Addendum to the Environmental and Social Impact Assessment – Rapid Cumulative Impact Assessment

Project Number: 51274-001
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THA: Bangkok Mass Rapid Transit (Pink and Yellow Lines)

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List of Abbreviations

ADB	Asian Development Bank
ASI	Avoid-Shift-Improve Approach
BMA	Bangkok Metropolitan Administration
BMR	Bangkok Municipal Region
BMTA	Bangkok Mass Transit Authority
BOD	Biochemical Oxygen Demand
BRT	Bus Rapid Transport
BT	Thai Baht
BTS	Bangkok Mass Transit System Public Company Limited
CBD	Central Business District
CIA	Cumulative Impact Assessment
CO	Carbon Monoxide
CO2	Carbon Dioxide
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EXAT	Expressway Authority of Thailand
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRM	Grievance Redress Mechanism
LECZ	Low Elevation Coastal Zone
M-Map	Mass Rapid Transit Master Plan in Bangkok Metropolitan Region
MRT	Metropolitan Rapid Transit
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
OECD	Organization for Economic Cooperation and Development
OTP	Office of Traffic and Transport Policy and Planning
PM_{10}	Particulate Matter < 10 micron
$PM_{2.5}$	Particulate Matter <2.5 micron
PPP	Public Private Partnership
RCIA	Rapid Cumulative Impact Assessment
ROW	Right-of-Way
SO_2	Sulfur Dioxide
SPS	ADB Safeguard Policy Statement (2009)
SRT	State Railway of Thailand
TOD	Transport Oriented Development
VEC	Valued Environmental Component
WHO	World Health Organization

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Executive Summary

In contrast to many other Asian megacities, Bangkok lacks a major subway or overhead metro system. But this will soon change. The Government of Thailand has an eight-year plan to develop the country's transportation infrastructure. The goal of the strategy is to advance the logistics system and integrate all transportation platforms – rail, air, road and water – both internally and with adjacent countries. In Bangkok, the plan entails developing ten metro lines expanding from the current 100 km of lines in service to a complete integrated mass transit system over 500 km in length by the late 2020s. The ADB is assisting in this effort by financing two overhead monorail lines, the Pink and Yellow metro projects, through a Public-Private Partnership (PPP).

As part of project due diligence and environmental and social compliance review associated with project financing, a cumulative impact assessment (CIA) is required to assess the contribution of the Yellow and Pink Lines to cumulative impacts on key valued environmental components or VECs. This report assesses those cumulative impacts arising from development of both projects and the entire mass transit and road transportation network.

A Rapid Cumulative Impact Assessment approach was used following guidelines of the International Finance Corporation (IFC). Cumulative impacts were assessed on five selected valued environmental components: air quality, water quality, hydrology, property values and economic activity. A six-step approach to the CIA was followed involving selection of spatial and temporal boundaries, selection of valued environmental components and trend assessment, selection of included projects and activities, identification of cumulative impacts on each VEC, assessment of impact significance and development of management actions.

The Rapid Cumulative Impact Assessment anticipates positive cumulative impacts resulting from development of Bangkok's mass transit system, including the Pink and Yellow Lines. Highly positive and significant impacts on property values are expected to occur around metro stations and positive and significant impacts of increases in economic activity around metro stations are predicted. Null cumulative impacts of construction and operation of the Pink and Yellow lines are anticipated regarding water quality, hydrology and air quality.

Recommended management actions for cumulative impacts include: incorporating a transit-oriented development approach to expansion of the mass transit system, improving intermodal transport connections and pedestrian access, incorporating mitigation measures for flooding and climate change into operational procedures and further evaluation and data analysis of predicted changes of project development to property values, economic activity and air quality.

A. BACKGROUND

1. Bangkok is one of Asia's emerging megacities. As of 2010, the Bangkok Metropolitan Region (BMR), or area of continuous urban (and suburban) development numbered nearly 15 million residents.[1] The urban area covers approximately 900 square miles (2,330 square kilometers) and has a population density of 16,200 per square mile (6,200 per square kilometer). This is 1.5 times the density of the Paris urban area and more than 2.5 times that of Los Angeles.[2]

2. The BMR represents about one fifth of Thailand's population, but contributes to over one-half of the national GDP. It is critical to the overall performance of the country's economy and energy efficiency, as it accounts for nearly one-half of all of Thailand's gasoline and diesel fuel consumption.[3]

3. Due to rising property values in the inner-city core, many Bangkok residents have chosen to relocate to the urban periphery and commute into the city. Between 2000 and 2010, Bangkok city grew by 30% while the suburban provinces (Samut Prakhan, Nonthanburi and Pathum Thani) grew by 66%. Much of the urban expansion has been on the periphery, both within the city of Bangkok and in the adjacent provinces of Samut Prakon to the east, Samut Sakhon to the west and Pathum Thani to the north. Unlike most cities in Asia, where new development has taken high-rise form, much of this new construction has been in the form of townhouses and detached housing.[4] The urbanized area of Bangkok increased 16-fold between 1944 and 2002; an average growth rate of 4.8% per annum.[5] Transportation has been a key challenge arising out of this suburban expansion.

4. The tradition of transportation planning in Thailand is quite recent. The first official urban transport plan in Bangkok was the 1960 land use plan, or the Litchfield Plan, followed by the 1971 Bangkok Transportation Study. Since then, the country has progressively developed its transportation planning practice to cope with rising urban transport problems and challenges.

5. The Bangkok Metropolitan Region (BMR) has a unique historical pattern of development. Roads were originally created by paving over canals, or by extending existing roads outward as need arose. This strategy eliminated the need for expropriating residential land for roads and allowed commercial businesses to maintain existing relationships with their customers. As a result, connecting streets between the main roads are few, and most are narrow, dead-end residential lanes, known as "sois". Little has been done to develop a secondary distributor road network despite almost universal recognition on the part of transportation analysts that the lack of connecting roads contributes greatly to traffic congestion problems.[6]

6. Beginning in the 1990's, the development of expressways (which total about some 210 km) was the focus of transport investment in Bangkok. Although the Expressway Authority of Thailand (EXAT) has a further 120 kilometers of expressway planned, major funding does not seem to forthcoming; the emphasis has shifted instead to rail based mass transit systems.[7]

7. Bangkok's widespread traffic congestion significantly reduces the efficiency of the city's urban transport network, and creates widespread journey time delays, excessive fuel consumption, and polluting air emissions. Congestion is made worse by the current distribution of road space and an unbalanced spatial pattern of distributor roads, unnecessarily forcing the mixing of both long- and short-distance trips.[8]

8. In Bangkok, the car is king; current motor vehicles ownership in the Bangkok Metropolitan Region is estimated at 9,000,000 vehicles (2017). In 2010, 55% of this total was cars, 39% motorcycles, 4% other and 2% truck and bus.[9] Car ownership in Bangkok (2007) was 399 per 1000 people.[10] Previous subsidies for first-time car buyers have added to the proliferation of privately owned vehicles on roads.

9. Main commuting modes in Bangkok Metropolitan Region are classified into three groups: private modes (e.g. car, pick-up, and motorcycle), public modes (e.g. bus, boat, van-taxi, and MC-taxi) and nonmotorized modes (e.g. waking and cycling). Among these modes, it was estimated there were about 19.44 million linked person trips made each day in the BMR with 46% by private modes, 40% by public modes (3% of MRT and 37% of bus and other public transport) and 14% by non-motorized modes in 2005.[11]

10. According to the OECD, motorization and urban sprawl is a serious threat to the future of the BMR's green growth. Traffic congestion is holding back both Bangkok's economic development and its quality of life and the rapid growth in the number of vehicles has exceeded the capacity of the road infrastructure. While there is a good network of motorways throughout Bangkok, connecting arterial roads are few; the shortage of bridges across canals and rivers is a major problem affecting traffic congestion. Commutes into Bangkok can take as much as 2 to 2.5 hours one way. Average travel speeds have decreased; in 2012 the average speed on roads was 19 km per hour. Bangkok evening rush hour traffic has been ranked as worse in the world two years running (2016-2017).[12]

11. The efficiency of the transportation network is complicated by poor coordination and planning of intermodal transport connections. Bangkok's bus system has stagnated. The average age of the Bangkok bus fleet is estimated to be over 20 years old, and the accumulated deficit of the Bangkok Mass Transit Authority (BMTA) is estimated to be about Bt70 billion.[13] Transfers from metro stations to other metro stations and between other forms of intermodal forms of transport (taxi, bus, microbus) pose major challenges to system efficiency and pedestrian usage.

12. Convenience is a major reason for use of private vehicles over other forms of transit. Even though mass rapid transit lines (BTS, MRT, BRT and SRT lines) were developed in the city, the transit network doesn't go through the large settlements outside of inner Bangkok, and access to stations always involves a mixed-access mode pattern which is both inconvenient and ineffective.[14] Walking to metro stations in Bangkok is troublesome due to long distances, barriers to access or inexistent sidewalks.[15]

13. Because of the dependence on motor vehicles, air quality in Bangkok has become a major health and environmental concern. Although air quality has improved remarkably in the past 20 years and is now within both WHO and Thai National Air Quality Standards, high

concentrations of PM_{10} and $PM_{2.5}$ remain a challenge. Levels of ozone are also high in the city outskirts. The transport sector is the main source of CO_2 emissions, its' contribution estimated at 50%.[16]

14. In contrast to many Asian megacities, Bangkok lacks a major subway or overhead metro system. But this will soon change. The Government has an eight-year plan to develop the country's transportation infrastructure at a cost of Bt2.4 trillion. The goal of the strategy is to develop the logistics system and integrate all transportation platforms – rail, air, road and water – both internally and with neighboring countries. The priority is to develop over 500 km of track in 10 metro rail routes throughout Bangkok and its suburbs, worth Bt700 billion in total, by 2019.[17]

15. The government has tasked the Office of Traffic and Transport Policy and Planning (OTP) to oversee and actively assist the development of urban transport plans for Bangkok and regional cities. Over the last 10 years the OTP has been successful in its tasks; Bangkok revised its mass transit master plan in 2009, and transport master plans have been produced for all regional cities. [18] The most recent transport plan for Bangkok is M-Map 2, released in March 2017.

16. Currently, there are five in-service routes – the Dark Green Line (Mo Chit-Bearing), Light Green Line (National Stadium-Bang Wa), Blue Line (Hua Lamphong-Bang Sue), the Airport Rail Link (Phaya Thai-Suvarnabhumi), and Purple Line (Bang Yai-Tao Poon), comprising 77 stations totaling 107.8 km in length. In addition to these existing lines, extension routes and five more lines are currently under construction.[19]

17. The Pink Line is planned to accommodate travel in northern Bangkok between Min Buri district and Nonthaburi Province. The route is 34.5 km in length, consisting of 30 stations with a depot and a 3000-car park and ride structure at the Min Buri station. The system will consist typically of an elevated single column viaduct structure with a dual track; the system will have a service capacity of 30,000 passenger per hour in each direction.[20]

18. The Yellow Line is a 30.4 km elevated monorail with 23 stations extending from Lat Phrao to Samrong. It is the interconnecting line between the Blue Line at Ratchada station (Lat Phrao station of the Blue Line) and the other 4 lines of mass transit system, i.e. the Grey Line (BMA) at Chalong Rat intersection, the Orange Line at Lam Sali intersection, Airport Rail Link at Rama IX interchange and the Green Line: Bearing-Samut Prakan at Samrong station. A seven story 3000-car park and ride structure will be located near the Samut Prakan Highway district. One depot is to be located west of the Sringagrinda – Bangna Trat interchange.[21]

19. Through a Public-Private Partnership (PPP), the Asian Development Bank (ADB) is financing construction of two of these metro lines, the Yellow and Pink lines in Bangkok. As part of project due diligence and environmental and social compliance review associated with project financing requirements, a cumulative impact assessment (CIA) is required to assess the contribution of both projects to cumulative impacts on key valued environmental components, or VECs. This report assesses cumulative impacts arising from development of the Pink and Yellow lines and the entire mass transit and road transportation network in Bangkok.

B. OBJECTIVES

20. The objectives of the cumulative impact assessment are as follows:

    a. Assess the cumulative impacts of construction and operation of the Pink and Yellow Lines in accordance with best environmental assessment practice and the 2009 ADB Safeguard Policy.

    b. Determine the significance of identified cumulative impacts.

    c. Prepare management actions to be implemented by the proponent and other third parties to minimize cumulative impacts.

C. METHODOLOGY

21. The methodology for the Cumulative Impact Assessment (CIA) of the Pink and Yellow Lines follows that of Annex 3: Rapid Cumulative Impact assessment (RCIA) of the IFC Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets.[22] The RCIA tool was used for reasons of timing constraints and the limited amount of baseline data.

22. The definition of cumulative effects/impacts used in this assessment is that of Hegmann et al. 1999 as "changes to the environment caused by an action in combination with other past, present and future actions.[23]

23. The specific methodology used in the cumulative impact assessment is as follows:

    a. **Selection of spatial and temporal boundaries**. The spatial boundary selected was the outermost extent of all mass transit metro projects identified in the M-Map 2 Plan plus a 500 m buffer to represent the average walking distance people will travel to a metro station. The temporal boundary selected was the completion date of the last envisaged metro project in M-Map 2, or 2029.[24]

    b. **Selection of valued environmental components** (VECs or VCs)[25]. Based on the two EIAs, five VECs were selected to evaluate cumulative impacts of transport projects. These were air quality, surface water quality, hydrology, property values at metro stations and economic activity. The consideration of trend in the status of each of the five VECs considered three scenarios; no change (null), declining trend (negative), increasing trend (positive).

       Selection of projects. Due to complications of an urban setting, the availability of data on land use, cadastral and properties, it was decided to limit the CIA to an evaluation of the cumulative impacts of transport projects only; road and metro. The selection of metro projects was made using those listed in the March 2017 M-Map 2 plan and existing road alignments available in Google Earth and Trimble Data.

c. **Assess cumulative impacts on each VEC.** Cumulative impacts were assessed on each of the five VECs. Cumulative impacts were evaluated in several categories (see Table 1) considering the following criteria: impact balance, spatial extent, temporal context, magnitude, probability and level of confidence (see Table 1).

d. **Determine the significance of cumulative impacts**. The significance of cumulative impacts was qualitatively assessed in five categories: null, positive (+), highly positive (++), negative (-), and highly negative (- -).

e. **Develop specific management actions**. Collaborative management actions were developed to minimize cumulative impacts on each selected VC. These consider two perspectives; firstly, those actions that MRT/BTS can do to minimize cumulative impacts at the project level (Yellow and Pink lines) and secondly, broader collaborative actions involving multiple parties in the Bangkok Metropolitan Area.

f. **Maps.** Three maps have been prepared to represent the spatial boundaries and the metro and road transportation networks. The metro alignments are shown in **Figure 1** and the transportation network in **Figure 2**. The combined metro and road transportation spatial area is shown in **Figure 3**.

Figure 1: Existing and Proposed Metro Lines, Bangkok

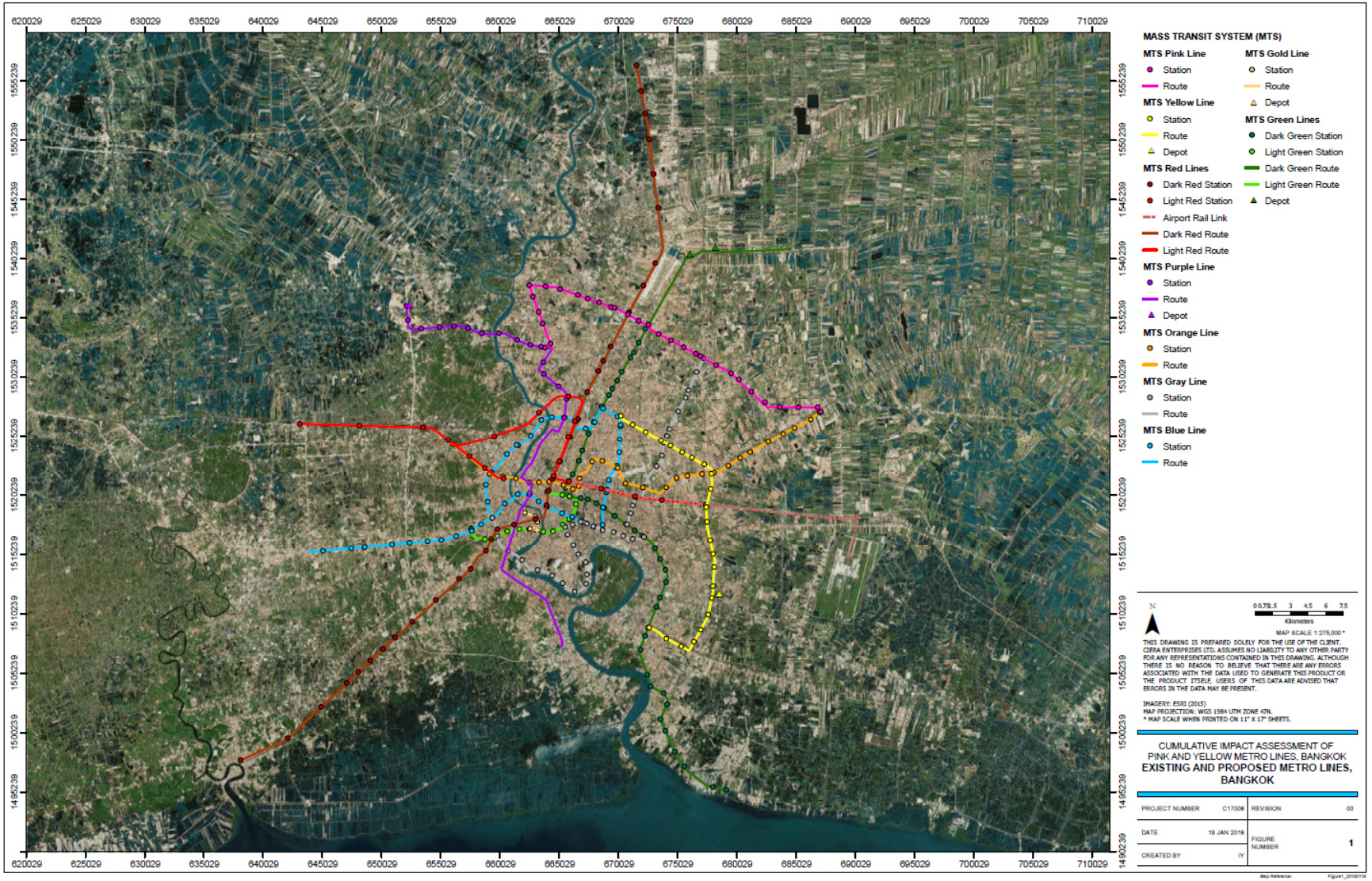


Figure 2: Major Road Networks, Bangkok

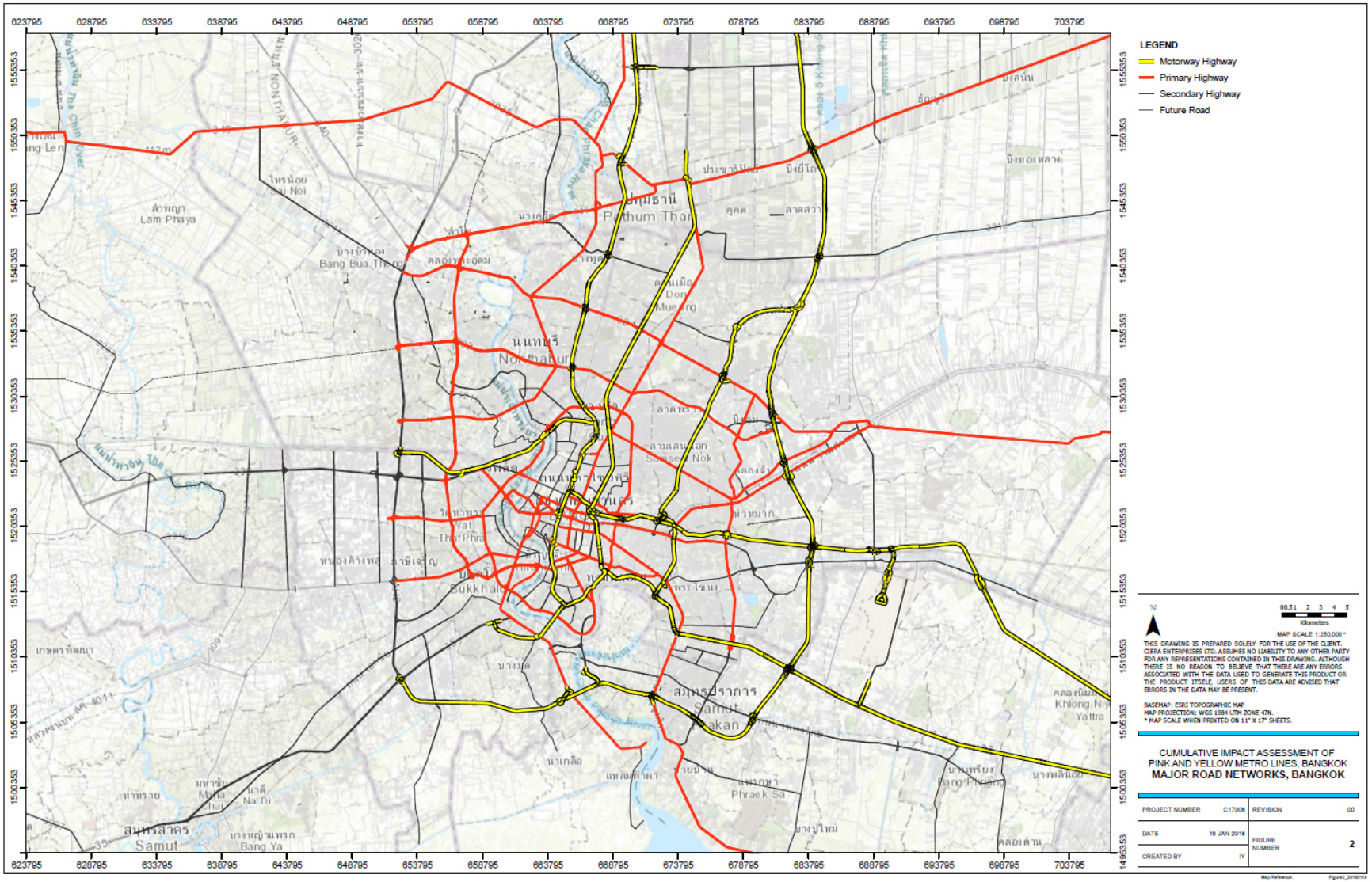
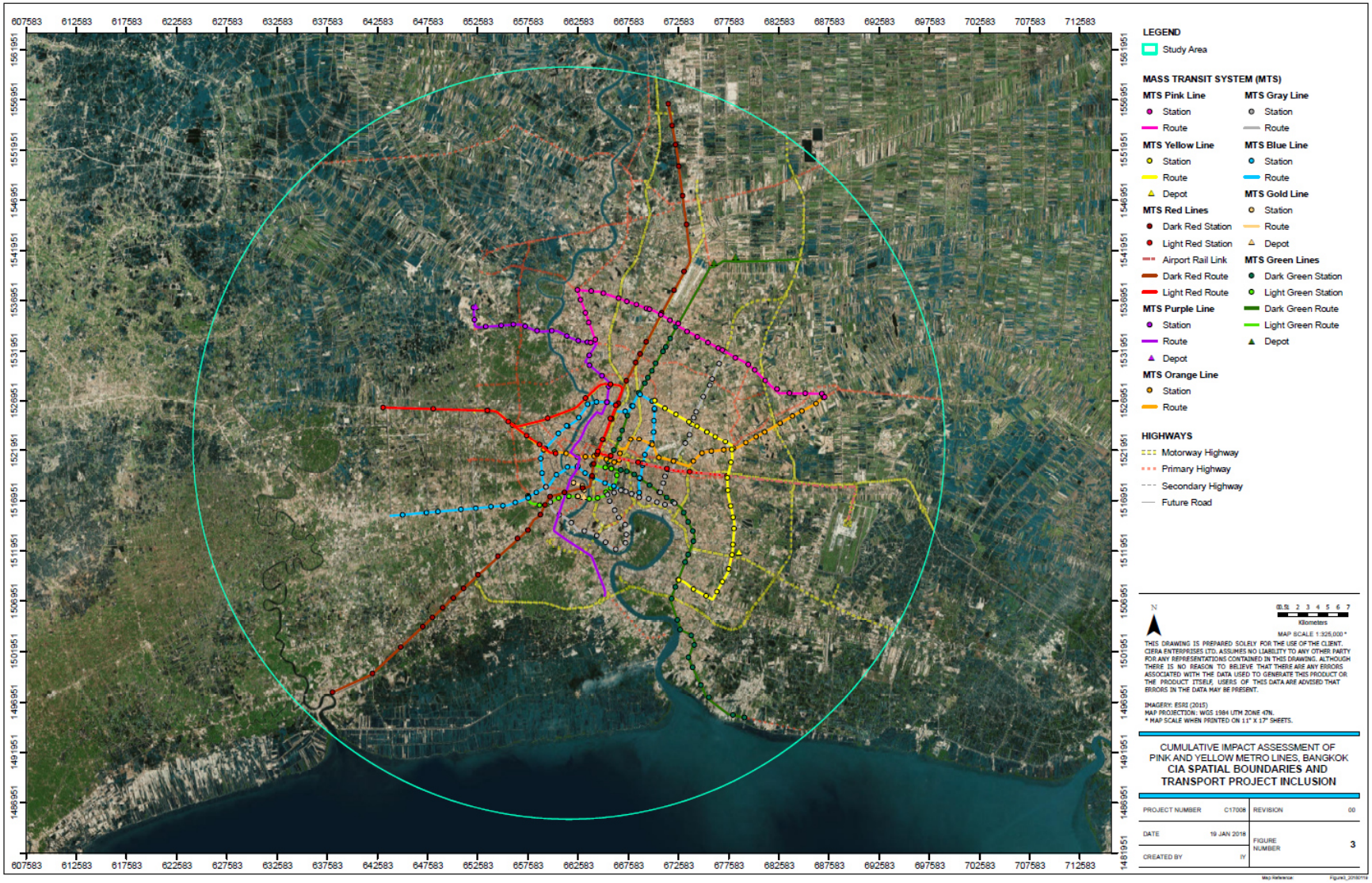


Figure 3: Combined Spatial Area of Metro and Road Transportation Network, Bangkok



D. LIMITATIONS OF THE ASSESSMENT

24. The limitations of the RCIA were as follows:

a. **Data** – data used in the cumulative impact assessment was solely from secondary sources, compiled from the existing environmental impact assessments for both the Pink and Yellow Lines. Due to time and scope limitations, no primary data collection was undertaken; a site reconnaissance was made on 30 November – December 2017 to gain a familiarization with conditions along both routes.

b. **Public consultation** – for similar reasons as described above, there was no public consultation on the selection of VECs. The five valued environmental components were selected following review of the two EIAs and in consideration of public comments expressed during the EIA process that are referenced in both environmental impact assessment reports.

c. **Selection of projects** – ideally all projects and activities should be selected within the spatial and temporal boundaries selected for the cumulative impact assessment. In an urban setting, this was not possible. Instead, it was decided to limit the cumulative impact assessment to the transport sector considering two classes of projects. The first was the full buildout of metro lines in the M-Map 2 Plan; the second was to include all major roads and motorways within the spatial boundary. This allowed a comparison of cumulative impacts on each VEC considering only the two types of transport projects.

d. **Spatial boundaries** – the spatial boundary was established by taking the outer limit of all metro lines in the M-Map 2 Plan and adding a 500 m buffer to represent the average walking distance that people will walk to metro stations (see Figure 3).

e. **Temporal boundaries** – the temporal boundary of the assessment was to 2029 representing the expected completion date of the final planned metro line. The reliability of completion dates beyond 2022 is considerably less. Similarly, on the selection of road projects, no new roads were included that what is currently in operation. The ready availability of road transport data and projects, in English, was very limited.

f. **Assessment Methodology** – Cumulative impacts were assessed on each VEC against a set of criteria presented in Table 1. A qualitative approach was to assign significance into one of five classes: null, positive and significant (+), highly positive and significant (++), negative and significant (-) and highly negative and significant (- -).

Table 1: Criteria and Ratings used to Evaluate Significance of Cumulative Impacts

Assessment Criteria	Definition	
Impact Balance		
Positive	Residual effect has a net benefit to biophysical or socio-economic conditions.	
Neutral	Residual effect has no net benefit or loss to biophysical or socio-economic conditions.	
Negative	Residual effect has a net loss or is a detriment to biophysical or socio-economic conditions.	
Spatial Extent		
Footprint	The land area directly disturbed by the Pink and Yellow Line Metro Project, including assessment, construction, operation and decommissioning/reclamation activities and including associated physical works and activities.	
Local	The Bangkok Metropolitan Area (BMA).	
Regional	The surrounding provinces to the BMA.	
National	All of Thailand.	
Temporal Context		
Duration (period of the event causing the effect)	Short-term	Event occurs during the extent of clearing and construction through to project commissioning.
	Mid-term	Event occurs during the first 10 years of operations.
	Long-term	Ongoing event that extends greater than 10 years, over the life of the Project and beyond.
Frequency (how often would the event that caused the effect occur)	Accidental	Event occurs rarely over the life of the Project.
	Isolated	Event is confined to a specified Project activity.
	Occasional	Event occurs intermittently and sporadically over the life of the Project.
	Periodic	Event occurs intermittently however, repeatedly over the life of the Project.
	Continuous	Event occurs continually over the life of the Project.
Reversibility (period of time over which the residual effect extends)	Short-term	Residual effect is limited to the project construction through to commissioning.
	Mid-term	Residual effect extends during the first 10 years of operations.
	Long-term	Residual effect extends beyond the first 10 years of operations.
	Permanent	Residual effect is irreversible.
Magnitude		
Negligible	No detectable change from existing (baseline) conditions.	
Low	Change is detectable and results in a limited effect on the VEC.	

Assessment Criteria	Definition
Medium	Change is detectable and results in a moderate effect on the VEC.
High	Change is detectable and results in a severe effect on the VEC.
Probability	
Low	Unlikely
High	Likely
Level Of Confidence	
Low	Confidence is based on an incomplete understanding of cause-effect relationships and/or data availability pertinent to the Project.
Moderate	Confidence is based on a reasonable understanding of cause-effect relationships and/or data availability pertinent to the Project.
High	Confidence is based on a full understanding of cause-effect relationships and/or data availability pertinent to the Project.

Note: Significance was assigned based on a qualitative assessment of the criteria rankings, how substantial the residual effect predicted is, and the likelihood of the residual effect.

E. ASSESSMENT FINDINGS – CONCEPTUAL RELATIONSHIPS

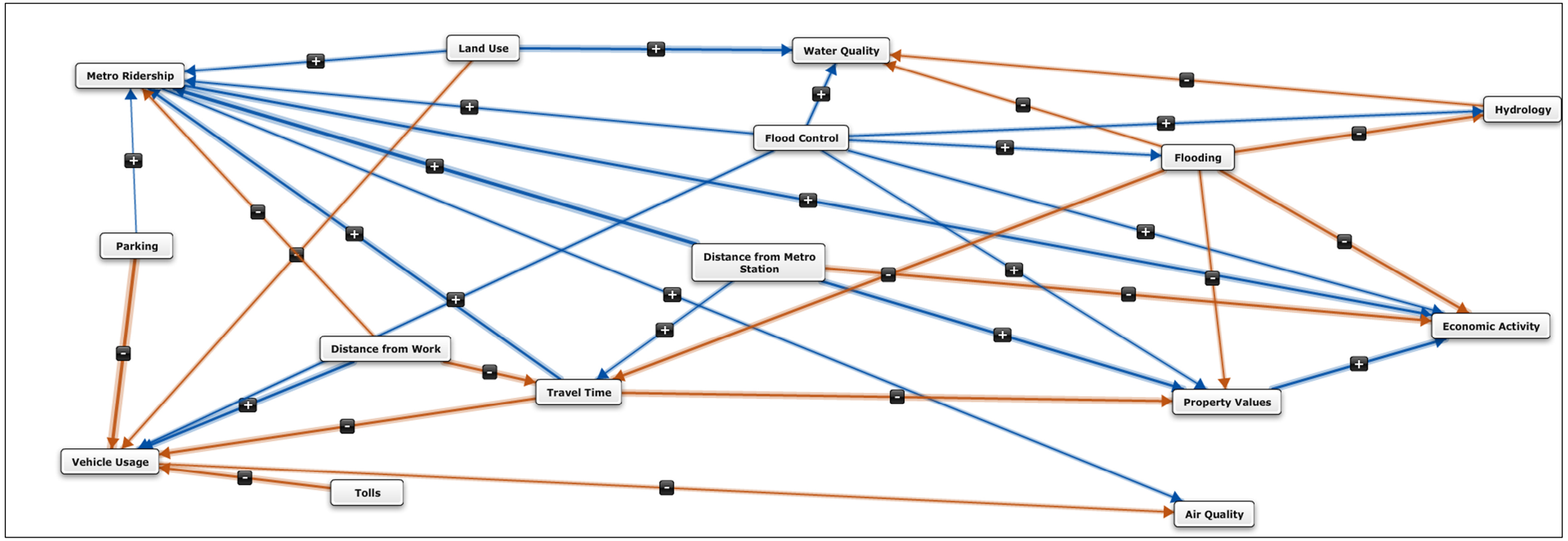
25. The first step in the cumulative impact assessment was to prepare a mental model of the relationships between the valued ecosystem components and the various drivers or forces influencing affecting them.[26] These relationships are shown graphically in Figure 4. The relationship between each two components is directional and considered to be either negative or positive.

26. Figure 4 shows the relationship between the selected valued environmental components and drivers or influences, either positively or negatively. Several points are noted as follows:

    a. Increased ridership on the metro lines has a positive relationship with three of the four valued components: air quality, property values around metro stations and economic activity.
    b. Vehicle usage has a negative relationship with air quality. Property values are affected positively in consideration to the location to on-ramps to major roadways.
    c. Economic activity has a positive relationship with the distance from a metro station – economic hubs will develop from metro stations.
    d. Travel time is an important consideration in choice of using the metro versus driving vehicles. If commuting times can be reduced by use of the metro with no reduction in convenience, metros have a more positive relationship than does travelling in private vehicle.
    e. Distance from the metro station has a positive relationship with property values but in an inverse manner. The closer the property to a metro station, the higher its' value.
    f. Parking and tolls have a negative relationship with the use of vehicles.
    g. Parking has a positive relationship with metro usage, if parking at the park and go's is free and convenient.
    h. Flooding in Bangkok has negative effects on hydrology, water quality, economic activity, property values and travel time. Limited effects are anticipated on operation of the mass transit system.
    i. Flood control will ensure effective operation of the mass transit system and metro ridership and use of the road transportation network.

27. These relationships were used to assess cumulative impacts on each valued environmental component using the criteria of Table 1. The results of this assessment are presented in the following sections.

Figure 4: Conceptual Relationships in the Cumulative Impact Assessment Affecting Valued Environmental Components



F. ASSESSMENT FINDINGS – PROPERTY VALUES

28. Since opening of the BTS and MRT transit systems, property values have risen in Bangkok around metro stations. Due to its popularity, the urban rail transit system and the large daily influx of metro riders has had a large influence on its surrounding area, especially around the metro stations. This had led to increased property values dependent on distance from each station.[27]

29. Premiums for residential units are valued at $10 per linear meter of distance in Bangkok; a property located near to a metro station is worth $10,000 more than a similar property located 1 km away.[28] However, access to an arterial road is $8 per linear meter more than access to a BTS Station.[29] This requires further evaluation, because as the metro systems builds out, property values around metro stations should become more valuable than properties adjacent to road access points.

30. Not only have residential property values increased in Bangkok, but the same applies to commercial properties. Rents in Bangkok were 19 Bt per sq. m. more than a similar commercial office space one km away. This increase was dependent on location; in the central Silom district this value was 78 Bt per sq. m. more.[30]

31. The premium for residential and non-residential land parcels is approximately 15,000 Bt/sq.m per kilometer (US$ 500) and 60,000 Bt/sq.m per kilometer (approximately US$ 2,500) closer to a metro station.

32. This not only applies to metro stations but also property adjacent to major roadways. Better access to the expressway especially in outer areas can add value to the residential land price from 2,000 Bt/sq.m per kilometer (US$ 70) to 8,800 Bt/sq.m per kilometer (US$ 270) and non-residential land price from 10,000 Bt/sq.m per kilometer (US$ 336) to 20,000 Bt/sq.m per kilometer (US$ 772). However, these effects were found a dis-benefit for residential and non-residential land parcels being near the urban rail transit corridors and the Central Business District (CBD).[31]

33. Differences in MRT and BTS land values have also been noted. Analysis of land price models shows that the BTS Skytrain confers greater economic benefit to residential land increasing 15 percent at 500 meters from a metro station and nearly 10 percent at 500 meters to one kilometer from a station. In contrast, residential land parcels lying within one kilometer of a MRT Blue Line stations were worth around 10 percent less and 6 percent less within 1 to 1.5 kilometers from a metro station.[32] More research is needed to substantiate these differences.

34. The cumulative impacts of metro line construction are expected to increase property values around the Pink and Yellow line metro stations, but this will differ depending on location (see Table 2). Commercial properties are expected to increase within the central business district. It is also expected that property values will increase higher around clusters of connecting stations than at single node stations. The cumulative impact of increased property values is anticipated throughout the extent of the entire mass transit system.

35. More research is needed to substantiate these anticipated increases in property values.

Table 2: Cumulative Impacts on Property Values Around Metro Stations

VEC	Criteria Rating	Criteria Rating Rationale
Change in Property Value at Metro Stations	Impact Balance: Positive	Property values are expected to increase around metro stations and decrease with distance from the station.
	Spatial Boundary: Footprint	Impact is expected to occur within 500 m of metro stations.
	Duration: Long term	Property values are expected to increase, and degree will also be dependent on TOD development and connection to other metro lines.
	Frequency: Continuous	Expected to occur over the life of the Project and beyond.
	Reversibility: Long-term	Property values are not expected to decrease over the life of the Project.
	Magnitude: High	Property values are expected to increase along the extent all metro lines, but increases may be more prevalent at some stations over others.
	Probability: High	Based on experience to date, property values are expected to increase.
	Confidence: Moderate	Confidence is based on a reasonable understanding of experience to date in increased property values around metro stations in Bangkok.
	Significance: Positive and significant	The change in property values as a result of metro development is expected to be highly positive and significant (++) throughout the extent of the entire Bangkok metro system.

G. ASSESSMENT FINDINGS – ECONOMIC ACTIVITY

36. Economic activity is also expected to increase with the buildout of metro lines in Bangkok. The closer a property is to a department center, the higher the property value. When coverage of the department store increases from 0-10% per sq. km., average land values also increased.[33]

37. The Bangkok Declaration for 2020 is a multi-country commitment to sustainable actions and measures for achieving safe, secure, quick, reliable, affordable, efficient, people centric and environmental friendly transport in Asia. Goal 2 of the Bangkok 2020 declaration states – "Achieve mixed-use development and medium-to-high densities along key corridors within cities through appropriate land-use policies and provide people-oriented local access, and actively promote transit-oriented development (TOD) when introducing new public transport infrastructure".[34]

38. The Rio+20 Outcome Document, *The Future We Want*, notes that "transportation and mobility are central to sustainable development". Sustainable Transport enables access to jobs, goods and services that support equitable development while limiting both short and long-term adverse environmental, social and economic effects. Achievement of sustainable transport can be realized through implementing an " Avoid-Shift-Improve "(ASI) approach, which aims to: (1) improve access to jobs, goods and services while enabling users to Avoid motorized trips by smarter land use and logistics planning; (2) Shift the transport of goods and persons to the most efficient mode; and (3) Improve the efficiency and environmental performance of transport systems by improved vehicle, fuel, and network operations and management technologies.[35]

39. A Transit Oriented Development approach will lead to increased economic activity and value around metro stations and help implement an ASI approach in Bangkok.[36] Previously the lack of coordination between land use and transportation planning has hindered a coordinated approach to transport integration. BMA's ability to manage land use and development is improving but gaps exist. BMA's Department of City Planning prepares and administers the Bangkok city plan, which in practice, has had insufficient impact on the type of developments in each of BMA's 13 zones. The BMA can impose controls on individual buildings in terms of (i) setbacks along specified roads and within specified areas, (ii) their gross floor area and proportion of a site to be occupied, and (iii) parking requirements. However, the BMA imposes such controls inequitably, and they are not always enforced during implementation or during subsequent building operations.[37]

40. The design of future transit station neighborhood or/ and redevelopment of existing station areas requires the knowledge and understandings of urban economic choices, cooperation among potential actors, and visions for transit-oriented development. The context of TOD implementation is multi-dimensional considering regulatory, institutional and socioeconomic aspects (i.e. affordable housing, community outreach, lifestyles, private sector investment and market conditions) and needs to involve urban planners across multiple institutions charged with efficient development of Bangkok's mass transit network.[38,39]

41. The cumulative impacts of the Yellow and Pink line projects on economic activity is expected to be positive and significant and will also extend throughout the entire mass transit system (see Table 3). More data is required to substantiate this anticipated effect.

Table 3: Cumulative Impacts on Economic Activity

VEC	Criteria Rating	Criteria Rating Rationale
Economic Activity	Impact Balance: Positive	Economic activity is expected to improve at metro stations and throughout the entire mass transit system.
	Spatial Boundary: Regional	Impact is expected to occur throughout the entire mass transit system area.
	Duration: Long term	Expected to occur over the life of the Project and beyond.
	Frequency: Continuous	Expected to occur over the life of the Project and beyond.
	Reversibility: Long-term	Economic activity will continue to expand at metro stations if transit-oriented development is encouraged.
	Magnitude: High	Economic activity will improve primarily at metro stations but will be experienced throughout the entire system due to spinoff benefits from media and advertising.
	Probability: High	High if TOD is implemented.
	Confidence: High	Confidence is based on a good understanding of experience from other metro projects.
	Significance: Positive and significant	Improvements to economic activity are expected to be positive and significant (+).

H. ASSESSMENT FINDINGS – AIR QUALITY

42. According to the OECD, improvement in fuel standards have resulted in an improvement in air quality over the last 20 years. Pollutants, such as sulphur dioxide and nitrogen dioxide now fall below WHO standards and Thai National Ambient Air Quality Standards.

43. Particulate matter, PM_{10} and $PM_{2.5}$ remains a challenge in Bangkok and more so in surrounding regions. OECD reports that "while annual average concentrations of PM_{10} have decreased from 89 $\mu g/m^3$ in 1997 to 54.3 $\mu g/m^3$ in 2013 in roadside areas and decreased over the same period from 81 $\mu g/m^3$ to 41 $\mu g/m^3$ in residential areas, concentrations are still far above WHO standards (20 $\mu g/m^3$). $PM_{2.5}$ is the most harmful pollutant, because of its small size. The annual level of $PM_{2.5}$ in the city of Bangkok was 20 $\mu g/m^3$ in 2012, better than many other Asian cities but above WHO annual standards of 10 $\mu g/m^3$".[40]

44. As noted in both project EIAs, construction and operation of the Yellow and Pink lines, and the entire mass transit system are expected to have no impact on air quality in the BMR.

45. The cumulative impact of the Pink and Yellow lines during construction and operation is expected to be null; similarly, for the entire mass transit system. However, the cumulative impact of increased commuter usage of the metro system compared to use of private vehicles will result in an indirect positive cumulative impact on air quality.

46. This effect is clearly shown in the two project EIAs for the Pink and Yellow Lines. Both EIAs present a case for greenhouse gas (GHG) reduction due to mass transit operations as vehicle operators switch to use of metros over the next 20 years. In both, results are presented for a distance-based fare and a 20-Baht flat fare. For the Pink line, calculations show that GHG reductions from 2018 to 2037 increase from 27 tCO2e/hr to 121 tCO2e/hr for the distance-based fare and 43 tCO2e/hr to 144 tCO2e/hr for the 20-Baht flat fare.[41] Similarly, calculations for the Yellow line present GHG reductions from 2019 to 2049 that go from 129.05 tCO2e/hr to 953.34 tCO2e/hr for the distance-based fare and 126.51 tCO2e/hr to 935.50 tCO2e/hr for the 20-Baht flat fare with transfer fees to other lines.[42] The data shows in both cases that the 20-Baht flat fare leads to higher ridership than a distance-based fare, leading to higher GHG reductions in the flat fare case. In the case of Yellow line, calculations for a 20-Baht flat fare with free transfers to other lines resulted in higher GHG reduction, 191.78 tCO2e/hr to 1,209.01 tCO2e/hr, compared to the 20-Baht flat fare with transfer fees, showing higher ridership if transfers to other lines are free. Fare and ease of connection are clearly factors in the choice of metro ridership leading to greater sustainable benefits in greenhouse gas reduction.

47. It should be noted that the calculations are markedly different between the two lines for the same time and that further evaluation of the difference in this effect is needed.

48. The transport sector is a significant contributor to air quality impacts and CO_2 contributions in the BMR. The Environmental Impact Assessments for both the Pink and Yellow lines

predict improvements to air quality in the coming years, as metro ridership increases, and less people make use of private vehicles.

49. Air quality will only improve if less drivers use motor vehicles to commute to work, or those vehicles switch to low or zero emission vehicles.
50. More monitoring is required to understand the relationship between increased metro ridership and declines in vehicle use regarding air quality, fare values and greenhouse gas contributions and the extent of this positive impact.

Table 4: Cumulative impacts on Air Quality

VEC	Criteria Rating	Criteria Rating Rationale
Air Quality	Impact Balance: Positive	The cumulative effect of the Yellow and Pink lines on air quality is expected to be null. Similarly, cumulative impacts on air quality of the entire mass transit system are expected to be null. Air quality is expected to improve in Bangkok as more commuters use mass transit instead of private vehicles.
	Spatial Boundary: Regional	Impact is expected to occur throughout the entire mass transit area.
	Duration: Long term	Expected to occur over the life of the Project and beyond
	Frequency: Continuous	Expected to occur over the life of the Project and beyond.
	Reversibility: Long-term	Air quality improvements will not be reversible if metro ridership increases, and private vehicle use decreases. However, this relationship is much more complex than a reduction in vehicle use leads to an increase in metro ridership.
	Magnitude: High	Air quality improvements are expected to continue with expected reductions in levels of particulates.
	Probability: High	Based on experience to date and that of modelling, air quality will improve.
	Confidence: High	Confidence is based on a good understanding of air quality improvements
	Significance: Positive and significant	Air quality improvements are expected to be positive and significant.

I. ASSESSMENT FINDINGS – WATER QUALITY

51. Baseline water quality in Bangkok rivers and canals is poor. Water quality was surveyed in 95 canals along the Pink Metro Line. Water quality varied from degraded to fair-good

and was deemed suitable only for irrigation, transportation and drainage. Similarly, water quality at six sampling stations along the Yellow Metro Line was assessed to be deteriorated (Class 5).

52. Water quality is not expected to be impacted by either construction or operation of the Pink and Yellow Metro Lines. Waste water treatment facilities will be installed at metro stations and depots. The environmental management plans of both metros specify measures to prevent water quality impacts during construction.

53. Cumulative impacts of both projects on water quality are expected to be null providing management commitments to minimize construction impacts during construction and ensure effective waste water treatment are upheld.

54. Similarly, cumulative impacts due to construction and operation of the entire mass transit system on water quality are expected to be null.

55. Based on existing information, no conclusions can be made on the cumulative impacts of the existing road network on water quality.

56. Water quality sampling results as presented in the EIAs for the Pink and Yellow lines show that water quality in the BMR is fair-good to degraded. Only 40% of household sewage effluent is currently treated. The cumulative impacts on water quality of the contribution of mass transit and transportation networks are expected to be minimal in comparison to the impacts caused by inadequate treatment of sewage and industrial effluent sources.

Table 5: Cumulative Impacts on Water Quality

VEC	Criteria Rating	Criteria Rating Rationale
Water Quality	Impact Balance: Neutral	Water quality is not expected to be impacted by construction of the mass transit system provided environmental protection and management measures are followed during construction and waste water treatment facilities are fully functional during operations. The contribution of the transportation network to water quality in the Bangkok canal system is unknown, but likely minimal compared to untreated sewage and industrial discharges.
	Spatial Boundary: Regional	Impact is expected to occur throughout the BMR region.
	Duration: Long term	Expected to occur over the life of the Project and beyond
	Frequency: Continuous	Expected to occur over the life of the Project and beyond.
	Reversibility: Long-term	Water quality however is expected to continue to improve in the BMR through improvements to sewage treatment and flood control not related to the transportation network.
	Magnitude: Negligible	Metro projects are not considered to have an impact on water quality within the BMR. The net contribution of the road transportation system to water quality is unknown.
	Probability: High	High if treatment schemes for domestic and industrial waste water treatment are implemented.
	Confidence: High	Confidence is based on a good understanding of experience from other metro projects.
	Significance: Null	No cumulative impacts on water quality expected from the Pink and Yellow lines or build out of the mass transit system. No conclusions can be made on the cumulative effects of water quality from the existing road network.

J. ASSESSMENT FINDINGS – HYDROLOGY

57. Bangkok is at high or extreme risk to flooding during the rainy season. Since 1942, nine floods have occurred in the BMR; the 2011 flood resulted in damages of $9.1 billion.[43]

58. According to the ADB Aware system, both projects are in a Low Elevation Coastal Zone (LECZ) subject to sea level rise. A high rating was also given due to the potential for flooding as a result of the 2011 flood. Overall, the Aware climate risk rating for both the Pink and Yellow Line Projects was assessed as medium risk.[44]

59. Hydrology was selected as a VEC representing natural water flows across the BMR and the importance of preventing flooding in Bangkok. No cumulative effects on hydrology are anticipated from construction or operation of the Pink and Yellow lines, providing site specific flood mitigation measures are implemented as per the two EIAs.

60. The contribution of the road network to flooding is not known, but roads can act as conduits for overland water flows. Flooding of roads due to overtopping of canals from excessive river/canal flows or storm surges can paralyze the road network making transit impassable and causing delays until the drainage system can remove standing water.

61. Bangkok has an extensive flood control network in place consisting of a polder system, retention ponds, pumping stations, tunnels and drainage canals. This system will be upgraded through the installation of more diversion tunnels, an automated flood monitoring and response system and the construction of two east-west flood bypass systems to divert water away from the BMR.

62. Flood control measures, both existing and planned, should result in minimal impacts to operations of overhead monorail and underground metro systems in Bangkok.

63. Operators of both the Pink and Yellow lines should ensure that contingency plans are developed to ensure continued operations during flood events.

Table 6: Cumulative Impacts on Hydrology

VEC	Criteria Rating	Criteria Rating Rationale
Hydrology	Impact Balance: Neutral	Flooding has been a significant issue in Bangkok. No cumulative impacts on hydrology are expected from construction and operation of the Yellow and Pink Line projects and buildout of the Bangkok mass transit system. The contribution of the road network to flooding is not known but roads direct floodwaters and poor drainage causes significant flooding and impediment to the road network. Existing and planned flood control efforts are expected to reduce flood risk and impact on the mass transit and roadway systems in Bangkok.
	Spatial Boundary: Regional	Impact is expected to occur throughout the entire mass transit area.
	Duration: Long term	Expected to occur over the life of the Project and beyond
	Frequency: Continuous	Expected to occur over the life of the Project and beyond.
	Reversibility: Long-term	Bangkok's long-term flood control measures should reduce risk of flooding to the metro transit system and road network.
	Magnitude: Negligible	No cumulative impacts to hydrology are expected from the mass transit system.
	Probability: High	Based on information presented in the EIAs on design. Implementation of proposed flood control measures should reduce future flood risk.
	Confidence: High	Confidence is based on information presented in the EIAs.
	Significance: Insignificant	There are no anticipated cumulative impacts from construction or operation of the Pink and Yellow lines and the entire mass transit system.

K. SUMMARY OF CUMULATIVE IMPACTS AND MANAGEMENT RECOMMENDATIONS

64. **Significance of Cumulative Impacts** – a summary of cumulative impacts of the Pink and Yellow lines in combination with expected cumulative impacts from buildout of the mass transit system in combination with the existing road network is presented in Table 7.

65. Highly positive and significant cumulative impacts are expected on property values because of construction and operation of Bangkok's mass transit system. The extent of these increases will vary depending on location throughout the BMR. Further study on this issue should be undertaken during construction and operation of the Pink and Yellow Metro Lines and other planned mass transit expansions.

66. Positive and significant impacts are anticipated in relation to economic activity around metro stations. The extent of this effect will rely on coordinated planning between transportation and land use planning agencies towards a transit oriented nodal development approach. Improvements in transfers between stations and connections with other forms of intermodal transport should be addressed.

67. Null cumulative impacts of construction and operation of the Pink and Yellow lines are anticipated regarding water quality, hydrology and air quality. A similar effect of buildout of the entire mass transit system is also anticipated.

68. With implementation of management measures identified in the environmental impact assessments for the Pink and Yellow lines, the two metro projects are not expected to increase any flood risk nor are there expected to be flood risks affecting operational capabilities. This is expected to occur across buildout of the entire transit system.

69. **Recommendations** – the following action items are recommended arising from this evaluation.

    a. Bangkok planning authorities should expand on transit-oriented development initiatives from the original BTS and MTR lines and apply this concept to development of Pink and Yellow lines and future mass transit lines. This will help facilitate a sustainable approach to mass transit development in Bangkok aligned with an Avoid-Shift-Improve approach.

    b. Improvements should be sought regarding intermodal transport at metro stations and maximizing efficiencies in transfer between various transport systems.

    c. Contingency plans for continued operations during flood events should be developed as part of operational plans for the Pink and Yellow Metro lines and other future metro lines.

    d. Monitoring studies should be considered to evaluate property value changes and impacts to economic activities at metro stations.

    e. More evaluation is required to assess improvements to air quality resulting from ridership of the Pink and Yellow lines and resultant shifts away from private vehicle use as system efficiencies improve. Further study is recommended on the relationship between increase metro ridership, decreased vehicle use and air quality.

Table 7: Evaluation of Cumulative Impacts

Valued Environmental Component (VEC)	Existing condition and trend of VEC	Cumulative Impacts Expected from the Yellow and Pink Lines	Cumulative Impacts Expected from Buildout of the M-Map 2 Metro System	Cumulative Impacts Expected from Road Transportation Network	Significance of Cumulative Impacts	Suggested Management Actions for Cumulative Impacts
Property values	Property prices have risen very modestly in Thailand in the past several years, partly due to the country's prolonged political uncertainty. From 2008 to 2016, house prices rose by 29.1% (10% in real terms).[45] Five trends have been presented regarding Bangkok's current and future property market:[46] a. Localization – the development of self-contained neighborhoods offering convenience and proximity and a mix of commercial, retail, leisure and residential components. b. Mass transit effect – development of the buildout of metro lines will offer impetus and momentum for non-central locations to flourish as residential and commercial neighborhoods. c. Rising land prices – rising land prices, particularly in the CBD, are changing size and price of high end housing and may ultimately shift development to other locations. d. Shrinking premium condos – rising land prices are shrinking condo sizes but also opening up the market for used properties where new builds have been favored. e. Super luxury condos – these are now the norm for foreign buyers seeking value in Bangkok over other Asian locations. High end properties are booming in Bangkok, whereas low end housing is declining.	Existing data shows that residential properties are higher in value the closer they are to a metro station. Values can be from US$10-40,000 more than a similar property located one kilometer away from a metro station. It is expected that this trend will continue along both the Yellow and Pink lines. However more evaluation is needed, and properties values should be monitored following construction.	Property values are expected to increase along all metro lines with full buildout to system completion, however there may be differences in individual values dependent on location. It would be useful to determine differences in property values comparing an overhead monorail line to an underground subway system.	Evidence shows that proximity to an access ramp equates to higher property values than elsewhere along roadways, however these values were less than increases due to proximity of metro stations.[47]	**Highly positive and significant (++)** Property values are increasing in Bangkok; the cumulative impacts of the expected increases in property values around metro stations are expected to be positive and significant based on current information. Goal 2 of the Bangkok 2020 declaration aims *to achieve mixed use development and medium to high densities along key corridors within cities through appropriate land use policies and provide people oriented local access and actively promote transit-oriented development when introducing new public transport infrastructure*.[48]	• Monitor residential and commercial property values around metro stations. • A focus to implement a Transit Oriented Development (TOD) approach around station "nodes" should be a priority across the entire Bangkok mass transit network. • The success of TOD will also be dependent on improving access between adjoining metro stations and intermodal access to connect to taxi, buses and other modes of transport outside of metro stations.
Economic activity	In 2010, the BMR, consisting of the City of Bangkok and the Provinces of Nakhon Pathom, Pathum Thani, Nonthaburi, Samut Prakan and Samut Sakhon, was home to an estimated 14.5 million people, including unregistered migrant workers and commuters from surrounding provinces. While accounting for just over 20% of the national population, the region generated 44.2% of national gross	Economic activity is expected to increase around metro stations. An increase in department stores in a district by 10% can increase average land values by 3.1 and 4.3%.[50] Economic activity is expected to increase around metro stations on both the Pink and Yellow lines	Similar effects to increased economic activity around metro stations should occur through the entire Bangkok mass transit system. Revenue from online advertising on metro lines and coupling that to opportunities may have a significant economic impact across the entire metro system.	Unknown, many commercial centers currently rely on customers arriving in private vehicles and parking onsite.	**Positive and significant (+)** A positive significant impact on economic growth is expected around metro stations across the entire Bangkok mass transit system.	• Measures should be taken to encourage commercial development around metro stations as part of TOD. This will include incentives that have been successful in the past relating to Floor-Area and Open Space Ratios (FAR/OSR).

Valued Environmental Component (VEC)	Existing condition and trend of VEC	Cumulative Impacts Expected from the Yellow and Pink Lines	Cumulative Impacts Expected from Buildout of the M-Map 2 Metro System	Cumulative Impacts Expected from Road Transportation Network	Significance of Cumulative Impacts	Suggested Management Actions for Cumulative Impacts
	domestic product (GDP) in 2012. The BMR faces several challenges to its long-term growth, including the lack of a highly qualified labour force and growing social inequality between rich and poor.[49]	because of influx and efflux of metro commuters.	In 2016, 41% of BTS revenue was derived from media, including advertising and online.[51]			• Lessons learned in Transit Oriented Development from other Asian metro rail developments (e.g. Singapore, Jakarta) should be sought out and applied to Bangkok.
Air quality	OECD states that air quality in the City of Bangkok has improved remarkably in the past 20 years and is now within both WHO and National air quality standards. High concentrations of PM_{10} and $PM_{2.5}$ remain a challenge. Levels of ozone are also high in the city outskirts. The transport sector is the main source of CO_2 emissions, estimated at 50%. Energy production in Thailand is dependent on fossil fuels accounting for 76% of final energy consumption in 2013.	Impacts to air quality from construction of the Pink and Yellow line EIAs was predicted to be low and within national standards. Similarly, during operations. Cumulative impacts on air quality resulting from both construction and operations of the Pink and Yellow metro lines are estimated to be negligible.	Cumulative impacts on air quality resulting from both construction and operations of the build out of the M-Map2 metro system are estimated to be neutral. The contribution of CO_2 generation of M-Map2 from the combustion of fossil fuels to provide electrical power to the metro system is unknown and should be evaluated.	Both EIAs state that increased ridership on the metro lines in Bangkok will decrease CO_2 emissions over the next 20 years. The extent of that decrease is not fully certain as substantial differences are predicted between the Pink and Yellow line ESIAs. The extent of future motor vehicle usage will affect levels of future GHG emissions. If there is a switch to more metro use, this will be positive. If vehicle usage continues following the same trend, this could result in higher GHG emissions that may not be offset by reduced GHG emissions from metro operations. This requires further evaluation, ongoing monitoring and additional verification.	**Null** The cumulative effects of metro line construction of the Yellow and Pink lines in addition to the entire M-Map 2 network on air quality are estimated to be insignificant. The contribution of the existing road network to cumulative effects on air quality cannot adequately be assessed from existing information.	• Additional evaluation of air quality improvements because of metro line usage. • Monitoring of air quality around the Yellow and Pink lines during construction and operation. • Ongoing air quality monitoring of the transport sector.
Water quality	Water quality was surveyed in 95 canals along the Pink Line. Water quality varied from degraded to fair-good and was deemed suitable only for irrigation, transportation and drainage. Similarly, water quality at six sampling stations along the Yellow line was assessed to be deteriorated (Class 5).	Concerns were raised in the Pink Line ESIA regarding water quality impact, primarily waste water, at construction sites and within 500 m of construction sites. Similar concerns were raised in the Yellow Line EIA of impacts during construction. No impacts to water quality are expected during operations of both Lines. Provided that the proposed water treatment measures are put in place at stations, no impacts on water quality are expected during Project operations.	None during construction and operation provided that measures for waste water treatment contained in both project environmental management plans are implemented.	Road drainages may introduce hydrocarbons and other chemicals into the canal system of Bangkok. The cumulative contribution of contaminants from the road transportation network to water quality in canals and natural drainages in the Bangkok metropolitan area are unknown, but likely minimal in comparison to untreated sewage and industrial discharges into the canal system.	**Null** No significant cumulative impacts on water quality are expected from operation of the mass transit system and road transportation network, compared to the cumulative impacts of lack of sewage treatment (about 40% coverage in Bangkok).	• Ensure that EMP measures for preventing water quality impacts during construction. • Ensure proper operation at waste water treatment facilities at metro lines during operations.

Valued Environmental Component (VEC)	Existing condition and trend of VEC	Cumulative Impacts Expected from the Yellow and Pink Lines	Cumulative Impacts Expected from Buildout of the M-Map 2 Metro System	Cumulative Impacts Expected from Road Transportation Network	Significance of Cumulative Impacts	Suggested Management Actions for Cumulative Impacts
		No cumulative impacts on water quality are expected during construction and operation of both lines.				
Hydrology	As per OECD, Bangkok is at high or extreme risk to flooding during the rainy season. Major floods have occurred in 1942, 1978, 1980, 1983, 1995, 1996, 2002, 2006 and 2011. Weather, climate events, exposure and vulnerability are common factors of flood risk. OECD further states that it is difficult to assess the future impact of climate change on precipitation and the likelihood of flood occurrence.[52] Bangkok's flood control system consists of several measures. a. A polder system consisting of numerous dykes to prevent water discharge from the north and east and overflow from urban drainage. b. A drainage system consisting of 1682 canals, 6400 km of drainage pipes, 158 pumping stations, 7 drainage canals and 25 storm water retention ponds. Future plans including improving the existing drainage system, installing four new large tunnels, creating east and west flood bypass structures and installing an automatic monitoring and information system.[53]	No impacts are expected from the construction and operation of the Pink and Yellow lines regarding blockage of existing drainage conditions. Two retention ponds have been designed at the Pink Line depot station including sizing in relation to the flood risk. In both lines, mitigation measures have identified for discharge of waste water at depots to avoid flooding.	Similarly, there are no expected cumulative impacts of construction and operation of the M-Map2 system on drainage. The entrances to all underground metro stations (MRT) have been designed to be above the 100-year maximum rainfall (1-1.5 m). Limited implications to access to the overhead monorail system are anticipated due to the implementation of flood control measures.	Flooding is exacerbated on Bangkok roads as they become a conduit for drainage and there is insufficient drainage capacity to move water off roads into adjacent canals. Insufficient information is available to assess drainage impacts because of the road transportation network.	**Null** No significant impact of the mass transit systems is anticipated on drainage and hydrology in the metropolitan Bangkok area. Flood control measures, both existing and planned should result in minimal impacts to operations of overhead monorail and underground metro systems in Bangkok. No conclusions can be made on the road transportation network due to insufficient information.	• Consider contingency plans for flooding events into environmental management plans for metro operations.

Endnotes

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[25] In this report Valued Environmental Components (VEC) and VC (Valued Components) are used interchangeably.
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[49] See 16 above.
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