58DD: Plan 1958-D with Simulated Deviations

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Lake Ontario – St. Lawrence River Regulation Study

The outflows from Lake Ontario are set each week under the direction of the International St. Lawrence River Board of Control to meet a number of criteria established by the International Joint Commission in their 1956 supplementary Orders of Approval. Several "regulation plans" were developed in the late 1950s and early 1960s to aid in determining the amount of water to be released each week. These regulation plans are sets of rules or methodologies that specify a release based on the hydrologic state of the system. In addition to approving the use of the regulation plan, the Commission granted the Control Board the authority to deviate from the plan specified flows under a number of broadly defined circumstances. Thus, the present method of regulating the releases from Lake Ontario is known as "Plan 1958-D with deviations". This paper explains this method of regulation and describes a method of estimating the releases from Lake Ontario that simulate those that occur with Plan 1958-D with deviations. The primary need for this simulator is to estimate releases that would be made under hydrologic sequences and conditions other than those recorded, but reflective of the outflow deviation decisions made by the International St. Lawrence River Board of Control in the recent past.

Plan 1958-D. (Taken from International St. Lawrence River Board of Control 1997 report) The regulation plan in use since 1963, Plan 1958-D (International St. Lawrence River Board of Control 1963), was designed to regulate flows to fit the Commission=s criteria with the 1860-1954 sequence of water supplies to the Lake Ontario - St. Lawrence System.

Plan 1958-D consists of two sets of rule curves, a supply indicator, seasonal adjustments and a number of minimum and maximum outflow limitations. The regulated outflow is determined in the following manner. The water supply to Lake Ontario for the past week is determined. The supply indicator is calculated as the difference between the actual weighted supply for the week and the Aweighted normal supply@ for that time of year. An adjustment, based on the change in the supply indicator in the past three months, is added to the supply indicator to form the "adjusted supply indicator". The basic regulated outflow is then computed from one of the two sets of rule curves, depending on the season, using the computed end-of-period lake level and the "adjusted supply indicator". The outflow specified by the rule curve increases as the Lake Ontario level rises and as the adjusted supply indicator increases. The rule curve flow is then adjusted by adding the seasonal adjustment. The resultant seasonally adjusted flow is compared to a number of maximum and minimum outflow limitations which vary throughout the year. These limits include seasonal minimum flows for hydropower, maximum flows for stable ice cover formation and safe velocities and levels for navigation in the international section, maximum flows in the last half of December to promote ice cover formation at the outlet

of Lac St. Louis, maximum and minimum flows so downstream flows/levels are no greater than would occur without regulation, and a limit to the maximum change in flow from week to week. If the seasonally adjusted flow is between the least maximum limit and the largest minimum limit for the period, then it becomes the Plan Flow. Otherwise, the applicable outflow limit becomes the Plan Flow.

Deviations. The outflow calculated according to Plan 1958-D is directed to be the weekly flow unless the International St. Lawrence River Board of Control or the Commission opts for a different flow to better manage the system. A flow different from that specified by the plan is called a deviation from the plan. From the beginning of regulation plan development in the 1950s, it was recognized that deviations from the flow specified by the plan would be required in some circumstances. Criterion (k) was included in the Commission=s Orders to guide deviations from the plan during supply situations that were outside the bounds of the 1860-1954 supply sequence used to design the regulation plan. Soon after regulation of outflows began in the early 1960's, the Commission recognized the benefit of deviations from the plan in more common circumstances and granted the Board limited discretionary authority to deviate from the regulation plan to Aprovide beneficial effects or relief from adverse effects to one interest without appreciable adverse effects to others@.

Although Plan 1958-D satisfied all of the Commission's criteria under the 1860-1954 design supply sequence, and has generally worked to satisfy the criteria with supplies in the design range, it does not work well with extreme water supply conditions. This is largely due to the absolute constraints on outflow that Plan 1958-D contains. During the very low supply period of 1964-1965 flows below the minimum outflow limits of the plan were necessary to maintain levels of Lake Ontario. During the high supply sequences in the mid-1970's, the mid-1980's and again in 1990s, the upper flow limits were too restrictive and significant over-discharge deviations from the plan had to be made to minimize flooding on Lake Ontario. Also, Plan 1958-D is not responsive to the relatively fast rise of the Ottawa River and other downstream tributary flows in the spring. Plan 1958-D, to satisfy Criterion (d), limits maximum Lake Ontario outflows in the spring to no more than would have occurred prior to regulation, but it does not consider the state of downstream inflows. By temporarily reducing the flow below that specified by Plan 1958-D during the Ottawa River spring peak flow, significant reductions in flooding on Lac St. Louis and downstream have been accomplished without significant harm to upstream interests. At other times when Ottawa River outflows were relatively low, reductions in Lake Ontario flood levels were achieved by increasing the Lake Ontario outflow above that specified by the "no higher than pre-project" limit in Plan 1958-D. The benefits of this approach were recognized by the Levels Reference Study Board (1993) and they recommended that Criterion (d) be modified accordingly.

In actual operations, Lake Ontario outflows are reduced when ice begins to form in the Beauharnois Canal to enable the formation of a complete, smooth, stable ice cover. Lower flows are maintained until the ice cover progresses upstream and is completed in the reach above Iroquois Dam. This is done to prevent ice jams/restrictions or, in other words, reduce the hydraulic head loss caused by the ice. In turn, this enables higher

flows to be maintained in the rest of the ice season. Plan 1958-D assumes that ice will begin to form on Lake St Louis on December 15th of each year and continue forming upstream until January 31st. Plan 1958-D limits the maximum outflow during this entire period. Variations in weather are such that the ice formation period rarely coincides with these dates and in actual operation flows usually are not reduced until ice begins to form, and is increased as soon as the ice cover stabilizes.

As a result of these and other deviations from the plan, the actual levels and flows experienced in the Lake Ontario - St Lawrence River system since the beginning of regulation only partially reflect the performance of Plan 1958-D.

Need for a simulator of Plan 1958-D with Deviations. Plan 1958-D "with deviations" has been selected by the Study Board as the Base Case for comparison purposes. Plan 1958-D with deviations made under the direction of the International St. Lawrence River Board of Control and the Commission represents the method now in use for regulation of Lake Ontario outflows. These deviations from the specified Plan 1958-D outflow may be made for a number of reasons under several different authorities granted to the Board by the Commission, including winter ice formation operations, discretionary deviations (to benefit one or more interests without adverse effects upon others), or in cases of extreme supply conditions beyond those for which Plan 1958-D was designed (criterion k operations). A record of these deviations from Plan 1958-D exists for the period since regulation began. Although the needs of the interests have evolved since regulation began in 1960, and the membership and perspective of the Control Board has changed, one might assume that similar deviations from Plan 1958-D would again be made by the Board given the same circumstances, both in terms of hydrology and user needs. With that assumption the historic deviations could simply be added to the computed 1958-D flows generated from the historic hydrologic sequence to arrive at a series of 1958-D with deviations flows. However, if the Base Case is to be compared to other regulation methods under different climate and water supply sequences (be they stochastic, climate change or the pre-regulation period from 1900 to 1959), then there needs to be some method of estimating what deviations in flow, if any, would be made from flows specified by Plan 1958-D to represent the Base Case.

58DD Development: The task began with a review of the historic deviations from Plan 1958-D along with the hydrologic and other conditions existing at the time of the deviation to determine if there were consistent patterns. Empirical relationships between the hydrologic conditions and the deviations were developed where possible based on these patterns. The adequacy of these empirical relationships was tested by comparing the estimated and recorded levels and flows for the 1960 to 2001 period with emphasis on the last decade (~1990 on), since it was the most recent and assumed representative of the present regime. The work conducted to formulate Plan 1998, which is a regulation plan developed for the Control Board that was intended to replace Plan 1958-D with deviations, was reviewed to assist in the development of the estimators of deviations.

Those relationships that were determined to be useful estimators of the plan with deviations were programmed as extensions to the Plan 1958-D regulation model.

Since in actual operations, deviations from the plan are sometimes made several times within the week in response to changing conditions, such as ice formation or rapid increases in Ottawa River flows, the rules of the Plan 1958-D with Deviations simulator (58DD) were formed assuming that the current hydrologic and ice conditions are known at the time the flow decision is made.

The determination of the 58DD flow starts with the calculation of the Plan 1958-D flow. 58DD then checks this flow to see if deviations are appropriate due to low Lake Ontario levels and then checks the flow against a number of modified flow limits that attempt to mimic the flow decision made by the Control Board. The effect of the deviations on the Lake Ontario level are tracked so that both the level with and the level without deviations are simulated. The computed Plan 1958-D flow is based on the level that would have occurred without deviations, while the 58DD revised limits are applied based on the level with deviations.

The following list summarizes the additions and revisions to the limits of Plan 1958-D to simulate the flow with deviations.

- Ignore the ice formation maximum flow limit of Plan 1958-D during the last half of December. (This was originally included in Plan 1958-D in anticipation of a hydropower plant at the outlet of Lac St. Louis that has not been built.)
- Apply revised maximum outflow limits in the winter using a method similar to that used in Plan 1998. This limit is based on actual ice formation and ice roughness conditions rather than simply the date used in Plan 1958-D.
- Use increased maximum outflow limits at high Lake Ontario levels during the navigation season with regard for the level of Lake St Lawrence.
- apply Plan 1998 type maximum outflow limits to reduce Lac St. Louis flooding
- Use modified minimum outflow limits to simulate deviations to maintain levels for navigation.
- Add rules to reduce the outflow under certain conditions in the spring and summer to raise Lake Ontario levels and/or store water for later use.
- Add rules to accumulate and reset the deviations to zero (This resets computed Plan 1958-D level to the "actual" level that results from deviations)

A detailed description of these additions and revisions is included in the appendix to this report.

58DD Compared to Recorded Plan 1958-D with deviations flows: As mentioned above, the adequacy of 58DD as a model of the present regulation regime was tested by comparing the simulated and recorded levels and flows for the 1960 to 2001 period with emphasis on the last decade (~1990 on). This was done using the recorded quarter-monthly net total supply series to Lake Ontario and the recorded ice status indicator, river roughness factors and added inflow to Lac St. Louis.

Comparisons of the recorded Lake Ontario average quarter-monthly levels and those produced by 58DD are shown in Figures 1 and 2 for the 1960-2001 and 1990-2001 periods respectively. This shows that, on average, the 58DD simulator reproduces the average Lake Ontario levels well with a small bias to higher levels in the winter.

Figure 1. Lake Ontario Average Quarter-Monthly Level 1960-2001
58DD vs. Recorded

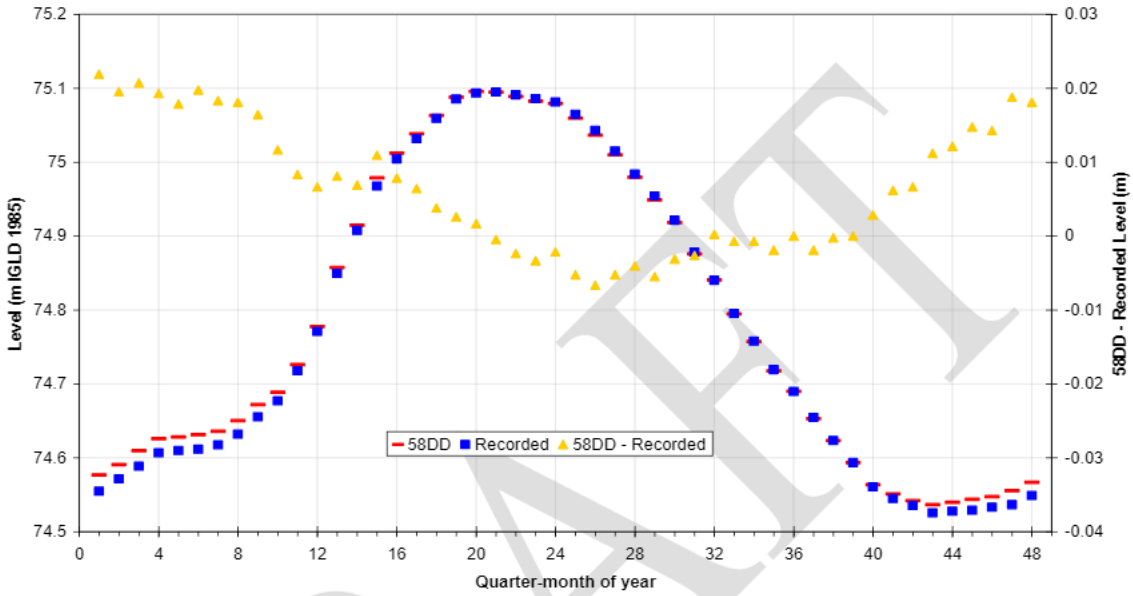


Figure 2. Lake Ontario Average Quarter-Monthly Level 1990-2001
58DD vs. Recorded

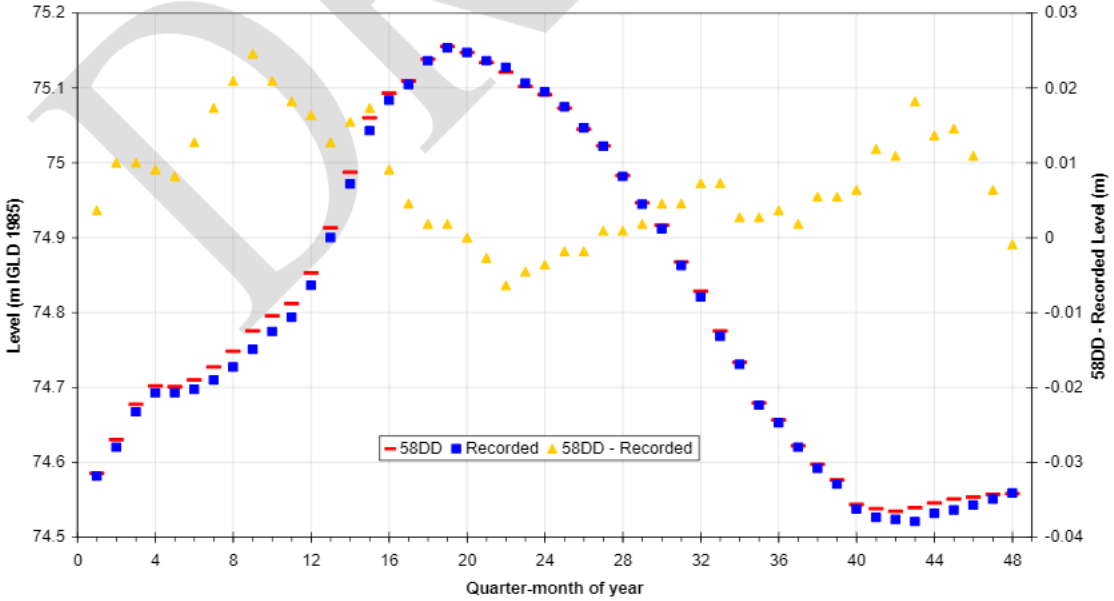


Figure 3. is a plot of the 1960-2001 time series of recorded and 58DD simulated quarter-monthly Lake Ontario levels. The RMSE of the difference in levels in this period is 0.075 m with a maximum error of 0.22 m and minimum error of -0.24 m. For the last decade, 1991 to 2001, the RMSE of the difference in levels is 0.057 m with a maximum error of 0.14 m and minimum error of -0.17 m.

Figure 3 shows that there are two periods in the last decade in which the departures between the 58DD simulator and the recorded Lake Ontario level are greater than 0.1 m. In the fall of 1992 the Board of Control agreed to a request to reduce the release from Lake Ontario to less than that specified by Plan 1958-D to reduce spillage at the Hydro Quebec hydropower facilities which at the time had a number of turbines out of service for maintenance. As a result about 0.1 m of water was stored on Lake Ontario relative to Plan 1958-D in the fall of 1992. This turned out to be an ill-fated decision since Lake Ontario received high supplies that fall which resulted in higher than desired levels. The Board of Control has not agreed to such requests under similar conditions in the autumn since then. The second exception to the generally good match in the 1990s is a period from late 1998 to late 1999. During the relatively dry period in late 1998 the Board of Control made a decision to release more water than specified by Plan 1958-D in order to prevent the level at Montreal Harbour from declining below Chart Datum. As a result, the level of Lake Ontario was drawn down further during a period of already low water level which raised concerns on the lake in late 1998 and early 1999. The Board was thus forced to stop the discharges above those called for by Plan 1958D in 1999 even though water levels at Montreal Harbour were further below Chart Datum than they would have been in late 1998. After this experience, during subsequent periods of low supplies, the Board no longer attempted to keep the level at Montreal Harbour at Chart Datum, but instead augmented the Plan 1958-D flow to maintain levels at Pointe Claire of not less than 20.6 m during the Seaway season, as Lake Ontario levels permit. This later practice has been programmed into the 58DD and, as a result, 58DD simulates a higher Lake Ontario level than was recorded in late 1998 and 1999.

To eliminate the possible error in the comparison of recorded versus 58DD levels of Lac St. Louis at Pointe Claire that might be introduced by the Lac St Louis level model, Lake Ontario outflows levels for both the 58DD the recorded cases were used in the same Lac St Louis model to generate levels at Pointe Claire for comparison. The average quarter-monthly levels and those produced by 58DD and recorded Lake Ontario outflows are shown in Figure 4 for the 1960-2001 period. This shows that, on average, the 58DD simulator reproduces the average Lac St. Louis levels well with a small bias to higher levels in the spring and lower levels in the fall.

To compare the frequency distribution of levels produced by 58DD to the recorded case, cumulative frequency curves were produced. Three periods were selected: the entire year, April and August. The individual months' results are included to check that the distribution of levels in key months was adequate. April was selected as levels in this month are thought to be important for fish spawning, while August levels are important for recreational boating. Figures 5, 6 and 7 compare the frequency distributions for Lake Ontario while Figures 8, 9 and 10 show similar results for Lac St Louis.

Figure 3. Lake Ontario level 58DD Simulated vs. Recorded 1960-2001

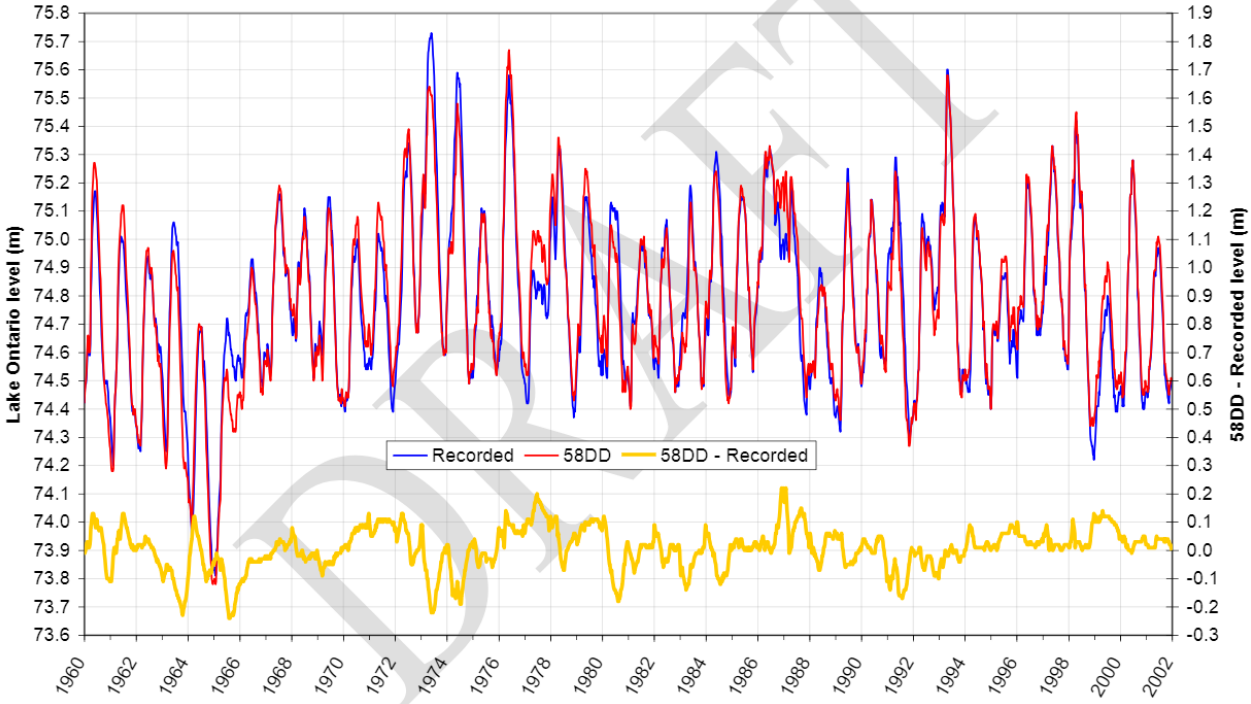


Figure 4. Lac Saint Louis at Pointe Claire Average Quarter-Monthly Level 1960-2001
58DD vs. Recorded

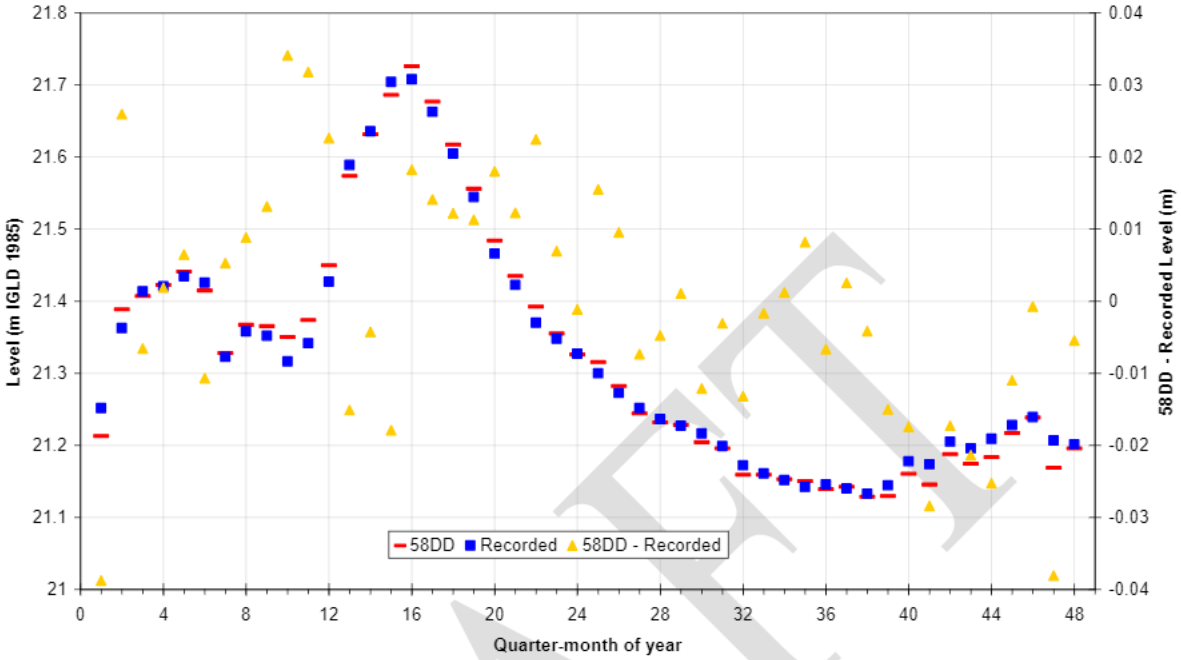


Figure 5. Cumulative Frequency of Lake Ontario Levels 58DD vs. Recorded
All Year 1960-2001

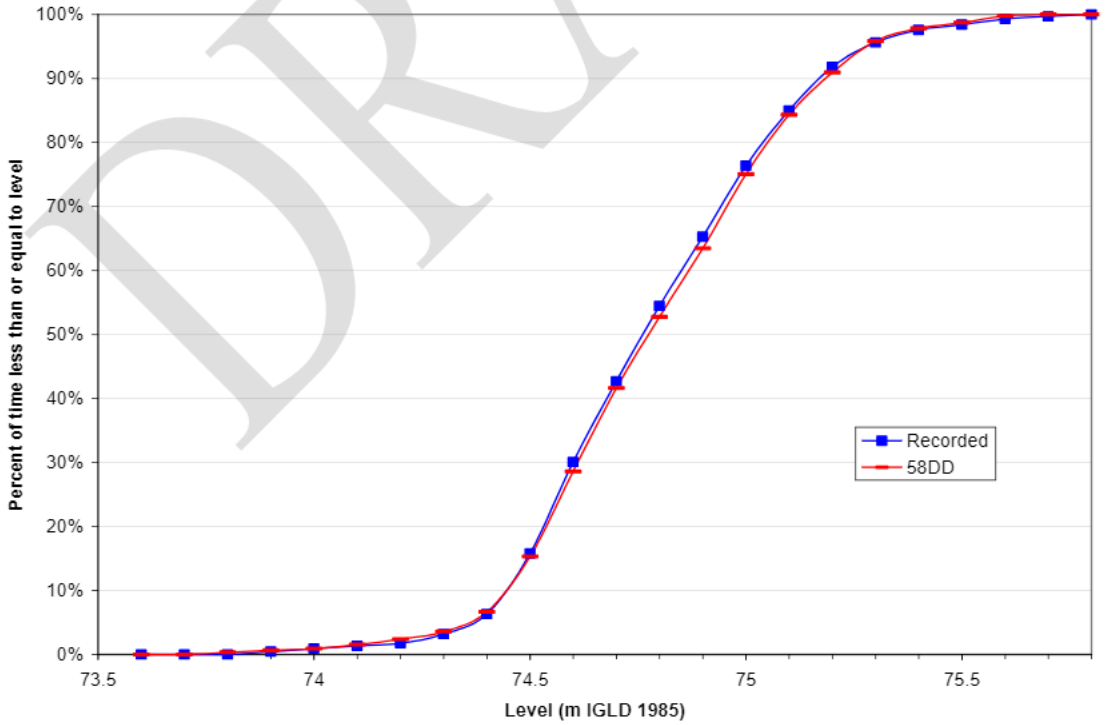


Figure 6. Cumulative Frequency of Lake Ontario Levels 58DD vs. Recorded April 1960-2001

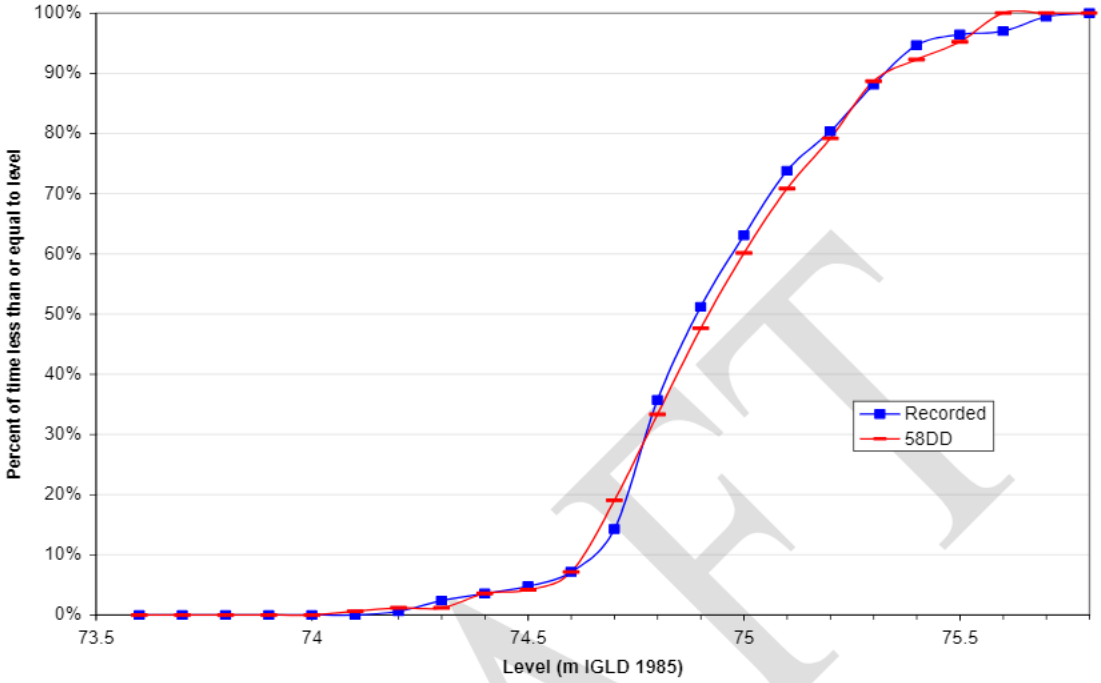


Figure 7. Cumulative Frequency of Lake Ontario Levels 58DD vs. Recorded August 1960-2001

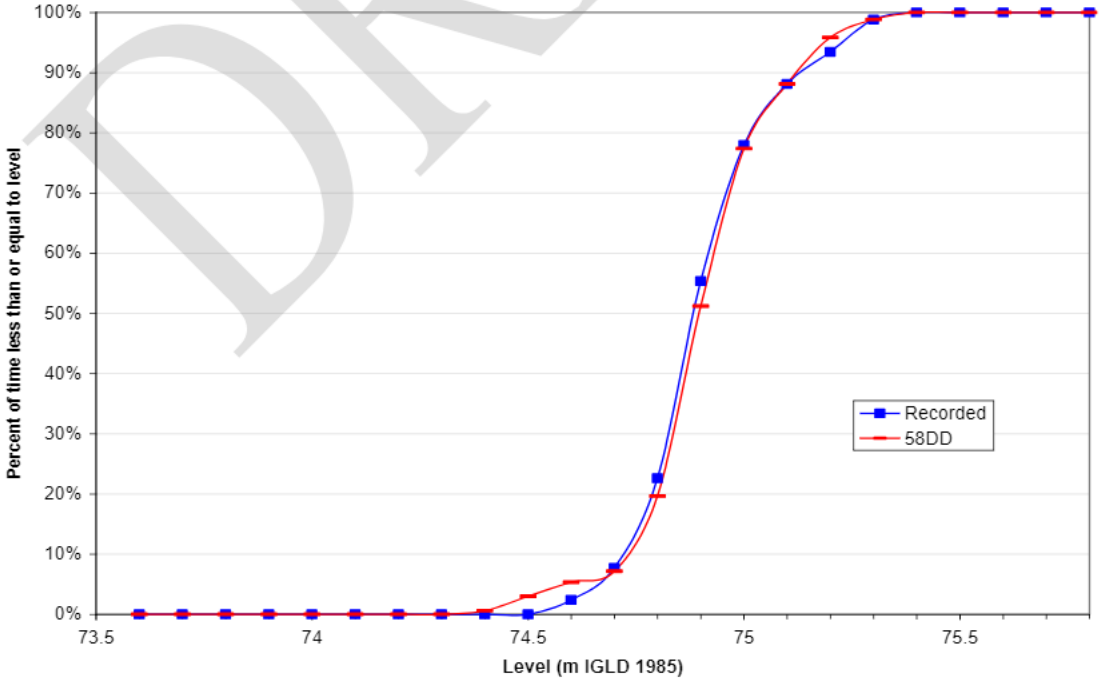


Figure 8. Cumulative Frequency of Lac St Louis Levels 58DD vs. Recorded All Year 1960-2001

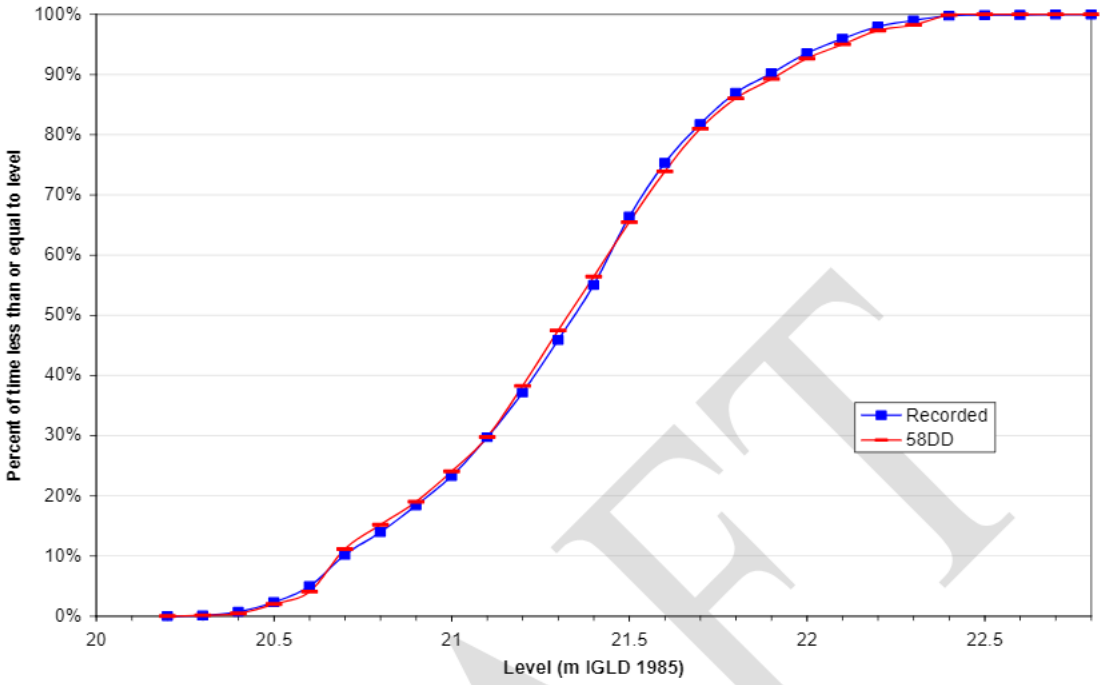


Figure 9. Cumulative Frequency of Lac St. Louis Levels 58DD vs. Recorded April 1960-2001

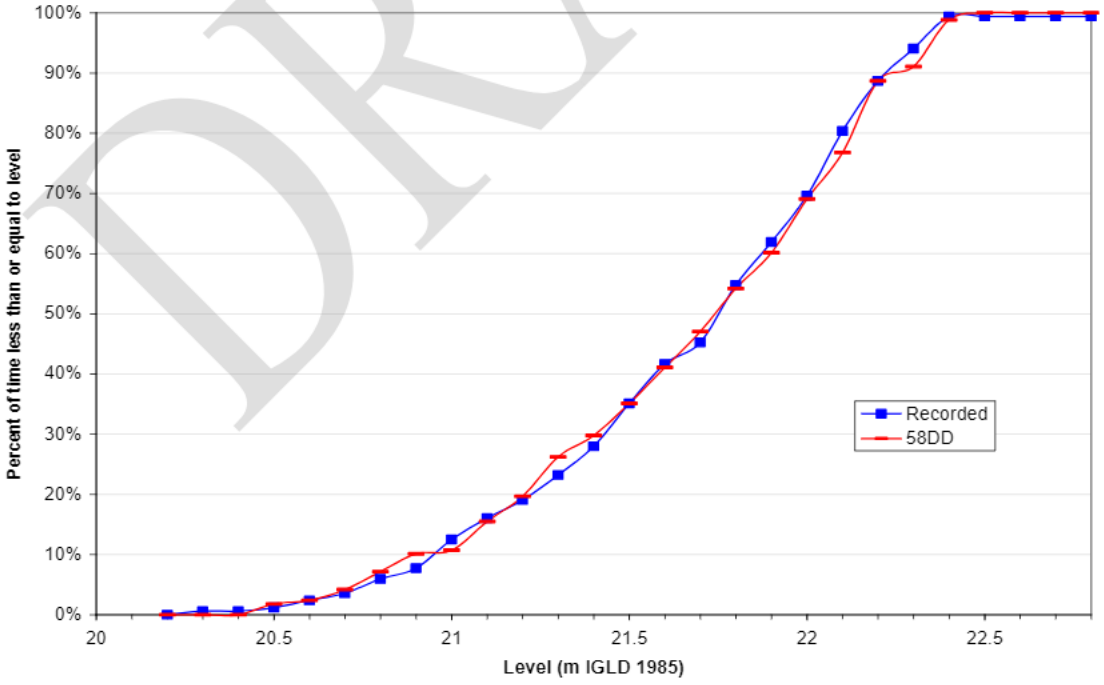
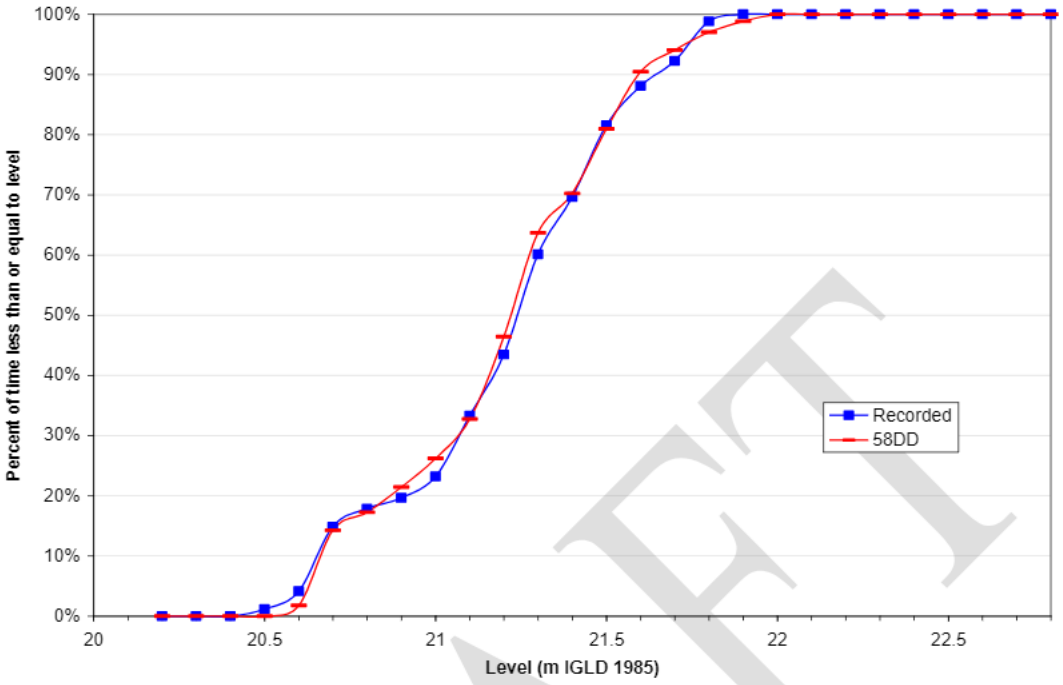
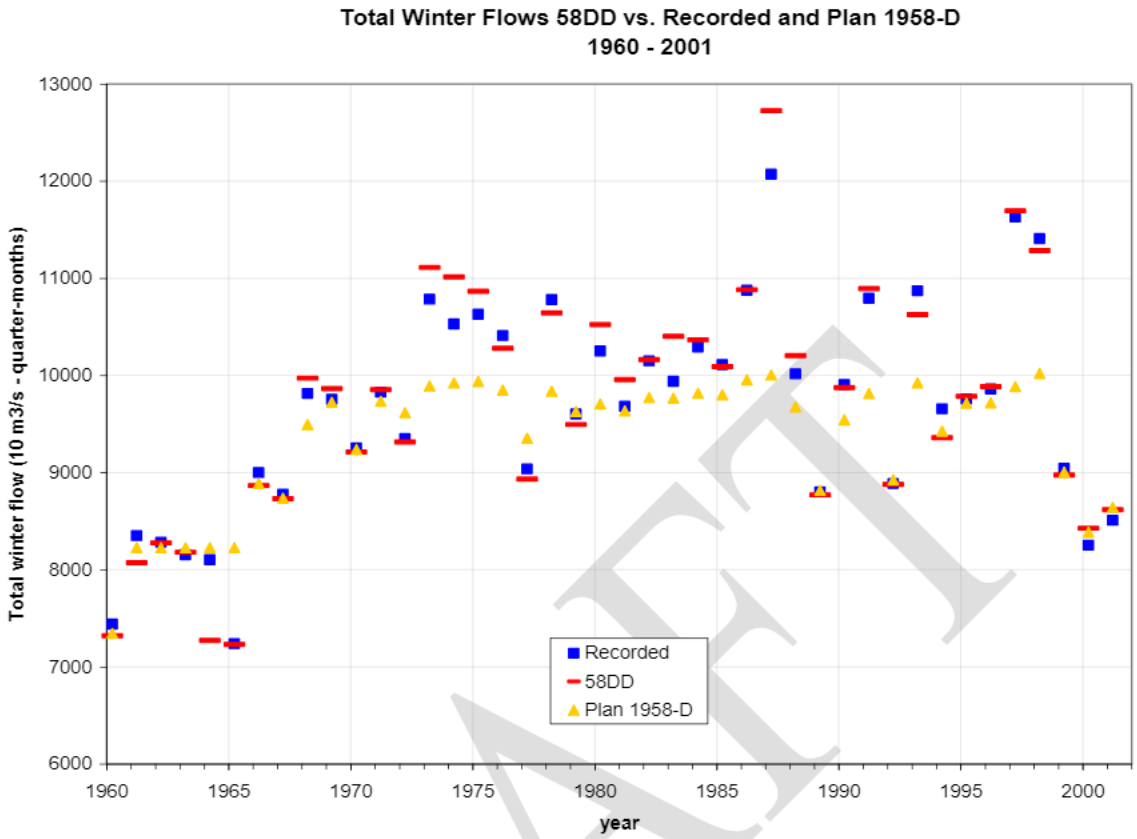


Figure 10. Cumulative Frequency of Lac St. Louis Levels 58DD vs. Recorded August 1960-2001



Comparing the frequencies shown in Figures 5 through 10, it can be seen that 58DD produces similar overall distribution of levels through the year on Lake Ontario. The frequencies of extreme low and high are levels are almost identical in 58DD as the recorded case. 58DD results in somewhat more levels from 74.4 to 74.6 on Lake Ontario, and slightly fewer levels below 20.6 m on Lac St Louis, in August than were recorded in the 1960-2001 period. This may be the result of the simulation of the Board of Control's strategy in recent years that attempts to keep the level of Lac St. Louis above 20.6 m in the Seaway season.

As mentioned above, the inflexible, date-specific, maximum winter flow limits of Plan 1958-D result in frequent deviations from the Plan 1958-D specified flows in the winter due to the variability of ice conditions in the river from year to year. The actual winter flows were found to be among the most difficult to simulate due to a lack of data on the factors governing the flow under ice conditions. A method similar to that developed for use in Plan 1998 (ISLRBC 1997) was used in 58DD to estimate maximum winter flows with deviations. This method uses a simple indicator of the ice formation status in the Beauharnois Canal and the international section, and a coefficient to estimate the roughness of the ice cover in the international section, to aid in setting the maximum winter flows. Figure 11 compares the 58DD and the recorded total winter flows (10 m3/s-quarter-months) in each year from 1960 to 2001. From this figure it can be seen that 58DD estimates the total winter flow quite well, particularly in the last decade.



Discussion. The resulting levels and flows from 58DD can only be approximations of actual historical flow decisions made by the Board of Control. This is due to evolving and often subjective decision factors that are taken into consideration by the Board. The Board of Control has changed the way it deviates from Plan 1958-D over time as the needs of the interests have changed, its understanding of the variability of the hydrology of the Lake Ontario – St. Lawrence River has developed, and the values of the Board shifts with the turn over in its membership. Thus, a simulator of flow release decisions based solely on a few physical hydrologic inputs cannot be expected to exactly replicate each quarter-monthly decision. In this light, 58DD is considered as an adequate approximation of the existing flow regulation method.

References

International St. Lawrence River Board of Control (ISLRBC), July 1963. *Regulation of Lake Ontario: Plan 1958-D.* Report to the International Joint Commission, Ottawa and Washington.

International St. Lawrence River Board of Control (ISLRBC), June 1997. *An Updated Regulation Plan for the Lake Ontario - St. Lawrence River System.* Report to the International Joint Commission, Ottawa and Washington.

Levels Reference Study Board, March 1993. *Levels Reference Study: Great Lakes - St. Lawrence River Basin.* Main report. Report to the International Joint Commission, Ottawa and Washington.

Not complete

Appendix

Detailed description of the changes to the Plan 1958-D in 58DD

Reduce flow to store water on Lake Ontario in the spring-summer.

From mid-march (qm 11) to the end of August (qm 32) then

IF the accumulated deviations are less than -1800 cms-qm (roughly 6 cm stored on Lake Ontario) AND the Lake Ontario level is more than 5 cm below the target level
then reduce the adjusted rule curve flow by 300 cms

Use Plan 1998 J LIMIT

If Ontario level > 75.20 then allow J increase to be 1420 cms
Otherwise J increase is 570 cms

J decrease remains at 570 cms.

(recall that another limit may take precedence over the J limit. The "J increase" is a max limit and the "J decrease" is a minimum limit. If a maximum limit is less than a minimum limit then the maximum limit governs. EG. Flow reduction due to max limit for ice formation)

Plan 1998 P Limit with further modifications

Modified the Lake St. Louis outflow limit to reduce flooding.

If Lake Ontario is below 75.2 m,

If from 1st qm of February to 3rd qm April then:
limit Ontario outflow such that it plus forecast (perfect in 58DD) difference between L. St. Louis and Ontario flows is less than the L St Louis flood flow of 11500 m3/s
Qont = 11500 - StlOnt
(corresponds to 22.1 m alert level computed using the Pointe Claire relationship) or the original Plan 1958-D P limit, whichever is less.

For rest of year:
limit outflow such that flow plus forecast (perfect in 58DD) difference between L. St. Louis and Ontario flows is less than the L St Louis flood flow of 11500 m3/s

If Ontario level is above 75.2 m, but below 75.45 m,
then use 12400 m3/s (corresponds to 22.33m flood level).

If Lake Ontario is above 75.45 m
then revert back to original P limit or the 12400 m3/s whichever is greater.

Plan 1998 I limit modified

Replaced winter L LIMIT of Plan 1958-D by a new I limit calculated based on Long Sault level. It is seasonal to account for shipping and ice condition.

1. If ice is forming at Beauharnois or was forming the previous period at Beauharnois (assumed to be forming in international reach) then limit max flow to 6230 cms.

2. IF qm = 48 OR qm < 13 THEN assume no Seaway navigation and govern max flow based on Long Sault threshold levels and the supplies (adjusted supply indicator).

```
SELECT CASE adjusted supply indicator
  CASE IS < 0
    Long Sault target level = 72.2
  CASE 0 TO 100
    Long Sault target level = 72.0
  CASE ELSE
    Long Sault target level = 71.8
  END SELECT
```

Revised to prevent too low downstream levels with very low Ontario levels for stochastic and Climate Change cases

```
   IF Ontario level <= 73.60 THEN
     Long Sault target level = Long Sault target level - .2
```

Calculate flow to give Long Sault target level with forecast ice roughness factor. The following equation calculates flow LSq for given Kingston level and Long Sault Dam level (lslev) and roughness n

```
LSq = 2.29896 * (Kingston lev - 62.4) ^ 2.2381 * ((Kingston lev - lslev) / n) ^ .387
```

Modifed maximum outflow L limits compared to Plan 1958-D during the navigation season

Applies for assumed Seaway season from April 1 to December 3rd qm.

Use same L limits as in 1958-D if level below 75.13 m. Then, as in Plan 1998:

If Ontario level between 75.13 and 75.44 then
    L limit = 8780 + linear increase to 9910 at 75.44 m

In Plan 1998, If above 75.44 m then
    L limit = 9910 cms

But, added for stochastic cases,
If above 75.7 then L Limit = 10200 cms
the 75.7 level is an estimate of threshold to go to extreme flow that could stop Seaway traffic. This is the maximum qm flow that has occurred in navigation season.

Supersede L limit if needed to keep Long Sault level above Seaway minimum. Use 72.6 m at Long Sault as limit since this is based on beginning of period Ontario level. To deal with very low levels, if the Ontario level is less than chart datum (74.20 m)then allow the LS level to be equally below the 72.6 m limit in an effort to provide enough water downstream.

```
IF Ontario level >= 74.20 THEN
        lsMintarget = 72.6
    ELSE
        lsMintarget = 72.6 - (74.2 - Ontario level)
 END IF

maxLS = LSq(Kingston level, lsN, lsMintarget)

 IF max flow to keep Long Sault above 72.6 < normal L limit then
        Set L limit to this flow
```

```
'  SIMULATED DEVIATIONS


' save 58d Pstar to compare
   pstar58d = MINPSTAR

'  updated flow amounts June 2004 to reflect newer Pte Claire equation
'   revised from 670 to 680 July 2004 and changed trigger level from
74.4 to 74.3
' new Pstar limit to keep St Louis level above 20.64m (680 m3/s) if Ont
> 74.3
'  keep St Louis level above 20.5 m (640 m3/s) if 74.2 <Ont < 74.3
' keep St Louis level above 20.4 m (610 m3/s) if 73.8 <Ont < 74.2
' added next case in version 6 and later Dec 1 2002
' keep St Louis level above 20.3 m (577 m3/s) if Ont < 73.8
'
' apply to all year
'
   SELECT CASE Ontario level
    CASE IS > 74.301
      MINPSTAR = 680 - round(stlont(ya%, ma%, qa%), 1)
      ' added July 4 04
       IF devlev < -.3501 THEN
        MINPSTAR = MINPSTAR - 20
       END IF
    CASE 74.201 TO 74.301
      MINPSTAR = 640 - round(stlont(ya%, ma%, qa%), 1)
      ' added July 4 04
       IF devlev < -.3501 THEN
        MINPSTAR = MINPSTAR - 20
       END IF
    CASE 73.799 TO 74.201
      MINPSTAR = 610 - round(stlont(ya%, ma%, qa%), 1)
   ' force M lim to equal Pstar if Ontario less than 74.2
      MINM = MINPSTAR
' added next case in version 6 and later Dec 1 2002
    CASE IS < 73.799
      MINPSTAR = 577 - round(stlont(ya%, ma%, qa%), 1)
   ' force M lim to equal Pstar if Ontario less than 73.8
      MINM = MINPSTAR

' added next case in version LS and later Feb 27 2005
    CASE IS < 73.601
       MINPSTAR = 520 - round(stlont(ya%, ma%, qa%), 1)
' force M lim to equal Pstar if Ontario less than 73.8
      MINM = MINPSTAR

   END SELECT
 '
'  version 6  apply only to Seaway season qtrmth 12 to 47
   IF i% > 11 AND i% < 48 THEN
' don't let Pstar it be less than old P* in Seaway season Dec 1 2002
' version 9a Let this apply only if Ontlev >74.4

  IF Ontario level > 74.401 THEN
     MINPSTAR = MaxT1(MINPSTAR, pstar58d)
```

```
    END IF
   END IF

' end of mod

'  need to add part for low Ontario levels to save water in spring if
Ontario
' levels or maybe SI is below some threshold and St Louis above some
threshold

' old part not yet changed
      CALL MaxLim(MaxLa, MAXP, maxi, MAXLIMIT, MaxtLims$)
      CALL MinLim(MINPSTAR, MINM, MINLIMIT, MintLims$)
' change to make max govern even if its less than Mlim Dec 1 2002
      CALL FLOWSdev(CALFLOW, CALLIM$, MAXLIMIT, MaxtLims$, MINLIMIT,
MintLims$, MINM, apflow, ApLim$)


 ' recorded devs don't apply
      FlowDev = apflow - cflow
      accdev = accdev + FlowDev
'
' test of revised calc method

' Keep track of level to 6 decimals to avoid lack of precision problem
at 2 decimals
'     but round to 2 decimals to enter into the plan rules to preserve
consistency with operations
'
'
      Ontario level6 = clev6 + round((OntNTS(year&, month%, q%) - cflow
- accdev) / 2970, 1000000)
      Ontario level = round(Ontario level6, 100)

      clev6 = clev6 + round((OntNTS(year&, month%, q%) - cflow) / 2970,
1000000)
      clev = round(clev6, 100)

      WS = round(ko / 16.5, 1)
      ko = ko - WS + OntNTS(year&, month%, q%)
      WS = round(ko / 16.5, 1)
      si = WS - NWS(month%, q%)
 ' added Dec 2002 to calc dev form target level
       devlev = round(Ontario level - avglev(month%, q%), 100)

      CALL adjustdata(i%, si, supind(), chgsi(), adjwint, adjsi, qback%,
ps%, pw%, fu%, fd%, ul, ll)
      CALL ptline(1, q%, month%, OntNTS(year&, month%, q%), ko, WS,
NWS(month%, q%), si, chgsi(8), adjsi, BRC, SEAADJ(month%, q%), brcadj,
apflow, ApLim$, cflow, CLims$, accdev, clev, Ontario level)
' historic devs no longer apply
'       CALL SetDev(accdev, Ontario level, clev, q%, month%, year&)

'
' new modification
' ****************************
' reset computed Ont level clev to Ontario level if conditions met
```

```
'  if positive reset in July or August if > 1000
'  if negative reset at end of march if < -700
'
   SELECT CASE accdev
    CASE IS > 1000
     IF month% >= 7 AND month% < 9 THEN
      accdev = 0
      clev = Ontario level
      clev6 = Ontario level6
     END IF
    CASE IS < -700
     IF month% = 3 AND q% = 4 THEN
      accdev = 0
      clev = Ontario level
      clev6 = Ontario level6
     END IF
   END SELECT
' end of modification
```