12.2 Endorsement of Intensity-Frequency-Duration (IFD) Design Rainfall for Local and Regional Flood Modelling

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Responsible Officer: Amanda Pugh, Group Manager Community & Regional Prosperity

Purpose:

The purpose of this report is to seek both Council's endorsement of the IFD Study and its recommendations and the adoption of a suitable IFD design rainfall for the region that can be clearly justified and makes sense in a local context. This will support best engineering practice locally and avoid adverse outcomes in terms of planning, setting design flood levels, understanding flood behaviour and the design of assets.

Officer's Recommendation:

THAT Council:

1. **endorse the report *Comparison of IFD Products for Lockyer Valley Regional Council Area – Interim Report*, prepared by WMA Water dated April 2026;**
2. **adopt the Intensity-Frequency-Duration (IFD) design rainfall criteria in accordance with the findings of the report *Comparison of IFD Products for Lockyer Valley Regional Council Area – Interim Report*, prepared by WMA Water and dated April 2026, being an enveloped approach using the maximum of the LIMB2020 and QRA2025 IFD datasets for design flood estimation; and**
3. **commence preparation of the necessary amendment to the Planning Scheme Policy 6.4 Flood hazard to include these outcomes.**

RESOLUTION

THAT Council:

1. **endorse the report *Comparison of IFD Products for Lockyer Valley Regional Council Area – Interim Report*, prepared by WMA Water dated April 2026;**
2. **adopt the Intensity-Frequency-Duration (IFD) design rainfall criteria in accordance with the findings of the report *Comparison of IFD Products for Lockyer Valley Regional Council Area – Interim Report*, prepared by WMA Water and dated April 2026, being an enveloped approach using the maximum of the LIMB2020 and QRA2025 IFD datasets for design flood estimation; and**
3. **commence preparation of the necessary amendment to the Planning Scheme Policy 6.4 Flood hazard to include these outcomes.**

Moved By: **Cr C Wilson** **Seconded By:** **Cr D Neuendorf**
Resolution Number: 24-28/0542

CARRIED
7/0

Executive Summary

The LVRC Flood Risk Management Project is composed of two stages:

- Stage 1 – the IFD (rainfall intensity, frequency, duration) design rainfall study; and
- Stage 2 – the Climate change investigation, local flood study and flood risk management analysis.

This report concerns Stage 1. A copy of the IFD Study report, *Comparison of IFD Products for Lockyer Valley Regional Council Area – Interim Report*, prepared by WMA Water, is attached.

The Stage 1 IFD (rainfall intensity, frequency, duration) Study involved an assessment of the three rainfall data sets available, i.e. data from the QRA (HARC) Project, the LIMB Project, and the Bureau of Meteorology (BOM), in order to provide guidance on which IFD product(s) are to be used throughout the Lockyer Valley region.

Officers were advised that there were unexplained variances between the QRA (HARC) rainfall set and the LIMB IFD rainfall design grids (in use since 2021) that may lead to incorrect estimates of design rainfall in some localities. Council's consultants, WMA Water, examined and compared the rainfall datasets. There are large differences between the BoM 2016/LIMB 2020 and QRA IFD for some design rainfall estimates. The extracted rainfalls for the BoM and LIMB projects are very similar where the records overlap. The QRA IFD extend the rainfall record up to and including recent events.

The IFD Study ascertained that for the purposes of Stage 2, an envelope of QRA and LIMB data sets be used for the IFD design rainfall. Using an enveloped approach using the maximum of the LIMB and QRA IFD data sets, found good correlation of resultant flows between actual rainfall and flood operations and design flows, which adds a level confidence to the findings.

Therefore, it is recommended that Council uses an enveloped approach of the maximum of the LIMB and QRA IFD data sets. Council's endorsement of this will allow Stage 2 to proceed. This advice may be able to be further refined in Stage 2, but this will not change the general recommendation. The Stage 2 task relating to northwest calibration volume increase and the possible scaling of the design flood event AEP (Annual Exceedance Probability flood) may influence this work.

Proposal

<u>Background</u>

The BOM undertook a 12-year project that applied statistics to the historical Australian rainfall gauge readings to create IFD design rainfall grids. These were called the ARR 2016 IFD rainfall grid set. "IFD" is short for "intensity, frequency, duration" of rainfall.

An IFD rainfall grid is best imagined as a layer of rain applied over the whole land surface of a catchment. The actual grids will vary depending on historical rainfall trends. For example, rain tends to be heavier at the top of Laidley and Tenthill Creeks, and therefore at higher intensity in these locations compared to further down the floodplain in any one event.

These rainfall grids are used by Council and developers to design infrastructure and assess development. The rainfall patterns in Lockyer Valley are very complex. The flood modelling converts this layer of catchment wide rainfall into flows in the creeks and calculates what the flood extent looks like in the creek and on the floodplain downstream.

There were issues with the ARR2016 IFD rainfall set as it appeared to be low, it did not include the 2013 and later flood events for Lockyer Valley, and it did not properly account for the effect of rain shadow/ mountains in the region.

Council joined with three (3) other Councils (Ipswich, Moreton Bay and Brisbane) to review and update this work. This was the LIMB Project, which resulted in the creation of our own LIMB2020 IFD rainfall set for the four (4) local government areas.

The LIMB2020 IFD rainfall set was used in Council's 2021 modelling program to generate the flood maps that are currently available on the Flood Information Portal and used to determine the Design Flood Level. The view was that the grids were generally acceptable but there were some areas, e.g. the northwest part of the region and Withcott, that seemed low. Historically it has been observed that rainfall has fallen between the rain gauges in this area – so this may account for the anomaly.

In 2024, Council officers became aware that QRA had commissioned another study (like the LIMB) for the whole of the SEQ and North Coast area, and that this project was nearing its end. This project was undertaken by consultants HARC. Independent advice indicated that there were unexplained variances between the QRA (HARC) rainfall set and the LIMB2020 IFD rainfall design grids (in use since 2021) that may lead to incorrect estimates of design rainfall in some localities. Council officers also became aware that the QRA2025 (HARC) had used a different methodology to the LIMB Project, but it was unclear why there were differences.

After representations to QRA (and their consultant) to get them to review and resolve an appropriate approach were unsuccessful, the LIMB group of Councils consulted with WMA Water (who undertook the LIMB Project) to seek a resolution. This has led to the IFD Study being undertaken by Mark Babister of WMA Water to assess and provide guidance on which IFD product(s) are to be used throughout the Lockyer Valley Region.

<u>The IFD Study</u>

The purpose of the IFD study was to undertake an assessment and provide guidance on which IFD product(s) are to be used throughout the Lockyer Valley region, i.e. QRA(HARC) or LIMB or BOM rainfall data. Ipswich City Council has recently commissioned a similar study.

The investigation was critical because if the climate change multipliers are applied to unsuitable IFD design rainfall grids, this could accentuate/underestimate design flood levels. In local areas the climate change projection multiplier may be as high as 60% increase in rain over a 100-year time horizon (leading to increase in flows up to 2 or 3 times those at present). Inaccurate forecasting of future flood events (based on unsuitable IFD design rainfall grids) can lead to incorrect Design Flood Levels (DFL), an inappropriate flood hazard overlay, and unrealistic or insufficient development response in flood areas. This can negatively impact on rights of landowners and/or result in an acceptable risk to people and property.

Therefore, there was a need to adopt an IFD design rainfall data set that can be clearly justified and makes sense in a local context.

The study found that:

(a) There are large differences between the BOM2016, LIMB2020 and QRA2025 IFD for some design rainfall estimates.
(b) The QRA2025 IFD extends the rainfall record up to and including recent events.
(c) These differences are likely attributed to differences in the analysis methodology and processing by QRA of the input rainfalls used to generate the IFDs.
(d) The extracted rainfalls for the BOM and LIMB projects are similar where the records overlap. Any major differences are from the additional 7-8 years of data used for the LIMB Project and the use of a water year from 1 September compared to the BOM which used a calendar year.

(e) After a review of factors, it was ascertained that for the purpose of continuing Stage 2 of the LVRC Flood risk management project that an envelope of QRA and LIMB be used for the IFD design rainfall.

(f) To ensure consistency with actual rainfall and flood operations the study also verified its design rain flow outputs results against observed recorded flows. Using an enveloped maximum of the LIMB and QRA IFD data sets, there was found to be a good correlation of results which adds a level confidence to the findings.

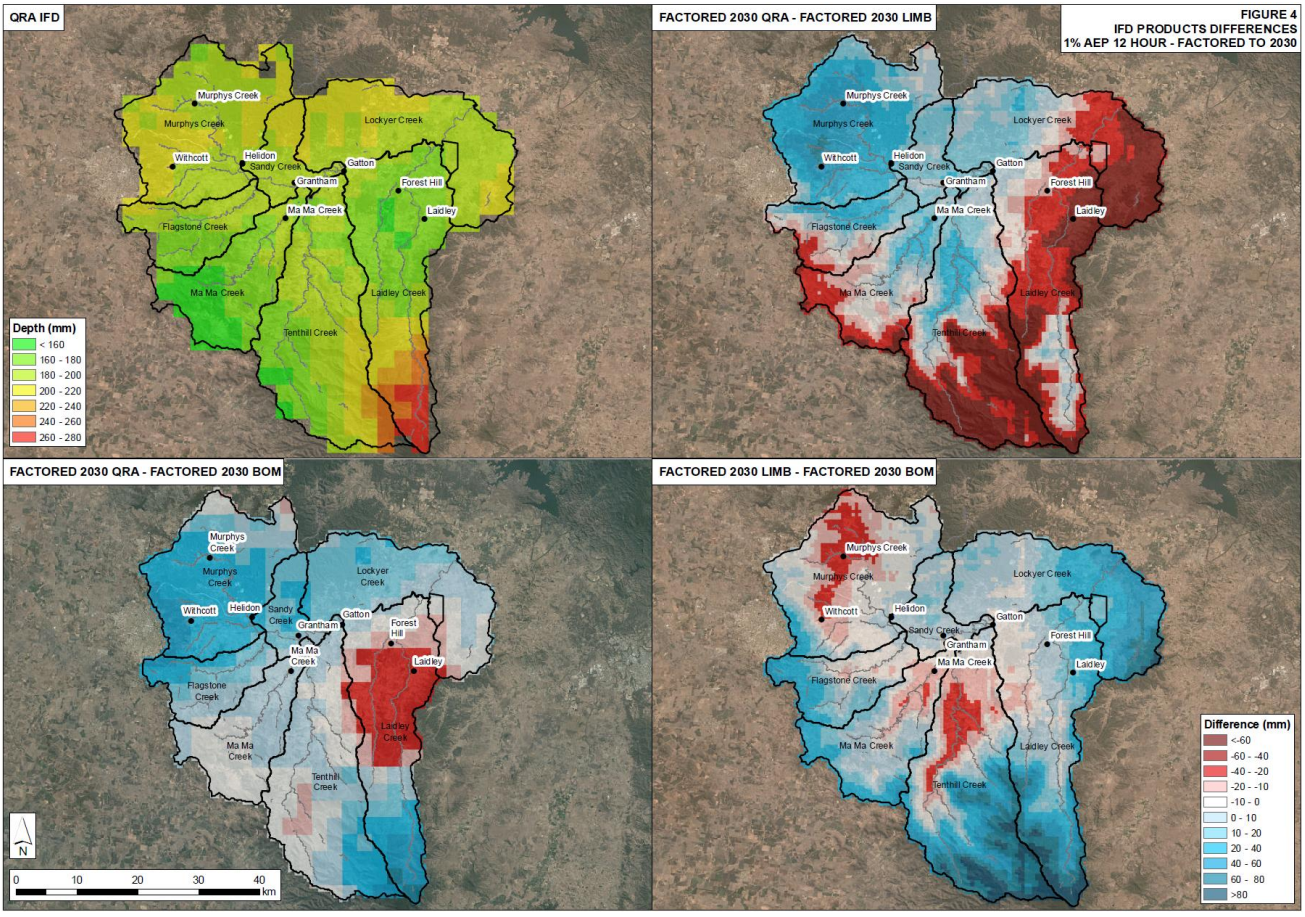

Diagram 1. Extract from WMA Water's report (Figure 4) – The top right shows the difference between QRA and LIMB IFD rainfall sets in a 12 hour 1% (1 in 100) AEP event. The red areas indicate significant difference (less)underestimation. The bottom right shows alignment of the LIMB IFD set with the BOM set (blues) with exception of the northwest and central area where it is less (red).

<u>Recommendation</u>

It is recommended that Council uses an enveloped maximum of the LIMB2020 and QRA2025 IFD data sets. With Council's endorsement, Stage 2 can proceed. The recommended IFD design rainfall grids can then be used in the updated local and regional flood modelling. The flood model outputs will be used to undertake the updated engineering flood risk management project as well as establishing the DFL and the revised flood hazard overlay.

This advice may be able to be further refined In Stage 2, e.g. tightening up the use of the QRA component (to allow easier use in analysis and avoid conservative outcomes). This will not change the general recommendation. The Stage 2 task relating to northwest calibration volume increase and the possible scaling of the AEP (Annual Exceedance Probability) design flood events may influence this work.

To ensure appropriate use of the updated IFD design rainfall it is proposed that the following actions are undertaken:

(a) That Council endorses the WMA Water 2026 report and its recommendations (and the placement of relevant advice) on the Australian Government Geoscience Australia Australian Rainfall and Runoff "ARR Data Hub". The ARR data hub is where design engineers source the design rainfall for a location. Pending the outcomes of Stage 2, we will need to consider how to manage the Council's Data Hub requirements.

(b) The report will be provided to the QRA (which funded the study) and others. QRA has already been advised on the likely IFD anomalies that may affect the updated Brisbane River Flood Study and other regional projects.

(c) That Council adopt the following Intensity-Frequency-Duration (IFD) design rainfall criteria: "Subject to the findings of the report, practitioners undertaking works in the Lockyer Valley Regional Council area are to use an enveloped maximum of the LIMB2020 IFDs and the QRA2025 IFDs design rainfall design grids". **Adopt the Intensity-Frequency-Duration (IFD) design rainfall criteria in accordance with the findings of the report *Comparison of IFD Products for Lockyer Valley Regional Council Area – Interim Report*, prepared by WMA Water and dated April 2026, being an enveloped approach using the maximum of the LIMB2020 and QRA2025 IFD datasets for design flood estimation; and**

(d) That Council look to amend Planning Scheme Policy 6.4 Flood hazard to include these outcomes. Council's flood model user guides and other relevant documentation will also be updated.

Options

The following are options that Council could consider in relation to the design rainfall requirements in the region:

1. Continue to use the (current) LIMB2020/BOM design rainfall advice. Without formal clarifying advice, there is a risk of confusion about what is best practice. There may be uninformed use where the QRA (HARC) rainfall (with its anomalies) may be used in design causing confusion, underestimation of design flows and under-sized engineering outcomes.
2. Adopt an enveloped maximum of the LIMB2020 IFDs and the QRA2025 IFDs design rainfall design grids which makes clear to external stakeholders that the matters have been investigated and what is considered acceptable engineering practice in the region.

Previous Council Resolutions

At the Ordinary Meeting of Council on 22 December 2023, Council resolved to:

- remove the Flood hazard overlay, Flood hazard overlay code, and zone changes due to extreme flood risk from the Draft Planning Scheme and progress the revised version of the Draft Planning Scheme to the Minister seeking approval for adoption; and
- endorse the amendments to the Flood hazard overlay following six (6) principles including investigate using a common design event, such as the 1% AEP + Climate Change, and using the 2022 LiDAR.

Critical Dates

The IFD design rainfall outcome is a key outcome that will be used to continue the updated programme of regional and local flood modelling and key engineering risk assessment. Councils Planning Scheme Policies can also be updated to reflect the change in rainfall design criteria as required.

Strategic Implications

The outcomes from the engineering risk management study are a step in satisfying Conditions 1 and 2 of the Minister's conditions of approval to adopt the Lockyer Valley Planning Scheme.

With the proposed actions of this report in place the design rainfall will be mandatory in relation to the planning assessment, the creation of donated assets (Development related activity). The design rainfall should also be used operationally in Councils normal business.

Corporate Plan

This work contributes to the objectives of "Lockyer Valley Regional Council Corporate Plan 2022 – 2027":

1. Lockyer Community - Enhanced wellbeing and safety of the community.
4. Lockyer Planned - Sustainable and safe infrastructure networks

Finance and Resource

The IFD Study was undertaken using funds from a (rescoped) QRA WP3 grant for flood risk assessment. The flood modelling, engineering risk assessment and planning risk assessment are partially funded by the same grant and funds from the 2025/26 Financial year. This work will extend into 2026/27 and will form part of current budget considerations.

Legislation and Policy

The outcomes from the engineering risk management project form part of the work necessary to undertake a fit-for-purpose risk assessment for the Flood hazard overlay consistent with State Planning Policy.

Risk Management

The recommendation seeks to make clear the acceptable engineering standards in relation to the use of design rainfall in the region. This will manage risks arising by works undertaken by others to avoid incorrect application and potential underestimation and overestimation of the effect of design events.

Consultation

Councillor Consultation

Mark Babister of WMA Water presented on the IFD Study to a Councillor workshop on 18 February 2026.

External Consultation

- The QRA has been formally consulted from the time the potential issues with the IFD design rainfalls arose. The QRA has funded this work. The QRA project group for the updated Brisbane River Food Study was notified of the preliminary findings to ensure they could understand and manage the implications of this risk in relation to the regional Brisbane River catchment flood study currently in progress.
- Council Officers engaged with their counterparts in Brisbane City Council, Ipswich City Council and the City of Moreton Bay (the LIMB group) as part of this project.
- Officers in the Department of Local Government, Water and Volunteers have been consulted to manage understanding and context and avoid issues by third parties when the Planning Scheme is amended

Community Engagement

The work being undertaken with inform the preparation of the draft Flood hazard overlay. The draft overlay and associated amendments to the Planning Scheme will be required to undergo public consultation in accordance with the Minister's Guidelines and Rules.

Attachments

1⇩	Comparison of IFD Products for Lockyer Valley Regional Council Area - Interim Report, by WMA Water, April 2026	6 pages

LOCKYER VALLEY REGIONAL COUNCIL

COMPARISON OF IFD PRODUCTS FOR LOCKYER VALLEY REGIONAL COUNCIL AREA

INTERIM REPORT

Image Credit: Luke Watson

APRIL 2026

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COMPARISON OF IFD PRODUCTS FOR LOCKYER VALLEY REGIONAL COUNCIL AREA

FINAL INTERIM REPORT

APRIL 2026

Project Comparison of IFD products for Lockyer Valley Regional Council area	**Project Number** **124031**
Client Lockyer Valley Regional Council	**Client's Representative** Quentin Underwood
Project Manager Behzad Jamali (RPEQ)	

Revision History

Revision	Description	Distribution	Authors	Reviewed by	Verified by	Date
0	Draft Interim Report	LVRC	B J H B	M B	M B	APR 26
1	Final Interim Report	LVRC	B J H B	M B	M B	APR 26
2						

EXECUTIVE SUMMARY

Introduction

Lockyer Valley Regional Council (LVRC) is updating all the Lockyer Creek regional and local flood models as part of the Local Floodplain Management Plan (LFMP). A critical input to this process is the selection of appropriate design rainfall data, specifically the Intensity–Frequency–Duration (IFD) dataset and associated climate change adjustments. Several IFD products are currently available for use within the LVRC area, including the Bureau of Meteorology (BoM) 2016 IFDs, the LIMB IFDs developed by regional councils, and the Queensland Reconstruction Authority (QRA) IFDs. Despite the recent release of the QRA IFD dataset, there is no explicit guidance on whether it supersedes previous products, and concerns have been raised that some of the IFD estimates may be too different to each other.

LVRC engaged WMAwater to provide evidence-based guidance on the most appropriate IFD dataset for design flood estimation in this area. This Interim Report is for the purpose of providing advice on which IFD product(s) should be used in flood studies.

Recommendation

The LIMB IFD dataset was found to be more reliable in several locations and for a range of storm durations. There are locations that LIMB and QRA IFD datasets were equally reliable. In the northwestern part of the catchment, the QRA data was assessed to be more reliable especially for multi-day storms.

Accordingly, it is recommended that LVRC adopt an enveloped approach, using the maximum of the LIMB and QRA IFD datasets for design flood estimation. This approach allows for most reliable information from each IFD datasets to be used. Taking the maximum of the two datasets avoids underestimating flows and levels but also does not result in overestimations when compared to each individual IFD. This means that taking the higher of the two IFD datasets will be similar to taking an appropriate IFD for each area.

The findings of this investigation have been presented to Council and the Peer Reviewer of the project in several sessions. It was agreed that these investigations provide enough evidence to support the recommendations at this stage. A more detailed report will be issued at a later stage describing the technical details of the investigation. These recommendations will be further refined based on the outcomes of the investigation in later stages if needed. Comparison of hydraulic model outputs against the updated Flood Frequency Analysis at several gauges will help to better understand if the enveloping approach should be limited to some parts of the catchment.

Summary of Investigations

Methods

Rather than reviewing the theoretical methodologies used to develop each IFD product, this study focused on objectively assessing how well each IFD dataset represents observed rainfall statistics. This could be achieved by comparing IFD grids to at site fits for all rainfall stations and investigating if there is a systematic bias. Catchment wide IFD estimates were initially compared to better understand how they vary across LVRC. A review of the underlying rainfall input data,

specifically the extracted Annual Maximum Series (AMS) was conducted. An assessment of estimation bias by comparing regional IFDs against at-site frequency analyses was also undertaken. Finally, hydrologic models for the LVRC region were rerun to compare the influence of LIMB and QRA IFD products, including 2030 climate change factors, on 1% AEP peak flow estimates.

Results

Catchment-wide comparisons showed substantial differences between the LIMB, BoM 2016, and QRA IFD estimates, particularly for sub-daily durations. These magnitude of differences vary by catchment and subregion as well as by storm rarity and durations. The LIMB IFDs exhibit stronger spatial variability, the QRA IFDs are generally smoother, while BoM IFD sits between the two. QRA IFD was found to be lower for durations up to approximately 12 hours in most areas of the catchment with a distinct exception in northwestern part of Lockyer Creek catchment. This area was known to have underestimation issue with design flood levels estimated using LIMB IFD.

Initial comparison of the AMS datasets revealed that the BoM 2016 and LIMB AMS are broadly consistent where records overlap, with minor differences attributable to longer records and the use of water years in the LIMB study as opposed to calendar year in BoM. In contrast, for several gauges, the QRA AMS were found to be lower than BoM and LIMB AMS particularly for short-duration events, probably due to differing QA/QC procedures. A following detailed Stage 2 report will further investigate these differences and importantly if they are of a material impact on design flood estimation levels.

Assessment of estimation bias showed that the LIMB IFDs are generally unbiased relative to at-site frequency analyses, with bias distributions centred near zero. The QRA IFDs exhibit an overestimation bias for short durations, particularly for rarer events. For longer durations, mean bias is smaller, but skewness remains evident for rarer quantiles.

Council advised that previous flood studies identified flood volume underestimation in the north-western upstream areas of Lockyer Creek during calibration. Based on advice, to manage uncertainty around impacts on the design events, Council has used a regulation line greater than 1%AEP. This will be examined in detail in Stage 2 of the Flood risk management project. The comparison of hydrologic modelling show that peak flows vary considerably by location and IFD product: QRA 2030 generally produces considerably higher peak flows compared to LIMB 2030 at Helidon and slightly higher flows at MaMa Creek. The LIMB IFD yield higher peaks for the remaining areas of the catchment including Gatton and Glenore Grove. Overall, the envelop of the two IFD products results in peak flows similar to the maximum of each individual IFDs.

Appendix A

APPENDIX A. Peer Reviewer's Note

I have reviewed this Executive Summary and find that the recommendation is sound, i.e. enveloping the LIMB and the QRA data sets. This conclusion is based on the preliminary investigations and analysis of the various data sets presented by WMAWater. Approximately 80% of the gauges used in the formation of the QRA dataset have longer and more recent records than the LIMB data set, further the QRA Dataset added additional rainfall gauges to the estimation process, albeit some with relatively short records. Approximately 12% of the source gauges found that HARC records were shorter than the corresponding LIMB records. Further some yearly rainfall depth maxima were found to be lower in the QRA data series compared to the LIMB series. This is possibly due to differing QA/QC procedures and will be teased out in later reporting as to what impact this may have on design flood level estimates. The LIMB data set shows greater variability across the shire possibly due to its use of elevation and associated steepness as covariates and due to a tighter averaging process (100 regionalized years) whereas 500 years was adopted in the generation of the QRA data set. It also shows less bias when compared to at-site for short durations. The QRA data set show higher design intensities in the north-west of the shire (upper Lockyer) which will likely address flood volume issues identified in previous reporting. So in summary enveloping the two data sets should result in getting the "***best of both worlds***" resulting in a more robust and defendable design flood estimates.

Don Carroll
RPEQ 3634

Don Carroll is a RPEQ engineer with over 40 years experience and has been involved in the review of design rainfall analysis for the LIMB, Gold Coast and most recently the QRA design rainfall data sets.