

フィリピン国

マニラ首都圏開発庁

フィリピン国
パッシング河予警報システム事業
復旧支援プロジェクト
洪水予警報アドバイザー業務
[有償勘定技術支援]

専門家業務完了報告書

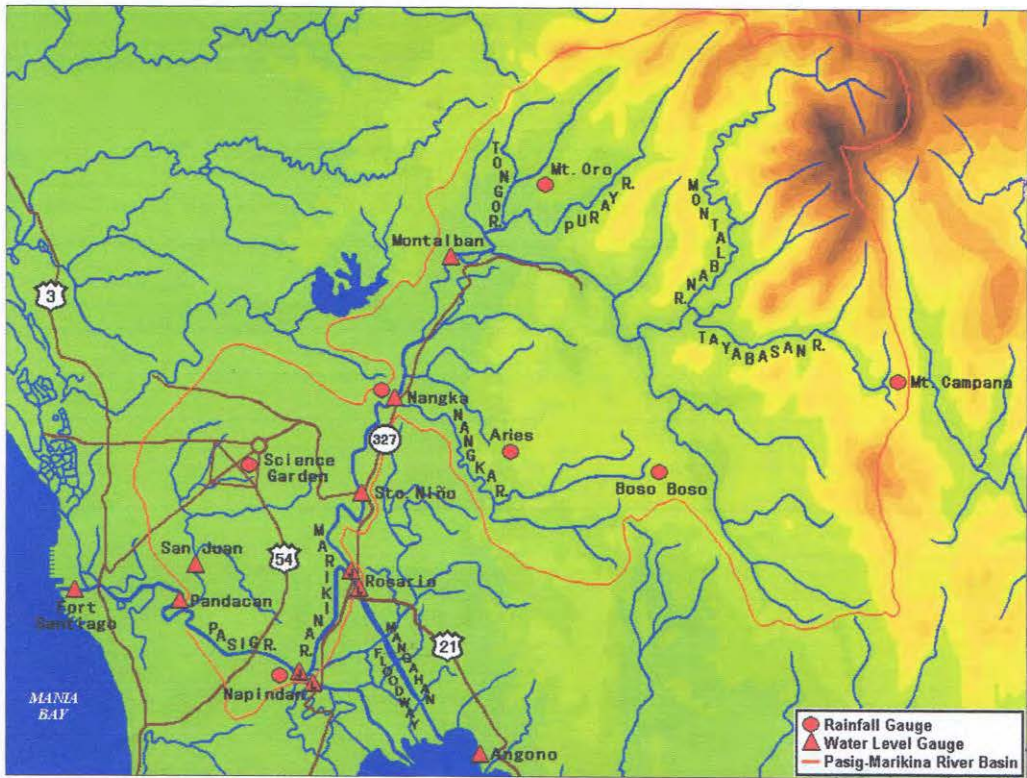
平成 28 年 3 月

(2016 年)

独立行政法人国際協力機構（JICA）フィリピン事務所
株式会社建設技研インターナショナル

フピ事
JR
15-004

位置図



ロザリ

目 次

位置図
目次

1.	背景と業務目的	1
1.1	背景	1
1.2	業務の目的	1
2.	業務範囲及び実施行程	2
3	土木工事、機材調達・製造・据付工事の進捗状況の確認	3
4.	協力内容の確認及び先方負担事項とその実施体制の確認	5
5.	「フィ」国側関係機関との協議及び実施体制調査	5
6.	洪水予警報に係る現状の確認	6
6.1	実施機関（MMDA）の現状・将来計画・要望の確認	6
6.2	他の「フィ」国政府機関、他のドナー等の現状・将来計画	7
6.3	大マニラ首都圏域の洪水対策と EFCOS Project の役割・位置づけ	8
7.	運営・維持管理計画（案）の作成	10
8.	運営・維持管理に係るセミナー・ワークショップの開催	11
9.	改修・復旧プロジェクトの関係スタッフ研修	13
10.	現地業務結果報告書の作成、提出及び報告	15
11.	EFCOS Project 改修・復旧事業の実施工程	15
12.	課題	16

添付一 1	: EFCOS Project 運営・維持管理計画（案）
添付一 2 a	: <セミナー> EFCOS 改修・復旧の概要 (Outline of EFCOS Improvement/Restoration Project)
添付一 2 b	: <セミナー> 防災に関する EFCOS データの活用 (Utilization of EFCOS Data for Disaster Management)
添付一 2 c	: <セミナー> フィリピン天文気象庁のメトロ・マニラにおける洪水予警報システム運営の概要 (Outline of Operation of PAGASA's Flood Forecasting and Warning System in Metro Manila)

1. 背景と業務目的

1. 1 背景

フィリピンは世界でも最も自然災害の多い国の一つである。自然災害による経済的、人的被害は甚大であり、社会経済基盤の度重なる被害は、フィリピンの経済活動に深刻かつ長期的な影響を与えている。自然災害の中でも台風・暴風雨や洪水による被害がそのほとんどを占めており、台風・暴風雨と洪水への対策は特に重要な課題となっている。

マニラ首都圏はフィリピンの政治、経済、文化の中心地である。しかし、沿岸低地地域という特性から台風の影響を受けやすく、同地域の経済・社会活動は、洪水や内水氾濫により深刻な影響を受けてきた。また、同地域における度重なる洪水被害とそれによる経済活動等の停滞は、同地域のみならず国全体の成長・開発に負の影響を及ぼすものとなっている。

かかる状況から、我が国は1970年代より継続的にマニラ首都圏の洪水対策を支援してきている。マニラ首都圏の中心部を洪水から守るべく、有償資金協力事業「パッシング河治水事業」（1975年3月L/A調印）にてマンガハン放水路と分流可動堰（ロザリオ堰）等の建設を支援し、「パッシング河洪水予警報システム事業」（1983年9月L/A調印）ではマンガハン放水路を有効かつ安全に活用するための、洪水警報装置とロザリオ堰の早期有効操作のためのシステム（Effective Flood Control Operations System: EFCOS）の整備を支援した。EFCOSはその整備以来、マニラ首都圏中心部を守る洪水予警報として機能し、その重要性に鑑み、我が国は無償資金協力「メトロマニラ洪水制御及び警報システム改善計画」（2000年度E/N署名）にてEFCOSのシステム全体の見直しと改善を支援した。

しかし、2006年9月の台風「ミレニオ」（国際名：シャンセン）、2009年9月の台風「オンドイ」（国際名：ケツァーナ）等、度重なる台風によりEFCOSの附帯施設（雨量計、水位計、通信システム等）は損傷を受け、EFCOSは現在、その機能を十分に発揮できない状況にある。特に台風「オンドイ」は180年に一度とも言われる大規模降雨を伴う大災害をもたらし、EFCOSも大きく損傷した。これを機に、フィリピン政府はそれまでのEFCOSの維持管理体制を見直す内部体制改革を実施するとともに、自己資金での改修を進めてきている。しかし、破損した機器の中にはシステムの中心にあるリピーター等、高額の機材も含まれており、自己資金によるすべての機器の回復は非常に難しい状況にある。

マニラ首都圏においては近年台風やモンスーンによる洪水が従前に増して頻発しており、EFCOSの復旧は喫緊の課題となっている。この状況を受け、フィリピン政府は日本政府に対し、破損した関連機器（無線装置、雨量計、水位計、警報関係機材等）の改修等によりEFCOSの洪水予警報機能の回復を支援する「パッシング河予警報システム事業復旧支援プロジェクト」（以下、EFCOSプロジェクトという）への支援を要請した。

右要請を受け、JICAは2014年7月に本プロジェクトの実施に向けた詳細計画策定調査を行い、EFCOSのシステム全体及び各施設・機材の現状確認を行うと共に、復旧対象施設・機材とその復旧方法、周波数変更に伴い必要な対応、また先方実施事項等の詳細をフィリピン側関係機関と協議した。右協議結果は、2014年10月に基本合意文書（Memorandum of Understanding: MOU）としてJICAとフィリピン側実施機関の間で署名・交換されている。また、プロジェクトの詳細計画（案）は、詳細計画策定調査報告書にまとめられている。同調査報告書の中でEFCOSシステムにおける運用・維持管理計画、運用・維持管理作業に対応可能な人数・予算不足が指摘されている。

1. 2 業務の目的

洪水予警報アドバイザー業務は、フィリピンのカウンターパート（C/P）機関であるマニラ首都圏開発庁（Metropolitan Manila Development Authority: MMDA）に対してEFCOSプロジェクトにより復旧した機材および新しく投入された機材を用いた円滑なEFCOSのシステム全体の運用・維持管理計画（人材育成および予算管理計画等を含む）に係る技術指導を行うことで開発効果増大を図るものである。

2. 業務範囲及び実施行程

本業務は、国内準備業務、現地業務、帰国後業務に分かれる。

(1) 国内準備期間 (2016年1月4日から1月8日 : 5日間)

以下の業務を実施した。

- 1) 要請背景・内容の把握、関連報告書のレビュー
- 2) ワークプラン(案)の作成
- 3) 復旧・改修工事における進捗状況の確認

(2) 現地派遣期間 (2016年1月10日—2016年2月24日 : 46日間)

現地業務は相手側実施機関(MMDA-EFCOS)が準備したパッシング市ロザリオのEFCOS Project事務所内で実施した。業務の範囲は以下の様である。

- 1) フィリピン側関係機関と協議およびその実施体制調査
- 2) 復旧・改修工事における進捗状況の確認
- 3) フィリピン側関係機関及び他ドナーの確認(現状・将来計画及び大マニラ首都圏域の洪水対策とEFCOSとの関連等)
- 4) 協力内容の再確認・整理
- 5) 先方負担事項と実施体制の確認・整理
- 6) 事業の実施中・実施後のEFCOSの留意点の検討・整理
- 7) 実施機関等への指導・助言
- 8) 運営・維持管理に係るセミナー・ワークショップの開催
- 9) 現地業務報告書の作成、報告
- 10) その他(必要に応じて)

(3) 帰国後整理 (2016年3月7日—2016年11月 : 5日間)

- 1) 業務完了報告書作成、報告。

3. 土木工事、機材調達・製造・据付け工事の進捗状況の確認

EFCOS Project の改修・復旧工事は、MMDA 側が実施する土木関係工事も 2016 年 1 月までに全て完了した。また、機器関係の調達・据え付け工事も日本の受注者と 2015 年 6 月 11 日に契約、2016 年 2 月 6 日までには実質完了した。工事の進捗状況の概要は以下のとおりである。(事業の計画・実施工程は、「1.1. EFCOS 改修・復旧事業の実施工程」を参照)

(1) MMDA 側が担当した土木工事

2015 年 10 月の MMDA と JICA フィリピン事務所間の合意書に基づき、MMDA は以下のような主要土木工事を実施した。いずれの工事も MMDA の直営で実施した。

- ① Nangka 観測所の嵩上げ (2009 年の台風 Ondoy の洪水の被災経験から 1 階建てを 2 階建て建物に変更) (2015 年 7 月完了)
- ② 警報装置基地 (Warning Post) No. 8 の嵩上げ (2009 年台風 Ondoy の洪水位の実績値に基づいて嵩上げ) (2015 年 8 月完了)
- ③ Napindan 水門管理棟の EFCOS Project 用の部屋の改良 (空調設備も設置) (2015 年 12 月完了)
- ④ Napindan 水門用地へ送受信用鉄塔の建設 (2015 年 12 月完了)
- ⑤ Antipolo Relay Station に空調設備設置 (2016 年 1 月完了)



Nangka 観測所の台風 Ondoy の洪水被災
(EFCOS Project 事務所撮影：2009 年 9 月)



2階建屋にしたNangka観測所(2016年1月)



Napindan HCS に建設された鉄塔

(2) 日本側が担当する機器改修・復旧支援工事

- ① 業者の調達：(株) 日本無線 (Japan Radio Co., Ltd.; JRC) と随意契約
- ② 契約日：2015年6月11日
- ③ 契約履行期間：2016年1月20日までの224日(当初)
- ④ 変更契約履行期限：2016年2月26日
- ⑤ 契約金額：129,125,592円
- ⑥ 工事概要
 - a. 現場踏査(2015年7月2, 3日)及び設計
 - b. MMDA/EFCOS Project 事務所、関係機関、請負業者と工事調整会議(2015年8月14日)
 - c. 設計承認図作成・提出・承認
 - d. 機器の製造
 - e. 工場検査
 - f. 機器の輸送(日本からEFCOS Project 事務所まで、海上及び陸上輸送。2015年12月4日EFCOS Project 事務所に到着)
 - g. フィリピン国内における機器の調達
 - h. 機器の据付け工事(2016年1月11日までに、雨量及び水位のデータ受信及び警報装置操作が可能になる。また、2016年2月1日までに、IP Radioの使用が可能及伝送データの受信が各モニター基地で可能)
 - i. 試運転及び検査
 - j. インベントリー検査(2016年2月9日-12日)
 - k. EFCOS Project Master Control Station 及び Monitor Station 設置関係機関スタッフのトレーニング(2016年2月19日及び3月1, 2日)



4. 協力内容の確認及び先方負担事項とその実施体制の確認

2016年1月11日、MMDA General Manager, EFCOS Project 事務所、JICA フィリピン事務所、JICA 短期専門家、コントラクターが参加した改修・復旧プロジェクトの調整会議が持たれた。会議では、工事の進捗状況の確認、MMDA 側負担事項の確認等が行われた。また、JICA 短期専門家の業務開始に当たり、ワークプランの説明を行い、協力内容の再確認を行った。

MMDA 側の主な負担事項には、以下のものがありいずれも完了した。

- (1) 観測所建屋の改修、鉄塔建設等の土木工事（3.（1）参照）
- (2) 日本からの機器輸入に関するフィリピン関税の負担
- (3) フィリピン国内の輸入機器の輸送費
- (4) NTC（国家電信電話委員会）へ周波数免許申請および関連手続き
- (5) EFCOS Project スタッフの事業への参与
- (6) EFCOS 事務所等の関連施設提供

5. 「フィ」国側関係機関との協議及び実施体制調査

フィリピン側関係機関 PAGASA と OCD-NDRRC と、EFCOS Project と関係機関の事業の関係について協議した。併せてそれらの機関の実施体制を調査した。

(1) PAGASA との協議

- a) 日時：1月26日（火）、午前11時-12時
- b) 面会者：
 - RLV Macalalad (Weather Specialist, PAGASA-Hydrometeorology Division)
 - Shiela S. Schneider (Weather Specialist, PAGASA-Hydrometeorology Division)
 - Nivagine Nievares (Weather Specialist, PAGASA-Hydrometeorology Division)
- c) 協議内容：
 - EFCOS の改修・復旧工事が2月20日ごろまでに完成することを PAGASA に伝えた。
 - 一方、PAGASA にあるモニター画面で EFCOS データが既に伝送されていることを確認した。
 - しかし、EWS2 Project で設置した大画面のモニターに EFCOS データを導入するつもりであるが、現在、技術上の問題で自動的に取り込めない状態である。そのために、マニュアルで入力している。
 - Pasig-Marikina 河の洪水予警報に関して、EFCOS Project と PAGASA の間の境界があいまいである。今年3月から EWS3 Project（別称 KOICA3 Project）の一部として EFCOS データを取り組んだ洪水予警報のソフト・コンポーネントが開始する予定である。
 - PAGASA が関与している他のプロジェクト、EWS2 Project 及び EWS3 Project、Project NOAH、Resilience Project、GMMMA Project に関して情報を収集した。

(2) OCD-NDRRMC との協議

a) 日時：2月9日（火）11時-11時半

b) 面会者：

Relan Jay J. Ascuncion (Chief, National Disaster Risk Reduction and Management Operations Center),

Kaye Maming (Staff, Communication, Electronics and Information Division)

c) 協議内容：

- EFCOS の改修・復旧工事が2月20日ごろまでに完成することを相手側に伝えた。
- また、NDRRMCにあるモニター画面でEFCOS データが既に伝送されていることを確認した。
- MMDA でセミナーを開催する予定及び NDRRMC のモニター機器の操作に関してトレーニングへの出席を要請した。
- NDRRMC からは、EFCOS Project に関して特にコメント、要請等はなかった。

6. 洪水予警報等に係る現状の確認

EFCOS Project を含むフィリピン国の洪水予警報関係の現状や問題点、能力強化ニーズ等の情報は、2013年9月の JICA 調査レポート(Data Collection Survey on Situation of nationwide Flood Forecasting and Warning System in the Philippines)から多くを得られる。このレポートの情報は2013年であることから、今回アップデートを行った。

6.1 実施機関 (MMDA) の現状・将来計画・要望の確認

MMDA は、洪水対策に関して以下のような現状計画、将来計画を有している。

(1) 既存大規模排水機場の修復及び新築

MMDA が運営管理している排水ポンプ場は数十年前から建設されてきており、現在の能力は設計能力より可成り劣っている。MMDA は世界銀行の支援で、それら既存の排水ポンプ場約40か所の近代化と付属施設の改良（例えばジーゼルエンジンから電動機に交換等）、また、大型排水ポンプ場の新設、既存排水路内の調整貯水能力向上等を2016年から実施する予定である。事業名は Metro Manila Flood Management-Phase 1（事業費362.6百万US\$）で、世界銀行の大マニラ首都圏洪水対策マスタープラン実現の一環である。

(2) 洪水予警報システム新設の可能性を検討

La Mesa 貯水池からメトロ・マニラの北（ケソン、マラボン、バレンズエラ）を流れ延長約15kmのTullahan川の洪水に対して洪水予警報システム新設の可能性を検討している。これは、PAGASAのEWS3 Projectと対象域が重複している。

6. 2 他の「フィ」国政府機関、他ドナー等の現状・将来計画

パッシング-マリキナ河流域およびマニラ首都圏の気象水文監視を目的として、EFCOS のみならず以下のような他国のドナーおよび「フィ」国政府機関が、各々独自の方法により関与している。

- (1) PAGASA の KOICA 支援 EWS2 Project 及び EWS3 Project
- (2) CIDA/UNDP の Resilience Project
- (3) DOST-ASTI や UP が主導した Project NOAH

(1) EWS 2 Project 及び EWS 3 Project

PSAGASA 実施の EWS 2 Project は、パッシング・マリキナ河流域にテレメータ雨量、水位観測所、警報装置、洪水予警報システムを確立するものである。

- 1) 事業名称：Automation of Flood Early Warning System for Disaster Mitigation in Greater Metro Manila
- 2) 事業期間：2010 年 11 月 - 2012 年 5 月
- 3) 事業目的：雨量・水位データ収集、洪水予報、早期警報システム及び通信システムの確立
- 4) 観測所・警報施設設置規模：10.水位観測所、10.雨量観測所、20 警報施設、4 自動気象観測所
- 5) 実施機関：PAGASA
- 6) ドナー：KOICA

EWS 3 Project は、2017 年完成を目標に 2016 年に開始した。パッシング・マリキナ河流域に更に 11 か所の雨量観測所を増設、また北方で隣接する Tullahan 川流域に 4 か所の雨量観測所、3 か所の水位観測所、14 か所の警報装置を設置する計画である。更に、Tullahan 川の洪水予警報システムをパッシング・マリキナ河流域の予警報と統括することを目標としている。

(2) Resilience Project

メトロマニラを対象とする Resilience Project は、自治体の災害被害の軽減への能力強化と自然災害に対する地域社会の弾力性及び自然災害の脆弱性軽減への対応を強化することである。

- 1) 事業名称：Building Community Resilience and Strengthening Local Government Capacities for Recovery and Disaster Risk Management
- 2) 事業期間：2010 年 - 2013 年
- 3) 事業目的：パッシング・マリキナ河流域に及び Tullahan 川流域の早期洪水警報の確立、EFCOS、KOICA、DOST-ASTI 及び本事業で設置したシステムの統合、及び自治体（マリキナ市-パッシング市-カインタ町）が色々な関係者を取り込む災害対応の計画立案のサポート。
- 4) 観測所・警報施設設置規模：1 水位観測所、22 雨量観測所
- 5) 実施機関：OCD-NDRRMC
- 6) ドナー：CIDA (Canadian International Development Agency) 及び UNDP (United Nations Development Plan)

(3) Project NOAH

Project NOAH (Nationwide Operational Assessment of Hazards) は、フィリピン全土の特に災害リスクの高い地域における、より早期に正確で統合された災害防止・軽減システムの確立を目指す大統領の要求に対して、DOST が対応したものである。プロジェクトは、フィリピン大学国立地質科学研究所やフィリピン大学工学部の協力の下に、DOST 傘下の ASTI が有する技術面と PAGASA、PHIVOLCS の運営面のそれぞれの優位性を活用・連携しながら進められている。

元来、プロジェクトは 8 つのコンポーネントから構成されているが、EFCOS と関係しているのは次の 3 つのコンポーネントである。これらは、全国を対象としている。他のコンポーネントとしては、他の自然災害を対象としたもので、地すべり、海岸災害および高潮、さらにはドップラーレーダーや地すべりセンサーの開発などがある。これらのプロジェクトは、2013 年 12 月を目標に整備が進められ、現在は運用段階に入っている。

- 1) フィリピンの災害多発地域への水文気象観測機器の配置 (Hydromet) : 洪水に関する全国の表流水の特性をより把握するため、パッシング・マリキナ川流域を含む主要河川の 18 流域に、自動雨量観測機器 600 ヶ所、水位観測所 400 ヶ所を設置する。
- 2) 災害リスク軽減のための評価プロジェクト : 光検出・測距方式 (DREAM-LiDAR) : 全国の浸水危険区域や主要河川流域を対象に、より正確な洪水氾濫・危険度マップを三次元で作成する。
- 3) 洪水情報ネットワークプロジェクト (FloodNet) : タイムリーでかつ正確な早期洪水警報を提供する洪水センターを完成する。FloodNet プロジェクトは、危険性の高い河川流域に対し、シミュレーションモデルを構築し、自動的にデータを収集処理し、洪水情報の出力に基づく洪水予測を提供する。

EFCOS Project 事務所は、DOST-ASTI がパッシング河 - マリキナ河 - サンホアン川流域及びトルハン (Tullahan) 川流域に設置した 3 雨量観測所及び 38 水位観測所の維持管理を行っている。

6. 3 大マニラ首都圏域の洪水対策と EFCOS Project の役割・位置づけ

リザール、ラグナ、カビテ、ブラカン州などからなる大マニラ首都圏域 (Greater Metro Manila) における洪水予警報を含む洪水対策における EFCOS プロジェクトの役割・位置づけを確認した。

(1) EFCOS Project のラグナ湖流域への拡張

2001 年に実施された EFCOS の改修・復旧事業 (Project for Rehabilitation and Warning System in Metro Manila under the Japanese Grant Aid in 2001) の計画調査のなかで、EFCOS Project のラグナ湖への拡張が論じられている。結論的には、EFCOS Project のラグナ湖流域への拡張は、以下に概要するように将来詳細に検討すべきとしている。

1) テレメーター雨量観測所

フィリピンの専門家によると、メトロマニラの降雨は、通常、北西からくる。これは、ほとんどの台風が北西からルソン島に接近するからである。ラグナ湖はメトロマニラの南東に位置するが、ラグナ湖の降雨は、パッシング・マリキナ河流域の降雨の前触れとなる。このためには、ラグナ湖流域にテレメーター雨量観測所を設置することによりメトロマニラの降雨予測を行うことができる。しかしながら、現在の既存データはこの現象を検証できるほど十分ではない。

ラグナ湖流域には長い間、雨量観測所が設置されてこなかった。1998 年、LLDA は 5 か所の雨量観測所を設置したが、目的は、湖の水量観測である。それらは、テレメーターリングされておらず、洪水予警報には使用されていない。これらのデータの蓄積を持って、将来、雨量観測所の設置などを検証すべきである。

2) テレメーター水位観測所

台風によって発生するラグナ湖の問題の一つは、強風と低気圧によって発生する突発的な湖水位の変動である（この現象を地元では seiche と呼ぶ）。1995 年 11 月、台風 Rosing によってこの現象が発生した。EFCOS Project の Angono 水位観測所の記録によると、11 月 3 日深夜 12 時の湖水位 12.6m が 3 日の午前 11 時に 10.8m まで降下した。その後、上昇して同日午後 3 時に 13.5m に達した。この変動は 2.7m であった。この現象で Laguna や Rizal の湖岸で甚大な被害が発生したという。

日本の琵琶湖（670 km²）は、6 か所のテレメータ水位観測所を設置している。ラグナ湖では、Angono 水位観測所だけである。将来、テレメータ水位観測所の増加を検討すべきである。

(2) 「全国洪水予警報システムの状況情報収集調査」(JICA、2013 年 9 月) の検討

「全国洪水予警報システムの状況情報収集調査」報告書 (JICA、2013 年 9 月) は、パッシング・マリキナ河-ラグナ湖流域の洪水予警報に関して、以下のコメントをしている。

パッシング・マリキナ河及びラグナ湖流域には、既に、EFCOS、KOICA や NOAH などいくつかの雨量・水位観測システムが確立されている。更に、UNDP/AusAID (Ready for GMMA) と UNDP/CIDA (Resilience Project) には、大マニラ首都圏の早期洪水予警報システムの分野も含んでいる。PAGASA は、現在、これら KOICA、CIDA、AusAID や EFCOS のシステムを全てのステークホルダーへの洪水情報を発信するために、統合を図っている。PAGASA は、GMMA Project の中で水理水文情報全てを自治体と共有することを考えている。このような状況のもと、特に、次のようなニーズが将来考慮されるべきである。

	項目	ニーズ
1	洪水警報水位	最近の洪水の例を考慮して統一された水位が適用されるべきである。
2	洪水予警報	現在の洪水予警報モデルの再検討
3	洪水情報の発信	洪水情報や警報の発信で MMDA と PAGASA の明確なデマケが必要。 EFCOS 及び KOICA を統合した Operation Manual が必要。
4	公共情報・教育	MMDA、PAGASA、OCD 及び自治体間の調整を強化すること
5	NOAH が設立した観測所	運営・維持管理の再編成が必要

(3) パッシング・マリキナ川河道改修事業のマリキナ堰建設計画上の運営・維持管理計画

マリキナ川の洪水を確実にマンガハン放水路に分流するために、パッシング・マリキナ川河道改修事業の中でロザリオ堰とロザリオ橋の間にマリキナ堰 (Marikina Control Gate Structure: MCGS) の建設が計画されている。将来、EFCOS Project は、ロザリオ堰およびナピンダン水門と同様に、MCGS の運営・維持管理を行う必要があるだろう。

(4) 大マニラ首都圏洪水対策マスタープラン(2012)

フィリピン政府は世界銀行の支援のもと、2012 年に大マニラ首都圏洪水対策マスタープラン (M/P) を策定した (Master Plan for Flood Management in Metro Manila and Surrounding Areas)。M/P は 2012 年 9 月 NEDA Board に承認されたが、優先すべき構造物対策及び非構造物対策を策定している。事業は 20 年から 25 年先を目標としてその必要資金を 3,520 億ペソ (80 億 US\$) と見積もっている。M/P の主要対策案は次のようである。

- 1) 都市域を流れる河川の洪水対策
- 2) ラグナ湖の長期にわたる洪水対策
- 3) 都市域の排水改善
- 4) 洪水予報・早期警報やコミュニティベースの洪水対応などの非構造物対策
- 5) 包括的な洪水対策組織制度の改善

上記4)では、次のような優先事業を早期に実施すべきであるとしている。ただし、詳細は記述されていない。

- EFCOS Project の改善
- 洪水予警報カバー区域をラグナ湖流域と Malabon-Tullahan 川流域へ拡大

7. 運営・維持管理計画（案）の作成

運営・維持管理計画（案）を作成するために、以下のような活動を行った。

(1) 現場視察

EFCOS Project の運営・維持管理の現況を把握するために、EFCOS Project 施設の現場視察を1月18日から1月22日の間に実施した。

(2) EFCOS の現状の運営・維持管理システムや EFCOS 事務所の組織（人員、役割）、予算配分等の確認を行った。

(3) 運営・維持管理上の現在の問題点・課題を整理、現状を評価した。主な留意点は以下の様である。

- 1) EFCOS Project と、EFCOS に関連する Mangahan 放水路と Napindan Hydraulic Structure (NHCS) の3つの施設は、一人の Director が管轄しており運営・維持管理上の齟齬を防ぐことができ、組織上評価できる。
- 2) 2014年の詳細調査でも指摘されているように、主要な人員(Engineer クラス)が不足している。
- 3) 各年間の必要予算の積み上げがなされてきていない。
- 4) 最近の主な運營業務は、伝送されてくる観測データの収集・整理、関係機関へその生データを伝送、Rosario Weir のゲート操作であり、洪水予警報の業務はなされていない。
- 5) 従って、EFCOS から同様に MMDA 内部の組織である Flood Control Information Center (FCIC) へ伝達する洪水情報は時間雨量や時間河川水位だけであり、洪水予警報が無い内容のため、FCIC から Public への情報発信には不十分さがある。
- 6) Napindan HCS の水門ゲートは操作できているが、舟運ロックは故障しており開口したままである。DPWHによると、現在、修理のためのアクションをDPWHは取っているという。
- 7) Napindan HCS の操作記録が完全に整理されていない。また、この操作記録を年報に含めるべきである。

(4) 運営・維持管理計画(案)の基本構成の立案

復旧された EFCOS が持続的に機能を発揮するためには、システムの管理責任機関である MMDA-EFCOS 組織の実施体制が、十分な体制と人員を有し、機器補修および更新に対して相応の予算措置が行われていることが不可欠である。O&M 計画(案)の基本構成は以下のとおりである。

- 1) 序論 (EFCOS Project の必要性・目的を明確、事業の時間的流れ、O&M 計画の必要性・見直し、O&M マニュアル)

- 2) EFCOS Project 施設の概要 (施設台帳)
 - 3) EFCOS Project の運営 (ゲート操作ルール、Mangahan 放水路沿いの警報発令ルール、予警報、洪水情報の伝達)
 - 4) 施設の維持管理計画
 - 5) 組織計画
 - 6) 年間予算計画
 - 7) 関連事業情報の収集 (KOICA、Resilience Project、Project NOAH、GMA Project)
 - 8) 将来計画 (ラグナ湖への拡張計画、JICA2013 年全国予警報情報調査の提案、パッシング・マリキナ河道改修事業におけるマリキナ堰建設計画、WB の M/P の計画)
- (5) 運営・維持管理計画(案)の作成 (添付-1 参照)

8. 運営・維持管理に係るセミナー・ワークショップの開催

洪水予警報システムの運営・維持管理を主体としたセミナー・ワークショップを2月18日(木)に開催した。準備はEFCOS 事務所スタッフおよびMMDA Training Center と協力して行った。概要は以下の様である。なお、EFCOS Project に直接関係するプログラムのプレゼンテーションを添付-2a、添付-2b、添付-2c に示す。

メトロマニラ洪水予警報システムの運営維持管理に関するセミナー・ワークショップ Seminar/Workshop On the Operation and Maintenance of Flood Forecasting and Warning System in Metro Manila		
日時：2016年2月18日(木) 13:15 - 16:00		
場所：Makati City Room, MMDA Main Building (EDSA Guadalupe, Makati City, Metro Manila)		
プログラム		
(項目)	(発言者)	(実時間)
1. 受付(Registration)		12:30-13:20
2. 国歌斉唱(Philippine National Anthem & National Anthem of Japan)		13:20
3. お祈り(Invocation)		13:25
4. 開会式の辞(Opening Remarks)	Mr. Emerson S. Carlos Chairman, MMDA	13:30-13:35
5. JICA メッセージ(Message from JICA)	Mr. Takahiro Morita Senior Representative, JICA Philippines Office	13:35-13:40
6. MMDA 管轄の洪水対策施設の維持管理(MMDA Maintenance Works on Flood Control Facilities)	Engineer Baltazar N. Melgar Director IV, MMDA-FCSMO (Flood Control and Sewerage Management Office)	13:40-13:50

7. EFCOS 改修・復旧の概要 (添付-2a) (Outline of EFCOS Improvement/Restoration Project)	Engineer Maxima M. Quiambao Director III, Head of EFCOS Project	13:50-14:25
8. EFCOS ウェブサイトの確立の概要 (Outline of Establishment of EFCOS Website)	Mr. Francis Funa Consultant of CTII for DPWH-Pasig Marikina River Channel Improvement Project (Phase III)	14:25-14:50
9. 防災に関する EFCOS データの活用 (添付-2b) (Utilization of EFCOS Data for Disaster Management)	Mr. Ramon J. Santiago Head of MMDA-FCIC/MMDRRMOC (Flood Control Information Center/Metro Manila Disaster Risk Reduction and Management Operation Center)	14:50-15:00
10. フィリピン天文気象庁のメトロ・マニラにおける洪水予警報システム運営の概要 (添付-2c) (Outline of Operation of PAGASA's Flood Forecasting and Warning System in Metro Manila)	Engineer Maximo Peralta PAGASA-HMD (Hydrometeorology Division)	15:00-15:40
11. オープンフォーラム (Open Forum) (質疑応答の概要) <ul style="list-style-type: none"> ● マリキナ川上流に治水ダムができた場合、EFCOS Project はどうするのか？ (回答-ダム建設に合わせて EFCOS システムを修正する必要がある) ● EFCOS Project、KOICA2、Project NOAH の水位計の標高基準は何か？ (回答-EFCOS と KOICA2 はマニラ湾の Mean Low Low Water Level を EL. 10.0 m とした同じ基準を使用している。Project NOAH は明確でないが現地の川底を基準にしていると思われる) ● EFCOS Project の PAGASA モニター基地と DPWH モニター基地間の接続はどういう状況か？ (回答-障害物があるため 2 点を直線で接続することは出来ない。Napolcom 経由で 2 点間を接続する計画で PAGASA と Napolcom が合意書を締結する予定である) 		15:40-15:50
12. 閉会の辞 (Closing Remarks)	Undersecretary Corazon T. Jimenez General Manager, MMDA	15:50-16:00

(出席者) 合計 71 名

	参加所属先	参加者数
1.	フィリピン天文気象庁 PAGASA (Philippine Atmospheric, Geophysical, and Astronomical Services Administration)	2
2.	市民防衛局 OCD (Office of Civil Defense)	3
3.	ラグナ湖開発庁 LLDA (Laguna Lake Development Authority)	1
4.	国家電信電話委員会 NTC (National Telecommunication Committee)	1

5.	国家経済開発庁 NEDA (National Economic and Development Authority)	3
6.	公共事業道路省 DPWH (Department of Public Works and Highway)	2
7.	科学技術省 - 先端科学技術研究所 DOST-ASTI (Department of Science and Technology - Advanced Science and Technology Institute)	2
8.	JICA フィリピン事務所 JICA Philippines Office	4
9.	JICA Expert	4
9.	マニラ首都圏開発庁 MMDA (Metropolitan Manila Development Authority)	50
10.	(株) 日本無線 (EFCOS 改修・復旧工事業者)	4



9. 改修・復旧プロジェクトの関係スタッフ研修

今回の改修・復旧事業の完成に伴い、事業受注者（(株) 日本無線）により、EFCOS 及び関係機関のスタッフに対して、機器の運営・維持管理のトレーニング開催をモニターした。トレーニングのプログラム、スケジュールは以下の様である。なお、研修内容は、主に、新規に導入されたシステムや機器を対象にして行った。

	日	時間	内容	対象者
1 日目 (1 st Day)	2 月 19 日 (金)	9:00-12:00	改修・復旧事業の概況 Outline of Rehabilitation Works and Subsystem	MMDA (EFCOS 事務所及び関係部署) : 27 名参加
		13:00-14:00	圧力型及びフロート型水位計の詳細 Detailed Explanation of Pressure Type and Float Type Water Level Gauge	
		14:00-15:00	雨量計センサーの詳細 Detailed Explanation of Rain Gauge Sensor	
		15:00-17:00	新設データメモリーパッケレ	

			コーダー及びリーダーの詳細 Detailed Explanation of DMP (Data Memory Package) Recorder and DMP Reader Software	
2 日目 (2 nd Day)	3 月 1 日 (火)	9:00-11:00	新設のマイクロ IP 多重無線装置の詳細 Detailed Explanation of IP Radio Equipment	MMDA (EFCOS 事務所及び関係部署)
		11:00-12:00	マイクロ IP 多重無線装置操作方法及び保守管理 Hands on for IP Radio	
		13:00-14:00	IP ベースのネットワーク構築の詳細 Detailed Explanation of Network	
		14:00-17:00	EFCOS データのウェブサイトモニター及び報告のためのトレーニング Operator's Training for Website Monitoring and Reporting of EFCOS Data	
3 日目 (3 rd Day)	3 月 2 日 (水)	9:00-10:30	通信施設の詳細及び保守管理 Detailed Explanation of Telemetry Equipment	MMDA (EFCOS 事務所及び関係部署)
		10:30-12:00	新設の独立型電源設備の詳細及び保守管理 Detailed Explanation of Power Supply	
		13:00-15:00	新規交換した送受信機器及び液晶ディスプレイを含む警報装置の詳細及び保守管理 Detailed Explanation of Warning Equipment	
		15:00-16:00	新規交換した 150MHz 帯送受信器の詳細 Detailed Explanation of 150MHz band Radio Equipment	



初日の研修の様子（１）



初日の研修の様子（２）

10. 現地業務結果報告書の作成、提出及び報告

現地での業務の内容、活動、経過等を「現地業務結果報告書」として取りまとめ、JICA フィリピン事務所にて2016年2月24日報告した。

11. EFCOS 改修・復旧事業の実施工程

基本合意文書（Memorandum of Understanding）に添付されている Plan of Operation に沿って、事業の計画及び実施工程を次図に示す。事業は、目標とした2016年3月に完了した。

REPUBLIC OF THE PHILIPPINES
METRO MANILA DEVELOPMENT AUTHORITY (MMDA)

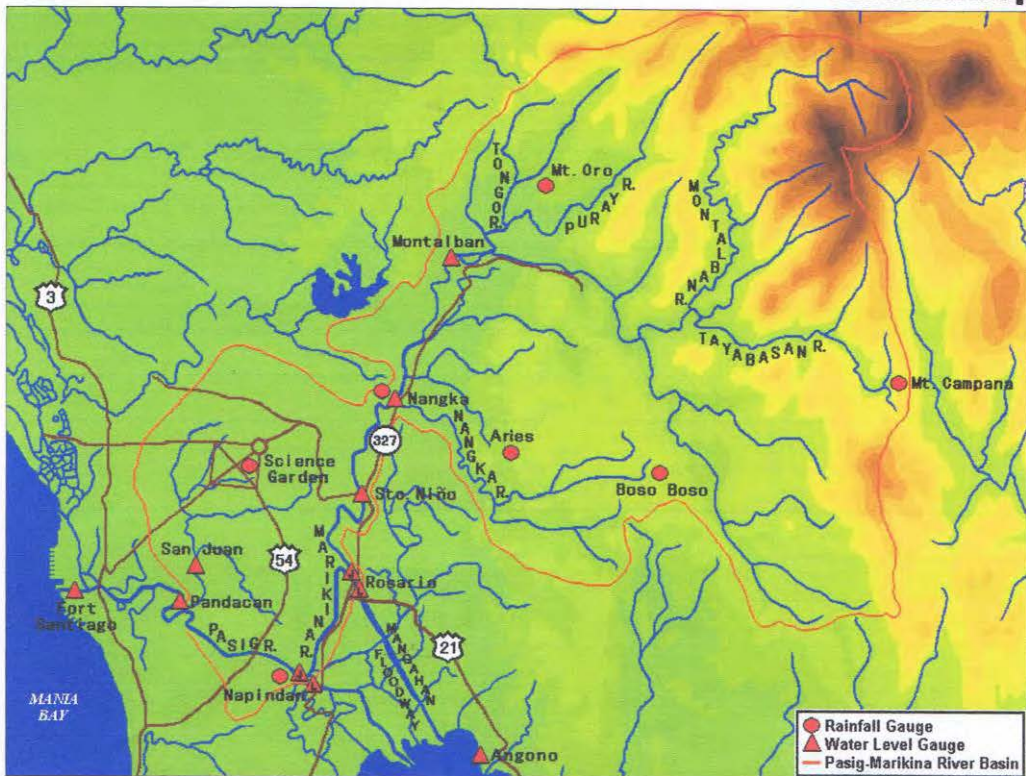
**EFFECTIVE FLOOD CONTROL
OPERATION SYSTEM (EFCOS PROJECT)**

OPERATION AND MAINTENANCE PLAN
(DRAFT)

MARCH 2016

FLOOD CONTROL AND SEWERAGE MANAGEMENT OFFICE
EFCOS PROJECT OFFICE

Location Map



EFCOS Rosario Master Control Station and Rosario Well

Table of Contents

Location Map
Table of Contents

CHAPTER 1. INTRODUCTION.....	1-1
1.1 Necessity of the EFCOS Project.....	1-1
1.2 Rehabilitation and Improvement Works of the EFCOS Project.....	1-1
1.3 Validity of the EFCOS Project.....	1-3
1.4 Objectives of the EFCOS Project.....	1-3
1.5 Purpose of Operation and Maintenance (O&M) Plan.....	1-3
1.6 Effectiveness of O&M Plan.....	1-4
1.7 O&M Manuals.....	1-4
CHAPTER 2. CONFIGURATION OF THE EFCOS PROJECT.....	2-1
2.1 Pasig-Marikina River and Laguna Lake Complex.....	2-1
2.2 Configuration of the EFCOS Project under the Phase 3.....	2-4
2.3 Features of Stations of the EFCOS Project (Phase 3).....	2-5
CHAPTER 3. OPERATION PLAN OF THE EFCOS PROJECT.....	3-1
3.1 Gate Operation Rule of Rosario Weir.....	3-1
3.1.1 General.....	3-1
3.1.2 Data Processing System.....	3-1
3.1.3 Operation Rule of Rosario Weir.....	3-2
3.2 Operation Rule of Napindan Hydraulic Control Structure.....	3-5
3.3 Operation of Flood Warning along Mangahan Floodway.....	3-6
3.4 Flood Forecasting.....	3-6
3.5 Transmission and Dissemination of Flood Information.....	3-7
3.5.1 Flood Information Transmitted from MMDA-EFCOS.....	3-7
3.5.2 Flood Information for Dissemination.....	3-9
CHAPTER 4. PLAN OF MAINTENANCE WORKS.....	4-1
4.1 General.....	4-1
4.2 Maintenance Works.....	4-1
4.3 Plan for Maintenance Schedule.....	4-2
4.4 Spare Parts Supply.....	4-3
CHAPTER 5. PLAN FOR ORGANIZATION OF THE EFCOS PROJECT.....	5-1
5.1 Organization of MMDA.....	5-1
5.2 Current Organization of the EFCOS Project.....	5-2
5.3 Plan for Structural Organization of the EFCOS Project.....	5-5
CHAPTER 6. PLAN FOR BUDGETARY REQUIREMENT.....	6-1
6.1 General.....	6-1
6.2 Plan for Yearly Budgetary Requirement.....	6-1
CHAPTER 7. RELATED PROJECTS.....	7-1
7.1 General.....	7-1
7.2 KOICA Project (II).....	7-1
7.3 The Resilience Project.....	7-3
7.4 Project NOAH.....	7-4

7.5	GMMA Ready Project.....	7-5
CHAPTER 8.	FUTURE DEVELOPMENTS IN THE PASIG-MARIKINA RIVER AND LAGUNA LAKE COMPLEX RELATED TO THE EFCOS PROJECT....	8-1
8.1	Perspective for Future Expansion of EFCOS to Laguna Lake Basin.....	8-1
8.2	Recommendation in the Report on Data Collection Survey on Situation of Nationwide Flood Forecasting and Warning System Conducted by JICA for PAGASA (September 2013).....	8-2
8.3	O&M of Proposed Marikina Control Gate Structure (MCGS).....	8-3
8.4	World Bank Report for Master Plan for Flood Management.....	8-3

CHAPTER 1. INTRODUCTION

1.1 Necessity of the EFCOS Project

As part of the Metro Manila Flood Control and Water Resource Development Projects, the Mangahan Floodway and Napindan Hydraulic Control Structure (HCS) were completed in 1988 and 1983, respectively.

The efficiency and effectiveness of the Mangahan Floodway depends on the integrated, synchronized operation of the two control facilities above. There is a certain chance of danger of failure in the operation that may cause a serious man-made flooding. In order to avert any such error in the manipulation of the control structures, it is imperative to establish/set-up an effective procedure for flood control operation and subject facilities.

A reliable and effective telemetering and warning system was necessary for the flood control operation. Therefore, the construction of Mangahan Floodway Project gave emphasis to the formulation of an effective telemetering and warning system, EFCOS Project. To attain this, the **Feasibility Study** on EFCOS Project, as a part of construction of Mangahan Floodway project, was conducted in 1981.

During the time between the completion of Mangahan Floodway in 1988 and the completion of EFCOS Project in 1993, the Rosario Weir for the flood diversion into Laguna Lake through Mangahan Floodway was operated based on the on-site observation of the water level of Marikina River at Rosario Weir.

With the EFCOS Project, through the weather forecast and flood information, real time hydrological data and analysis, the Rosario Master Control Station can estimate and determine the effective flood diversion operation at Rosario Weir. It also enables the gate operation of Napindan HCS, which is another inlet/outlet gate of Laguna Lake.

Warning system along the Mangahan Floodway is provided to prevent man-made calamity in consideration of the abrupt rises of the water level in the Mangahan Floodway.

1.2 Rehabilitation and Improvement Works of the EFCOS Project

After completion in 1993, the EFCOS Project was improved and rehabilitated twice in 2001 and 2016. As a matter of convenience, they are called as follows:

- Phase 1 : original project completed in 1993 (Feasibility Study in 1981 and Detailed Design in 1985), under Overseas Economic Cooperation Fund (OECF) loan package of Japan.
- Phase 2 : Project for the Rehabilitation of the Flood Control Operation and warning System in Metro Manila completed in December 2001, under the Japan's Grant Aid Program.
- Phase 3 : Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS) completed in February 2016, under JICA's Technical Cooperation Program.

(1) Project for the Rehabilitation of the Flood Control Operation and Warning System in Metro Manila

The EFCOS system designed in 1985 was an analogue telemetry system, and it was practically unable to function as a flood forecasting system. Data were input manually into the computer to calculate water discharge and, therefore, no time allowance was made to provide for advanced flood information. Furthermore, the meteorological and hydrological monitoring network was inadequate.

In this circumstances, the Government of the Philippines (GOP) improved and enhanced the overall function of the EFCOS Project established in 1993 under the Japan's Grant Aid program, which was completed in December 2001. The Project included:

- a) Construction of additional hydrological observation stations (2 water level gauging stations and 5 rainfall gauging stations),
- b) Installation of digitized telemetry system as well as on-line data processing system,
- c) Introduction of flood forecasting system,
- d) Radio communication system needed to be installed at pumping stations, LGUs and other agencies concerned for sharing flood-forecasting information,
- e) Visual images for display of data collected.

(2) Transfer of Operation and Maintenance of Flood Control Facilities from DPWH to MMDA

Flood control in Metro Manila in which EFCOS Project is a component was transferred to MMDA from DPWH on August 2002. However, due to unavoidable circumstances and lots of strong typhoons that hit the entire Metro Manila and nearby provinces, some of the monitoring and relay stations were damaged and not operational and that temporary repair did not materialized due to MMDA budgetary constraints.

On May 2, 2008, there was an order from the MMDA Main Office to close EFCOS Project Office and remain all the gates open at Rosario Weir and Napindan HCS. Although the operations on the said gates were to remain open, maintenance and data gathering at the telemetry gauge stations still continued.

(3) Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS)

In recent years, floods brought about by typhoons and monsoonal storms occur more frequently than before in Metro Manila; therefore rehabilitation of the EFCOS has become an urgent and critical issue. With this situation, the GOP requested Japanese Government for assistance to "Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS)" with the aim to restore the function of EFCOS by rehabilitating the damaged facilities/equipment.

In response to the request, JICA dispatched a survey mission to the Philippines in July 2014 for the purpose of developing a detailed plan for the Project. The Mission exchanged views and held a series of discussions on damaged facilities/equipment to be repaired/replaced, frequency changes, works to be done by MMDA, etc., with the representatives of relevant organizations. Detailed planning for the restoration project was compiled in the report of Detailed Planning Survey (October 2014).

Results of discussions were concluded as Memorandum of Understanding (MOU) between JICA Mission and MMDA which signed in October 2014. The improvement/restoration project was completed in February 2016.

1.3 Validity of the EFCOS Project

JICA Report on Detailed Planning Survey (2014) mentioned the verification of EFCOS Project as follows:

As observed during flood occurred in 2014 caused by Typhoon Glenda, the EFCOS is still working as a core player in meteorological-hydrological monitoring and telecommunication system during floods, although some parts and equipment were already damaged in the previous typhoons and are deteriorated by aging. The EFCOS could be central in the Metro Manila flood monitoring and telecommunications based on the following observations:

- During onslaught of Typhoon Glenda, only the EFCOS functioned in monitoring rainfall and water levels and sent the data to the Rosario Master Control Station MCS. Although various monitoring and telecommunication systems exist in the Pasig-Marikina River basin, it was verified that the EFCOS Project could be regarded as a suitable and robust system among the others in order to effectively operate the related flood control structures along the river courses.
- Since such kind of telecommunications system was developed in Japan, which is also a flood and typhoon-prone country similar to the Philippines, prioritized requirement for the entire system is high reliability even if slightly costly.
- Therefore, the EFCOS Project is essential to cope with the recurrent floods and to mitigate flood damages because it is closely related to the effective operation of flood control structures along the Pasig-Marikina river course. Furthermore, its importance will increase from the future roles to provide the reliable hydrological data for effective operation of the structures including the Marikina Control Gate Structure (MCGS) which is under planning as a flood control structure in the basin.

1.4 Objectives of the EFCOS Project

The objectives of the EFCOS Project are as follows:

- (1) Synchronized operation of Rosario Weir of Mangahan Floodway and Napindan Hydraulic Control Structure (HCS) to mitigate flood damages in the Pasig-Marikina River and Laguna Lake Complex through its telecommunication meteorological-hydrological monitoring and warning system.
- (2) Flood warnings are disseminated to residents along the Mangahan Floodway.
- (3) Strengthening flood control management including implementation of flood forecasting operations.
- (4) Dissemination of data/information on rainfall and water level in the Pasig-Marikina River Basin in order to Local Government Units and other agencies concerned for sharing flood-forecasting information.

1.5 Purpose of Operation and Maintenance (O&M) Plan

The purposes of Operation and Maintenance (O&M) Plan for the EFCOS Project are itemized below:

- To ensure that the facility is operated according to the planning/design of the EFCOS Project
- To extend the useful life of the facilities installed
- To ensure the required quality of meteorological and hydrological data

1.6 Effectiveness of O&M Plan

This O&M Plan is prepared on the basis of the latest Phase 3 (improvement/restoration of telecommunication equipment project completed in February 2016). The established O&M Plan should be reviewed and revised based on the accomplishment of O&M activities, in principle, every 5-year duration.

1.7 O&M Manuals

There are two (2) O&M Manuals which were prepared in Phase 1 (1993) and Phase 2 (2001) for rehabilitated/improved EFCOS Project.

The O&M Manual is:

- To give guidance on O&M Plan
- To give how to operate and maintain the completed project to ensure the effective, efficient and sustainable operation and maintenance.
- A key to an effective O&M performance
- To be also revised/updated on the basis of accumulating O&M activities.

- (1) Operations and Maintenance Manual for Nationwide Flood Control and Dredging Project, Part B – An Effective Flood Control Operation System including Telemetry and Flood Warning System in the Pasig-Marikina-Laguna Lake Complex (October 1993).

This was prepared at the time of completion of the original Project and is composed of the following:

- a) Institutional Arrangement
- b) Flood Operation and Warning Manual
- c) Maintenance Manual
- d) System Facilities
- e) Guidelines of Gate Operation for Mangahan Floodway and Napindan Hydraulic Control Structure in Non-rainy Season
- f) Hydrological Data Analysis and Computer Manual

- (2) Report on Technical Guidance for the Project for Rehabilitation and Warning System in Metro Manila (March 2002)

This Manual is for the rehabilitated/improved EFCOS which included computer system, telemetry system, warning, multiplex radio and emergency radio system in the Pasig-Marikina-Laguna Lake Complex.

This manual is the revised one of original manual stated above (1) and is composed of the following:

- a) *Revised* Institutional Arrangement
- b) *Revised* Flood Operation and Warning Manual
- c) *Revised* Maintenance Manual
- d) *Revised* System Facilities
- e) Guidelines of Gate Operation for Mangahan Floodway and Napindan Hydraulic Control Structure in Non-rainy Season (no revision made in original Manual)
- f) Hydrological Data Analysis and Computer Manual (partially revision of original Manual based on the system improvement and application of MIKE 11 for flood predict)

CHAPTER 2. CONFIGURATION OF THE EFCOS PROJECT

2.1 Pasig-Marikina River and Laguna Lake Complex

(1) Location of the Project Area

The subjective area is located in latitude 14°50'N and longitude 121°00'-121°35'E and administratively comprises portions of Metropolitan Manila, Rizal Province and Laguna Province, which are approximately equivalent of the catchment area of Pasig-Marikina River plus Laguna de Bay, about 3,800 km² or 1.3% of the total land area of the Philippines. Flooding in the Pasig-Marikina River and Laguna Lake Complex are affected by the interrelationships.

(2) Pasig River-Marikina River – Napindan River - Laguna Lake Watershed

Upper Marikina River runs in the Marikina Valley enclosed by hills and mountain, forming its eastern and western boundaries. The upstream of Marikina Valley is in the Sierra Madre mountain range and the river channel in this area runs in a sharp gorge.

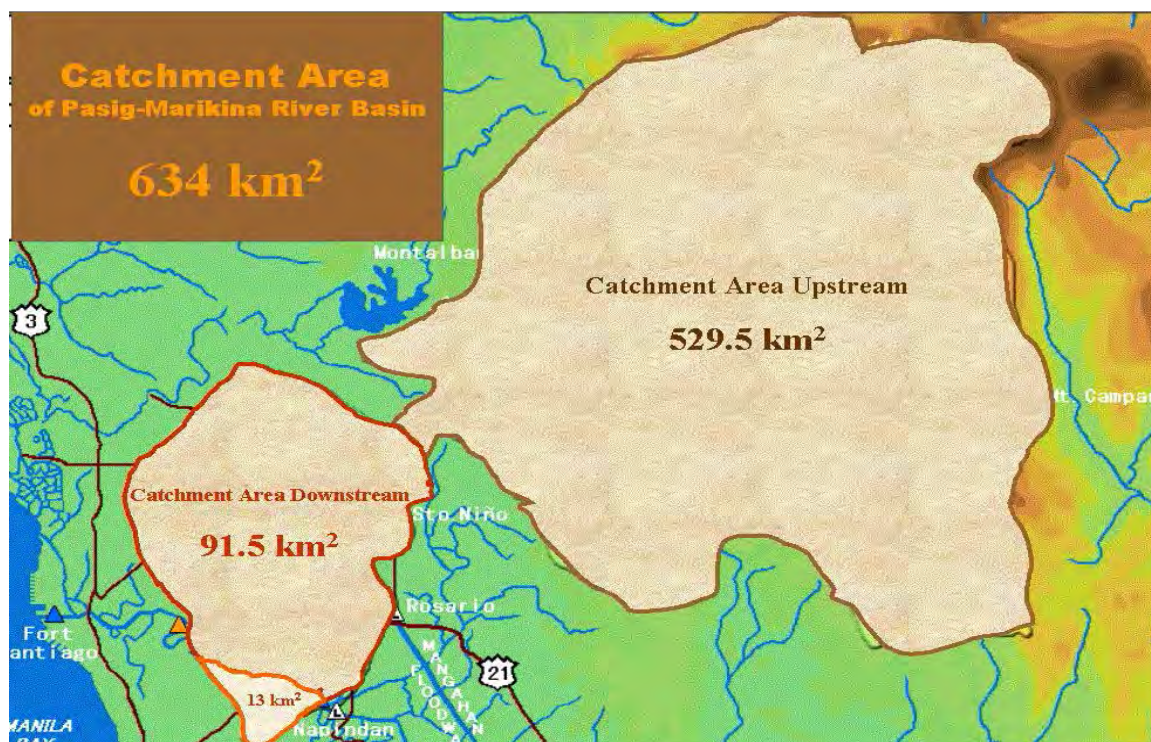
Lower Marikina River is from Rosario Weir to Napindan Channel and its downstream is called Pasig River. This river with a meandering river course flows from east to west into Manila Bay through the heavily urbanized Metropolitan Manila area.

Pasig-Marikina River Basin	634 km ²	
Pasig-Marikina River	from Manila Bay to Montalban Bridge	<ul style="list-style-type: none"> • 45.5 km long
Marikina River	From Montalban to Napindan Channel	<ul style="list-style-type: none"> • 27 km long • C.A at Napindan junction: 516.5 km² • C.A at Rosario Weir: 505.2 km² • C.A at Sto. Nino: 499 km² • C.A at Montalban Bridge: 365.5 km²
- Upper Marikina River	from Montalban bridge to Mangahan Floodway (Rosario Weir)	<ul style="list-style-type: none"> • 20.5 km long
- Lower Marikina River	from Mangahan Floodway (Rosario Weir) to Napindan Channel	<ul style="list-style-type: none"> • 6.5 km long
Pasig River	from Napindan Channel to Manila Bay	<ul style="list-style-type: none"> • 18.5 km long
Napindan Channel	from Laguna Lake to junction point of Pasig River/Marikina River	<ul style="list-style-type: none"> • 7.5 km long
San Juan River	Largest tributary of Pasig River at 7.15 km upstream from Manila Bay.	<ul style="list-style-type: none"> • 91.5 km² • 8.7 km long
Laguna Lake Basin	Water Surface at El. 11.5m: 900 km ²	<ul style="list-style-type: none"> • 3,159 km² • Shallow depth less than 4 m
Mangahan Floodway	Design Discharge: 2,400 m ³ /s 8 gates x 18.75m wide x 3.0m high Total open width: 150m	<ul style="list-style-type: none"> • 8.5 km long. • Top of gate closed: EL. 14.0m • Bottom of gate closed: EL. 10.5 m • Bank level: EL. 11 to 13.5 m
Napindan HCS	(a) Gated Dam (Steel Roller Gate) 4 gates x 15.0 m wide x 9.0m high Total open width: 60.0 m (b) Lock (Steel Submersible Radial	<ul style="list-style-type: none"> • Top of gate closed: EL. 15.0m • Bottom of gate closed: EL. 6.0 m • Bank level: EL. 11.0 to 13.5 m

	Gate) 1 gate x 18.0 m wide x 9.0m high	<ul style="list-style-type: none"> • Top of gate closed: EL. 15.0m • Bottom of gate closed: EL. 6.0 m
--	---	---

Pasig-Marikina River Basin Catchment Area

Name of Structure/River (Reference Point)	Catchment Area (km ²)
Wawa Dam	269.0
Rodriguez Bridge	365.5
Nangka River (Upstream of the junction)	434.3
Marikina Bridge (Sto. Nino)	499.0
Mangahan Floodway (Upstream of the junction)	505.9
Napindan Channel (Upstream of the junction)	516.9
San Juan River (Upstream of the junction)	529.5
Pasig – Marikina River (River mouth)	634.0



Major tributaries of the Upper Marikina Rivers are those joining from the left bank, such as the Burgos Creek, the Ampid Creek and the Nangka River as tabulated below:

Name of River/Creek	Area (km ²)	Distance* (km)
Burgos Creek	27.8	12.05
Ampid Creek	24.4	6.83
Nangka River	51.4	5.66

Note: Distance is from the Marikina Bridge, St. Nino.

(3) Meteorology

The Philippines may be classified into four climatological regions. The Project Area belongs to 1st type, which has two prominent seasons, dry season from November to April and rainy season from May to October.

These meteo-hydrological characteristics are mainly governed by seasonal dominant monsoons, trade winds, tropical cyclones and combinations of them.

Out of them, the tropical cyclone is the most influential to floods in the Project Area. The annual mean tropical cyclones that pass near the Philippines are 19.6 in number. For Central Luzon, the landing rate of tropical cyclones counts for 16 percent.

The meteorological characteristic of the area is dominated by two seasons: the rainy season from June to November and dry season from December to May.

- Northeast monsoons dominates from May to September.
- Tropical Cyclone takes places from July to December.
- Typhoons associated with northeast monsoon brings heavy rainfall which causes flooding.
- Serious flooding usually occurs from August to November.

(4) Rainfall

The annual rainfall distribution shows the annual rainfall of more or less 3,000 mm over the high Sierra Madre mountain range where the headwaters of the Marikina River are located. On the other hand, the annual rainfall of approximately 2,000 mm spreads over the rainfall zone of the Manila Bay to the Laguna Lake.

The monthly rainfall distribution, except the western area of the Laguna Lake, accords with that of the first climatological region and have high rainfall months from May to October. The total rainfall of the months counts for about 80 percent of the annual rainfall, and it is brought mainly by the wet southwest monsoon, plus the occasional typhoons. The monthly rainfall distribution over the western area of the Laguna Lake has a longer rainy season up to December. This is because of the influence of the northeast monsoon, which invades the area across the low terrain of the Sierra Madre ranges bordering the first and the second climatological zones.

2.3 Features of Stations of the EFCOS Project (Phase 3)

The facilities of EFCOS Project are summarized in the following table:

Summary of EFCOS Project Stations

No.	Facility	Installed in	Remarks
(1) Rainfall Gauging Station			
EFCOS-R-1	Boso Boso Rainfall Gauging Station	1993	
EFCOS-R-2	Mt. Oro Rainfall Gauging Station	1993	
EFCOS-R-3	Mt. Campana Rainfall Gauging Station	2001	
EFCOS-R-4	Aries Rainfall Gauging Station	2001	
EFCOS-R-5	Nangka Rainfall Gauging Station	2001	
EFCOS-R-6	Napindan Rainfall Gauging Station	2001	
EFCOS-R-7	PAGASA S.G. Rainfall Gauging Station	2001	
(2) Water Level Gauging Station			
EFCOS-W-1	Montalban Water Level Gauging Station	1993	Marikina River
EFCOS-W-2	Nangka Water Level Gauging Station	2001	Nangka River
EFCOS-W-3	Sto. Nino Water Level Gauging Station	1993	Marikina River
EFCOS-W-4	Rosario J.S. Water Level Gauging Station	1993	Marikina River
EFCOS-W-5	Rosario L.S. Water Level Gauging Station	1993	Mangahan Floodway
EFCOS-W-6	Napindan J.S. Water Level Gauging Station	1993	Marikina River
EFCOS-W-7	Napindan L.S. Water Level Gauging Station	1993	Napindan River
EFCOS-W-8	San Juan Water Level Gauging Station	2001	San Juan River
EFCOS-W-9	Pandacan Water Level Gauging Station	1993	Pasig River
EFCOS-W-10	Fort Santiago Water Level Gauging Station	1993	Pasig River
EFCOS-W-11	Angono Water Level Gauging Station	1993	Laguna Lake
(3) Master Control Station			
EFCOS-MC-1	EFCOS Rosario Master Control Station	1993	
(4) Monitor Station			
EFCOS-MT-1	Napindan HCS Monitor Station	1993	
EFCOS-MT-2	MMDA-FCIC (Flood Information Center) Monitor Station	2016	
EFCOS-MT-3	PAGASA-HMD (Hydrometeorology Division) Monitor Station	1993	
EFCOS-MT-4	DPWH (Central Office) Monitor Station	1993	
(5) Relay Station			
EFCOS-RL-1	Antipolo Relay Station	1993	
EFCOS-RL-2	PAGASA S.G. Relay Station	1993	
(6) Warning Post			
EFCOS-WP-1	Warning Post No. 1	1993	
EFCOS-WP-2	Warning Post No. 2	1993	
EFCOS-WP-3	Warning Post No. 3	1993	
EFCOS-WP-4	Warning Post No. 4	1993	
EFCOS-WP-5	Warning Post No. 5	1993	
EFCOS-WP-6	Warning Post No. 6	1993	
EFCOS-WP-7	Warning Post No. 7	1993	
EFCOS-WP-8	Warning Post No. 8	1993	
EFCOS-WP-9	Warning Post No. 9	1993	
			(Facilities in Total: 34)

(1) Rainfall Gauging Station

No.	Name	Elevation (EL. m)	Coordinate		Location
			Latitude	Longitude	
1	2	3	4	5	6
EFCOS-R-1	Boso Boso	381	14°38'23"	121°13'21"	Barangy Boso Boso, Antipolo, Rizal
EFCOS-R-2	Mt. Oro	64	14°45'48"	121°09'28"	Barangay San Isidro, Montalban, Rizal
EFCOS-R-3	Mt. Campana	450	14°40'01"	121°17'34"	Sitio San Jose, Barangay San Jose, Antipolo, Rizal
EFCOS-R-4	Aries	395	14°39'41"	121°10'14"	Sitio Aries, Barangay Malanday, San Mateo Rizal
EFCOS-R-5	Nangka	23	14°40'28"	121°06'33"	Barangay Banaba, San Mateo, Rizal
EFCOS-R-6	Napindan	15	14°33'27"	121°04'04"	Napindan HCS Compound, Barangay Buting, Pasig City
EFCOS-R-7	PAGASA S.G.		14°38'43"	121°02'40"	Science Garden Compound, BIR Road, Quezon City

(Note) Type of Equipment: Tipping Bucket Type.

(2) Water Level Gauging Station

No.	Name	River & Distance from Rosario Weir	Coordinate		Location	Type & Range of Equipment
			Latitude	Longitude		
1	2	3	4	5	6	7
EFCOS-W-1	Montalban	Upper Marikina 21.0 km	14°44'06"	121°07'39"	Amang Rodriguez Bridge, Montalban, Rizal	Float Type Gauge: Range EL.18.7m to EL.30.0m
EFCOS-W-2	Nangka	Nangka 12.0 km	14°40'28"	121°06'33"	Near Nangka Bridge, Barangay Banaba, San Mateo, Rizal	Float Type Gauge: Range EL.18.7m to EL.25.0m
EFCOS-W-3	Sto. Nino	Upper Marikina 6.7 km	14°38'15"	121°05'33"	Marikina Bridge, Brgy. Sto. Nino, Marikina, MM	Float Type Gauge: Range EL.9.8m to EL.22.8m)
EFCOS-W-4	Rosario J.S.	Upper Marikina 0.0 km	14°36'00"	121°05'16"	Amang Rodriguez, Barangay Rosario, Pasig City	Range EL.10.0m to EL.18.5m)
EFCOS-W-5	Rosario L.S.	Mangahan FW 0.0 km	14°36'00"	121°05'16"	Amang Rodriguez, Barangay Rosario, Pasig City	Pressure Type Gauge: Range EL.-10.0m to EL.18.5m
EFCOS-W-6	Napindan J.S.	Pasig 6.5 km	14°33'32"	121°04'01"	Napindan HCS Compound, Barangay Buting, Pasig City	Float Type Gauge Range: EL.7m to EL.16.0m
EFCOS-W-7	Napindan L.S.	Napindan 6.5 km	14°33'32"	121°04'01"	Napindan HCS Compound, Barangay Buting, Pasig City	Float Type Gauge Range: EL.7m to EL.16.0m
EFCOS-W-8	San Juan	San Juan	14°36'01"	121°01'28"	San Juan Elementary School, A. Luna St., San Juan City	Float Type Gauge Range: EL.9.5m to EL.16.0m
EFCOS-W-9	Pandacan	Pasig 16.5 km	14°35'28"	121°00'40"	Pandacan Independent Floodgate, Pandacan, MM	Float Type Gauge Range: EL.9.7m to EL.14.1m
EFCOS-W-10	Fort Santiago	Pasig 22.8 km	14°35'49"	121°58'07"	Port Area, Manila	Float Type Gauge Range: EL.9.7m to EL.13.0m
EFCOS-W-11	Angono	Laguna Lake 10.0 km	14°31'28"	121°08'27"	Mabuhay Resort House, Angono, Rizal	Float Type Gauge Range: EL.9.8m to EL.17.1m

(Note) Datum Line (DL) = EL.0.0m, Mean Lower Low Water Level (MLLW) = EL.10.0m, Mean Sea Level (MSL) = EL.10.46m.

(3) Warning Posts along Mangahan Floodway

No.	Location			Coordinate		Elevation (EL. m)
	Station of MF	Bank	Distance*	Latitude	Longitude	
1	2	3	4	5	6	7
EFCOS-WP-1	Rosario MCS	West	0.00	14°36'00"	121°05'16"	+18.0
EFCOS-WP-2	Sta. 2+200	East	2.20	14°34'56"	121°05'50"	+16.5
EFCOS-WP-3	Sta. 3+300	West	3.30	14°34'20"	121°06'03"	+18.0
EFCOS-WP-4	Sta. 4+400	East	4.40	14°33'57"	121°06'31"	+18.0
EFCOS-WP-5	Sta. 5+350	West	5.35	14°33'27"	121°06'42"	+16.0
EFCOS-WP-6	Sta. 6+300	East	6.30	14°33'07"	121°07'07"	+16.0
EFCOS-WP-7	Sta. 7+250	West	7.25	14°32'36"	121°07'18"	+15.5
EFCOS-WP-8	Sta. 8+200	East	8.20	14°32'16"	121°07'43"	+15.0
EFCOS-WP-9	Sta. 8+450	West	8.45	14°32'04"	121°07'40"	+15.0

Note: *Distance from Rosario Master Control Station (km).

(4) Master Control Station, Monitor Station and Relay Station

No.	Name	Location	Coordinate		Elevation (EL. m)
			Latitude	Longitude	
1	2	3	4	5	6
EFCOS-MC-1	EFCOS Rosario Master Control Station	Amang Rodriguez, Barangay Rosario, Pasig City	14°36'00"	121°05'16"	+15
EFCOS-MT-1	Napindan HCS Monitor Station	Napindan HCS Compound, Barangay Buting, Pasig City	14°33'32"	121°04'01"	
EFCOS-MT-2	MMDA-FCIC (Flood Information Center) Monitor Station	Metro Base, MMDA Bldg., Orenza St., EDSA Guadalupe, Makati City	14°33'45"	121°02'30"	+20
EFCOS-MT-3	PAGASA-HMD Monitor Station	BIR Road, Dillman, Quezon City			
EFCOS-MT-4	DPWH (Central Office) Monitor Station	Bonifacio Drive, Port Area, City of Manila	14°35'23"	120°58'12"	
EFCOS-RL-1	Antipolo Relay Station	Town and Country Subdivision, Antipolo, Rizal	14°36'46"	121°08'44"	+110
EFCOS-RL-2	PAGASA S.G. Relay Station	Science Garden Compound, BIR Road, Quezon City	14°38'45"	121°02'35"	+50

CHAPTER 3. PLAN OF OPERATION OF THE EFCOS PROJECT

3.1 Gate Operation Rule of Rosario Weir

3.1.1 General

The Gate Operational Rule was established in Phase 1 (1993) upon the completion of the EFCOS Project, and the Rule was updated in Phase 2 (the *Project for Rehabilitation project of the Flood Control Operation and Warning System in Metro Manila*) in March 2002. The Rule was formulated, based on the relationship among tidal level monitored at Fort Santiago Gauging Station, water levels at Sto. Nino Gauging Station and Montalban Gauging Station.

3.1.2 Data Processing System

The following functions are in the online processing subsystems:

- (1) This subsystem automatically collects and processes information on the telemeter system, Rosario Weir, and Napindan HCS Gate operations. It also computes rainfall in 10, 15 and 30 minutes, 1 hour, and accumulative rainfall and converts the water level to the discharge. In addition, it has an automatic computing function for their statistical data, such as minimum, average and maximum in day, month, and year.
- (2) This subsystem accumulates processed data into three kinds of database files and automatically renews the database when new data are collected.
- (3) This subsystem reads data in a memory pack in which raw observed rainfall or water level data are stored as a backup of the telemetry system and compensates/corrects missing data in the basic database.
- (4) This subsystem works out reports (daily, monthly, annual reports and operation logs) based on the processed.

Data to be Collected

Data	Nos. Data	Collection Frequency	Information
Rainfall	7 Stations	Usually, the data collection interval is every hour. The interval can be changed to every 10, 15, or 30 minutes.	<ul style="list-style-type: none"> • Time of observation: year, month, day, hour, minute. • Total rainfall from the previous observation.
Water-level	11	Usually, the data-collecting interval is every hour. The interval can be changed to every 10, 15, or 30 minutes.	<ul style="list-style-type: none"> • Time of observation: year, month, day, hour, minute. • Total rainfall from the previous observation.
Gate information (Rosario weir: total 8 gates, Napindan weir: total 4 gates)	12	At gate operation	<ul style="list-style-type: none"> • Time of gate operation: year, month, day, hour, minute. • Status after operation

3.1.3 Operation Rule of Rosario Weir

Planning/design of Rosario Weir is explained as follows:

(1) Original Purpose of Rosario Weir

BPW Master Plan for the Drainage of Manila and Suburbs (1952) stated that “The most serious obstacle to the realization of this scheme (construction of floodway) will be the objections of towns bordering the lake, based on the fear that the lake level will rise substantially as a result thereof. It should be pointed out that it is not intended to close the Marikina River and divert its flow completely into the lake. The proposed channel will not be excavated to the same depth as the bed of the Marikina River. The bottom of the channel at the point of diversion will be kept permanently at elevation 13.00 m or 3 meters above the bed of the Marikina River (by construction of Rosario Weir at the entrance of Floodway). Only when the flow in the Marikina River exceeds this depth, will there be flow in the proposed channel”.

(2) Original Structural Design under the Feasibility Study of Mangahan Floodway Project

The original design of Rosario Weir is a concrete ogee shape crest weir that will pass 2,400 m³/s with a head over the weir of 3.85 m. by building the weir crest at elevation 14.0 m, and by operating the MCGS properly, a water surface upstream from the weir of 17.85 m is provided. The ogee weir crest is 126 m long.

(3) Deferment of Construction of MCGS and Re-design of Rosario Weir

In 1979, Ministry of Public Works (MPW) determined the indefinite deferment of the construction of the MCGS related to the navigation in the Marikina River and instead, its function of controlling diversion of the floodwater of the Marikina River, achieved by the operation of a re-designed Rosario Weir with movable full gate, up to 2,000 m³/s floods even without the MCGS before the improvement of Upper Marikina River.

Also, the re-design to a fully movable gate structure was intended to examine the function of Rosario Weir in lowering the flood level in the Laguna Lake by allowing reverse flow through the floodway channel.

As a solution to alleviate flooding conditions of long duration that cause heavy damage to the lakeshore areas, the MPW conceived of the idea of reversing the flow of water from Laguna Lake to Marikina River during high lake water stages and will, therefore, necessitate the redesign of the Rosario Weir.

The latest operation rule is the one revised in 2012 considering the actual development conditions along the Pasig-Marikina River and Laguna Lake Complex.

- (1) **(Pre-caution Stage)** During the **pre-caution stage** of flood, all gates are usually closed but then an announcement is given to persons within the Floodway Channel as a pre-cautionary measure. This stage occurs when water level at Sto. Nino Water Level Gauging Station on the Marikina Bridge is more than its alert level of **EL. 13.0 m** corresponding to 150 m³ discharge and when the Basin Average Rainfall Intensity is **more than 30 mm**, or in case the water level at Montalban Water Level Gauging Station exceeds **EL. 22.4 m** corresponding to 100 m³ per second.
- (2) **(Caution Stage)** Once the flood water level at Sto. Nino Water Level Gauging Station reaches at **EL.13.8 m**, the gates of Rosario Weir are to be opened sequentially from the center one in accordance with water level rising at Sto. Nino Water Level Gauging Station.

When Caution Stage starts, some floodgates are open causing the sudden increase of floodwater,

to flow in the Floodway Channel. Warning consisting a siren warning and speaker warning is issued around **30 minutes before** the opening of the gates of Rosario Weir to provide enough time for people to stay away from the Channel.

- The Napindan HCS is closed and the Rosario Weir is operated for opening only to store the flood water from Marikina River into Laguna Lake.
 - This Caution Stage occurs when the water level at Sto. Nino Water Level Gauging Station reach **Critical Level 1 (EL.13.8 m to 13.9 m)** hence, **two (2) gates** of Rosario Weir are open.
 - But, when the water level comes up halfway between **Critical Level 1 (EL.13.8 m to 13.9 m) and Critical Level 2 (EL.14.0 m to 14.4 m)** **four (4) gates** are open simultaneously.
 - when the water level comes up halfway between **EL.14.5 m to 15.1 m**, **six (6) gates** are open simultaneously
- (3) **(Emergency Stage)** When the flood water level at Sto. Nino Water Level Gauging Station reaches at **EL.15.3 m**, **all the gates** are to be opened.
- (4) **(Subsiding Stage/ Post Flood Stage)** After passing the flood peak through Sto. Nino Water Level Gauging Station and the flood water level is **below 15.0 m**, the opened gates are to be closed in accordance with water level subsiding at Sto. Nino Water Level Gauging Station.

Elevation of Critical Water Level 1 and 2 vary depending on the tidal level of Manila Bay observed at Fort Santiago Water Level Gauging Station.

The Above-rules are summarized in the following tables:

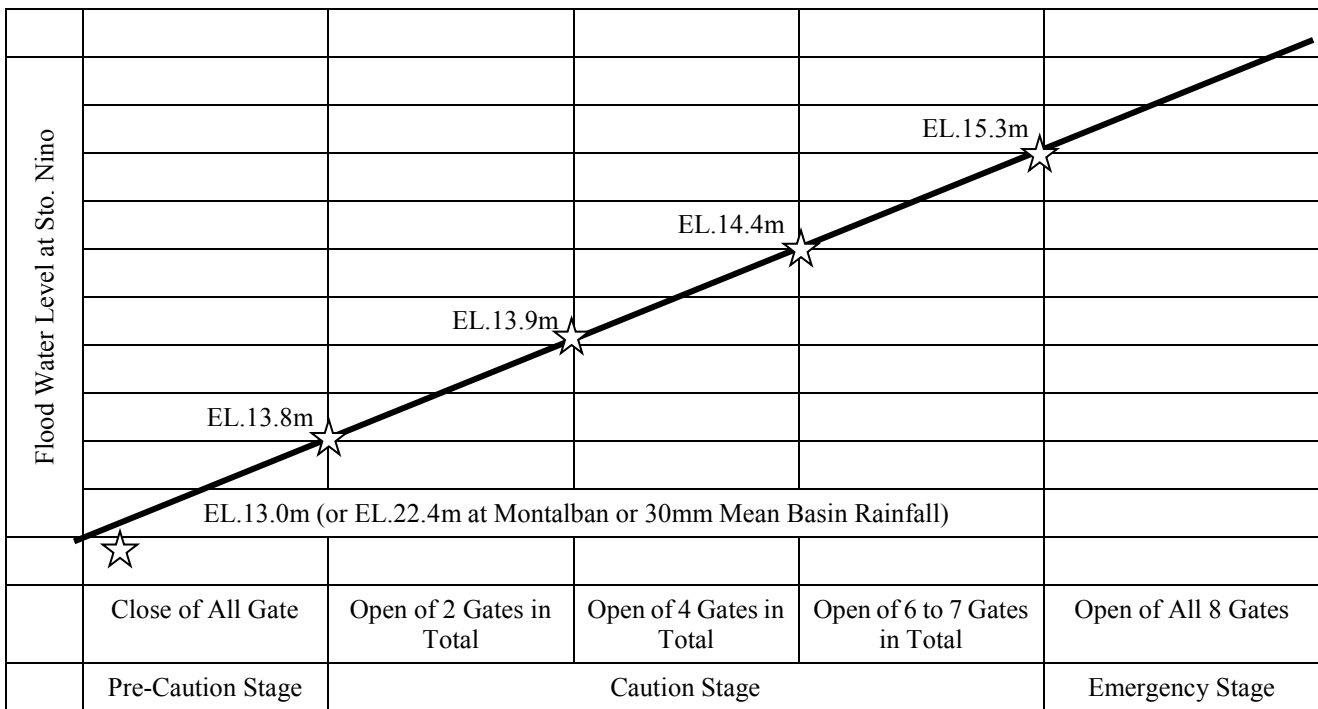
Gate Operational Rule of Rosario Weir

I. OPENING OF ROSARIO WEIR FLOODGATES

WATERLEVEL (M)	NO. OF GATES TO OPEN	GATE NO.	REMARKS
13.80 13.90	1 1	GATE 4 GATE 5	ISSUE WARNING TO ALL WARNING POST STATION
14.00-14.40	4	GATE 3 & 6	
14.50-15.10	6	GATE NO. 2 & 7	
15.30 - UP	8	GATE NO. 1 & 8	ALL GATES SHOULD BE OPEN AND REMAINED OPEN IF CONTINUOUS RAINFALL IS BEING MONITORED UPSTREAM

II. CLOSING OF ROSARIO WEIR FLOODGATES

WATERLEVEL (M)	NO. OF GATES CLOSED	GATE NO.	REMARKS
15.00	2 gates	GATE 1 & 8	If there will be no rainfall monitored upstream gates should be randomly closed except for the last two gates which will be randomly closed when the elevation at Sto. Niño Station reached at 13.80m waterlevel at Rosario should be closely monitored due abnormalities of the difference in the elevation bet Sto. Niño and Rosario J.S. when waterlevel is at its normal stage.
14.50	4 gates add 2 gates	GATE 2 & 7	
14.00	6 gates add 2 gates	GATE NO. 3 & 6	
13.80	7 gates add 1 gate	GATE NO. 8	
13.60	ALL GATES SHOULD BE CLOSED	GATE NO. 1	ALWAYS CHECK watelevel level at Rosario J.S. at the moment it was closed, if overtopping persists at the gate, open 1m height at one of the gates.



Gate Operation Procedure at Rosario Weir for Opening

3.2 Operation Rule of Napindan Hydraulic Control Structure

(1) Project Description

The Napindan HCS is intended to control the lake storage and firm up a dependable discharge and prevent saltwater intrusion from Manila Bay into the lake during low water level of Laguna Lake and high stages of Manila Bay.

The Napindan HCS is operated to maintain the lake within the designed level to serve all purposes. The lake water is intended to serve and at the same time adverse inundation of the surrounding lands.

The Napindan HCS located upstream of the Napindan Channel at the junction of the Pasig-Marikina River-Napindan Channel, is an essential component in the Laguna de Bay Development Scheme for water resources and is aimed to:

- Protect and improve the quality of lake water by cutting off the backflows of saline and polluted water from the Pasig River particularly during high tide in summer when the lake water is lower than that of the tide in Manila Bay.
- Control the lake storage to firm up dependable discharge of water supply for irrigation and other use.
- Prevent the overflow of flood water along the Pasig River in coordination with the Mangahan Floodway, thus protecting Manila and suburbs from floods.

(2) Project Components

The Napindan HCS consists of:

- a) Gated Spillway Dams (4 vertical roller type steel gates x 15.0 m wide x 9.0 m high),
- b) Navigational Lock (2 submersible radial steel gates x 18.0 m wide x 9.0 m high),
- c) Mooring Facilities, and
- d) Control Tower at where Napindan HCS Monitor Station is located.

(3) Gate Operation Rule of Napindan HCS

The water level of Laguna Lake reveals that the water level at the Rosario Weir is always higher than that of the Laguna Lake at the flooding of Marikina River.

There is no clear correlation between water levels at the confluence of the Napindan Channel and the Pasig-Marikina River, and the Laguna Lake.

A part of floodwater from the Lower Marikina River into the Napindan Channel/Laguna Lake is not significant.

Thus, all the gates of the Napindan HCS shall be closed to storage temporarily the Marikina River floodwater diverted through Mangahan Floodway into the Laguna Lake, so as not to cause overbank flooding along the Pasig River.

3.3 Operation of Flood Warning along Mangahan Floodway

(1) General

Rosario Weir is usually closed during dry/rainy season. When the opening of gates for diverting flood water into Mangahan Floodway, there is fear that floodwater and surge wave might cause man-made calamity. Therefore, issuance of warning is necessary before opening gates.

Combination of siren/speaker system on Warning Posts and patrol car system is applied for the warning. The remote control system is adopted for prompt issuing of warning. Eight (8) Warning Posts are provided at the interval of 1.0 km (500 m radius) along the Floodway.

(2) Issuance Warning

Warnings shall be issued for the four (4) stages:

	Stage	Warning	Gate Operation	Warning Operation
1	Pre-Caution	Pre-caution	All gate closed	Broadcast recorded voice from Warning Post (WP) No.1 (3 minutes)
2	Caution	Urgent	Start of gate opening after warning	1) Siren warning by all WPs (4 minutes) 2) Broadcast recorded voice by all WPs (3 minute) 3) Gate opening
3	Emergency	Informative	Floodwater level rising	1) Siren warning by all WPs (4 minutes) 2) Broadcast recorded voice by all WPs (3 minutes)
4	Post-flood	Informative	Flow subsiding (Closing gates)	Broadcast recorded voice by all WPs (3 minutes)

3.4 Flood Forecasting

At present, the flood control structures are operated utilizing the actually monitored data such as water levels at Sto. Niño, Montalban and Fort Santiago, and rainfall.

Normally, floodwaters take only 30 minutes to travel between Sto. Niño and the Rosario Weir and 2.5 hours between Montalban and Rosario Weir. A flood forecasting system based on the monitored or forecasted rainfall is therefore essential and effective for the overall flood management in Metro Manila as well as operation of flood control structures.

There might be two ways to utilize the flood forecasting information for the operation, as follows:

- To utilize the forecasted data produced by the existing flood forecasting system in PAGASA through sharing the observed rainfall and water level data; and
- To construct a new system using license-free software, such as the HEC model produced by the US Army Corps of Engineers.

Since the MIKE11 for flood forecasting introduced in the improvement/rehabilitation Project in 2002 is not used at present due to need of license fee. To resolve this issue, mutual discussion shall be made among PAGASA and MMDA-EFCOS Project. On the other hand, the EFCOS staff shall make an effort to utilize the license-free software.

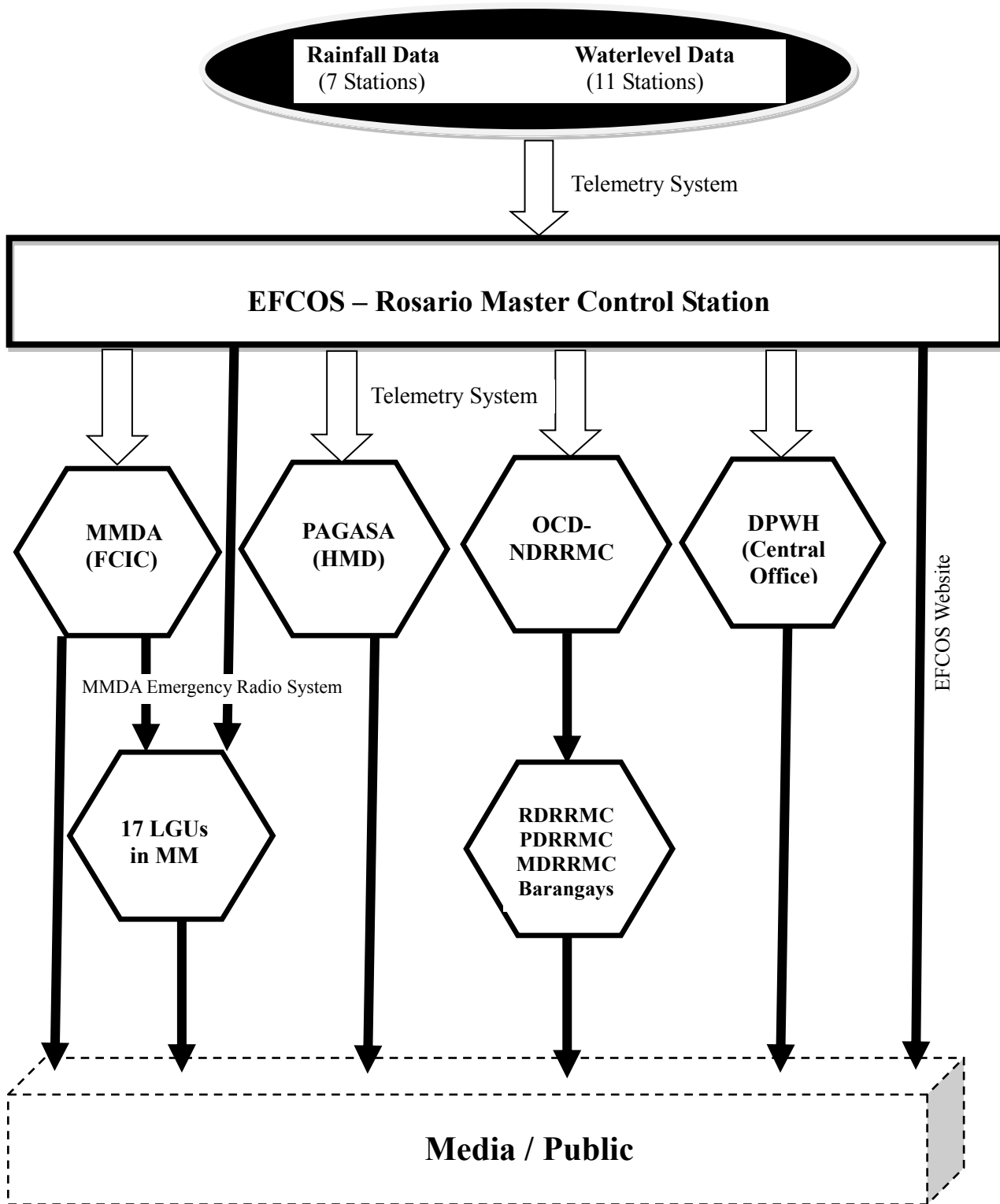
3.5 Transmission and Dissemination of Flood Information

3.5.1 Flood Information Transmitted from MMDA-EFCOS

Flood Information for the Pasig-Marikina River and Laguna de Bay Complex using the telemetry system under the EFCOS Project, is managed and controlled by the MMDA. Currently MMDA is responsible for issuing flood warning information to the concerned government agencies such as OCD-NDRRMC, PDRRMC, and other LGUs.

PAGASA/HMD has no authority to manage and control the system. It receives and monitors information from the MMDA.

The MMDA-EFCOS Rosario Master Control Station is responsible for issuing the flood information. The overall process diagram of Flood Information Network in Pasig-Marikina River and Laguna Lake Complex is shown as below.



Transmission of Rainfall/Waterlevel Data Provided with Telemeters in the Pasig-Marikina River and Laguna Lake Complex

3.5.2 Flood Information for Dissemination

(1) Water Level

Flood situation (Alert, Alarm and Critical Water Level) is set making reference to rating curve approximated by hydraulic calculation and discharge corresponding to a certain water level.

(a) Pasig-Marikina River

Alert Waterlevel is defined as the water level (W.L.) at each gauging station corresponding to the pre-caution stage water level at Sto. Nino (approx. 150 m³/s and W.L. 13.0m).

Critical Water Level is defined as the water level over which floodwater overtop river dike around area governed by the water level gauging station., thus indicating that the critical water level at each station is corresponding to the water level of the caution stage at Sto Nino Water Level Gauging Station.

(b) Tributary River (San Juan River and Nangka River)

Critical Water Level for the tributaries are decided from the flow capacity (San Juan 50 m³/s and Nangka 100m³/s) and rating curve. Alert and Alarm Water Levels are decided with a certain interval from Critical Water Level.

The Alert, Alarm and Critical Water Levels are as listed below:

(Unit: EL. m)

Situation	Pasig-Marikina River					Tributary River	
	Montalban	Sto. Nino	Rosario	Napindan	Pandacan	San Juan	Nangka
Alert	22.4	13.0	12.5	10.9	11.0	11.0	17.1
Alarm	23.0	14.1	13.2	11.9	11.5	11.5	17.7
Critical	23.6	14.9	13.8	12.9	12.0	12.0	18.3

(2) Rainfall

Based on the simulation result by MIKE 11, the relationship between basin mean rainfall intensity (mm/hour) and increase of water level after Pre-caution Stage are as follows:

Status	Rainfall Intensity (mm/hour)	Increase of Waterlevel (m)	
		Montalban	Sto. Nino
Light	10 to 30	0.1 to 0.6	0.1 to 0.6
Light to Moderate	30 to 50	0.6 to 1.2	0.6 to 1.3
Moderate	50 to 70	1.2 to 1.8	1.3 to 2.1
Moderate to Heavy	70 to 90	1.8 to 2.2	2.1 to 2.8
Heavy	90 to 100	2.2 to 2.5	2.8 to 3.1

CHAPTER 4. PLAN OF MAINTENANCE WORKS FOR THE EFCOS PROJECT

4.1 General

All system facilities of EFCOS Project shall be constantly checked, inspected, adjusted, repaired and maintained to meet the objective of the EFCOS Project based on the Maintenance Manual which was prepared in March 2002 in Phase 2.

Other reference manuals for maintenance which are usable for detailed check/inspection of telemetry and equipment facilities are prepared by the Contractor (Japan Radio Co., Ltd.) as follows:

- (1) Operation and Maintenance Manual
- (2) Instruction Manual or Technical Brochure for Individual Equipment
- (3) Instruction manual for measuring instruments is included in the “Instruction Manual” or “Technical Brochures” for individual equipment mentioned above.

4.2 Necessary Maintenance Works

Upon finding the malfunction of the system or equipment, the EFCOS staff shall take necessary actions. Major actions to be taken are summarized as follows:

- (1) In case the malfunction occurs at station, the EFCOS staff shall immediately be dispatched to the station site for finding the faulty equipment or unit.
- (2) For the telemetry and equipment maintenance work at the site, the EFCOS staff shall bring the Maintenance Manuals and spare parts so as to repair the equipment or unit as quick as possible.
- (3) When the EFCOS staff is dispatched to a station site, he shall inspect all the equipment adding to the faulty equipment and shall also check the station civil works.
- (4) After typhoon and floods, special inspection shall be performed to check and repair any abnormal condition in and around the station housing.
- (5) The equipment room of Rosario Master Control Station is air-conditioned, so that the telemetry master and warning supervisory equipment experienced less failure and still operational up to the present. Based on this experience, Napindan HCS monitor station and Antipolo Relay Station were air-conditioned under the improvement/restoration project in 2016. Attention on maintenance of air-conditions in these stations shall be paid.
- (6) Since adequate repair at the site is rather difficult on the telecommunication system, various spare units and spare parts shall be stocked to promptly restore operation of the system by replacing the faulty units at the site.
- (7) The necessary stock of spare parts shall be determined and insufficient parts shall be always replenished, based on the list of spare parts prepared under the improvement/restoration project in 2016.
- (8) After inspection, adjustment, and repairing, the measured value, trouble conditions, repair contents, etc., shall be recorded in the formatted sheet “Inspection Report of Equipment” to serve as

maintenance reference materials.

- (9) If damage or malfunction is too complicated, contact the Contractor’s maintenance services “JRC Philippine Branch Office” in Makati City, Metro Manila.
- (10) In addition to the maintenance works for stations, the EFCOS Project Office shall have responsibility for maintenance of Rosario Weir, Mangahan Floodway and Napindan HCS.

4.3 Schedule for Maintenance Works

The maintenance work consists of daily maintenance, periodic maintenance and emergency maintenance.

(1) Daily Maintenance Work

The daily maintenance is to be performed mainly from the Rosario MCS by collecting data from individual gauging stations and checking if there is any unavailable gauging station.

(2) Monthly Maintenance Work

The periodical maintenance is to be performed by visiting the stations and checking to find if there is any malfunction of equipment and civil works. The periodical maintenance shall be done monthly.

- 1) Monthly Maintenance Work including equipment performance test as preventive maintenance and clearing the station sites for design requirements.
- 2) Monthly Maintenance Work including electrical checking and equipment calibration by using measuring instruments to know degradation/deterioration of equipment to be done before the onset of the rainy season.

The following table shows a yearly maintenance schedule. The daily and periodic maintenance program consists of combination of several maintenance works depending on maintenance period as presented in the following table.

(3) Emergency Maintenance Work

Emergency maintenance work shall be needed in flooding season, especially after typhoon and flood.

Schedule of Maintenance Work

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monthly Maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Emergency Maintenance					✓	✓	✓	✓	✓	✓	✓	

Maintenance Items in Daily and Monthly Maintenance Work

Maintenance Item		Maintenance Works		Remarks
		Daily	Monthly	
1	Operation Check (Overall)	✓	✓	Operation from Rosario MCS
2	Operation Check		✓	Individual Equipment
3	Metering Check		✓	Voltage, Power, Signal
4	Alarm Check	✓	✓	Equipment Alarm
5	Physical Appearance Check		✓	Equipment Physical Damage
6	Performance Check		✓	Electrical Check

7	Equipment Calibration		✓	Power, Frequency, etc.
8	Equipment Clearing		✓	Rainfall Gauge, Water Level Sensor
9	Civil Works		✓	Floor Cleaning, tree/ grass/bush trimming

4.4 Spare Parts Supply

Additional spare parts are supplied in 2016 under the Phase 3 for the EFCOS Project to compensate for the equipment newly installed considering the history of spare parts consumption as analyzed in the Detailed Planning Survey conducted by JICA in 2014 for improvement/restoration of the EFCOS Project.

Record of utilization of spare parts should be strictly made and inventory check should also be done periodically for additional supply.

CHAPTER 5. PLAN FOR ORGANIZATION OF THE EFCOST PROJECT

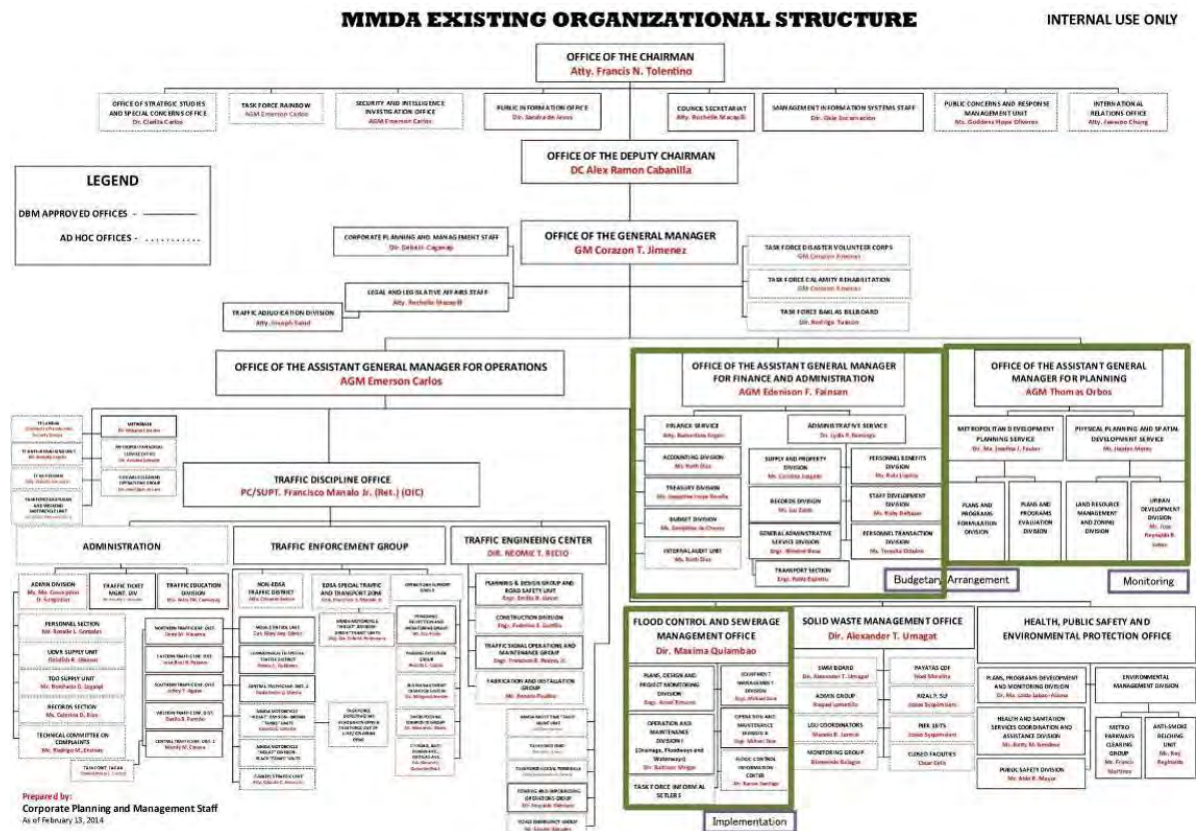
5.1 Organization of MMDA

There are three assistant general management offices in MMDA, namely:

- (1) Office of the Assistant General Manager for Planning,
- (2) Office of the Assistant General Manager for Finance and Administration, and
- (3) Office of the Assistant General Manager for Operations.

Under the Office of the Assistant General Manager for Operations are four offices, namely;

- (a) Solid Waste Management Office,
- (b) Traffic Discipline Office,
- (c) Health, Public Safety and Environmental Protection Office, and
- (d) Flood Control and Sewerage Management Office



Organizational Structure of the MMDA

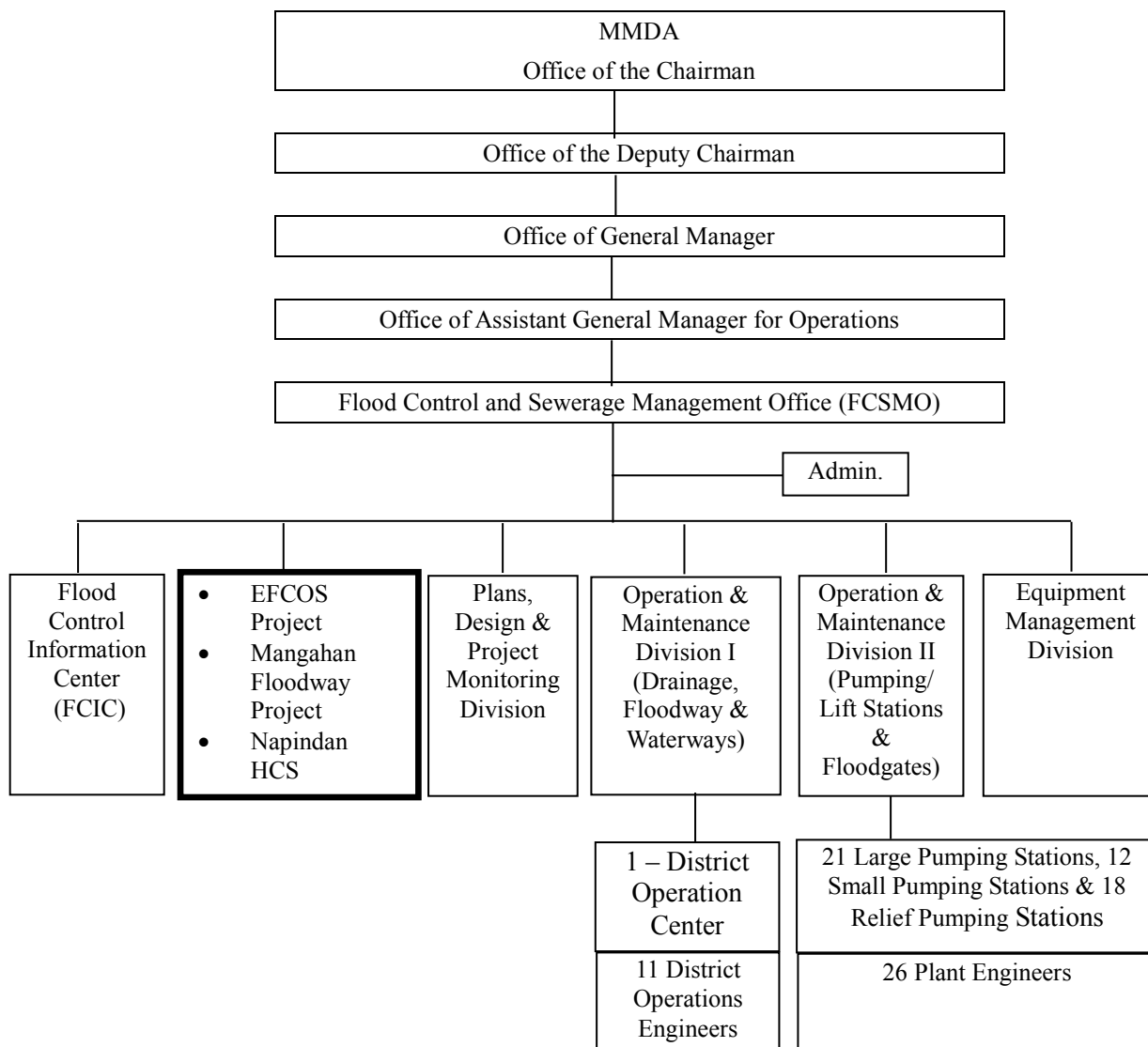
Source: MMDA

5.2 Current Organization of the EFCOS Project

The EFCOS Project, Mangahan Floodway Project (MFP) including Rosario Weir and Napindan Hydraulic Control Structure (NHCS) are under the Flood Control and Sewerage Management Office. They are directly under one responsible Director.

Figure below shows the organizational structure of the EFCOS Project as the implementation body of the system.

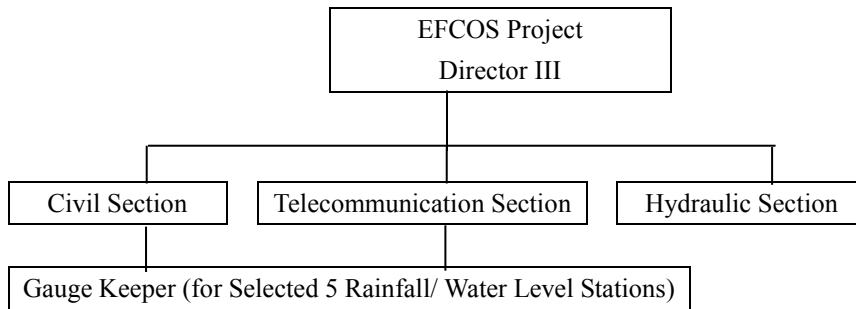
(1) Structural Organization of MMDA-Flood Control and Sewerage Management Office



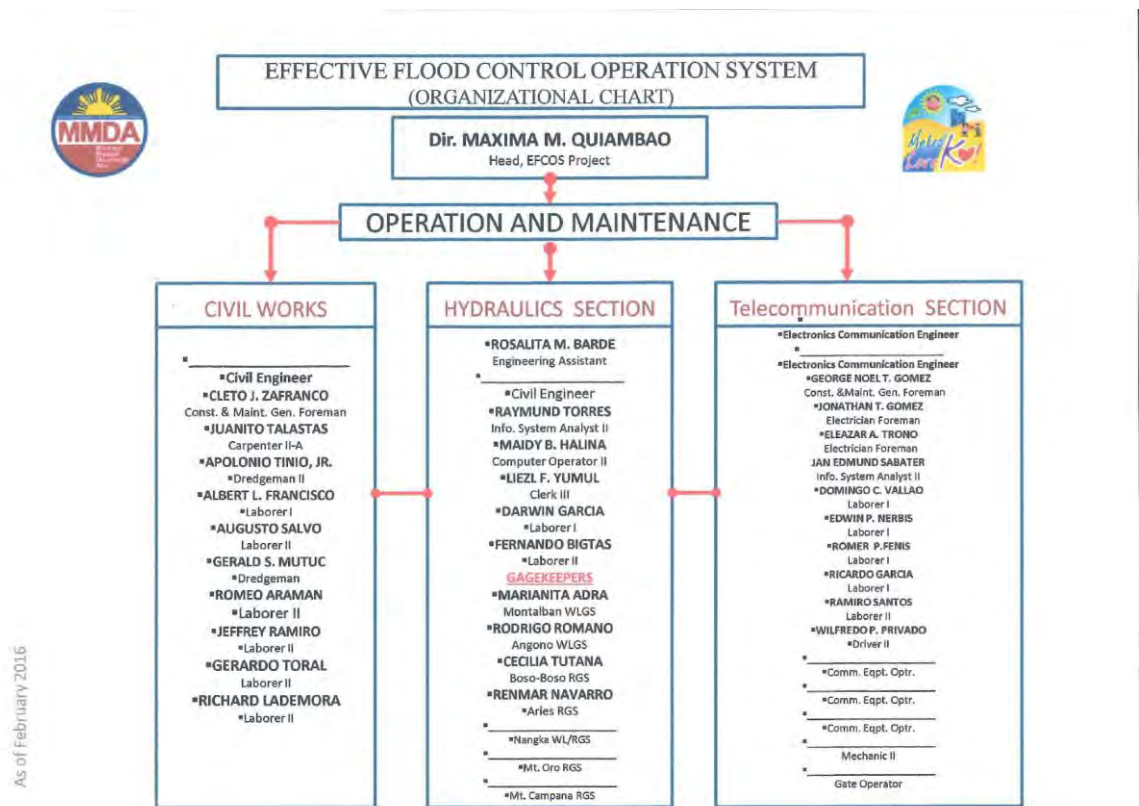
Organizational Structure of the Flood Control and Sewerage Management Office

(2) Organization of the EFCOS Project

The EFCOS Office for operation and maintenance is divided into 3 sections:



Based on the figure above, the below-table summarizes the staffing structure by capacity level in the EFCOS Office as of February 2016. The EFCOS Office consists of total 31 staff, and only one engineering assistant and four foreman are capable for the technical operation and maintenance works among them.



Current Organizational Structure of the EFCOS

(3) Role and Responsibility

Works	Role/Responsibility
1. Civil Works	(1) Gate Operation of Rosario Weir (2) Gate Operation of Napindan HCS (3) Warning operation along Mangahan Floodway (4) Maintenance of civil works of all stations (5) Maintenance of channel at water level stations (clearing, deepening, slope protection, etc.) (6) Preparation of reports (for monthly activity, yearly activity, particular activity, etc.)
2. Hydraulics	(1) Collection and observation of hydrological data and analysis (rainfall, water levels and discharges) (2) Estimation of hydraulic conditions of the Pasig-Marikina River, Mangahan Floodway, Napindan Channel, Nangka River, San Juan River, etc., with the use of available software in relation with the weather forecasting and gate operation during flooding condition (3) Preparation of flood information for flood control and warning operation for EFCOS Website for public, LGUs, and agencies concerned (4) Improvement of data collection through on-line data processing (5) Continuous study on actual hydrological condition for the effective flood control operation system in Pasig-Marikina River and Laguna Lake Complex. (6) Recording of data and reporting of the above-activities (monthly and yearly)
3. Telecommunication	(1) Maintenance of telemetry and warning system (2) Inventory of spare parts of equipment (3) Preparation of reports of the activities above
4. Gauge Keeper (Part-time)	(1) To inform the status of stations periodically (monthly) (2) To inform the emergency on stations as soon as possible. (3) Cleaning/cutting trees at the stations

(4) Manning Schedule in Flood Phase at Rosario Master Control Station

The following is proposed Plan of Structural Organization of EFCOS Project, considering the above-situation. During flooding phase, two (2) staffs of EFCOS Office be assigned at Rosario Master Control Station to monitor the real time data and flood information for 24 hours under three (3) shifts.

During flood phase, EFCOS Project Office need to establish the special manning assignment. All staff perform the task during flood phase, as scheduled below:

	Stage in Flood Phase	Arrangement of Technical Staff to be Assigned
1	Pre-caution	3 shifts
2	Caution	All staff on duty
3	Emergency	All staff on duty
4	Post-flood	3 shifts

5.3 Plan for Structural Organization of the EFCOS Project

(1) Reinforcement of Operation and Maintenance Staff

The EFCOS needs reinforcement of technical staff for operation and maintenance of the telecommunication system. After completion of restoration of the EFCOS in February 2016, there is requirement of new skill for maintenance of newly installed equipment. At least two (2) more technicians with skill and knowledge on telecommunication systems should be required in addition to the current number of staff members of the Telecommunication Section of the EFCOS.

In addition, the Telecommunication Section of EFCOS has recently undertaken the responsibility of maintaining about 40 water level and 4 rainfall gauge stations provided by DOST-ASTI in the entire Metro-Manila. Even under the current situation, EFCOS is short of operation and maintenance staff because there are one assistant engineer and four foremen only. It is apparent that the Telecommunication Section of EFCOS has a shortage of work force to be involved in maintaining EFCOS.

(2) Manning Schedule in Flood Phase at Napindan HCS

Staff stationed at Napindan HCS are to execute the gate open/close per instruction of EFCOS Project Office.

Manning Arrangement for O&M of EFCOS Project

	Designation	Number of Personnel		
		Planned (Total)	Occupied (as of March 2016)	Vacant (as of Feb. 2016)
1	Director	1	1	-
		(1)	(1)	(-)
2	Civil Section			
1)	Civil Engineer	1	-	1
2)	General Foreman for Construction & Maintenance	1	1	-
3)	Carpenter II-A	1	1	-
4)	Dredgeman I	1	1	-
5)	Dredgeman II	1	1	-
6)	Laborer I	1	1	-
7)	Laborer II	5	5	-
	(Total)	(11)	(10)	(1)
3	Hydraulics Section			
1)	Engineering Assistance	1	1	-
2)	Civil Engineer	1	-	1
3)	Information System Analyst II	1	1	-
4)	Computer Operator II	1	1	-
5)	Clerk III	1	1	-
6)	Laborer I	1	1	-
7)	Laborer II	1	1	-
	(Total)	(7)	(6)	(1)

3	Telecommunication Section			
1)	Electronics Communication Engineer	2	1	1
2)	General Foreman for Construction & Maintenance	1	1	-
3)	Electric Foreman	2	2	-
4)	Information System Analyst II	1	1	-
5)	Laborer I	4	4	-
6)	Laborer II	1	1	-
7)	Common Equipment Operator	3	-	3
8)	Mechanic II	1	-	1
9)	Gate Operator	1	-	1
10)	Driver II	1	1	-
	(Total)	(17)	(11)	(6)
4	Gauge Keeper			
1)	Montalban Water Level	1	1	-
2)	Nangka Rainfall/ Water Level	1	-	1
3)	Angono Water Level	1	1	-
4)	Boso Boso Rainfall	1	1	-
5)	Aries Rainfall	1	1	-
6)	Mt. Oro Rainfall	1	-	1
7)	Mt. Campana Rainfall	1	-	1
	(Total)	(7)	(4)	(3)
	(Grand Total)	(43)	(32)	(11)

CHAPTER 6. PLAN FOR BUDGETARY REQUIREMENT

6.1 General

The EFCOS office is under the Flood Control and Sewerage Management Office, which has the third biggest annual budget in the MMDA.

The O&M cost covers regular maintenance and manufacturer's maintenance cost.

It is assumed that MMDA-EFCOS make and contract with the manufacturer (Japan Radio Corporation Philippines Branch) for maintenance of telemetry equipment. The manufacturer's maintenance is to confirm the EFCOS functions periodically. If defects are found, the manufacturer shall repair them. The manufacturer's cost is only for the dispatch

Of maintenance staff, excluding cost of materials for repair.

6.2 Plan for Yearly Budgetary Requirement

Budgetary requirements for O&M of EFCOS Project are planned from 2016 to 2020 (5-year) in this O&M Plan as shown in the tables below:

Summary of Proposed Annual O&M Budgetary Requirement of EFCOS Project

(Unit: million PHP)

Year	2016	2017	2018	2019	2020
Proposed Budget	14,904,000.00	15,703,000.00	16,574,000.00	17,685,000.00	19,605,000.00
Remarks	Improvement/Restoration works completed in February 2016 and within Contractor's guarantee period.				

(1) Breakdown of Proposed Budget for Year 2016

(Unit: PHP)

I.	Operating Expenses	9,025,000.00
	(1) Salary	6,495,000.00
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00
	(3) Car Maintenance	845,000.00
	(4) Miscellaneous	100,000.00
II.	Civil Works Maintenance	3,000,000.00
III.	Maintenance of Telecommunication Equipment	2,879,000.00
	(1) Manufacturer's Periodical Maintenance	1,836,000.00
	(2) Radio Station License Fee	43,000.00
	(3) Materials	1,000,000.00
	Total	PHP14,904,000.00

(2) Breakdown of Proposed Budget for Year 2017

(Unit: PHP)

I.	Operating Expenses	9,785,000.00	
	(1) Salary	7,144,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	946,000.00	
	(4) Miscellaneous	110,000.00	
II.	Civil Works Maintenance	3,000,000.00	
III.	Maintenance of Telecommunication Equipment	2,918,000.00	
	(1) Manufacturer's Periodical Maintenance	1,875,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	PHP15,703,000.00	

(3) Breakdown of Proposed Budget for Year 2018

(Unit: PHP)

I.	Operating Expenses	10,303,362.75	
	(1) Salary	7,859,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	750,000.00	
	(4) Miscellaneous	110,000.00	
II.	Civil Works Maintenance	3,000,000.00	
III.	Maintenance of Telecommunication Equipment	3,270,000.00	
	(1) Manufacturer's Periodical Maintenance	2,227,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	PHP16,574,000.00	

(4) Breakdown of Proposed Budget for Year 2019

(Unit: PHP)

I.	Operating Expenses	11,090,000.00	
	(1) Salary	8,645,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	750,000.00	
	(4) Miscellaneous	110,000.00	
II.	Civil Works Maintenance	3,000,000.00	
III.	Maintenance of Telecommunication Equipment	3,595,000.00	
	(1) Manufacturer's Periodical Maintenance	2,552,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	PHP17,685,000.00	

(5) Breakdown of Proposed Budget for Year 2020

(Unit: PHP)

I.	Operating Expenses	11,829,000.00	
	(1) Salary	9,444,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	750,000.00	
	(4) Miscellaneous	110,000.00	
II.	Civil Works Maintenance	3,000,000.00	
III.	Maintenance of Telecommunication Equipment	4,876,000.00	
	(1) Manufacturer's Periodical Maintenance	2,833,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	2,000,000.00	
	Total	PHP19,605,000.00	

CHAPTER 7. RELATED PROJECTS

7.1 General

In Pasig-Marikina River basin and greater Metro Manila, there are major projects assisted by the international donors regarding the flood control. For the O&M activities of the EFCOS Project, these related projects should be closely monitored and participated.

Although vulnerability to the flooding extends over the territory of the Philippines, Metro Manila has a high risk against flooding. Among the river system in Metro Manila, the Pasig-Marikina River basin has the highest one. The EFCOS Project is categorized into meteorological and hydrological monitoring network and early warning system among the various flood control measures.

The following are other major projects in this field. PAGASA as a leading national agency in meteorological and hydrological monitoring and flood forecasting is the one of the responsible agencies of these major projects.

In the Pasig-Marikina River basin, PAGASA has a responsibility on overall flood forecasting over the entire basin through the KOICA Project (II), while MMDA has a responsibility on the meteo-hydrological monitoring network of EFCOS to manage the flood control structures along the river system. As of date (2016), the donors installed the following networks in the basin.

- Establishment of early warning and monitoring system for disaster mitigation in Metro Manila (KOICA Project (II)) funded by KOICA (Korea International Cooperation Agency);
- Building community resilience and strengthening local capacities for recovery and disaster risk management (Resilience Project), funded by CIDA (Canadian International Development Agency) and UNDP (United Nations Development Plan);
- Nationwide operational assessment of hazards project (Project NOAH), a national project managed by the DOST-ASTI (Advanced Science and Technology Institute); and
- Enhancing Greater Metro Manila's Institutional Capacities for Effective Disaster/Climate Risk Management towards Sustainable Development (GMMA READY Project)

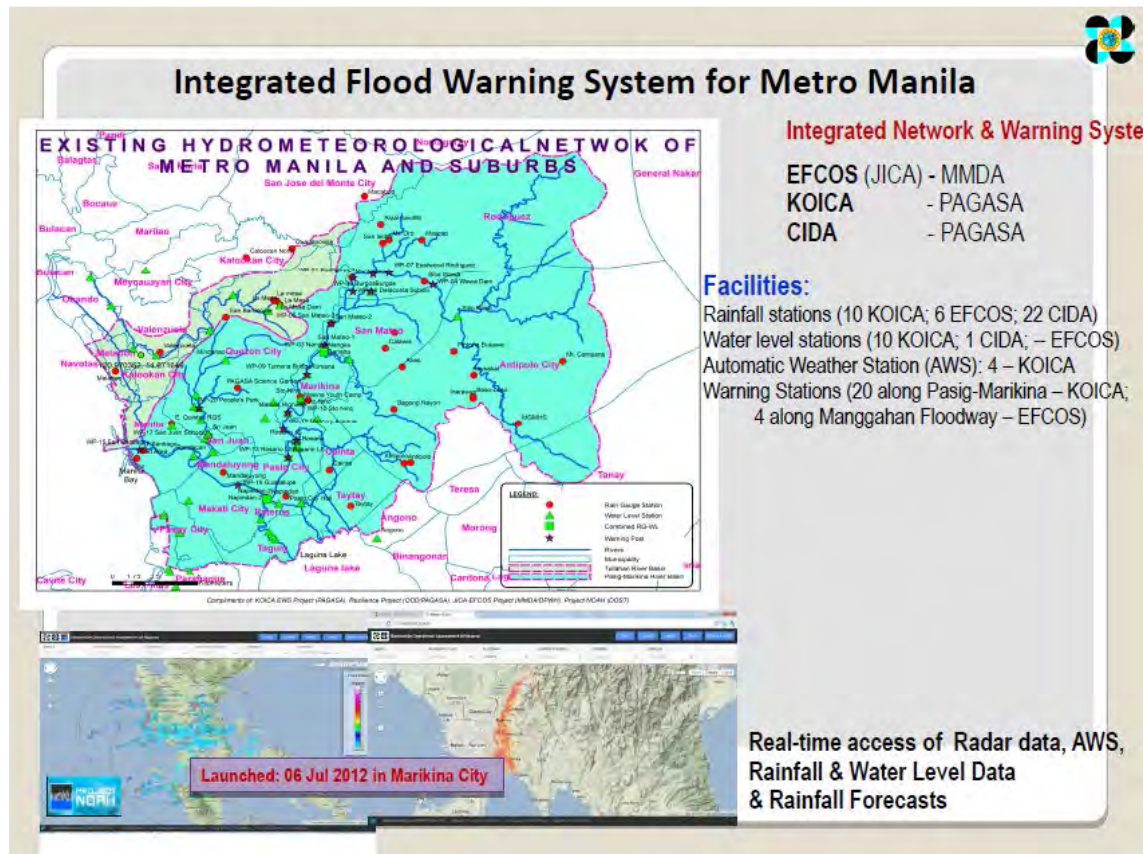
As presented the following summarized project features, each project has been implemented following its different objectives, even though their target basin is the same Pasig-Marikina River basin. KOICA Project (II) has its objective to establish the early flood warning system along the Pasig-Marikina and San Juan River. The objective of Resilience Project is to strengthen community-based disaster risk management, while that of Project NOAH is to construct nation-wide hydrological monitoring network. From those different objectives, the system configuration and their robustness are different.

7.2 KOICA Project (II)

The KOICA Project (II) constructed hydrological monitoring and telemetering system and flood forecasting system in the Pasig-Marikina River basin to establish the early flood warning system, and PAGASA manages the whole system from monitoring of meteo-hydrological parameters to the warning posts installed along the river course. The following is a summary of the Project:

- (1) Project Period: Started in November 2010 and completed in May 2012.
- (2) Project Objectives: To establish a data collection system, flood forecasting system, early warning system, and radio communication network.
- (3) Monitoring and Warning Stations Installed: summarized as table below and shown in location map.
- (4) Telecommunication Media: VHF network with 150MHz band, and GSM backup network.

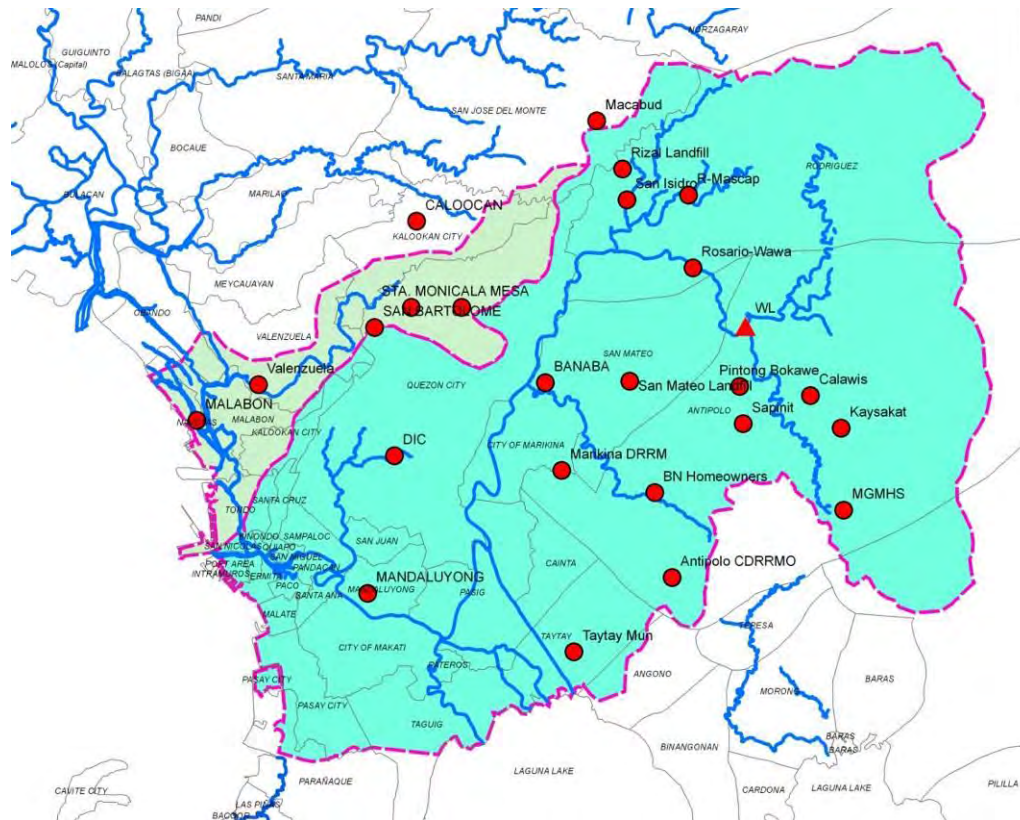
	Station	Name	Location
1	Water Level Gauge Stations (10)	<ol style="list-style-type: none"> 1. San Mateo-1 2. Burgos 3. Tumana Bridge 4. Sto. Nino 5. Marcos Highway 6. Rosario LS (Lake Side) 7. Rosario JS (Junction Side) 8. Napindan LS 9. Napindan JS 10. Mindanao 	<p>San Mateo Bridge</p> <p>Rosario Bridge</p> <p>San Juan River</p>
2	Rainfall Gauge Stations (10)	<ol style="list-style-type: none"> 1. San Mateo-2 2. Napindan-2 3. Guadanoville 4. NAIA 5. Marikina Youth Camp 6. Cainta City Hall 7. Pasig City Hall 8. Port Area Synop 9. Antipolo 10. La Mesa Dam 	<p>San Mateo Bridge</p> <p>Near Marikina Bridge</p>
3	Warning Posts (20)	Along the Pasig-Marikina River and San Juan River	
4	Relay Stations (3)	<ol style="list-style-type: none"> 1. PAGASA S.G. 2. Mt. St. Cruz 3. Mt. Mataba 	
5	Automatic Weather Stations (AWS) (4)	<ol style="list-style-type: none"> 1. Antipolo 2. La Mesa Dam 3. Pasig City Hall 4. Port Area Synop 	



7.3 The Resilience Project

The Project was funded by CIDA (Canadian International Development Agency) and UNDP (United Nations Development Plan), and its objective is to strengthen LGU capacities in disaster risk reduction and management towards building community resilience to disasters and reducing vulnerability to natural hazards. The target area of the Project is Metro Manila. The following is a summary of the Project:

- (1) Project Period: Started in 2010 and completed in 2013.
- (2) Project Objectives: To establish a flood early warning system in the Pasig-Marikina River and Tullahan River basins; to integrate EFCOS, KOICA, NOAH, and the system installed by the Project; and to support strategic roles of LGUs (Marikina-Pasig-Cainta) in creating disaster risk management sensitive policies and plans ensuring people’s participation, accountability and partnership with various stakeholders.
- (3) Monitoring and Warning Stations installed: 22 rainfall gauging stations and 1 water level station as shown in location map below).
- (4) Telecommunication media: GSM network.



7.4 Project NOAH

The Project NOAH is the DOST’s response to the call of the President for a more accurate, integrated, and responsive disaster prevention and mitigation system, especially in high-risk areas throughout the Philippines. The Project is harnessing technologies and management services by the DOST through PAGASA, PHIVOLCS, and the DOST-Advanced Science and Technology Institute (ASTI), in partnership with the UP National Institute of Geological Sciences and the UP College of Engineering.

Originally, the Project NOAH has eight (8) components. Among them, the following three (3) components are closely related to the EFCOS, but these are nationwide target projects. Others have different targets of natural disasters, such as landslides, coastal hazards and storm surge, and different devices development, such as Doppler radar and landslide sensor. These projects progressed targeting the date of December 2013, and the projects enter the operational stages at present.

- (1) Distribution of hydro-meteorological devices in hard-hit areas in the Philippines (Hydromet): a total of 600 automated rain gauges and 400 water level monitoring stations were installed along the 18 major river basins by December 2013 to provide a better picture of the country’s surface water in relation to flooding.
- (2) Disaster risk exposure assessment for mitigation – Light detection and ranging (DREAM-LiDR) project: the project, which was targeted to complete by December 2013, aims to produce more accurate flood inundation and hazard maps in 3D for the country’s flood-prone and major river systems and watersheds.
- (3) Flood information network (FloodNet) project: targeted to be completed by December 2013 is a flood center that will provide timely and accurate information for flood early warning systems. The FloodNet Project will come up with computer models for the critical river basins; automate the process of data gathering, modeling and information output, and release flood forecasts.

The EFCOS Project Office has responsibility to maintain 3 rainfall gauging stations and 38 water level stations installed by DOST-ASTI in Metro Manila (Pasig-Marikina River, San Juan River and Tullahan River basin).

7.5 GMMA Ready Project

The Project Enhancing Greater Metro Manila's Institutional Capacities for Effective Disaster/Climate Risk Management towards Sustainable Development (herein referred as the GMMA READY Project) aims to decrease the vulnerability of the Greater Metro Manila Area (GMMA) to natural hazards and increase its resilience, by strengthening the institutional capacities of the local government units, concerned national government agencies, academic institutions and civil society organizations to manage disaster and climate change risks. It will attempt to achieve this outcome by:

- (1) Assessing the GMMA's vulnerabilities to disaster and climate change risks;
- (2) Developing and implementing priority disaster/climate risk mitigation actions for GMMA such as formulation and testing of an integrated contingency plan and establishment of early warning systems;
- (3) Enhancing the competencies of GMMA LGUs and critical partners to mainstream DRM/CRM into local planning and regulatory processes;
- (4) Demonstrating the mainstreaming of DRM/CRM into local land use/development plan(s) and regulatory processes of Metro Manila and selected GMMA LGUs; and
- (5) Establishing a knowledge management system, including a vigorous Community of Practice, on Disaster/Climate Risk Management. The project is envisioned to achieve all the results over a period of three (3) years and expected to improve mechanisms and protocols on DRM/CRM. The project covers Metro Manila and the provinces of Rizal and Bulacan.

The READY Project is a multi-hazard mapping and assessment project undertaken by the NDRRMC and donor partner of AusAID, in partnership with key CSCAND (Collective Strengthening of Community Awareness for Natural Disasters) agencies such as PHIVOLCS, PAGASA, MGB, NAMRIA and other concerned agencies including MMDA. It is built on existing structures and provides the environment for stakeholders to work together with clear roles and responsibilities to perform.

The Project focuses on high-risk areas which were selected based on population size and the number of hazards to which they are vulnerable. It marks the first attempt to approach disasters in a multi-hazard fashion. The goal of strengthening the capacity of key stakeholders sits well in terms of creating an enabling environment in the communities.

The Project encompasses the Disaster Risk Reduction and Management (DRRM) process, to include community-based early warning system and information, education, and communications (IEC) activities. The data and information generated from the Study are utilized by the sectoral agencies and Local Government Units (LGUs) for disaster risk management and planning.

The following is a summary of the Project:

- Target Area/River Basin: Laguna, Rizal, Cavite, and Bulacan Provinces
- Project Period: 2010-2014
- Objectives/Salient Features
 - 1) Decrease the vulnerability of the Greater Metro Manila Area to natural hazards and increase its resilience, by strengthening the institutional capacities of the local government units, concerned national government agencies, academic institutions, and civil society organizations to manage disaster and climate change risks
 - 2) CBFWS (Community - Based Flood Early Warning System) component: install automatic rainfall and water level gauges with wireless capability, intelligence and stand alone operation,

independent power supply from solar and back-up batteries; establish Data Operation Station at the respective PDRRMOs and at PAGASA WFFC that will receive the data, store them in a database, and display real-time information from all the remote stations

CHAPTER 8. FUTURE DEVELOPMENTS IN THE PASIG-MARIKINA RIVER AND LAGUNA LAKE COMPLEX RELATED TO THE EFCOS PROJECT

Among several studied on the EFCOS Project made in the past, the following are to be considered on future development of the EFCOS Project.

8.1 Perspective for Future Expansion of EFCOS to Laguna Lake Basin

The following is recommendation in the Phase 2 (Project for Rehabilitation and Warning System in Metro Manila under the Japanese Grant Aid in 2001).

(1) Telemetry Rainfall Gauge Station

Experts concerned have been saying that rainstorms in Metro Manila generally come from the northwest since most typhoons approach Luzon in that direction. If so, rainfall in the Laguna Lake basin, which is located southeast of Metro Manila, could be an indicator of a coming rainstorm. It means that rainfall forecast for Metro Manila could be possible by installing a telemetry system in rainfall gauging stations in the Laguna Lake basin. At present, however, available rainfall data are still too scarce to examine this hypothesis.

The Laguna Lake had no rainfall gauge in its catchment area for a long time. For the first time in November 1998, LLDA installed five (5) rainfall gauging stations in this area. The purpose of these stations is to study water balance in the lake. Since the rainfall gauges are all automatic recording systems and not telemeterized systems, they are not used directly for flood forecasting purposes. After a few years' observation, however, the accumulated rainfall data could be used for the study on movement of rainfall areas and may provide ideas to determine the necessity of telemetry rainfall stations. Hence, this issue needs to be discussed further after a few years.

(2) Telemetry Water Level Station

One of the typhoon-induced problems along the lakeside areas is **seiche**, which is a sudden fluctuation of water level caused by strong winds and/or low atmospheric pressure. In November 1995, the worst seiche took place in the lake during Typhoon Rosing. Fluctuation of the lake water level and the track of Typhoon Rosing from November 2 to 4, 1995. At Angono the lake water began to be forced back into the lake by strong winds and low atmospheric pressure around 3:00 a.m. on the 3rd of November. The water level which was 12.6 m at 0:00 a.m. went down to the minimum level, 10.8 m at 11:00 a.m. Then, the lake water began to return towards Angono, and rose to reach 13.5 m at 3:00 p.m. The fluctuation range on this day was as large as 2.7 m.

According to EFCOS officials, the sudden water level rise had caused severe damage to lakeside areas in the Laguna and Rizal provinces. However, water level data have been so scarce that fluctuation of water level in the lake could not be generally identified.

A seiche like the one in 1995 would possibly occur again. However, the existing Angono telemetry water level gauge cannot cover all the 900 km² lake surface area, and it is very difficult to monitor such a seiche by only one telemetry gauging station. Even in Lake Biwa in Japan with a water surface area of 670 km², which is slightly smaller than that of the Laguna Lake, there are six (6) telemetry water level gauges. It is recommended that the telemetry system for water level gauges in the Laguna Lake be augmented in the future.

8.2 Recommendation in the Report on Data Collection Survey on Situation of Nationwide Flood Forecasting and Warning System Conducted by JICA for PAGASA (September 2013)

It should be noted that several monitoring systems already have been established in the Pasig-Marikina River and Laguna Lake basin such as EFCOS, KOICA and NOAH. Further, other initiatives of the UNDP/AusAID (Ready for GMMA) and the UNDP/CIDA (Resilience Project) also include components of flood early warning system in the basin. PAGASA is currently integrating all initiatives under KOICA, CIDA, AusAID, and EFCOS to issue flood information for all stakeholders. PAGASA envisages monitoring of all hydrometeorological data in the GMMA to be shared with LGUs. Under such circumstances, in particular, the following development needs should be taken into consideration:

Future Development Needs

	Job Category	Future Development Needs
1	Basin/River System Monitoring	<ul style="list-style-type: none"> • Density of monitoring stations increased drastically by NOAH. Classification of existing gauging stations might be required for appropriate maintenance. • Effective use of synoptic and NOAH's monitoring stations with development of management rules of monitoring stations.
2	Data Collection for Flood Forecasting	<ul style="list-style-type: none"> • Effective system for data processing, transferring and transposing to flood information will be necessary.
3	Database Management	<ul style="list-style-type: none"> • Integration of several database systems of KOICA, EFCOS, NOAH, UNDP/AusAID (Resilience Project) is crucial. • Skill for updating of the database contents. • Data transferring system to concerned agencies.
4	Discharge Measurement	<ul style="list-style-type: none"> • Periodical review and update of H-Q Curves.
5	Assessment and Update of Flood Warning Water Levels	<ul style="list-style-type: none"> • Uniform definitions of warning water levels shall be applied. Substantial review and update of water levels based on the recent occurrence of floods is essential at key monitoring stations.
6	Flood Forecasting	<ul style="list-style-type: none"> • Flood runoff model has been developed by UP under the Project NOAH. PAGASA will need to judge whether it is usable for flood forecasting proposes or not. • Expansion/updating of existing flood runoff models. • Development of IFAS (Integrated Flood Analysis System). • Development of inundation analysis model.
7	Issuance of Flood Information	<ul style="list-style-type: none"> • Clear demarcation of responsibility between MMDA and PAGASA for issuance of flood information and warning shall be examined and fixed. • Flood information issued by MMDA or PAGASA shall be examined together with development of the integrated data. • Data/information sharing system among agencies shall be re-established. • Development of more reliable means for rapid transmission of flood information. • Operation manual for utilization of EFCOS and KOICA is necessary.
8	Post-flood Investigation	Conduct of survey without exception will be encouraged.
9	Public Information and Education Drive	<ul style="list-style-type: none"> • Coordination with PAGASA-HMD, OCD, MMDA and LGUs shall be strengthened. • Experiences in the resilience Project shall be repeated with LGUs.
10	Telemetry and Telecommunication	<ul style="list-style-type: none"> • Integration of NOAH's stations under PAGASA-HMD with shifting ASTI's function including human resources to PAGASA (if required).

11	Flood Drills	<ul style="list-style-type: none">• Under the Resilience Project, flood drills were conducted involving LGUs integrating with issuance of flood information.• To repeat and encourage to conduct the drills.
----	--------------	---

8.3 O&M of Proposed Marikina Control Gate Structure (MCGS)

A control structure of the Marikina Control Gate Structure (MCGS) in the Marikina River between Rosario Bridge and Rosario Weir is proposed to ensure the flood diversion capacity towards the Mangahan Floodway under the Pasig-Marikina River Channel Improvement Project. Harmonious and effective operation of the three structures, as well as a retarding basin in the upstream areas and Marikina dam development, is one of the emerging issues in the flood control of Pasig-Marikina River. In future, the EFCOS Project will manage the operation and maintenance of MCGS as well as Rosario Weir and Napindan HCS.

8.4 World Bank Report for Master Plan for Flood Management

The government, with the technical and financial support of the World Bank, has prepared a Master Plan for Flood Management in Metro Manila and Surrounding Areas in 2012. The plan, approved by the National Economic and Development Authority (NEDA) Board on September 4, 2012, determines a set of priority structural and non-structural measures to provide sustainable flood management up to a certain safety level. The total estimated cost for the implementation of the Master Plan is about PhP352 billion (about US\$8 billion) over a 20-25 year period. The main elements of the Master Plan are:

- (1) Structural measures to reduce flooding from river systems that run through the city;
- (2) Structural measures to eliminate long-term flooding in the flood plain of Laguna de Bay;
- (3) Structural measures to improve urban drainage;
- (4) Non-structural measures such as flood forecasting and early warning systems and community-based flood risk management;**
- (5) Improved institutional structure to deal with flood management in an integrated manner.

The above (4) recommended the early implementation of the following prioritized projects:

- (1) Improvement of monitoring and telecommunication equipment of EFCOS, and
- (2) Extension of coverage of monitoring and telecommunication system to the Laguna Lake basin and the Malabon-Tullahan River basin for PAGASA.

The details are not described in the report and those are enumerated in the recommendations.



THE PROJECT FOR IMPROVEMENT/RESTORATION OF
TELEMETRY EQUIPMENT OF
EFFECTIVE FLOOD CONTROL OPERATION SYSTEM
(EFCOS PROJECT)



"Promote a Flood Resilient Metropolis"



WELCOME GUESTS AND PARTICIPANTS!!!

SEMINAR
ON
**"OPERATION AND MAINTENANCE OF
FLOOD FORECASTING AND
WARNING SYSTEM
IN
METRO MANILA"**

Date : February 18, 2016
Time : 1:00 – 5:00 PM
Venue : Manila City Room

EFCOS PROJECT



The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

OUTLINE OF PRESENTATION

I. EFCOS Project

- Purpose
- EFCOS Project Area
- How EFCOS Project works..

II. Phase 1

- Gauging Stations
- Warning Posts
- Warning System
- Relay and Monitoring Stations
- Phase 1 Configuration

III. Phase 2

- Gauging Stations
- Phase 2 Configuration
- Typhoon “Ondoy”
- History of Damaged Equipment
- Status of EFCOS before Rehabilitation

IV. Phase 3

- Work Responsibilities of MMDA
- Phase 3 Configuration

V. EFCOS Components

VI. Flood Forecasting and Gate Operation

PURPOSE:

- Designed to address perennial flooding in Metro Manila
- EFCOS Project is aimed principally for the effective operation of the two flood control structures

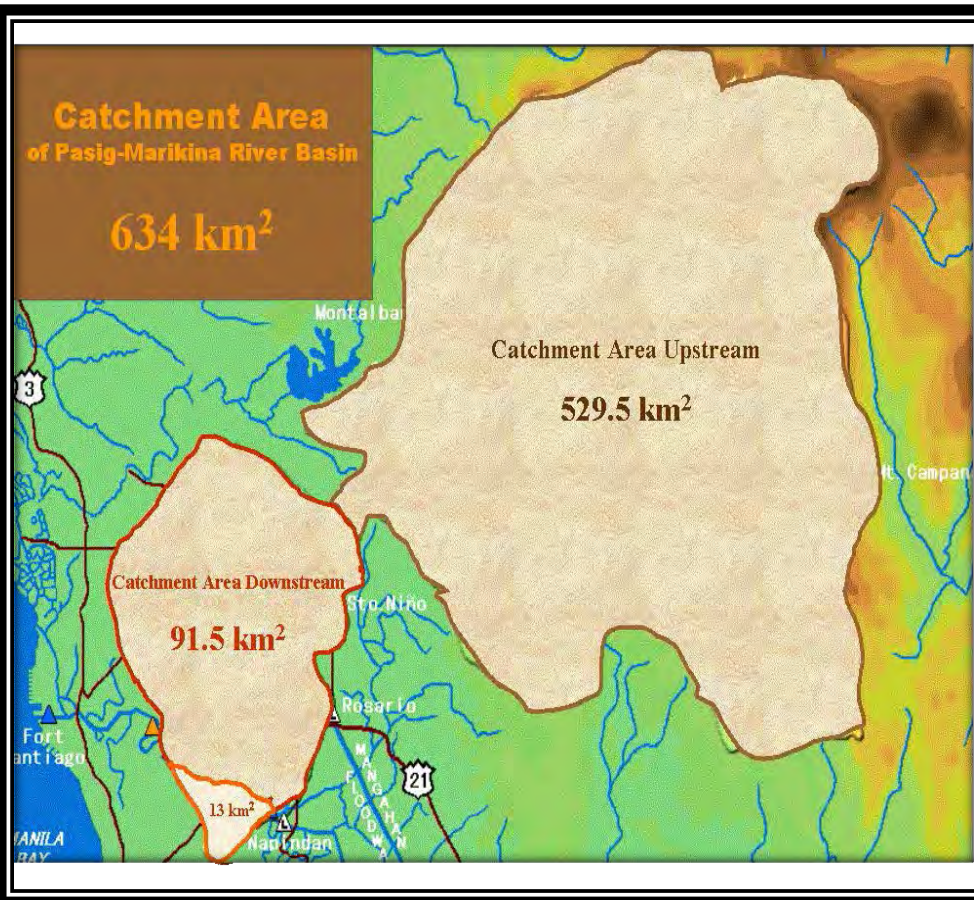


- Diverts excess water flowing from Marikina River into Laguna Lake temporarily
- Designed to limit the flood down into the Lower Marikina River and Pasig River to bank full capacity
- Also allows reverse flow from the lake to the Lower Marikina River



- Prevents the backflow of saline and polluted water from the Pasig River
- Constructed to improve the quality of water in Laguna Lake

EFCOS PROJECT AREA:



The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

HOW EFCOS PROJECT WORKS....



ACCURATE HYDROLOGICAL DATA COLLECTION

- UNIFORM DISTRIBUTION OF HYDROLOGICAL GAUGING STATIONS (RAINFALL & WATERLEVEL)
- MORE FREQUENT OBSERVATION
- DATA COLLECTION WITHOUT OMISSION

DATA TRANSFERRED TO RMCS

AUTOMATICALLY PROCESSED AND VISUALIZED

DATA PROVIDED TO PUMPING STATION AND RELATED AGENCIES

PRECISION & SWIFTNES OF FLOOD CONTROL FACILITIES OPERATION SHARING OF FLOOD INFORMATION BETWEEN RELATED AGENCIES

DECISION IN ISSUING THE FLOOD WARNING WITHIN THE BASIN. GATE OPERATION WILL COMMENCED

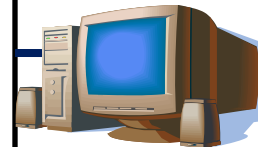
RESULTING TO MINIMIZATION OF FLOOD DAMAGE

TELEMETRY SYSTEM

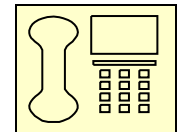
DATA PROCESSING SYSTEM

EMERGENCY RADIO COMMUNICATION

MULTIPLEX RADIO SYSTEM



TELEPHONE SYSTEM

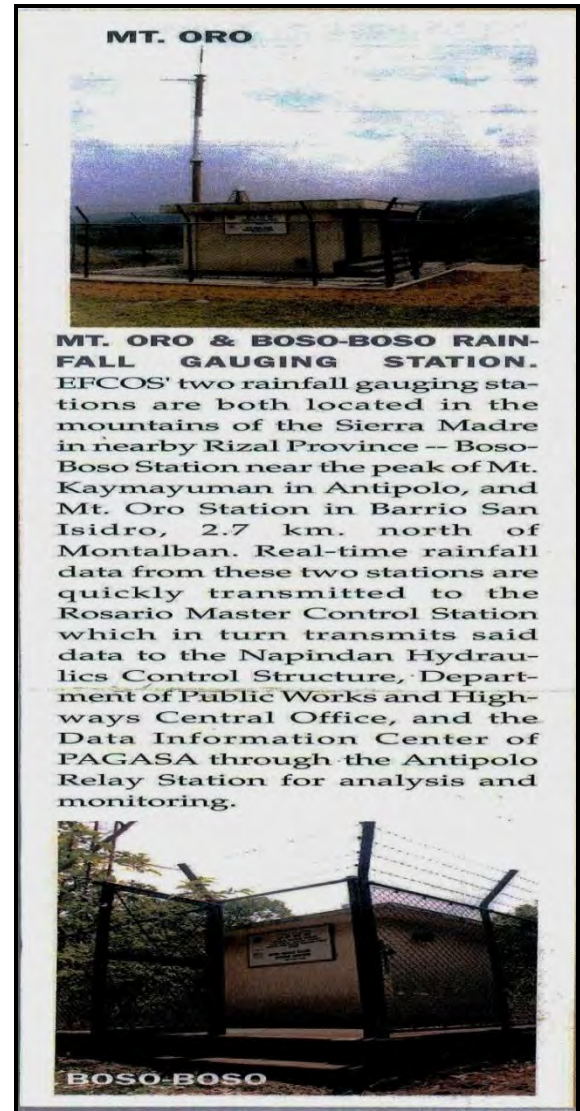


PHASE 1: 1993

- EFCOS system was designed in 1985 as an analogue telemetry system
- It is under Overseas Economic Cooperation Fund (OECF) loan package
- The project cost is 234M PhP
- Inadequate for the Pasig-Marikina River Basin
- Unable to function as a flood forecasting system
- Rehabilitation project was formulated to enhance the overall function of the EFCOS system

Rainfall Gauging Stations

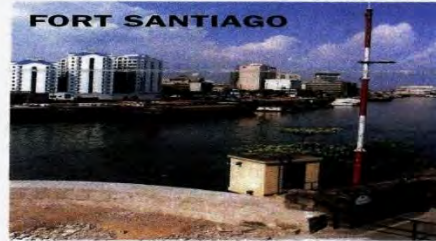
1. Mt. Oro



2. Boso-Boso

Water Level Gauging Stations

1. Montalban
2. Sto. Niño
3. Rosario Lake Side
4. Rosario Junction Side
5. Angono
6. Napindan Lake Side
7. Napindan Junction Side
8. Pandacan
9. Fort Santiago



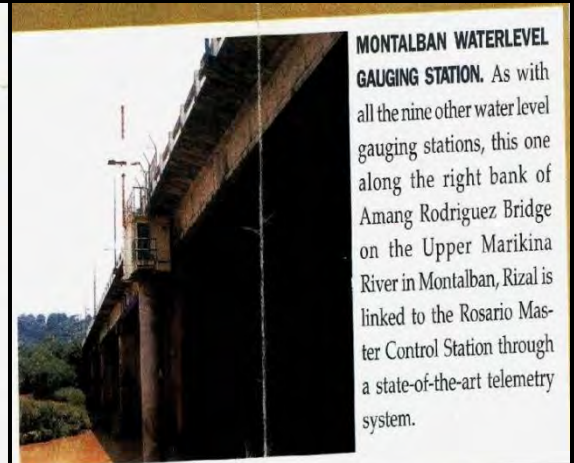
FORT SANTIAGO, PANDACAN, AND ANGONO WATERLEVEL GAUGING STATIONS. Northwest of Metro Manila lies the Fort Santiago Waterlevel Gauging Station, located at the Port Area of Manila. The Pandacan Station is located along the Pasig River in Pandacan, Manila, while the Angono Station is near the junction of the Mangahan Floodway and Laguna de Bay in Angono, Rizal.



PANDACAN



ANGONO



MONTALBAN WATERLEVEL GAUGING STATION. As with all the nine other water level gauging stations, this one along the right bank of Amang Rodriguez Bridge on the Upper Marikina River in Montalban, Rizal is linked to the Rosario Master Control Station through a state-of-the-art telemetry system.



STO. NIÑO WATERLEVEL GAUGING STATION. Water-level gauging stations measure real time water elevations. This particular waterlevel gauging station is a major control point and is located on the left side of the Marikina Bridge along the upper Marikina River in Sto. Niño, Marikina.

Warning Post



WARNING POST. Pictured here are two of the nine structures positioned on both sides of the Manggahan Floodway. These warning posts alert people along the floodway that the floodgates are to be opened and that they must evacuate the immediate area to prevent loss in lives and damage to properties caused by floodwaters diverted from the Pasig-Marikina River. Warning post 1 is located inside the Rosario Master Control Station, while the remaining eight are scattered on the east and west main dikes of the Manggahan Floodway Channel. These warning posts are connected to the Rosario Master Control Station through cable and simplex radio.



WARNING SYSTEM

LEVEL 1

PRECAUTION STAGE - ALL GATES ARE USUALLY CLOSE. DURING THIS STAGE ANNOUNCEMENT NO. 1 IS BROADCAST AND REPEATED.

LEVEL 2

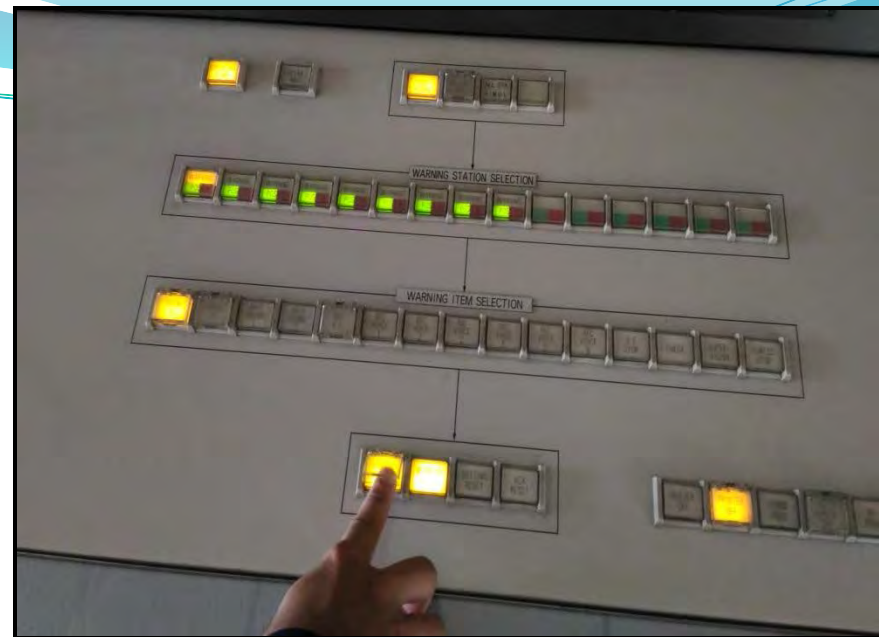
CAUTION STAGE - A WARNING CONSISTING OF SIREN, SPEAKER WARNING AND VOICE BROADCAST "NO.2" IS ISSUED WITHIN THIRTY MINUTES AFTER THE OBSERVATION OF THE CRITICAL WATERLEVEL AT STO. NINO WLGS.

LEVEL 3

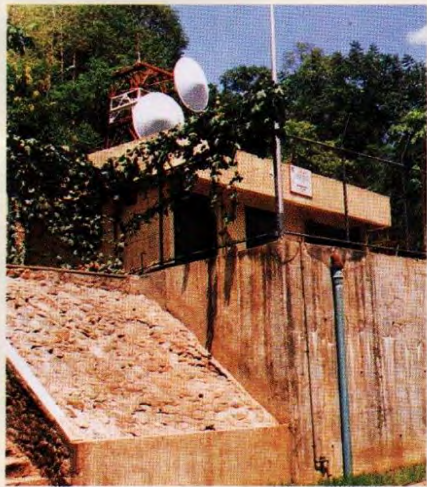
EMERGENCY STAGE - THE FLOODWAY IS EXPECTED TO RISE DUE TO LARGE VOLUME OF WATER COMING FROM UPSTREAM OF MARIKINA RIVER . A WARNING CONSISTING OF SIREN SPEAKER WARNING AND VOICE BROADCAST " NO.3" IS SENT BASED ON THE JUDGEMENT OF THE HYDROLOGIST IN ROSARIO MASTER CONTROL STATION.

LEVEL 4

POST FLOOD STAGE - DURING THIS STAGE, THE WATER IN THE FLOODWAY IS DECREASING BUT A CAUTION IS GIVEN TO THE PEOPLE BECAUSE OF THE POSSIBLE OCCURRENCE OF FLOOD. "VOICE BROADCAST NO. 4 IS SENT AND REPEATED.



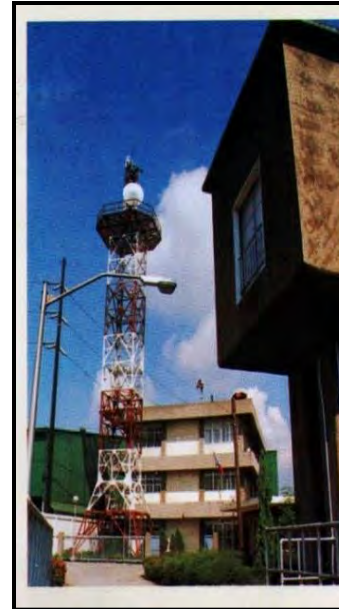
Relay and Monitoring Stations



ANTIPOLO RELAY STATION. An important EFCOS communication facility, the Antipolo Relay Station links the Rosario Master Control Station, the Napindan Hydraulics Control Structure, the Department of Public Works and Highways Central Office and PAGASA Compound through its modern telecommunication facilities. It is located inside the Town and Country Subdivision in Antipolo, Rizal.



PAGASA DATA INFORMATION CENTER. Together with the Napindan Hydraulics Control Structure, and the Department of Public Works and Highways Central Office, the PAGASA Data Information Center also monitors data received from the 2 rain gauge stations and 9 waterlevel stations via the Antipolo Relay Station. It is located within the PAGASA Compound in Diliman, Quezon City.



ROSARIO MASTER CONTROL STATION. The Rosario Master Control Station is located at the right bank side of the Rosario Weir in Pasig City. It houses EFCOS' major telecommunication, telemetry and warning equipment, as well as advanced computer equipment to process and analyze hydrological data coming from the different places of Metro Manila and Rizal.

PHASE 1 EFCOS CONFIGURATION



LEGEND :

-  Master Control Station
-  Monitor Station
-  Relay Station
-  Rain Gauge Station
-  Water Level Gauge Station
-  Warning Post
-  Multiplex Radio Link (2 GHz)
-  Simplex Radio Link (397.625 MHz for Telemetry)
-  Simplex Radio Link (350.350 MHz for Warning)
- Cable Link



PHASE 2: 2001

- The project includes the installation of hydrological observation stations
- Under Grant Aid Program and project cost is 411M PhP
- Deployment of emergency radio communication equipment
- Introduction of digitized telemetry system
- Introduction of flood forecasting system

Rainfall Gauging Stations

1. Mt. Campana
2. Boso-Boso
3. Aries
4. Mt. Oro
5. Nangka
6. Napindan
7. Science Garden

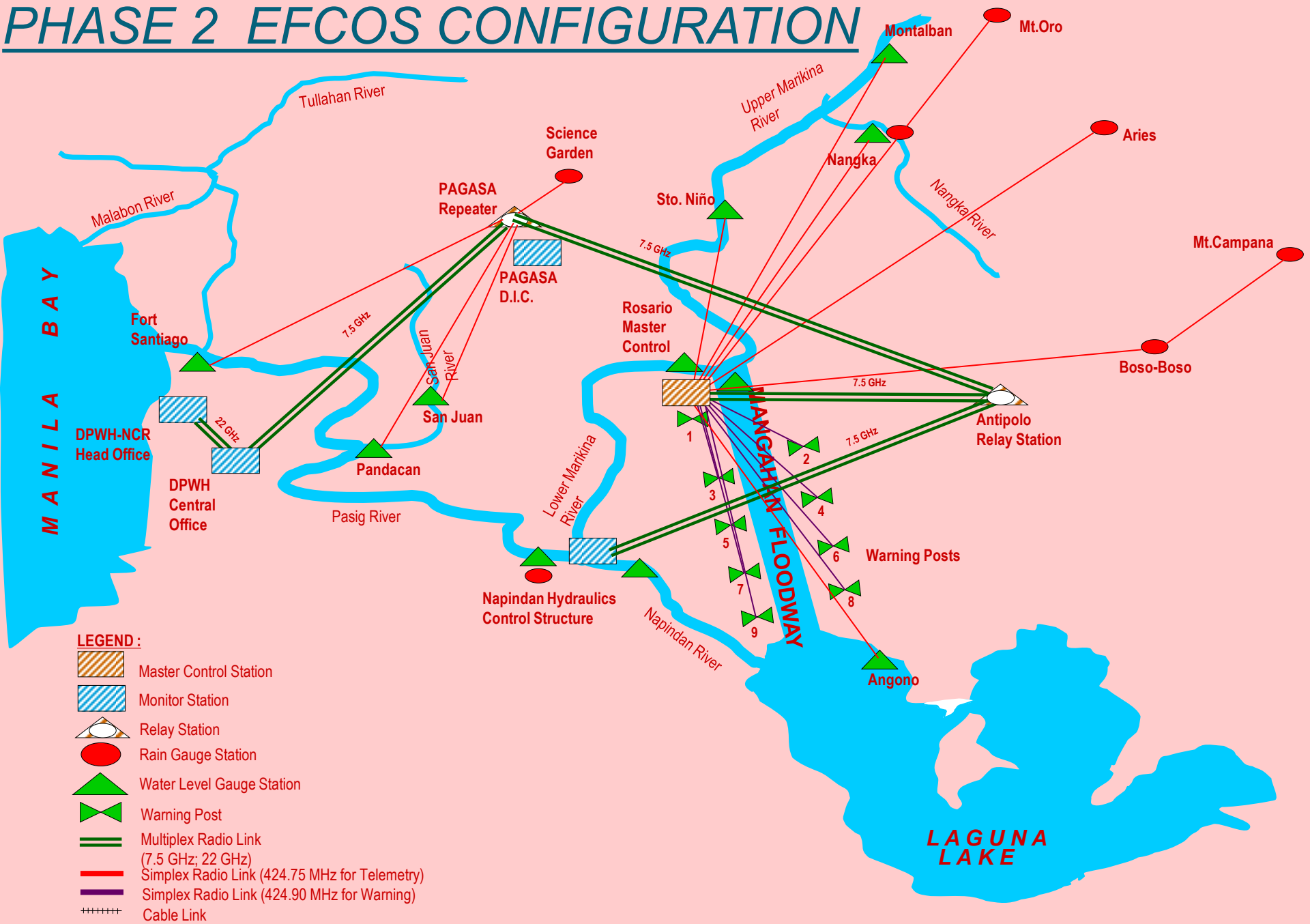
LEGENDS:


-  Additional gauging station
-  Existing gauging station

Water Level Gauging Stations

1. Montalban
2. Nangka
3. Sto. Niño
4. Rosario Junction Side
5. Rosario Lake Side
6. Angono
7. Napindan Junction Side
8. Napindan Lake Side
9. San Juan
10. Pandacan
11. Fort Santiago

PHASE 2 EFCOS CONFIGURATION





....but some of the telemetry equipment were severely damaged..

Typhoon "Ondoy"

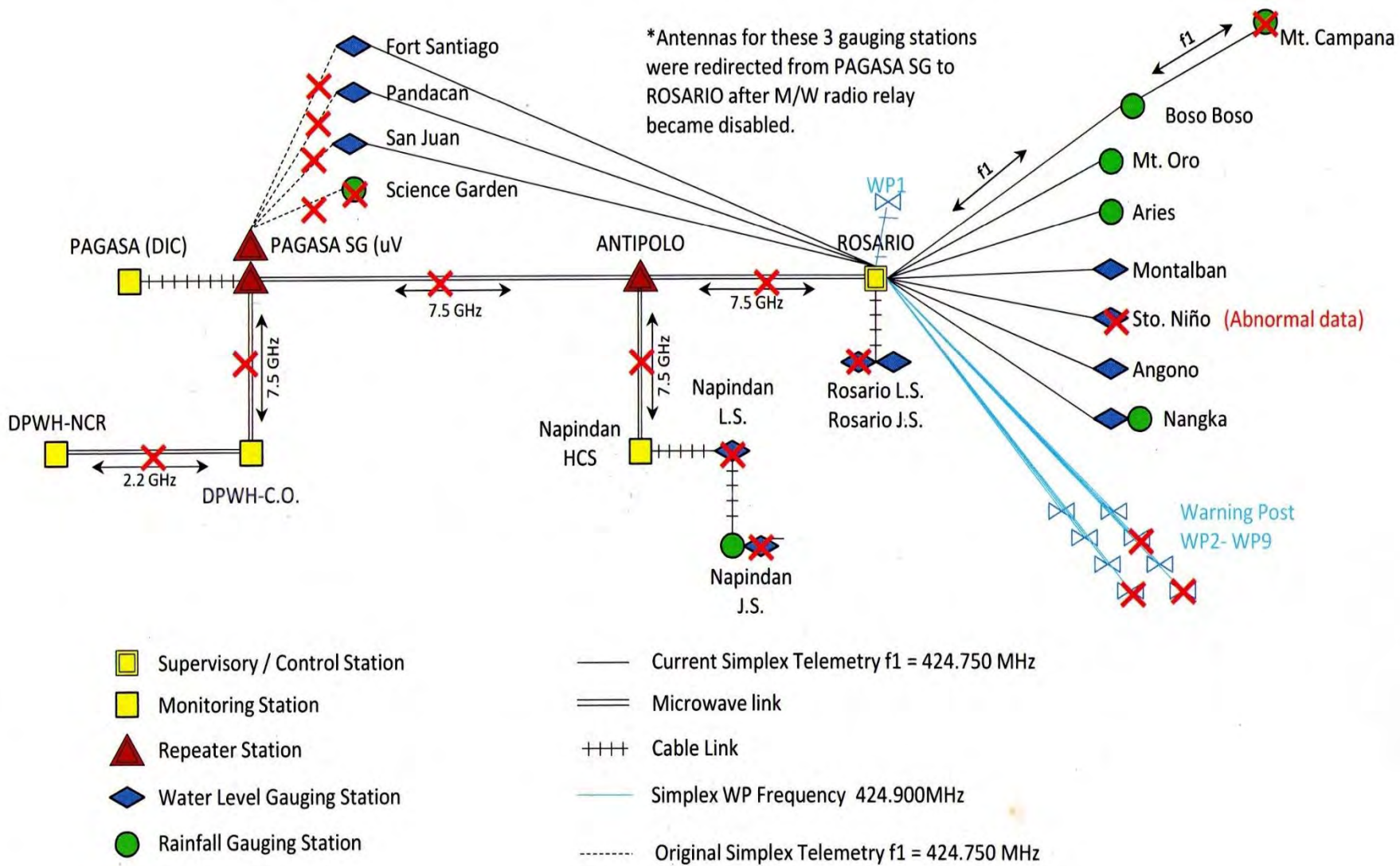


The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

History of Damage Equipment

NO.	STATION	CAUSE OF DAMAGE	DATE DAMAGED	CURRENT STATUS
1	Rosario L.S.	Typhoon "Lagalag"	Aug.02,2002	Manual reading after malfunction
2	Napindan L.S.	Sensor malfunction	Aug.28,2002	Manual reading after malfunction
3	Fort Santiago (Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Redirection of yagi antenna
4	Pandacan (Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Redirection of yagi antenna
5	San Juan (Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Redirection of yagi antenna
6	Science Garden(Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Telemetry replaced to Nangka
7	Napindan J.S./Rainfall	Multiplex system failure	Oct. 12,2006	Manual reading of waterlevel
8	Antipolo Relay Station	Multiplex system failure	October 2006	Shutdown
9	DPWH C.O.	Multiplex system failure	October 2006	Shutdown
10	DPWH N.C.R.	Multiplex system failure	October 2006	Shutdown
11	Nangka	Typhoon "ONDOY"	Sept. 26, 2009	Replace w/ S.G. telemetry unit
12	Sto.Nino	Typhoon "ONDOY"	Sept. 26, 2009	Cable was submerged
13	Warning Post No. 8	Typhoon "ONDOY"	Sept. 26, 2009	Warning eqpt. was submerged
14	Mt. Campana	Hit by lightning	2009-2010	Telemetry eqpt. was damaged
15	Science Garden R.F.	Reed switch problem	Nov.19,2010	Replaced w/ Napindan tipping bucket
16	Aries R.F.	Reed switch damaged by ants	Mar.03,2011	Replaced with spare tipping bucket
17	Boso-Boso R.F.	Reed switch problem	Sept.7,2011	Replaced with spare tipping bucket
18	Warning Post No. 2	Damage by rodents	Jan. 11,2012	Operational after repair
19	Warning Post No. 4	Stolen	May 14,2012	Shutdown
20	RMCS Server	Server sometimes malfunction	July 27,2012	New sensor under PAGASA Project
21	San Juan	Interference	June 09,2014	Install additional amplifier

Source: JICA Study Team



Status of the EFCOS Telemetry and Warning System before Rehabilitation

Source: MMDA

PHASE 3: 2015

- It is under JICA's Technical Cooperation Program (TCP)
- Project costs:
 - Government of Japan: 129,000,000 JPY
 - Government of Philippines: 16,000,000 PhP
- Improvement/Replacement of damaged equipment
- Relocation of currently used frequency for Telemetry and Warning Stations
- Restore the original objectives of EFCOS

Work Responsibilities of MMDA

STATION	WORKS	CURRENT STATUS
Monitoring Stations	Clearing the site including pulling out of unnecessary equipment and storing them in in the Rosario Master Control Station before disposal	COMPLETED
Science Garden Rainfall Gauging Station	Renovation of observation house <ul style="list-style-type: none"> • Repair of Door 	COMPLETED
Boso-Boso Rainfall Gauging Station	<ul style="list-style-type: none"> • Repainting of antenna mast • Repair door hinge 	COMPLETED
Napindan HCS	<ol style="list-style-type: none"> 1. 35 m Antenna Tower <ul style="list-style-type: none"> • Removal of tower • Transfer/mobilization from NCR to NHCS • Construction of tower foundation • Erection/Installation of tower 2. Repair of water level sensor box 3. Water proofing and improvement of building with air conditioning 	COMPLETED
Warning Post No. 8	Construction of 2 nd floor	COMPLETED
Mt. Campana	Erection of additional antenna pole	COMPLETED
Nangka Rainfall Gauging Station & Water Level Gauging Station	Renovation of observation house <ul style="list-style-type: none"> • Construction of 2nd floor 	COMPLETED
Sto. Niño Water Level Gauging Station	Repair of telemetry house door	COMPLETED
Fort Santiago Water Level Gauging Station	Repainting of antenna mast	COMPLETED
Antipolo	Room renovation with air conditioning	COMPLETED
Angono Water Level Gauging Station	Water-proofing and construction of security fence	COMPLETED
All	Necessary GOP procedures for an official request for GOJ on disposal of equipment provided under Grant Aid Project	

Work Responsibilities of MMDA



Warning Post No. 8 (BEFORE)



Nangka (BEFORE)



Napindan Tower (BEFORE)



AFTER

01.22.2016



AFTER



AFTER

The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

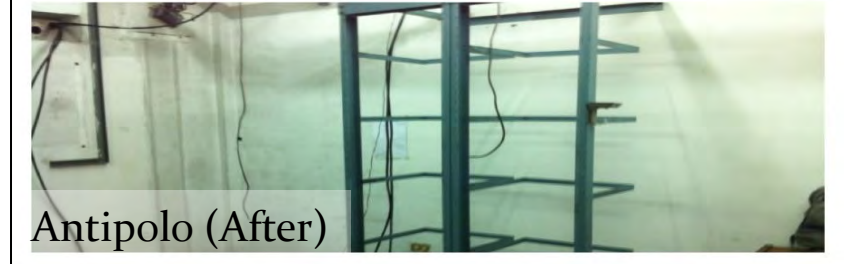
Work Responsibilities of MMDA



Napindan HCS (Before)



Antipolo (Before)



Antipolo (After)

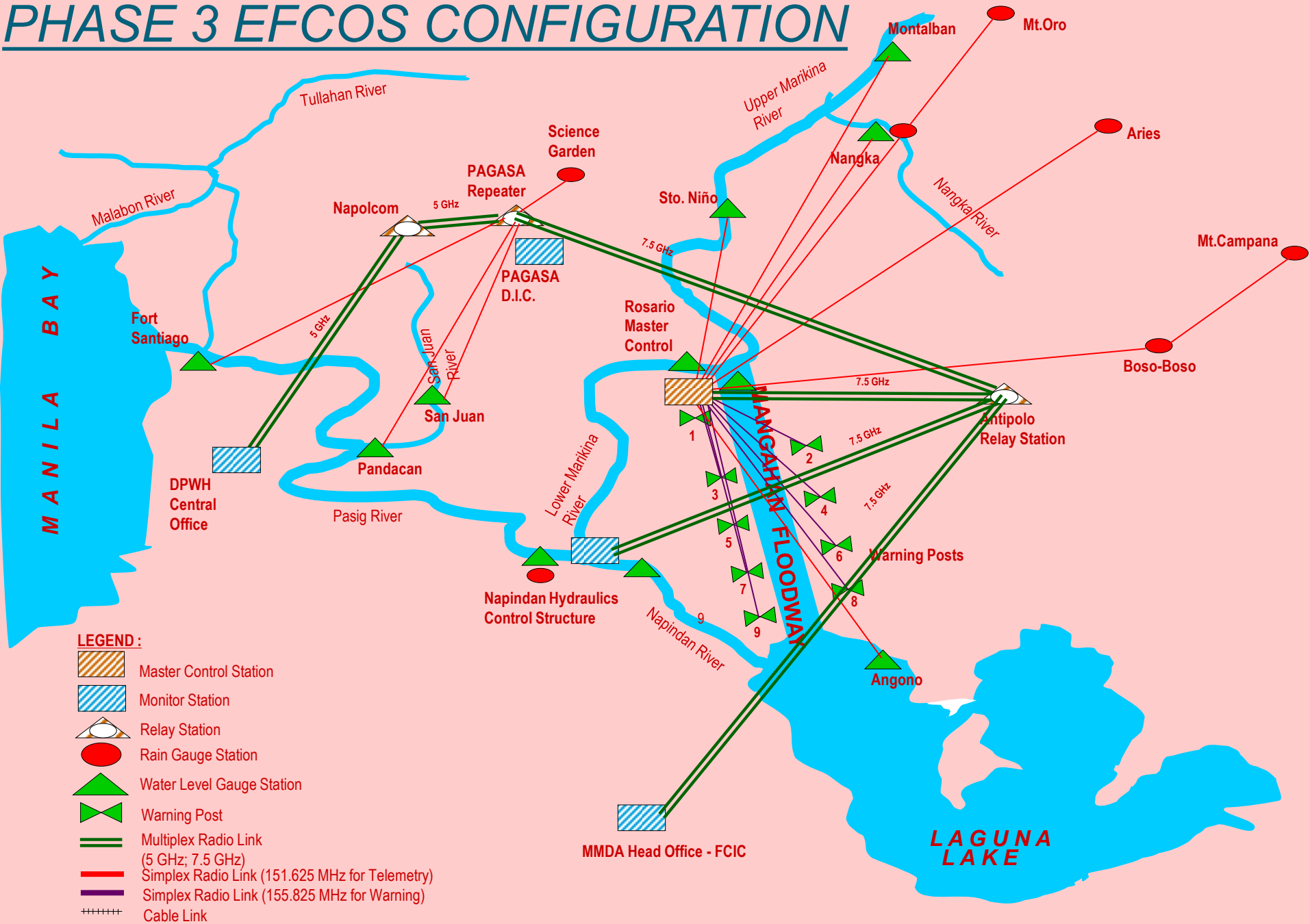


Napindan HCS (After)



Napindan (Now)

PHASE 3 EFCOS CONFIGURATION





EFCOS

COMPONENTS

PHASE 3

The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

Rosario Master Control Station

- Located at the West Bank side of the Rosario Weir along Manggahan Floodway
- It houses EFCOS major telecommunication, telemetry and warning equipment as well as advanced computer equipment
- The key station that supervises and controls all of the above mentioned equipment



Rainfall Gauging Station

- Used for measuring the amount and intensity of precipitation
- Also used for determining the time of beginning and ending of precipitation

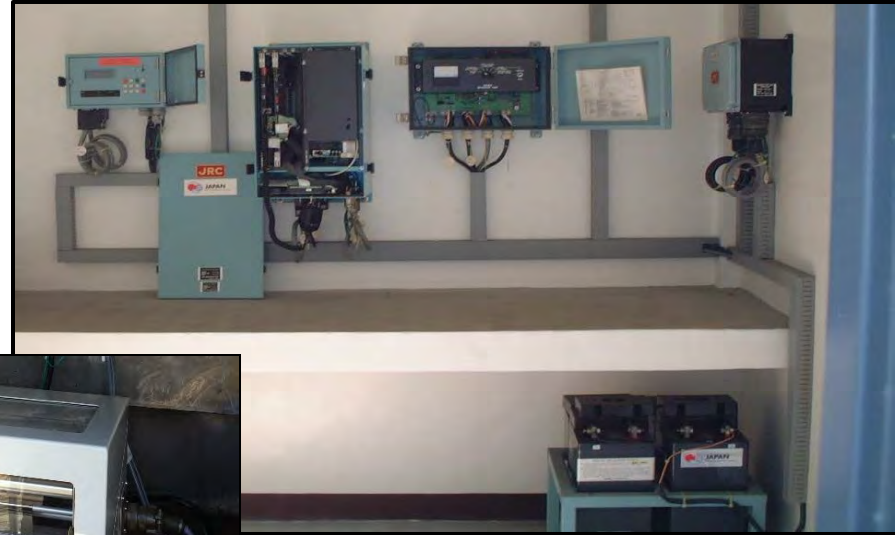


**TIPPING
BUCKET**

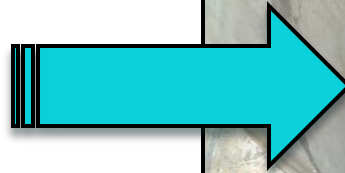


Water Level Gauging Station

A structure inside or close to the stream channel which records the height of water surface in the stream

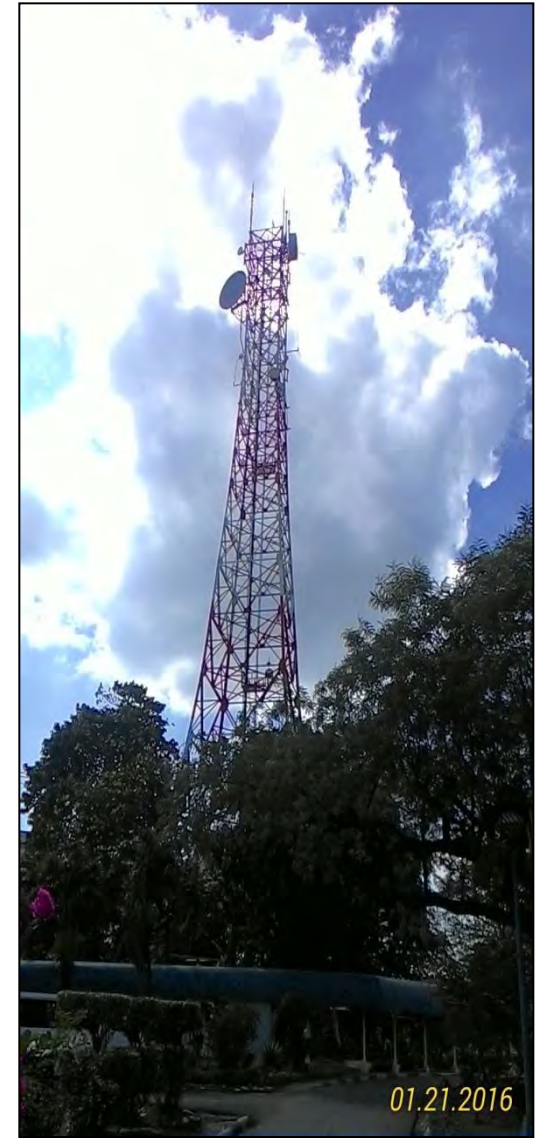


FLOAT TYPE - a wire connected to flat circular wooden float, counterweight, Analog to Digital converter and automatic recorder



Relay Station

- This station is the relay point for the multiplex communication system of EFCOS Project
- The master station for the multi-directional multiplex radio system and other slave stations such as rainfall and water level gauging stations
- The function of relay stations is to make sure that the data and voice transmission between the said stations will be made possible

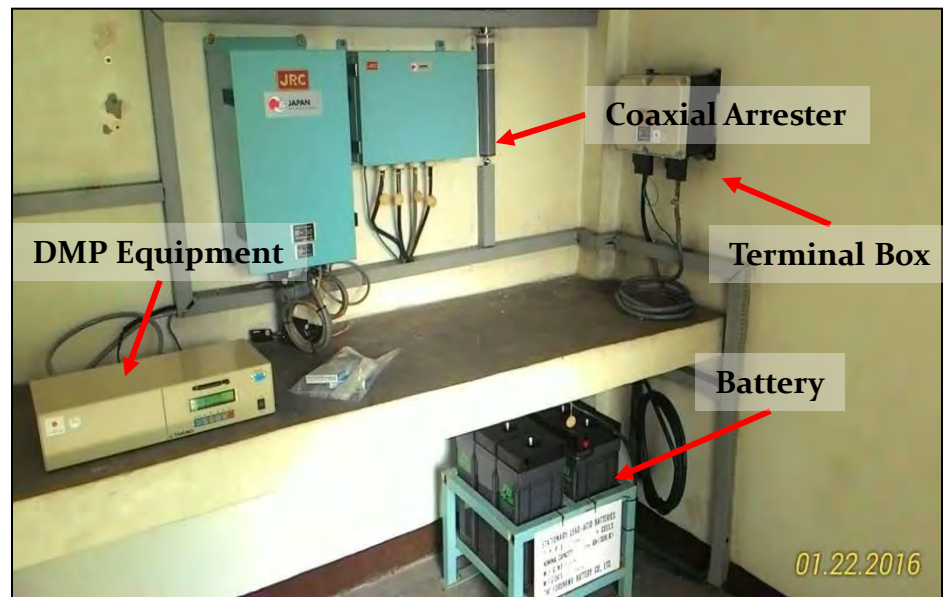
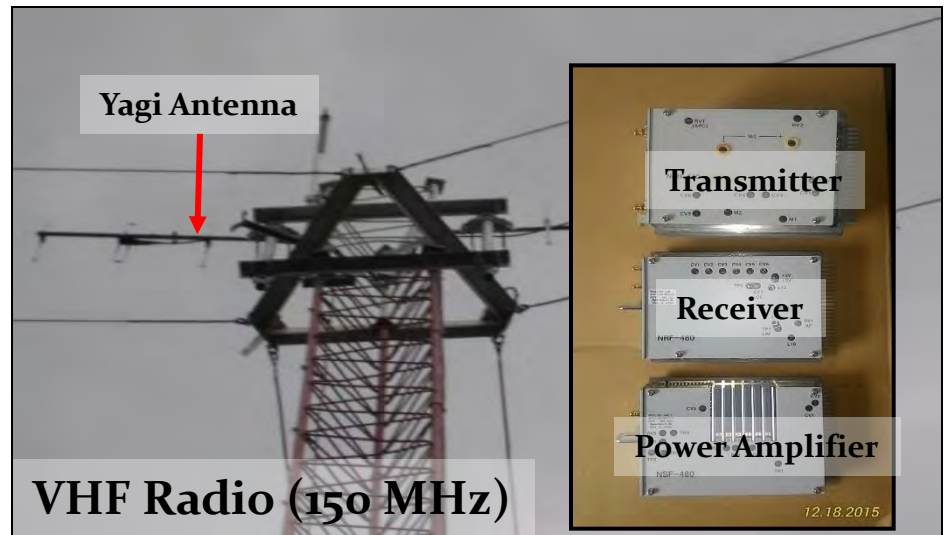
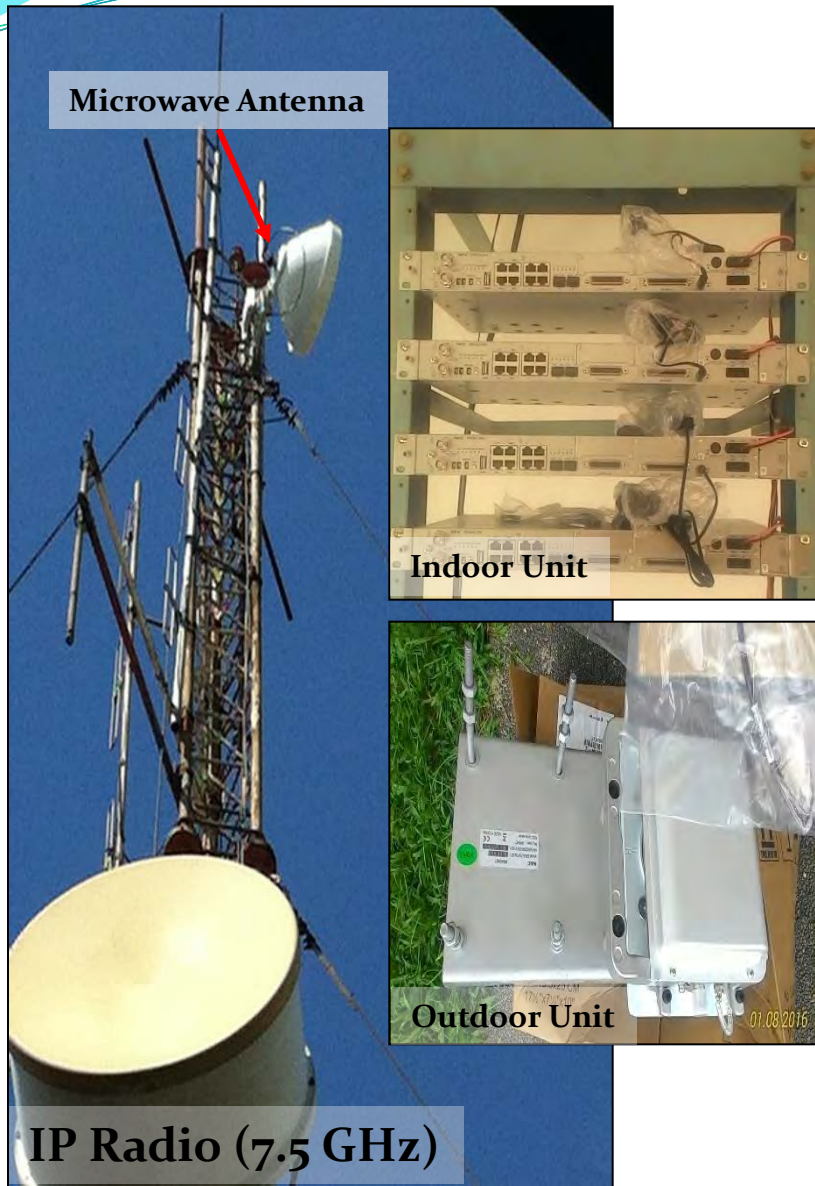


Warning Post

- Alert people along the floodway
- Warning Post 1 is Rosario located inside the Master Control Station
- Remaining eight are situated on the east and west main dikes of Manggahan Floodway Channel
- Connected to the RMCS through cable and Very High Frequency (VHF) radio

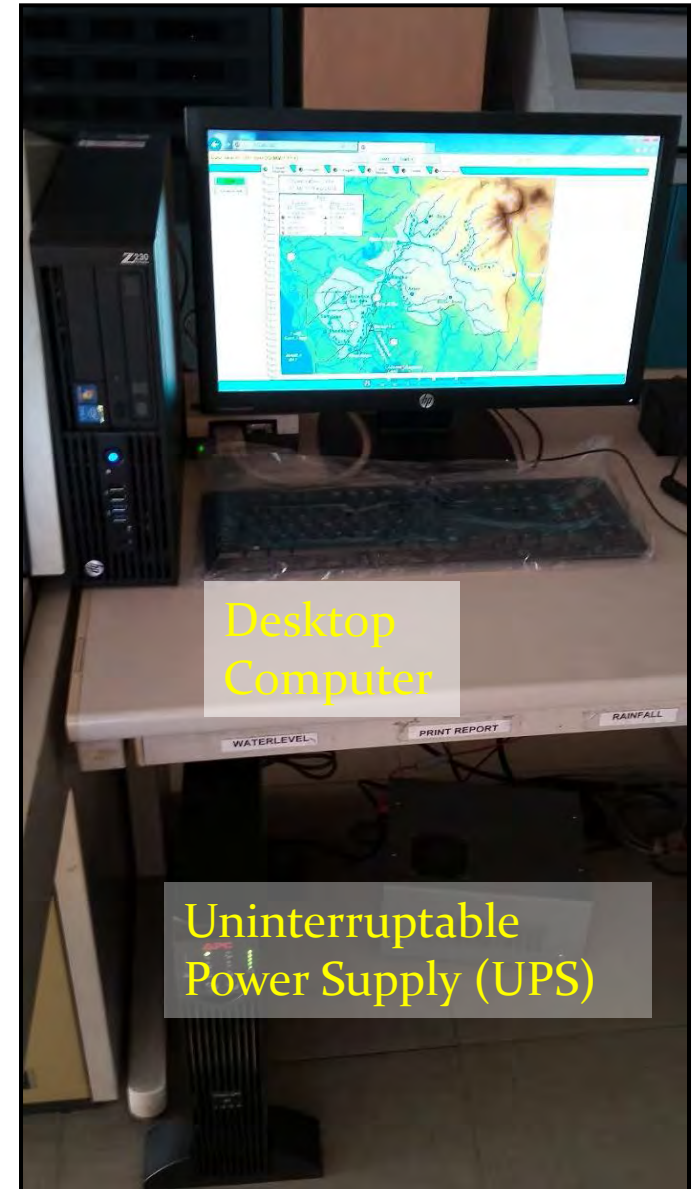
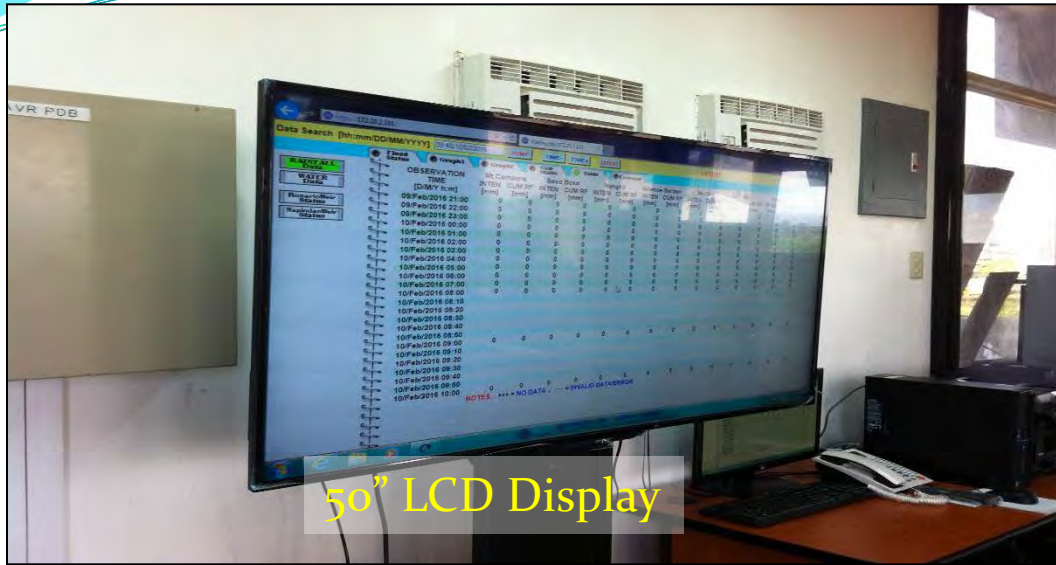


Newly Installed Equipment



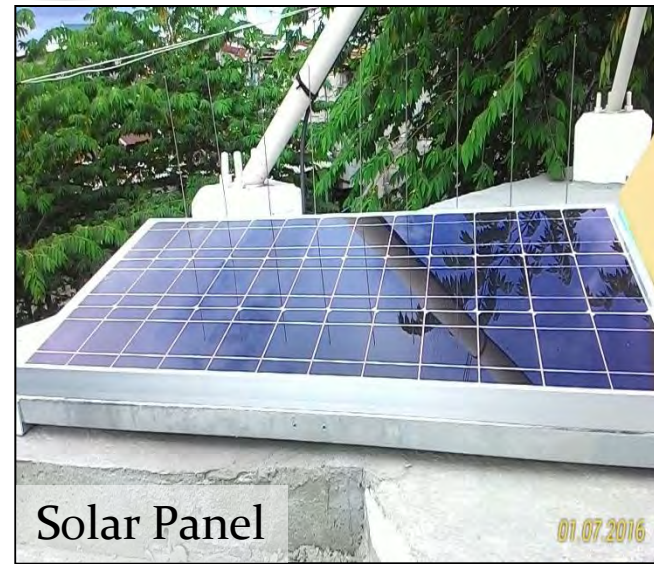
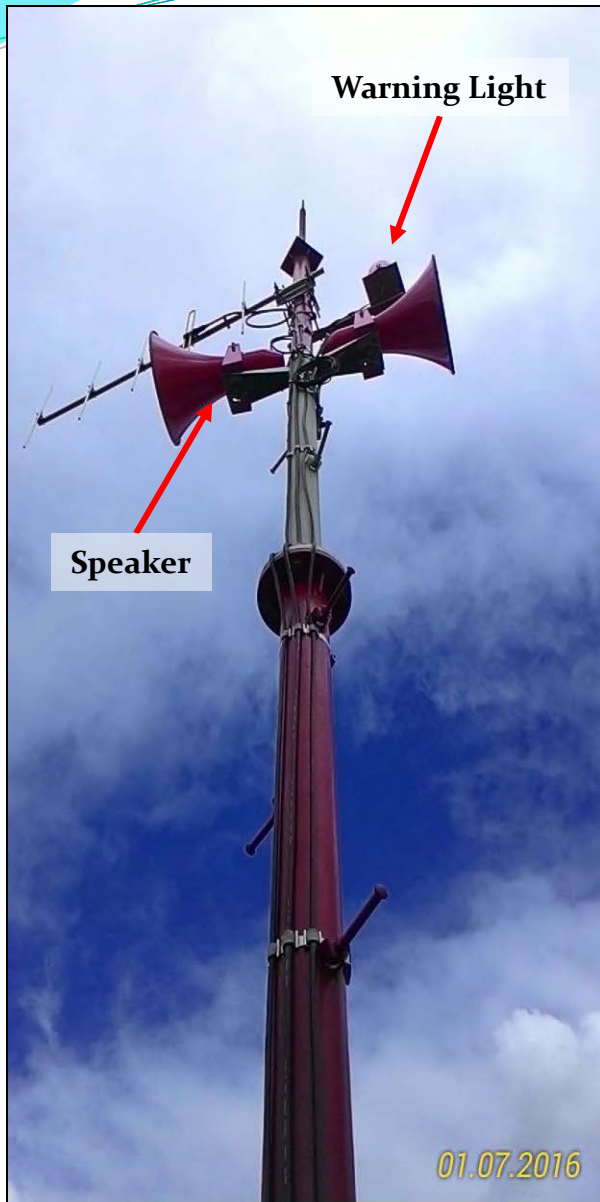
The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

Newly Installed Equipment



The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

Newly Installed Equipment





Flood Forecasting and Gate Operation

The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

Travel Time (Flood Propagation)

River	Section	Travel Time (min.)	Distance (km)	Propagation Velocity (m/s)
Upper Marikina River	Montalban - Nangka	80	9.0	1.9
	Nangka - Sto. Niño	50	5.3	1.8
	Sto. Niño - Rosario	30	6.7	3.7
San Juan	Tatalon - Junction	30	7.1	3.9

Water Level Status

Status	Pasig-Marikina River					Tributary	
	Montalban	Sto. Niño	Rosario	Napindan	Pandacan	San Juan	Nangka
Critical	23.6	14.9	13.8	12.9	12.0	12.0	18.3
Alarm	23.0	14.1	13.2	11.9	11.5	11.5	17.7
Alert	22.4	13.0	12.5	10.9	11.0	11.0	17.1

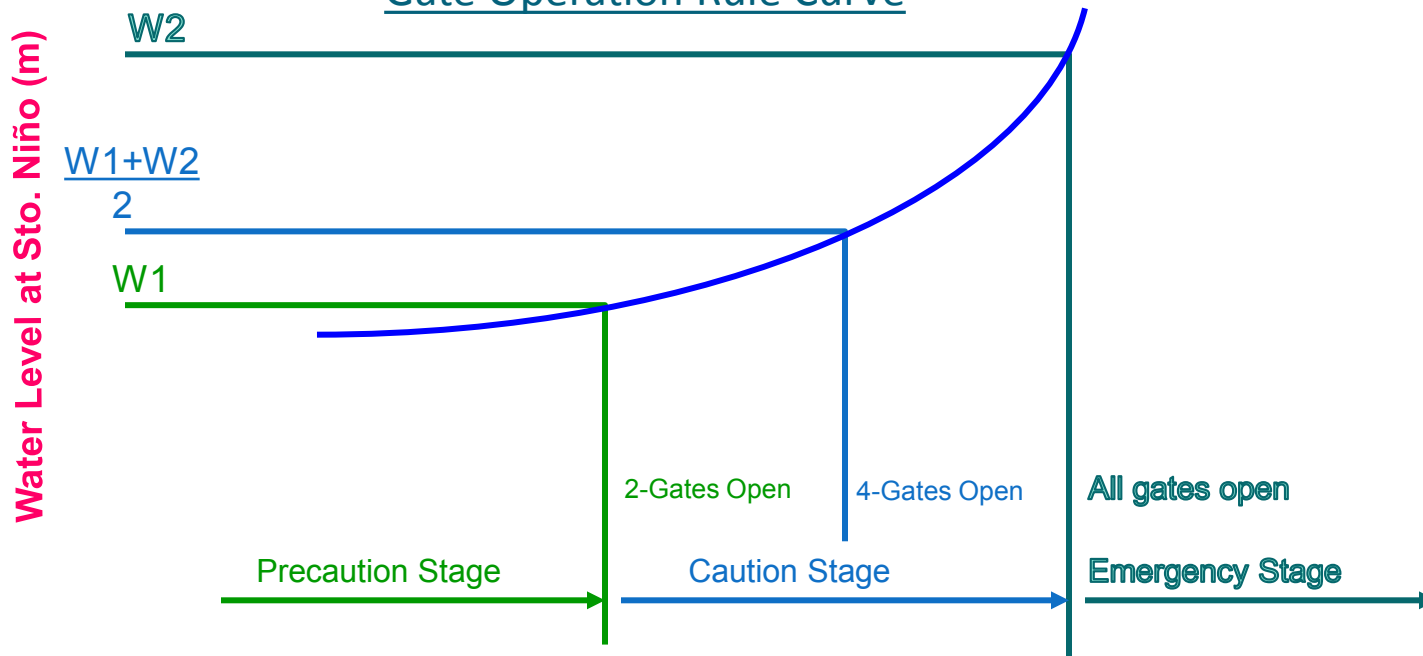
Relationship between Basin Mean Rainfall and Waterlevel

Rainfall Status

Status	Basin Mean Rainfall (mm/hr)
Heavy	Over 50
Moderate	Between 30 and 50
Light	Less than 30

Rainfall Intensity (mm / hour)	Increase of Water Level (m)	
	Montalban	Sto. Niño
10-30	0.1 - 0.6	0.1 - 0.6
30-50	0.6 - 1.2	0.6 - 1.3
50-70	1.2 - 1.8	1.3 - 2.1
70-90	1.8 - 2.2	2.1 - 2.8
90-100	2.2 - 2.5	2.8 - 3.1

Gate Operation Rule Curve



W1	$\frac{W1+W2}{2}$	W2
15.3	16.2	17.1
15.2	16.1	17.0
15.2	16.1	16.9
15.1	15.9	16.7
15.0	15.8	16.6
14.9	15.7	16.4

W1, W2 : Critical Water Level
 Sto. Niño : Control Point
 Fort Santiago : Tidal Level (m)

2012 REVISED GUIDELINE IN THE OPENING OF GATES AT ROSARIO WEIR

REFERENCE POINT: STO. NIÑO WATERLEVEL GAUGING STATION

STARTING ELEVATION	TOTAL RAINFALL UPSTREAM	FORECAST ELEVATION		GATES TO OPEN AT RANDOM	GATE OPERATI ON	WHAT TO DO FIRST	REMARKS
		LOW	HIGH		OPEN		
13.50 ALARM	NO RAINFALL MONITORED AT ALL EFCOS RAINFALL GAUGING STATION			ALL GATES CLOSED	0	ISSUE WARNING BEFORE OPENING ALL GATES	If there is no rainfall event yet Sto. Niño reads elevation 13.8m keep all gates closed
13.70 ALERT							If there is rainfall event follow the random opening of gates
13.80 CRITICAL	LIGHT 10-30	13.90	14.4	OPEN G4 OPEN G5 OPEN G3 & G6	1 2 4	ISSUE SEVERE WARNING AT ALL WARNING POST STATION	FIRST ALARM IN MARIKINA LGU (15.00) SECOND ALARM MARIKINA LGU (16.00) FORCE EVACUATION AT MARIKINA (17.00)
	LIGHT-MOD 30-50	14.50	15.10	OPEN G2 & G7 OPEN G8	6 7		
	MODERATE 50-70	15.30	15.90	OPEN G1	8		
	MOD-HEAVY 70-90	16.00	16.60		ALL GATES OPEN		
	HEAVY 90-100	16.70	16.90				

The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)



Maraming Salamat!

The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)