic of the Columbia River in Figure 2. The inventory of these major projects are summarized in the following Table 1. The projects indicated are considered major contributors to the TDG problems in the transboundary area for evaluation in the Framework Plan Phase 1.

<i>Project</i>	<i>Owner</i>	<i>Purpose</i>	<i>River Location</i>	<i>Project Upstream</i>	<i>Project Downstream</i>	<i>Data</i>
COLUMBIA HEADWATERS						
Mica	BCH	M(Treaty)	Columbia	None	Revelstoke	Y
Revelstoke	BCH	P	Columbia	Mica	Hugh Keenleyside	Y
Hugh Keenleyside (Arrow)	BCH	M	Columbia	Revelstoke	Grand Coulee	Y
KOOTENAI BASIN						
Libby	COE	F/P	Kootenai	Aberfeldie	Corra Linn	Y
Corra Linn	WKP	P	Kootenai	Duncan	Upper Bonnington	Y
Upper Bonnington	WKP	P	Kootenai	Corra Linn	Lower Bonnington	Y
Lower Bonnington	WKP	P	Kootenai	Upper Bonnington	South Slocan	Y
Bonnington Falls	City of Nelson	P	Kootenai	Upper Bonnington	South Slocan	Y
South Slocan	WKP	P	Kootenai	Lower Bonnington	Kootenay Canal	Y
Kootenay Canal	BCH	P	Kootenai	South Slocan	Brilliant	Y
Brilliant	CPC/WKP	P	Kootenai	Kootenay Canal	Grand Coulee	Y

Table 1. Summary of Hydroelectric Projects in Framework Phase 1.						
<i>Project</i>	<i>Owner</i>	<i>Purpose</i>	<i>River Location</i>	<i>Project Upstream</i>	<i>Project Downstream</i>	<i>Data</i>
PEND d'OREILLE BASIN						
Thompson Falls	MPC	P	Clark Fork	Milltown	Noxon Rapids	Y
Noxon Rapids	Avista	P	Clark Fork	Thompson Falls	Cabinet Gorge	Y
Cabinet Gorge	Avista	P	Clark Fork	Noxon Rapids	Albeni Falls	Y
Albeni Falls	COE	P	Pend d'Oreille	Cabinet Gorge	Box Canyon	(Y)
Box Canyon	Pend D'Orielle PUD	P	Pend d'Oreille	Albeni Falls	Boundary	Y
Boundary	Seattle City Light	P	Pend d'Oreille	Box Canyon	Seven Mile	(Y)
Seven Mile	BCH	P	Pend d'Oreille	Boundary	Waneta	Y
Waneta	Com/WKP	P	Pend d'Oreille	Seven Mile	Grand Coulee	Y
Legend: P = Power Production						

One project in the TGG geographic area has completed extensive investigations to reduce entrainment at their site. BC Hydro, owners of the Keenleyside project near Castlegar, BC have performed extensive studies and currently optimized operations to the extent possible without undertaking structural modifications. A power plant is under construction on the left abutment which will aid in reducing spill, and associated gas production.

Other projects have undergone some level of gas abatement review. For example, RL&L Environmental Services Ltd. presented a summary of this work on the Kootenai River at the September 1999 meeting (referenced in Monitoring work plan). These initial studies may lead to additional operational changes and power facility modifications to reduce gas entrainment. These actions will be incorporated into further investigations and progress reports of the TGG.

Systemwide Operational Criteria

This section describes the current systemwide operating conditions and criteria that are applied within the defined transboundary area.

At this point, all facilities are operated on primarily an individual basis. In some cases, the spill procedures or structural modifications that affect spill operations have been explored or implemented at a given facility as discussed previously.

Discussion has already been initiated by the TGG to consider adoption of the spill priority criteria applied in the lower Columbia River system. This issue is included for further review as part of the TGG framework Phase 1 investigations.

Systemwide operating criteria are considered a key long term objective and final product of the Transboundary Gas Group. Results from the screening models, combined later with other long-term tasks including biological studies, produced under the Phase 1 framework plan are ultimately intended to provide the information necessary to develop more accurate systemwide operational criteria.

Reference Information

Information provided includes a references for TGG Internet web-site where information and literature is available, a list of references for the literature cited in the framework plan, and a list of the primary contacts for the TGG committees and working groups.

TGG Internet Web-site References:

TGG Home Page:

<http://www.nwd-wc.usace.army.mil/TMT/1999/tbdry/tdg-con.html>

Biological research abstract:

http://www.nwd-wc.usace.army.mil/TMT/1999/tbdry/research_needs0127.htm

Monitoring and information sharing plan:

<http://www.nwd-wc.usace.army.mil/TMT/1999/tbdry/monitoring.htm>

Structural and operational plans:

http://www.nwd-wc.usace.army.mil/TMT/1999/tbdry/stops_tableA.htm

http://www.nwd-wc.usace.army.mil/TMT/1999/tbdry/stops_tableB.htm

Cited Literature References:

Columbia River Integrated Environmental Monitoring Program Committee. 1999. Summary CRIEMP Report: 1999 Total Dissolved Gas Pressure Monitoring in the Columbia River Basin in Canada. Drafted by R.L. & L. Environmental Services Ltd., Castlegar, B.C.

Fidler, L.E., B.L. Antcliffe, I.K. Birtwell, and C.A. Pinney. 1999. Biological Effects of Total Gas Pressure on Fish and Aquatic Biota and Outstanding Research Needs. Biological Effects and Research Workgroup report to the Transboundary Gas Group.

Fidler, L.E., and S.B. Miller, 1997. British Columbia Water Quality Criteria for Dissolved Gas Supersaturation - Technical Report. Contract report to the B.C. Ministry of Environment, Department of Fisheries and Oceans, And Environment Canada. Aspen Applied Sciences Ltd., Cranbrook, British Columbia.

Modeling Workgroup. 1999. Computational Modeling of Dissolved Gas Transport and Mixing in the Columbia River Basin. Workgroup report to the Transboundary Gas Group.

Monitoring and Information Sharing Workgroup. 1999. Draft Monitoring and Information Sharing Study Plan. Workgroup report to the Transboundary Gas Group.

National Marine Fisheries Service. 1995. Endangered Species Act Section 7 Re-initiation of Consultation on 1994-1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program in 1995 and Future Years - Biological Opinion. NMFS, Northwest Region.

National Marine Fisheries Service. 1998. Endangered Species Act Section 7 Consultation on Operation of the Federal Columbia River Power System Including the Smolt Monitoring Program and the Juvenile Fish Transportation Program: A Supplement to the Biological Opinion Signed on March 2, 1995. NMFS, Northwest Region.

Operational and Structural Workgroup. 1999. Preliminary ranking, Columbia River basin storage and hydroelectric facilities, based on total dissolved gas generation potential. Report to the Transboundary Gas Group.

U.S. Army Corps of Engineers. 1999a. COE's Plan of Action for Dissolved Gas Monitoring in 1999. Northwestern Division, Portland OR.

U.S. Army Corps of Engineers. 1999b. 1999 Total Dissolved Gas Management Plan. Northwestern Division, Portland OR.

TGG Contact List

The listing of contacts is as of September 1999. Please update as necessary with each issuance of the status report.

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