North Saskatchewan Watershed Alliance

Proposed Site-Specific Water Quality Objectives for the Mainstem of the North Saskatchewan River

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The North Saskatchewan Watershed Alliance (NSWA) is a non-profit society whose purpose is to protect and improve water quality and ecosystem functioning in the North Saskatchewan River watershed in Alberta. The organization is guided by a Board of Directors composed of member organizations from within the watershed. It is the designated Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan River under the Government of Alberta's Water for Life Strategy.

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OVERVIEW

What future water quality conditions do the North Saskatchewan Watershed Alliance (NSWA) stakeholders want to maintain or achieve in the North Saskatchewan River (NSR) basin? The answer to this question is a fundamental part of watershed planning that must be addressed in NSWA's Integrated Watershed Management Plan. Why? Good water quality is crucial to achieving the outcomes of *Water for Life: Alberta's Strategy for Sustainability*: safe, secure drinking water; healthy aquatic ecosystems; and quality water supplies for a sustainable economy.

A key step in the achievement of these outcomes for the NSR basin is the establishment of site-specific water quality objectives. The NSWA has initiated a process to develop objectives and has prepared this report to:

- inform stakeholders about water quality conditions in the NSR
- identify important water uses and key water quality indicators, and
- propose future, site-specific water quality objectives

The NSWA took a comprehensive approach to this work. Information and numerical guidelines contained in Canadian Council of Ministers of the Environment (CCME), Prairie Provinces Water Board (PPWB) and Alberta Environment (AENV) publications were used to evaluate water quality conditions and the ecological requirements of the NSR. These publications advocate the *non-degradation policy* in cases where current water quality is observed to be better than specific guideline values. The intent of the *non-degradation policy* is to protect local aquatic ecosystem functioning, which is adapted to the ambient water quality regime. The NSWA adopted this approach. The NSWA also took into consideration past and current regulatory efforts to manage water quality in the North Saskatchewan River. The overall objective development process was led by a technical advisory team consisting of water quality experts and NSWA members.

This report represents an initial step in the process of setting specific water quality objectives. It is limited to a basic set of quality indicators and only to specific sites along the river's mainstem. Future work could address a wider range of indicators and include more river sites, including key tributaries.

The broadly-based CCME, PPWB and AENV guideline values were reviewed for each water quality indicator to identify concentration limits that would protect the most sensitive water use known for selected sites on the NSR. Current measured concentrations for each indicator, based on statistical analysis of the last 20 years of data, were then compared to these values.

In general, water quality indicator concentrations at sites upstream of the Alberta Capital Region are much lower (i.e., better) than their respective CCME or AENV guideline values. The

site-specific objectives proposed in this report are intended to maintain and protect water quality in those upstream areas, and reflect the non-degradation approach.

The water quality indicators at the sites downstream of the Alberta Capital Region have improved in many respects during the past several decades as a result of upgraded wastewater treatment processes. However, the river still reflects some degree of urban, industrial and other impacts. Although indicator concentrations are notably higher than upstream, almost all are still within their respective CCME, PPWB and AENV guideline values. For these indicators, the proposed site-specific objectives are intended to maintain and protect the water quality improvements that have been achieved in recent decades, further reflecting the non-degradation approach. A few indicator concentrations are above (i.e., worse) than their guideline values and, for these indicators, the proposed objectives reflect the need to improve water quality to the guideline value, or even lower.

"No further degradation" in this report generally means no significant trend (upwards) in the measured concentrations of indicators for which objectives have been proposed. In our approach the "trigger" for future remedial action in the basin would be the observation of an upward statistical trend in data collected at the key long-term monitoring stations. Trends would be evaluated in the future in two ways: by looking at the average conditions (medians - 50th percentiles) over time; and by looking at the extreme values (peaks - the 95th percentiles) over time.

The objectives proposed in this report are intended to inform and initiate stakeholder discussion on the management of the future water quality of the North Saskatchewan River. The implications for maintaining or, in a few cases, improving water quality are significant and need to be carefully considered with respect to social, economic and environmental priorities. The key questions will be: are the objectives protective enough, (or possibly too protective); are they realistically achievable; and how will they be achieved?

The NSWA welcomes a full discussion among stakeholders and the public in order to arrive at a consensus about water quality objectives. These objectives will form a key component of the Integrated Watershed Management Plan for the North Saskatchewan River.

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1.0 INTRODUCTION

The North Saskatchewan Watershed Alliance (NSWA) was appointed as the *Watershed Planning and Advisory Council* (WPAC) for the North Saskatchewan River (NSR) basin in 2005. The NSWA has been authorized by Alberta Environment to prepare an Integrated Watershed Management Plan (IWMP) that will support the general outcomes identified in "*Water for Life: Alberta's Strategy for Sustainability"*. As one part of the IWMP, the NSWA initiated the process of developing water quality objectives for the North Saskatchewan River to protect various water uses.

In March 2008, the NSWA hosted a workshop with its members and stakeholders to initiate the key steps in developing water quality objectives. The first step was to identify the major human activities and other events that create *pressures* on the land and water resources of the basin. The next step was to determine how these pressures create specific *issues* affecting water uses. The last step was to select water quality variables (*indicators*) by which those water quality *issues* could be assessed. As an example, crop-based agriculture was identified as a *pressure* in many regions of the watershed. One of the water quality *issues* associated with crop agriculture is eutrophication, and total phosphorus was identified as one of the *indicators* of eutrophication.

The products of the March 2008 workshop included: a table of basin–wide pressures and issues; a table of pressures for each reach of the NSR; and a table identifying potential indicators for different water quality issues and uses (Golder 2008). The information outlined in the summary material and the associated tables provided the NSWA with a starting point for developing site-specific water quality objectives.

The NSWA then established a Technical Advisory Committee (TAC) to develop scientifically defensible water quality objectives for presentation to the NSWA stakeholders. This report presents the overall approach and methods used by the TAC, and the site-specific objectives developed.

The report is organized into the following sections:

- outline of the role and activities of the TAC (Section 2)
- explanation of the process for developing site-specific objectives developed by the TAC (Section 3)
- presentation of the proposed site-specific objectives (Section 4)
- discussion of the implications of the objectives (Section 5)
- presentation of the priorities for future work related to the objectives (Section 6) and
- discussion of next steps in considering proposed site-specific objectives (Section 7)

2.0 TECHNICAL ADVISORY COMMITTEE

The NSWA established a TAC which included technical experts from: the NSWA; Alberta Environment (AENV); Alberta Sustainable Resource Development (ASRD); Alberta Agriculture and Rural Development (AARD); the City of Edmonton; EPCOR Water Services Inc; and Golder Associates. The original purpose of establishing the TAC was to provide a focused, technical approach for developing *reach-specific* objectives for the mainstem of the North Saskatchewan River. The TAC included the following participants:

- Gordon Thompson, Technical Coordinator (NSWA)
- Stephanie Neufeld, Watershed Specialist (EPCOR Water Services Inc.) and member of the IWMP Steering Committee
- Dr. Anne-Marie Anderson, Senior Limnologist (AENV)
- Curtis Brock, Limnologist (AENV)
- Sarah Depoe, Water Quality Specialist (AARD)
- Dr. Lyndon Gyurek, Supervisor of Environmental Planning (City of Edmonton) and member of the IWMP Steering Committee
- J.P. Bechtold, Senior Water Quality Specialist (Golder Associates Ltd.)
- Alison Humphries, Water Quality Specialist (Golder Associates Ltd.).

Advisory support was provided to the TAC by:

- Isabelle Girard (ASRD);
- Stephen Spencer (ASRD);
- David Christiansen (ASRD); and,
- Dr. Michael Sullivan (ASRD).

Technical support to the TAC was provided by Rie Hatsushika and Konstantina Perdikea (Golder Associates Ltd.).

An initial technical report was prepared in 2009 by NSWA under contract for Alberta Environment. After further review by members of the NSWA Board, Staff, IWMP Steering Committee and the TAC, a more simplified approach was deemed desirable. This report, in which objectives are proposed for *specific sites* only, is the result of that final analysis and work.

3.0 PROCESS FOR DEVELOPING SITE-SPECIFIC WATER QUALITY OBJECTIVES

The following general approach was adopted by the TAC to develop the original reach-specific water quality objectives:

- identify water quality-dependent uses and outcomes relevant to the basin
- divide the river into reaches
- identify uses and outcomes for each reach
- select measurable indicators for each use, and
- develop numerical objectives for each chosen indicator using historical NSR monitoring data and published surface water quality guidelines

The same process formed the basis for the development of the site-specific objectives. Each of these steps is outlined in more detail below.

3.1 Identification of Water Uses Dependent on River Water Quality

Uses of the NSR that are water quality dependent were identified in the March 2008 stakeholder workshop (Golder 2008). These uses were consolidated into nine broad categories. Outcomes associated with these use categories were identified for the purposes of developing water quality objectives in the NSR (Table 3.1). A category for the protection of water quality for "downstream uses" was also included to allow objectives to be set upstream of where a specific use occurred. For example, if drinking water supply objectives in a downstream reach were not met due to upstream water quality, appropriate objectives were set in the upstream reach (even if drinking water supply was not a designated use in the upstream reach).

Table 3.1 Water Quality-Dependent Uses of the North Saskatchewan River

Uses	*Water for Life* Outcome
Protection of aquatic life (cold water species)	Healthy aquatic ecosystems
Protection of aquatic life (cool water species)	Healthy aquatic ecosystems
Drinking water supply	Safe, secure drinking water supply
Stock watering	Quality water supplies for a sustainable economy
Irrigation	Quality water supplies for a sustainable economy
Industry	Quality water supplies for a sustainable economy
Aesthetics	Quality water supplies for a sustainable economy; Healthy aquatic ecosystems
Recreation	Quality water supplies for a sustainable economy; Healthy aquatic ecosystems
Downstream water uses	Specific outcomes for downstream reaches are achieved

3.2 Identification of Reaches

The NSR was segmented into relatively homogenous reaches, from a water quality perspective, for the original purpose of developing reach objectives. The segmentation was based on recommended reach breaks outlined in Golder (2007) and North/South et al. (2007). The segmentation also took into consideration the TAC members' collective knowledge of the river and the surrounding watershed (e.g., the location of major tributary and wastewater inputs, or marked changes in land use). Locations of historic and current sampling sites were also considered.

Golder (2007) originally identified 17 unique reaches for the NSR based on hydrology, water quality and fisheries attributes. These 17 reaches were subsequently grouped by the TAC into seven reaches, as shown in Figure 3.1. The seven reaches are:

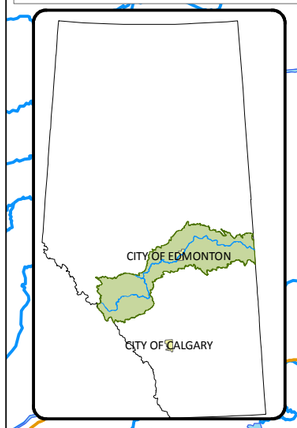
- Reach G - upstream of Abraham Lake
- Reach F - Abraham Lake
- Reach E - downstream of Abraham Lake to upstream of the Clearwater River confluence
- Reach D - downstream of the Clearwater River confluence to upstream of the Brazeau River confluence
- Reach C - downstream of the Brazeau River confluence to Devon
- Reach B - Devon to Pakan
- Reach A - Pakan to the Alberta/Saskatchewan Border

A decision was subsequently made by the NSWA to propose the objectives for specific sites only. This decision was made to simplify the application of these objectives in future water quality planning and management decision-making. It was agreed that sites should represent the *monitoring sites* for ongoing assessment, but that upstream reaches should generally be managed to ensure compliance with objectives at those sites.

Five mainstem sites were selected (Figure 3.1). These sites coincide with the locations of long-term monitoring sites on the NSR (Whirlpool Point, Rocky Mountain House, Devon, Pakan, and Hwy 17 at the Alberta/Saskatchewan boundary) and represent the locations on the NSR where water quality conditions are best understood.

Figure 3.1: North Saskatchewan River Sites for Water Quality Objectives

North Saskatchewan Watershed Alliance



Pakan

Alberta - Saskatchewan Border

Devon

Rocky Mt. House

Whirlpool Pt.

N
W
E
S

50 0 50
SCALE 1:1,252,369 KILOMETRES

Legend

- Highways
- Lakes
- Rivers
- Capital Region Towns & Cities
- Capital Region
- Sub-watersheds

River Reaches

- Reach A - Pakan to Border
- Reach B - Devon to Pakan
- Reach C - Brazeau River to Devon
- Reach D - Clearwater River to Brazeau River
- Reach E - Abraham Lake to Clearwater River
- Reach F - Abraham Lake
- Reach G - Upstream of Abraham Lake

3.3 Identification of Uses in Each Reach

The identified uses of the river are more diverse in the downstream reaches, reflecting overall settlement patterns and human activity in the basin. The uses are summarized by reach in Table 3.2:

- All uses were identified in Reaches A and C.
- In Reaches B and D most uses were identified.
- Stock watering was not identified as a use in Reach B
- Recreation, aesthetics and protection of aquatic life were the three uses identified in Reaches E to G

Table 3.2 Water Quality-Dependent Uses of the North Saskatchewan River by Reach

Use	Reach						
	Reach G	Reach F	Reach E	Reach D	Reach C	Reach B	Reach A
	Upstream of Abraham Lake	Abraham Lake	Downstream of Abraham Lake to upstream of Clearwater River	Downstream of Clearwater River to upstream of Brazeau River	Downstream of Brazeau River to Devon	Devon to Pakan	Pakan to Border
Protection of aquatic life (coldwater)	✓	✓	✓	✓	✓		
Protection of aquatic life (cool water)						✓	✓
Drinking water supply	[1]	[1]	[1]	✓	✓	✓	✓
Stock watering				✓	✓		✓
Irrigation				✓	✓	✓	✓
Industry					✓	✓	✓
Aesthetics	✓	✓	✓	✓	✓	✓	✓
Recreation	✓	✓	✓	✓	✓	✓	✓
Downstream water use protection	✓	✓	✓	✓	✓	✓	✓

Note: [1] No known, direct uses of NSR mainstem as a drinking water source in this reach

3.4 Selection of Indicators for Each Use

Indicators applicable to each use listed in Table 3.2 were selected using information provided by TAC members and Golder (2008). The water quality indicators associated for each use were divided into three categories:

- basic physical, chemical and biological water quality indicators which are routinely measured and for which published, quantitative guidelines are generally available
- other biotic and physical habitat indicators which are worthy of consideration, but for which existing data may be limited, or for which guidelines may be less readily available
- other potential indicators, which may be more issue-specific and narrow in applicability (i.e., tied to a unique, reach-specific pressure), or for which information and guidelines were also less readily available

The individual indicators placed into each category are outlined in Table 3.3. The TAC proceeded to develop objectives for the mainstem NSR sites using those indicators in the first category, which reflected the key basin issues. Availability of time and resources to the TAC was also a factor in selecting indicators. The TAC recognized that objectives for other indicators could be developed in the future for specific issues and locations not covered in this initial work.

Table 3.3 Water Quality Indicators Listed by Use and Category

Use	Outcome	Short-form	Basic Water Quality Indicators	Other biotic and Physical Habitat Indicators	Other Potential Indicators
Protection of aquatic life[1]	Maintaining healthy aquatic ecosystems	AL	total suspended solids, total phosphorus, total dissolved phosphorus, chloride, temperature, dissolved oxygen, total dissolved solids, nitrate + nitrite, ammonia[2]	algal biomass (as periphyton and phytoplankton chlorophyll *a*), benthic invertebrate abundance and diversity, fish abundance and diversity, riparian condition	organics, pesticides, metals, particle size, fish tissue contaminants, macrophytes, presence/abundance of exotic species, sediment quality
Stock watering[3]	Water supply of suitable quality for livestock (primarily cattle)	SW	calcium, fluoride, sulphate, nitrate, nitrite, nitrate + nitrite, total dissolved solids, pH, total coliforms, fecal coliforms	-	metals, pesticides, organics (including chlorinated organics and phenols), cyanobacteria
Irrigation	Water supply of suitable quality for irrigation	IRR	chloride, fluoride, fecal coliforms, total coliforms, EC, sodium adsorption ratio (SAR)	-	metals, pesticides, organics (including chlorinated organics)
Industry	Water supply of suitable quality for industrial uses	IND	total suspended solids, temperature, total dissolved solids, hardness	-	-
Aesthetics	Aesthetically acceptable water (visual observation)	AES	turbidity, oil and grease	Algal biomass	odour, macrophytes, floatables (foaming agents and floating debris), other debris, litter
Recreation	Suitable quality water for recreation (swimming, fishing, boating)	REC	turbidity, *E. coli*, fecal coliforms	fish abundance and distribution[4]	*Cryptosporidium, Giardia*, cyanobacteria
Drinking water supply within reach	Safe and secure drinking water supply	DWS	total organic carbon, total suspended solids, *E. coli*, fecal coliforms, total coliforms, *Giardia*, nitrate, nitrite, ammonia	Algal biomass	*Cryptosporidium*, metals, pharmaceuticals, pesticides, macrophytes, taste, odour, colour, cyanobacteria
Downstream water use protection	Key downstream uses and outcomes are achieved	DWP	*The indicators will vary according to the downstream use to be protected.*	*The indicators will vary according to the downstream use to be protected.*	*The indicators will vary according to the downstream use to be protected.*

Notes: (-) biotic and physical habitat or other potential indicators were not identified for this use.
[1] Protection of aquatic life for cool water and cold water species uses were combined, because they share the same indicators.
[2] Ammonia toxicity requires monitoring of pH and temperature.
[3] Focused on protecting drinking water for cattle.
[4] Focused on sports fish.

3.5 Development of Objectives

The development of water quality objectives is a complex process involving scientific and statistical analyses, a thorough understanding of river ecology and a knowledge of human effects on the river system.

The NSWA took a comprehensive approach to this work. Information and numerical water quality guidelines contained in Canadian and Alberta guidance documents were used to evaluate water quality conditions and the ecological requirements of the NSR. These broadly-based guideline values were reviewed for each water quality indicator to identify concentration limits that would protect the most sensitive water use known for each site on the NSR. Current measured concentrations for each indicator, based on statistical analysis of the last 20 years of data, were then compared to these values.

These guidance documents also advocate the *non-degradation policy* in cases where current water quality is observed to be better than the broadly-based guideline values. The intent of this non-degradation approach is to protect local aquatic ecosystem functioning, which is adapted to the ambient water quality regime. The NSWA adopted this *policy*.

The NSWA also took into consideration past and current regulatory efforts to manage water quality in the North Saskatchewan River.

This report represents an initial step in the process of setting specific water quality objectives. It is limited to a basic set of quality indicators and only to specific sites along the river's mainstem. Future work could address a wider range of indicators and include more river sites, including key tributaries. The further review, refinement and utilization of these objectives by stakeholders will also be complex steps, and will require ongoing support by technical experts.

3.5.1 Information Sources

Water quality objectives for the mainstem of the NSR were developed using three sources of information: historical monitoring data for the North Saskatchewan River (Table 3.4); published guidelines from various jurisdictions (Table 3.5) and the results of site-specific studies on the NSR.

3.5.1.1 Historical Monitoring Data

The primary sources of monitoring data (Table 3.4) used in developing objectives were the three Long Term River Network (LTRN) stations maintained by Alberta Environment and two stations maintained by Environment Canada. Other data used to evaluate water quality in the NSR were provided by: EPCOR (from water intake locations on the NSR); and Alberta Environment (short-term monitoring of temperature and dissolved oxygen at various locations using data loggers). Alberta Environment also provided data from basin-wide synoptic surveys of water quality, i.e., sampling conducted at multiple locations along the length of the river at time intervals approximating river "time-of-travel". Only data collected during the last 20 years (1988 - 2007) were used in this analysis.

The monitoring data were evaluated with respect to year, month, season, and flow rate. The data were also evaluated for evidence of empirical relationships between certain indicators (for example, statistical correlations were observed between total phosphorus and total suspended solids concentrations).

Table 3.4 Primary Sources of Monitoring Data Used to Develop Water Quality Objectives for the North Saskatchewan River Mainstem

Location	Description	Source
Long-Term River Network monitoring stations at Devon and Pakan	Monthly sampling from 1988 to 2007	AENV 2008
Long-Term River Network monitoring station at Rocky Mountain House	monthly sampling from 2003 to 2007	AENV 2008
Synoptic surveys	12 synoptic surveys in 1985-89 and 3 in 2008 which sample points down the length of river (and inputs) according to river water "time of travel"	AENV 2009a
Continuous river monitoring data at Devon and Pakan	Periodic (weeks to several months) data logger installations between 2004 to 2008	AENV 2009b
Long-term river monitoring stations at Whirlpool Point and Highway 17 (PPWB site)	monthly sampling from 1988 to 2007	Environment Canada 2009a
Intakes at the Rossdale and E.L. Smith Water Treatment Plants	daily to monthly sampling from 1998 to 2007	EPCOR Utilities Inc. 2009

3.5.1.2 Published Guidelines

The primary sources of water quality guidelines (Table 3.5) used in this project were: *Surface Water Quality Guidelines for use in Alberta;* the *Canadian Environmental Quality Guidelines;* and the *Prairie Provinces Water Board Water Quality Objectives.* In cases where these sources did not provide a guideline for a specific indicator or use, other agency reference sources were used. These agencies included: Alberta Agriculture and Rural Development; Alberta Sustainable Resource Development; and the U.S. Environmental Protection Agency. Site-specific information from the City of Edmonton's ammonia toxicity study on the NSR (City of Edmonton 2006) was also utilized.

Table 3.5 Published Sources of Water Quality Guidelines used to develop Water Quality Objectives for the North Saskatchewan River Mainstem

Publication	Source
Surface Water Quality Guidelines for Use in Alberta	AENV 1999
Canadian Environmental Quality Guidelines	CCME 1999
Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems	CCME 2003
Prairie Provinces Water Board Water Quality Objectives	Environment Canada 2009b
Fisheries Management Objectives for the North Saskatchewan River	ASRD 2008
Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems	AENV 2006
City of Edmonton: Ammonia Risk Assessment and Reduction Study	City of Edmonton 2006
Canadian Drinking Water Guidelines	Health Canada 2008
Report of the Upper Elbow River In-stream Objectives Working Group	UEWG 1999
Fact sheets and guidance documents on the Alberta Agriculture and Rural Development (AARD) website	AAFRD 2002, Agriculture and Agri-food Canada 2009
Quality Criteria for Water	U.S. EPA 1986
Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources	U.S. EPA 1991

Notes: UEWG = Upper Elbow Working Group; CCME = Canadian Council of Ministers of the Environment; U.S. EPA = United States Environmental Protection Agency

NSWA has adopted the following water quality definitions, based in part on CCME (1999):

> **Guideline**: **A numerical concentration or narrative statement recommended to support and maintain a designated water use.**
>
> Guidelines are upper limits (and lower limits for some parameters such as dissolved oxygen and pH) intended to protect water uses from human-caused changes to water quality. They provide consistent, science-based benchmarks for protection at national, regional or provincial scale but do not consider *site-specific, local factor and conditions.*
>
> For example, many of the specific Canadian Environmental Quality Guidelines address water quality for the protection of aquatic life. They are intended to protect all forms of aquatic life throughout Canada, at all life cycle stages (including the most sensitive life stage of the most sensitive species) and over the long-term. Some are based on controlled toxicological studies carried out at specific sites or in laboratories. They are considered as broad guidance, but do not consider localized factors for any specific river or lake - such as background chemical conditions or the presence/absence of certain

species. Therefore, the objectives developed for a specific site may need to be set higher or lower than CCME guideline values. The same considerations would apply to the use of guidelines contained in "*Surface Water Quality Guidelines for Use in Alberta".*

Objective: A numerical concentration or narrative statement that supports and protects a designated water use, or current water quality, at a specific site.

As stated above, a proposed objective may be an interpretation or modification of the broadly-based guideline, or may be based on local water quality conditions. Where there are no significant site-specific factors or considerations, a guideline may be directly adopted as the objective. Where significant local factors do exist, a comprehensive scientific assessment based on local water quality, resident biotic species, water use, etc., is utilized to derive an objective.

3.5.2 Development of Objectives for Devon and Sites Upstream of Devon

Site-specific limits were derived from guideline documents for all selected water quality indicators and compared to the water quality data for existing monitoring sites at Devon, Rocky Mountain House and Whirlpool Point. *All median concentrations for indicators were observed to be well below (i.e., better than) their respective guideline limits*. In recognition of the high quality of these waters, The TAC proposed to adopt the non-degradation policy (CCME 1999) which states: "for waters of superior quality…degradation of the existing water quality should always be avoided". This "non-degradation" policy simply means that future human activities (e.g., industrial, municipal, land use patterns, flow regulation, etc.) should not degrade water quality compared to that currently observed.

Using this approach, objectives for the three existing monitoring sites were then developed based on statistical measures of the long-term data from those sites, as follows:

- The 50th percentile (median) statistic was chosen to represent prevailing conditions and to provide a measure against which future water quality conditions could be assessed. Using this statistic as an objective means: at least half of future measurements should be below this value; and there should be no statistically significant, increasing trend detected in the analysis of future, long-term monitoring data.

- The 95th percentile statistic was chosen to represent extreme conditions associated with peak flows or other infrequent events, and to provide another measure against which future water quality conditions could be assessed. Using this statistic as an objective means: at least 95% of future measurements should be below this value; and there should be no statistically significant increasing trend detected in the analysis of future, long-term monitoring data. (A similar approach, using the 90th percentile, was taken by the Bow River Basin Council in setting objectives for the Bow River (BRBC 2008). Environment Canada has used both the 90th and 95th percentiles, although most recently the 95th percentile was used to define objectives in three southern Alberta rivers (Roe 2009)).

- Separate median and 95th percentile statistics were developed for open-water (April to October) and ice-covered (November to March) seasons, because values for most indicators differ significantly between the two seasons.
- Some indicators vary significantly with flow during open water; in those cases separate statistics were derived for selected flow ranges.

Although these objectives are being proposed only for specific monitoring sites in each reach, maintaining water quality upstream of each site is implied. Changes in water quality anywhere above a monitoring site would also change the quality at that site. Therefore, for conservative indicators (i.e., those that do not change physically or chemically once they are in the water), any increases in point or non-point source loadings entering the river would have to be offset by reductions in existing loadings. For non-conservative indicators (i.e., those that change due to physical, chemical or biological processes in the river - for example pH, dissolved oxygen or ammonia) water quality upstream of a monitoring site would need to be managed so as not to affect quality at that site. The use of water quality modelling and analysis will clearly be important tools in simulating and understanding these various processes, and in assessing the impacts of future development on water quality.

3.5.3 Development of Objectives for Sites Downstream of Devon

As was done for the reaches upstream of Devon, site-specific limits based on guideline values were derived for all selected water quality indicators and compared to the water quality data for the two monitoring sites downstream of Devon (Pakan and Hwy 17 at the Alberta/Saskatchewan Boundary). Almost all downstream indicator concentrations are higher than at Devon, and are generally closer to their respective guideline limits, but most still do not exceed those limits. Only four indicators are above (i.e. worse than) their respective guideline values, for the most sensitive use. They are: total suspended solids and turbidity during open water conditions; fecal coliforms during peak events (95th percentile), and total organic carbon.

The TAC noted that water quality in the two reaches downstream of Devon is affected by human activity, primarily within the Capital Region. The TAC also noted that water quality conditions at the sites downstream of the Alberta Capital Region have improved in many respects during the past several decades, as a result of wastewater treatment improvements and flow regulation. However, the river still reflects some degree of urban, industrial and other impact and water quality will be subject to ongoing pressures due to future growth and development.

The TAC therefore proposed a “management” strategy for these reaches and sites. This intent is: that existing and future additional human impacts on water quality should be managed over the long term to improve indicators that currently do not meet their guideline-based limits; and that conditions are maintained to protect those indicators that are presently better than their guideline limits (the non-degradation approach).

Based on this approach, water quality objectives were developed for two monitoring sites (Pakan and Alberta/Saskatchewan Boundary). For water quality indicators above (i.e., worse than) their guideline-based limits, and therefore needing "managed improvement", the following objective statement was developed:

- Achieve a declining trend in future river water quality indicator concentrations until the guideline limit is met, or lower.

For indicators below (i.e., better than) their guideline-based limits, the same statistical measures of the long-term data, as proposed for the reaches above Devon, would apply:

- The 50th percentile (median) statistic was chosen to represent typical conditions and to provide a measure against which future water quality conditions could be assessed. Using this statistic as an objective means: at least half of future measurements should be below this value; and there should be no statistically significant increasing trend detected in the analysis of future, long-term monitoring data.
- The 95th percentile was chosen to represent extreme conditions associated with peak flows or other infrequent events, and to provide another measure against which future water quality conditions could be assessed. Using this statistic as an objective means: at least 95% of future measurements should be below this value; and there should be no statistically significant increasing trend detected in the analysis of future, long-term monitoring data.
- Separate statistics were developed for open-water (April to October) and ice-covered (November to March) seasons, because values for most indicators differ significantly between the two. Some indicators also vary significantly with flow during the open water season; separate statistics were therefore derived for selected flow ranges.

As stated above in Section 3.5.2, these objectives are being proposed only for specific monitoring sites in each reach, however, maintaining water quality upstream of the site is implied.

3.5.4 Modifications to the Objective Setting Process

In several instances it was necessary to modify the objective setting process (Table 3.6). These modifications included: using different time periods for certain indicators when limited data were available; not applying agricultural-based guidelines that were deemed inappropriate for a specific reach; and grouping objectives for Reaches E to G, for the following reasons:

- The same uses were identified for all three reaches.
- Synoptic data collected by Alberta Environment from 1985-89 and again in 2008 (AENV 2009a) indicated that water quality does not change significantly along these reaches.
- Long-term data were available for only one location, Whirlpool Point (Environment Canada 2009a). This site is at the middle of (upper) Reach G.

Table 3.6 Objective Modifications

Indicator	Applicable Sites	Modification and Rationale
Total suspended solids	All	Open-water objectives were developed for flow ranges because total suspended solids concentrations vary significantly with flow.
Temperature	All	Objectives are set to maintain the *current* magnitude, frequency and duration of *exceedance* of the optimal upper and lower 7-day mean temperatures for the most temperature-sensitive fish species in a given reach. Because of the natural annual, seasonal, and diurnal temperature fluctuations, minimizing changes to these optimal ranges for 7-day mean temperature was deemed to be more relevant than seasonal median and 95th percentile objectives.
Total phosphorus	Devon	The open-water season objectives were developed so as to maintain the strong statistical relationship between total phosphorus and total suspended solids concentrations.
Dissolved phosphorus	Devon	Open-water season objectives were developed for flow categories because dissolved phosphorus concentrations vary significantly with flow.
pH	All where pH is an indicator	Objectives were developed as a range between the 5th and 95th percentile (instead of the 95th percentile alone) and no increasing or decreasing temporal trend. This reflects the nature of pH and existing pH guidelines, which set a range to stay within (AENV 1999).
Total coliforms, *E. coli* and fecal coliforms	All	In addition to the median and 95th percentile, an objective for the "geometric mean" of ambient data was developed. The geometric mean is a commonly applied statistical measure for these dynamic and highly variable bacterial indicator concentrations.
Total coliforms, *E. coli* and fecal coliforms	Pakan and Border	Based on information provided by local drinking water treatment plant operators, increases in bacterial concentrations at these sites would likely require upgrades to the water treatment plants. Therefore, where bacteria levels were below guideline-based objectives, a "current infrastructure constraint-based objective" is included that specifies no increase from current conditions. The time period used to define existing conditions for fecal coliforms and *E.coli* is mid-2005 to 2007 (instead of 1988 to 2007). Effluent disinfection was implemented at both the Gold Bar and Capital Region wastewater treatment plants by mid-2005, significantly reducing the continuous bacterial discharge from these two point sources.
Turbidity	All	Objectives were derived from the corresponding total suspended solids objectives because of the strong correlation between the two indicators.
Dissolved oxygen	All	Objectives for dissolved oxygen were developed for the 5th, instead of the 95th, percentile and no decreasing trend.
Nutrients	Pakan and Border	The time period used to define existing conditions for nutrient-related indicators (nitrogen and phosphorus) at downstream sites is mid-2005 to 2007 (instead of 1988 to 2007). Major upgrades to the Gold Bar and Capital Region wastewater treatment plants were completed in mid-2005 and nutrient levels are now much lower.

4.0 PROPOSED SITE-SPECIFIC OBJECTIVES

The water quality objectives proposed for monitoring sites on the North Saskatchewan River are summarized in detail in Table 4.1. As previously noted, reaches E to G were grouped and therefore share the same set of objectives, but only at the upstream Whirlpool Point site. Most objectives listed in Table 4.1 fall below their respective guideline–based limits, and if implemented as planning goals will ensure a highly protective approach to water quality in the NSR. The following five indicators exceed their respective guideline limits, and require further discussion.

- Total suspended solids at Pakan and the Alberta/Saskatchewan Boundary are above the guideline-based limit during the open-water season at flows less than 350 m^3/s. The peak level of turbidity at Pakan also exceeds its limit at flows less than 350 m^3/s.

- Median fluoride concentrations match or exceed the interim guideline value of 0.12 mg/L in reaches D, C, B and A. Upstream concentrations in reaches E, F, and G are close to the guideline, and reflect natural background levels. Fluoride toxicity can be reduced by factors such as water hardness, and the presence of calcium and magnesium, all of which are relatively high in the mid and lower reaches of the NSR (CCME 1999).

- Numerical objectives for total suspended solids and turbidity were not set for flows above 350 m^3/s. The reason is the objectives resulting from applying the CCME guideline were deemed to be unrealistically low. They do not account for the natural scouring, erosion and re-suspension of TSS that likely occurs at higher flows. Instead, the objective proposes a condition of "no increase" in TSS concentrations during open water flows greater than 350 m^3/s. This objective also recognizes that controlling TSS levels at lower flow rates will likely reduce TSS at higher flows. Sources of suspended solids and turbidity include storm sewers, combined sewers and/or wastewater treatment plant bypass systems. Other potential sources include agricultural runoff, runoff from linear disturbances, forestry operations, industrial and municipal development, bank erosion and ongoing bed load re-suspension.

- Although insufficient data are available to derive geometric means, fecal coliforms likely exceed the guideline-based limits at Pakan and the Border during the open-water season. *E. coli* are also likely above their limit at Pakan. This is suggested both by the monitoring data at the sites and the information presented in the City of Edmonton's report entitled *Development of Total Loading Management Objectives* (Golder 2005). Potential sources of coliform bacteria include sewer and wastewater systems, livestock and wildlife.

- Median total organic carbon less than 3 mg/L was selected as an objective to protect raw drinking water supplies in reaches *downstream* of the Capital Region. High levels of total organic carbon combined with high doses of chlorine can produce harmful disinfection by-products during drinking water treatment. This TOC objective is being exceeded at both Pakan and the Border. Although the operators of the Lloydminster

Water Treatment Plant are not currently aware of any issues with disinfection by-products (Thompson 2009) it would be prudent to reduce TOC loadings to lower the risk of problems in future. Reductions proposed above for total suspended solids and bacteria are expected to reduce total organic carbon concentrations as well, particularly if organic carbon makes up a significant portion of the solids.

Median total phosphorus concentrations have dropped significantly in reaches A and B in recent years, due to treatment improvements at the Gold Bar and the Alberta Capital Region municipal wastewater plants. The most recent levels reported are within the meso-eutrophic range established as the objective value (0.020-0.035 mg/L). However, current median levels are about 70% of the upper limit (0.035 mg/L) of the objective. As the Alberta Capital Region continues to grow phosphorus (and other nutrient) loadings to the river will increase until successive treatment improvements are put into effect at the wastewater plants. NSWA advocates an adherence to the meso-eutrophic range objective to minimize eutrophication impacts in the downstream reaches of the NSR.

The NSWA also notes that there are no specific, numeric guidelines available in Canada that can be used to develop site-specific water quality objectives for the protection of raw water sources used in the production of drinking water. The Canadian Drinking Water Guidelines (CDWG) apply only to the assessment of the final, treated water distributed by individual drinking water facilities.

Because of the lack of “source water” guidelines, livestock watering guidelines for calcium and TDS were nominally identified as most sensitive values for several NSR reaches (Table 4.1). However, these numeric values far exceed the levels of calcium and TDS that would be deemed acceptable for use in domestic drinking water production, consumption and use. The proposal to set site-specific objectives for calcium and TDS based on the non-degradation of current water quality in the NSR resolves this apparent dilemma. The proposed values (Table 4.1) reflect the high quality of the NSR upstream of the Alberta Capital Region, and are well within the operational tolerances required by drinking water facilities.

REACH(S)		**G Headwaters F Lake Abraham E d/s Lake Abraham to u/s Clearwater R.**			**D u/s Clearwater R to u/s Brazeau R**			**C u/s Brazeau R to Devon**			**B Devon to Pakan**			**A Pakan to Alberta/Saskatchewan Boundary**		
SITE(S)		**G Whirlpool Point F (potential future) E (potential future)**			**Rocky Mountain House Note 1**			**Devon**			**Pakan**			**Border (Highway 17)**		
INDICATOR and Guideline(s) for most sensitive (use)	**Condition: IC = ice-covered OW = open water**	**Flow m3/s**	**Objective**		**Flow m3/s**	**Objective**		**Flow m3/s**	**Objective**		**Flow m3/s**	**Objective**		**Flow m3/s**	**Objective**	
			50th percentile ≤	**95th percentile ≤**		**50th percentile ≤**	**95th percentile ≤**		**50th percentile ≤**	**95th percentile ≤**		**50th percentile ≤**	**95th percentile ≤**		**50th percentile ≤**	**95th percentile ≤**
Total suspended solids (mg/L) guidelines relative to background– clear flow: <25 short term increase <5 long term increase background >25 <250: <25 incre	IC		1	4		6			3	12		3	18		5	16
	OW	<25	2	6	<350	18 (14)		<350	12	139	<350	17 (20)	164 (214)	<350	17 (21)	156 (156)
	OW	>25 <175	27	175	>350 <750	144		>350 <750	96	396	>350 <750	166	858	>350 <750	205	851
	OW	>175	166	258							Note 2			Note 2		
Temperature (°C) guideline– maintain the current frequency of 7-day mean water temperatures and current maximums (aquatic life - most sensitive species) Note: Data are for monthly measurements. They are provided for referen			maintain current frequency of 7-day means between 12° and 15° maximum 22°			maintain current frequency of 7-day means between 12° and 15° maximum 22°			maintain current frequency of 7-day means between 8° and 18° maximum 24°			maintain current frequency of 7-day means between 15° and 24° maximum 26°			maintain current frequency of 7-day means between 15° and 24° maximum 26°	
	OW		6.5	8.8		9.1			14.2	21.0		14.7	21.9		20	25
Total phosphorus (mg/L)	IC		0.002	0.006		0.006			0.006	0.024		0.020	0.165		0.024	0.051
guideline– stay within trophic status of baseline conditions: IC ultra-oligotrophic: <0.004 (reaches EFG) IC oligotrophic: 0.004-0.010 (reaches CD) OW mesotrophic: 0.010-0.0	OW		TP=0.0004xTSS+0.0049			TP=0.0006xTSS+0.0105			TP=0.0006xTSS+0.0105		<350	0.026	0.066	<350	0.024	0.109
		Note: OW objective is based on the very strong (R^2=0.86) correlation between TP and TSS to remove the influence of TSS variations			Note: OW objective is based on the very strong (R^2=0.96) correlation between TP and TSS to remove the influence of TSS variations			Note: OW objective is based on the very strong (R^2=0.96) correlation between TP and TSS to remove the influence of TSS variations			Note 1			Note 1	
Dissolved phosphorus (mg/L) no guideline	IC		0.001	0.003		0.002			0.002	0.012		0.010	0.015		0.014	0.036
	OW		0.001	0.006	<350	0.003		<350	0.003	0.012	<350	0.006	0.013	<350	0.005	0.018
	OW				>350 <750	0.007		>350 < 750	0.007	0.037		Note 1			Note 1	

Note 1 Objectives are considered interim due to limited period of data

Note 2 Shaded cells indicates ambient water quality (shown bracketed) is above (ie worse than) a site-specific, guideline-based limit

REACH(S)		G Headwaters F Lake Abraham E d/s Lake Abraham to u/s Clearwater R.			D u/s Clearwater R to u/s Brazeau R			C u/s Brazeau R to Devon			B Devon to Pakan			A Pakan to Alberta/Saskatchewan Boundary		
SITE(S)		G Whirlpool Point F (potential future) E (potential future)			Rocky Mountain House Note 1			Devon			Pakan			Border (Highway 17)		
INDICATOR and Guideline(s) for most sensitive (use)	Condition: IC = ice-covered OW = open water	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤
Total Ammonia (mg/L)	IC		0.005	0.019		0.010			0.010	0.050		0.150	0.220		0.090	0.190
guideline– 0.018 unionized (aquatic life)	OW		0.005	0.016		0.005			0.005	0.080		0.040	0.110		0.010	0.050
Note: The unionized guideline applies to individual samples and depends on total ammonia, pH, and temperature												unionized < 0.018 Note 1			unionized < 0.018 Note 1	
Nitrate+nitrite as N (mg/L)	IC		0.107	0.121		0.078			0.078	0.102		0.310	0.410		0.330	0.510
guideline– 2.93 (the aquatic life nitrate guideline used because nitrite is very low in NSR)	OW		0.083	0.109		0.282			0.008	0.098		0.098	0.240		0.020	0.028
												Note 1			Note 1	
Nitrite as N (mg/L)	IC					0.002			0.002	0.010		0.002	0.010			
guideline– 0.06 (aquatic life)	OW					0.002			0.002	0.005		0.003	0.013			
												Note 1				
Calcium (mg/L)	IC					46			46	53		48	55			
guideline– 1000 (stock watering)	OW					42			42	46		43	49			
Fluoride (mg/L)	IC		0.08	0.10		0.12			0.12	0.21		0.12 (0.15)	0.23		0.12 (0.16)	0.20
guideline– 0.12 (acquatic life interim)	OW		0.06	0.10		0.12			0.12	0.19		0.12 (0.14)	0.20		0.12 (0.15)	0.18
Chloride (mg/L)	IC		0.6	0.7		0.7			0.7	2.6		3.7	10.4		4.1	10.1
guideline– 230 (aquatic life) 100-700 (irrigation, crop specific)	OW		0.4	0.8		0.8			0.8	2.4		3.0	6.0		3.0	5.8
Sulphate (mg/L)	IC		43	49		45			45	52		51	59		51	62
guideline– 1000 (stock watering)	OW		23	47		38			38	48		43	53		44	54
Total dissolved solids (mg/L)	IC		165	179		196			196	235		216	265		220	253
guidelines– 3000 (stock watering) 500-3500 (irrigation, crop specific)	OW		115	168		186			186	248		199	268		190	223
pH	IC					8.0			8.0	7.6-8.5		7.8	7.3-8.4		8.0	7.6-8.5
guideline– 6.5-9.0 (aquatic life)	OW					8.2			8.2	7.7-8.4		8.3	7.8-8.9		8.3	7.8-8.9

Note 1 Objectives are considered interim due to limited period of data

Note 2 Shaded cells indicates ambient water quality (shown bracketed) is above (ie worse than) a site-specific, guideline-based limit

REACH(S)		G Headwaters F Lake Abraham E d/s Lake Abraham to u/s Clearwater R.			D u/s Clearwater R to u/s Brazeau R			C u/s Brazeau R to Devon			B Devon to Pakan			A Pakan to Alberta/Saskatchewan Boundary		
SITE(S)		G Whirlpool Point F (potential future) E (potential future)			Rocky Mountain House Note 1			Devon			Pakan			Border (Highway 17)		
INDICATOR and Guideline(s) for most sensitive (use)	Condition: IC = ice-covered OW = open water	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤
Fecal coliforms (No/100 mL) guideline– the geometric mean of not less than five samples taken over not more than a 30-day period should not exceed 200 /100 mL , nor exceed this number in more than 20 percent of the samples examined during any month. (recreation) Note: Data are for m	IC		<1 geometric mean <1	2		10 geometric mean 8			5 geometric mean 4	10		10 geometric mean 15	62		2 geometric mean 4	389
	OW		1 geometric mean <2	10		10 geometric mean 11			8 geometric mean 10	100		< 200 (80% of the time) <100 for irrigation (20) (3250) geometric mean (65) Notes 1 & 2			< 200 (80% of the time) <100 for irrigation (26) (1415) geometric mean (34) Notes 1 & 2	
***E. Coli* (No/100 mL)** guideline– geometric mean of at least five samples collected within 30 days should be below 200 /100 mL). If a sample is above 400 /100 mL, another sample should be collected. (recreation) Note: Data are for monthly samples They are provided	IC		<1 geometric mean <1	5		10 geometric mean 8			5 geometric mean 5	10		7.5 geometric mean 10	58		5 geometric mean 6	153
	OW		1 geometric mean 8	<5		5 geometric mean 9			5 geometric mean10	138		< 200 (80% of the time) <100 for irrigation (10) (2650) geometric mean (37) Notes 1 & 2			30 geometric mean 20 Note 1	384
Giardia		no increase			no increase			no increase			no increase			no increase		
Conductivity (µS/cm) guideline– <1000 (irrigation)	IC	not applicable, use related to conductivity not identified			330			330	375		371	422		384	426	
	OW				309			309	341		330	375		334	380	
Sodium Adsorption Ratio guideline– <5 (irrigation)		not applicable, use related to sodium adsorption ration not identified			no increase			no increase			no increase			no increase		
Hardness (mg/L) >500 generally unacceptable, <200 preferred (drinking water)	IC	not applicable, use related to hardness not identified			not applicable, use related to hardness not identified			170	200		180	200		181	206	
	OW							160	176		160	181		161	178	

Note 1 Objectives are considered interim due to limited period of data

Note 2 Shaded cells indicates ambient water quality (shown bracketed) is above (ie worse than) a site-specific, guideline-based limit

REACH(S)		G Headwaters F Lake Abraham E d/s Lake Abraham to u/s Clearwater R.			D u/s Clearwater R to u/s Brazeau R			C u/s Brazeau R to Devon			B Devon to Pakan			A Pakan to Alberta/Saskatchewan Boundary		
SITE(S)		G Whirlpool Point F (potential future) E (potential future)			Rocky Mountain House Note 1			Devon			Pakan			Border (Highway 17)		
INDICATOR and Guideline(s) for most sensitive (use)	Condition: IC = ice-covered OW = open water	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤	Flow m3/s	Objective 50th percentile ≤	Objective 95th percentile ≤
Turbidity (NTU)	IC		0.9	3.7		2.7			1.7	6.7		3.0	14.0		4.2	10.8
guideline– derived from total suspended solids guideline through statistical correlations: reaches EFG turbidity = 0.91 X TSS (R^2=0.97) reach D scaled from reach C reach C turbidity = 0.56 X TSS reach B turbidity = 0.53 X TSS (R^2=0.86)	OW	<25	1.8	5.5	<350	6.7		<350	6.7	78	<350	5	87 (96)	<350	6	66
	OW	>25 <175	25	98	>350 <750	54		>350 <750	54	222	>350 <750	no increase (90)	no increase (389)	>350 <750	no increase (109)	no increase (827)
	OW	>175	152	236							Note 2			Note 2		
Oil and grease (aesthetic objective - applies to all reaches)		←			←			Oil or petrochemicals not present in concentrations that: -can be detected as a visible film, sheen or discoloration on the -can be detected by odour; or, -can form deposits on shores lines or bottom detectable by sight and odour.			→			→		
Total organic carbon (mg/L)	IC		0.6	1.0		0.5			1.6	3.4		2.1	3.7		2.6	4.2
<3 desirable for controlling drinking water disinfection byproducts	OW		1.1	4.5		1.1			2.8	7.9		3.0 (3.7)	10.0		3.0 (5.0)	16.8
												Note 2			Note 2	
Dissolved oxygen (mg/L)	IC		11.9	11.4		12.5			12.5	11.2		11.6	10.0		10.3	6.9
guideline– 9.5 mg/L for early life stages and 6.5 mg/L for other life stages for coldwater fisheries (aquatic life)	OW		10.6	9.9		9.5			9.5	12.5		9.4	7.6		11.9	9.7

Note 1 Objectives are considered interim due to limited period of data

Note 2 Shaded cells indicates ambient water quality (shown bracketed) is above (ie worse than) a site-specific, guideline-based limit

5.0 MANAGEMENT IMPLICATIONS FOR THE NSR WATERSHED

Proposing site-specific objectives to maintain and, in a few cases, improve current water quality conditions has inherent implications for the future management of the river and activities within the watershed.

Upstream of Devon, the proposed objectives imply that any additional wastewater discharges, land-use changes or flow changes in the future should not have measurable impacts on water quality at the monitoring sites. Any such future developments would require an evaluation of potential impacts on water quality, and an assessment of management options to minimize those impacts. To the extent that additional impacts could not be controlled, reducing the impacts of existing development, land use practices and flow regime changes would be needed in order to have no net effect on water quality conditions.

Downstream of Devon, reducing point source and non-point sources of total suspended solids, bacteria and total organic carbon will be needed to meet the proposed objectives. To meet the objective of maintaining existing water quality for those indicators that are currently below (i.e., better than) guideline-based limits, management of the cumulative water quality impacts of all future development, land use changes and flow management in the region will be required. Again, any impacts that cannot be controlled would need to be offset by reducing the impacts of existing development and land uses to avoid a net deterioration of water quality.

6.0 RECOMMENDATIONS

Recommendations for future work related to the implementation of water quality objectives for the NSR were compiled into the three categories: monitoring; adding/updating objectives; and “other” recommendations. They are listed in order of declining priority.

6.1 Monitoring

The continuation of the provincial long-term river network monitoring program will be fundamental to the utilization of these objectives as the basis for water quality management in the NSR. Statistical trend analyses have already been conducted on the NSR’s long-term water quality data base (Hebben 2005). These methods, with any necessary modifications, should also be applied in the future.

The historical data set may not adequately reflect the effects of peak runoff events on river chemistry. Municipal and industrial water users are particularly challenged during highly turbid conditions. More intensive monitoring will be needed to fully characterize water quality during peak flow events and related objectives may have to be modified in the future.

Water quality management will also require ongoing surveys of point-source discharges and key tributaries, biological assessments and the acquisition of high quality data to support the development of modelling tools to predict the effects of future development.

Specific monitoring recommendations include:

- Establish an overall monitoring framework that defines the information required to evaluate compliance with the site-specific objectives, including sample type (e.g., grab samples, flow-weighted samples and/or continuous monitoring), parameters, frequency and location.
- Establish an overall evaluation framework to guide data evaluation (e.g., how trend analyses and other statistical analyses should be completed). The utility of a water quality index as a reporting tool for the proposed NSWA objectives should also be investigated.
- Establish an overall reporting framework that defines how, and how often reporting is needed and provides guidance about content for various audiences.
- Conduct supplemental sampling to better quantify conditions during high flow events.
- Establish water quality monitoring stations near the downstream end of Reaches E and F (Abraham Lake and confluence of Clearwater River, respectively). The current site for which objectives have been set is Whirlpool Point, which is upstream of Reaches E and F.
- Establish a water quality monitoring station near the downstream end of Reach D (downstream of all inputs from Rocky Mountain House).
- Increase within-reach sampling efforts to characterize conditions throughout the reaches and determine if the existing long-term monitoring stations are representative.

6.2 Adding or Updating Objectives

- Define water quality objectives for the mouths of major tributaries to the NSR.
- Define objectives for biological indicators, including periphyton, phytoplankton, benthic invertebrates and fish.
- Define objectives for metals, should they be identified as a concern.
- Define objectives for pesticides as appropriate, perhaps using a pesticide toxicity index to define objectives.
- Define objectives or evaluate the need for objectives for sediment quality and riparian habitat.
- Define fish tissue and possibly invertebrate tissue objectives for key metals (e.g., selenium).

- Refine water quality objectives as more water quality data become available, or as sampling increases, preferably using a minimum of 5 to 10 years of data.
- Review objectives and confirm that they are appropriate, or advise specific changes, after a specified time period (e.g., every 5 years).
- Update objectives for nutrient-related parameters in Reaches A and B when at least 5 years of new data are available (post-2005 wastewater treatment plant upgrades).

6.3 Other Recommendations

- Further evaluate the short and long term management implications of meeting the objectives. Water quality modelling will be an important tool to assess future growth scenarios and potential water quality impacts.
- Quantify sources of suspended solids from the upper watershed to determine the relative influences of anthropogenic or natural processes on observed, in-stream sediment flux.
- Re-evaluate the indicator list on a periodic basis (e.g., every 10 years) as land-use pressures change.

7.0 NEXT STEPS

The objectives proposed in this report are intended to inform and initiate stakeholder discussion on the management of future water quality in the North Saskatchewan River. The implications for maintaining or, in a few cases, improving water quality are significant and need to be carefully considered with respect to social, economic and environmental priorities. The key questions are as follows: are the objectives protective enough, (or possibly too protective); are they realistically achievable; and how will they be achieved?

The NSWA welcomes a full discussion among stakeholders and the public in order to arrive at a consensus about water quality objectives. These objectives will form a key component of the Integrated Watershed Management Plan for the North Saskatchewan River.

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