

VOLUME II

BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE
APPEAL NO. 9 OF 2016 (WZ)



Dileep B. Nevatia

...Appellant

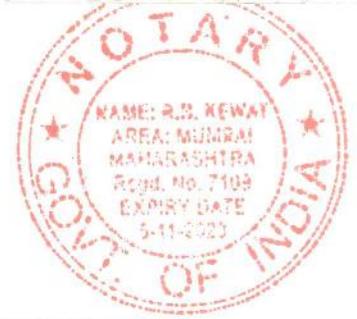
Versus

Union of India &Ors.

...Respondents

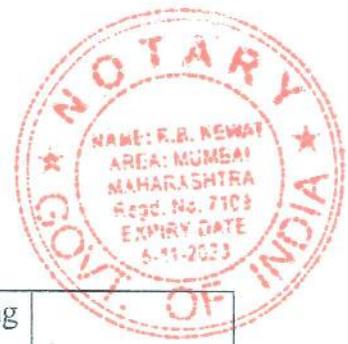
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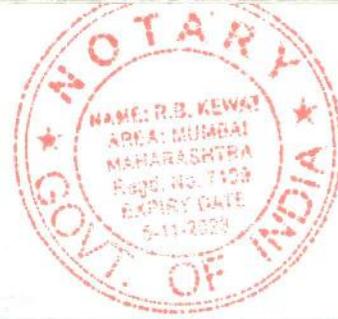
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EXHIBIT J

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NM/307/2016

BDPPS

IN THE HIGH COURT OF JUDICATURE AT BOMBAY
ORDINARY ORIGINAL CIVIL JURISDICTON
NOTICE OF MOTION NO.307 OF 2016
IN
PUBLIC INTEREST LITIGATION NO.87 OF 2006

Mumbai Metropolitan Region
Development Authority

..... Applicant.

In the matter between

Bombay Environment Action Group
and Another

.....Petitioners.

V/s

State of Maharashtra and Others.

.... Respondents.

Mr. Saket Mone a/w Mr. Subit Chakrabarti i/b Vidhi Partners for
applicant in Notice of Motion No. 307 of 2016 in PIL No.87 of 2016.

Mr. Navroz Seeryai, Senior Counsel a/w Ms. Shreya Parikh for the
Petitioner in PIL No.87 of 2006.

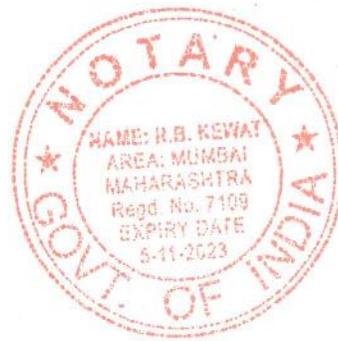
Mrs. P.H. Kantharia, AGP for Respondent/State in PIL No.87 of 2006.

Ms. Trupti Puranik for Respondent/BMC.

Ms. Sharmila Deshmukh for CRZ.

CORAM: V. M. KANADE &
MS. NUTAN D. SARDESSAI, JJ.

DATE: 28th November, 2016



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NM/307/2016

P.C.:-

1. This Notice of Motion is taken out by the Applicant for carrying out construction of the proposed Mumbai Trans Harbour Link (a proposed 22 km freeway grade road bridge connecting the island city of Mumbai with Navi Mumbai).

2. The learned Counsel appearing on behalf of the Applicant submits that Applicant has obtained clearance from all the concerned authorities. He submitted that Ministry of Environment and Forest, Government of India has granted approval on 22/01/2016 and CRZ clearance has been granted on 25/01/2016. Applicant has given an undertaking in paras 12 and 27 of the affidavit in support of the Notice of Motion. The said undertaking is accepted. Applicant shall comply with all the conditions which are imposed in the said letters of sanction granted by both the authorities.

3. We are satisfied that the said project is public utility project and we grant leave in terms of prayer clause (a) of the Notice of Motion subject to conditions imposed by both the authorities.

4. Notice of Motion is accordingly allowed in terms of prayer clause (a) and disposed of.

(MS. NUTAN D. SARDESSAI, J.)

(V.M. KANADE, J.)

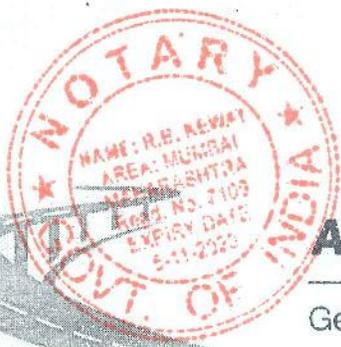


EXHIBIT K

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General Consultant for Mumbai Trans Harbour Link Project

Ref No: MTHL/GC/MMRDA/LT/ENV- 1157 /2020

15th January 2020

To,
The Chief Engineer
Engineering Division
Mumbai Metropolitan Regional Development Authority (MMRDA)
2nd Floor, New MMRDA Building,
Plot No R-06 & R-12, 'E' Block
Bandra Kurla Complex, Bandra (E),
Mumbai, Maharashtra, India 400051

Sub: General Consultancy services for Mumbai Trans Harbour Link (MTHL) project -
Uploading of CRZ and MCZMA compliance on MMRDA website

Dear Sir,

We are hereby submitting the updated version of the CRZ and MCZMA checklist along with their compliance.

This may please be uploaded on your Website which will be reflected in the six-monthly progress report to be submitted to Regional Office Nagpur.

Thanking you,

Yours faithfully,

M2 on 15 January 2020

Dr. S H Robin Sham, CBE
(BSc, PhD, DIC, FCGI, FRSA, CEng, FICE, FStructE, FHKIE)
The Engineer
General Consultant (MTHL)

Encl: As above

CC: Superintendent Engineer – MMRDA - Mr. Sakhalkar
Executive Engineer – MMRDA – Mr. Bhisikar
Executive Engineer – MMRDA – Mr. Vishal Jambhale

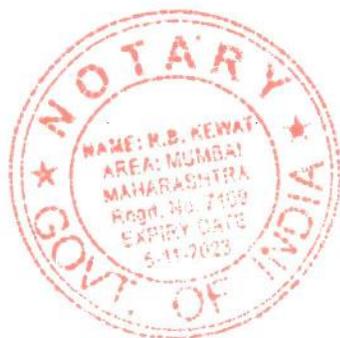


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**MUMBAI TRANS HARBOUR LINK
CRZ MOEF CHECKLIST**

SR. NO.	RET. NO.	ENVIRONMENTAL ATTRIBUTE	COMPLIANCE STATUS
The project proponent presented the EMP with the details as under			
1	4 (XI) 1	Environmental Monitoring- Air Act, Water Act, Noise levels: - Air Noise Water-Marine and Land Solid waste Ecology and Ecosystem Fishing etc. - Quarterly during Construction Phase.	Complied. Air Act, Water Act, Noise levels: - Air Noise Water-Marine and Land Solid waste Ecology and Ecosystem Fishing etc. are being regularly monitored on quarterly basis.
2	4 (XI) 2	Compensatory Restoration Plan Mangrove: - With the help of Forest department	Complied. Mangrove Cell of Maharashtra State Forest Department is entrusted with the job of Compensatory plantation over 200 Ha areas. Rs. 5.05 crores has been deposited with the Mangrove and Marine Biodiversity Foundation for the purpose. The Mangrove Cell has planned to carry out the necessary compensatory plantation in an area of 223 Ha plus maintenance for 7 year as informed by them vide their letter dated 27-07-2018. Mangroves Cell has completed plantation on 105 Ha in degraded land in different locations of Palghar and Mumbai Suburban Districts. Balance 118 Ha Mangrove Plantation will be done in identified areas in Palghar district.
3	4 (XI) 3	Implementation of the suggestions given by BNHS: - In accordance with their report	Complied. MMRDA has appointed BNHS for Implementation of Flamingos and Birds mitigation measures & birds monitoring program and Mudflat restoration for the MTHL project and this assignment will be executed & monitored through Mangrove Foundation Mumbai. A tripartite agreement between MMRDA, BNHS and Mangroves Foundation has been signed. Accordingly, MMRDA has deposited Rs. 31.92 crore with the Mangrove and Marine Biodiversity Foundation for disbursement to BNHS on the basis of deliverable activities. A project Implementation Committee (PIC) is also constituted which will monitor the progress.
4	4 (XI) 4	Noise barriers: - Along 4.5 x 2 = 9 km stretch abutting mudflats where flamingos gather	Complied. MMRDA has made provisions for installation of 3 m height (4.5 x 2 = 9 km stretch abutting mudflats where flamingos gather) on both side of the Sea link passing through CRZ I (mudflat & mangroves area) and CRZ IV area.
5	4 (XI) 5	Mitigation of marine water pollution caused due to the surrounding industries and Sewage from Urban Bodies, by providing Funding and Capacity Building for Enabling Effluent Treatment: - Identifying sources, treatability report, implementation of restoration and ETP	Complied. IIT Mumbai has been engaged to carry out water pollution study & designing of Effluent Treatment Plant in Mahul Creek. An amount of Rs. 5.8 crore has been paid to IIT towards the same. The final report is awaited. Based on the report, the mitigation measures would be implemented.
6	4 (XI) 6	Contribution to Mangroves fund, an initiative by Govt. of Maharashtra for Conservation and Protection of Mangroves in Coastal areas by depositing Seed Money. This can be used for Survey & Demarcation of Notified areas; Purchase of vehicles and equipment's for anti-Encroachment drives, etc.: - In accordance with their report this money will be deposited with GOM for restoration, conservation and Protection of mangroves in coastal areas	Complied. Mangrove Marine Biodiversity and Conservation Foundation, Mumbai (Mangroves Foundation) is entrusted with the job for which an amount of Rs 86.31 Cr. has been deposited with them.
7	4	Oil Spill Mitigation Plan: - State of the air Oil Spillage mitigation	Complied.

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	(XI) 7	equipment, etc.	The provision for the same has been incorporated in the contracts for all three packages. Regular monitoring in this regard is being carried out as a part of their environmental monitoring plans.
8	4 (XI) 8	Habitat quality assessment and monitoring * Surveillance management and monitoring team for migratory birds, marine flora, turbidity in sea floor, etc. * Corpus fund for mudflat restoration program: - Carrying out detailed habitat quality monitoring of mudflats, migratory birds, marine flora and fauna and surveillance study	Complied. BNHS has been appointed for the purpose and it is included in the assignment referred at Sr. No. 3 above amounting Rs. 31.92 Cr. has been deposited with the Mangrove and Marine Biodiversity Foundation for Execution, monitoring and disbursement to BNHS on the basis of deliverable activities.
9	4 (XI) 9	Appointment of Bird Monitor and his assistant till Restoration of Baseline data: - Monthly monitoring during CP and Seasonal monitoring during OP	Complied. BNHS has been appointed for the purpose and it is included in the assignment referred at Sr. No. 3 above amounting Rs. 31.92 Cr. has been deposited with the Mangrove and Marine Biodiversity Foundation for Restoration of Baseline data and Seasonal monitoring during OP to BNHS on the basis of deliverable activities.
10	4 (XI) 10	DMP, Firefighting, Risk Analysis: - Necessary equipment, Quick Response Vehicles etc. for implementation of the detailed DMP	Complied. The provision for the same has been made in all the 3 packages and regular monitoring and mock drills are taking place.
11	4 (XI) 11	Sustainable development including establishing Nature Interpretation Centre: - Establishing a centre for training and workshops at schools and e level	Complied. An amount of Rs. 10 crores have been paid to Mangroves & Marine Biodiversity Foundation of Maharashtra towards establishing Marine Nature Interpretation Centre at Airoli, Mumbai.
12	4 (XI) 12	Safety and Security: - It includes setting up safety measures and security measures including telecommunication systems, safety boats, wireless communications etc.	Complied. Regular monitoring and implementation in this regard is being carried out as a part of our Safety and Security programme.
13	4 (XI) 13	Energy conservation: - To use LED, Solar lamps on the bridge, ROW's etc.	Necessary provisions towards the use of LED, Solar lamps on the bridge would be considered along with package IV for ITS.
14	4 (XI) 14	Landscaping-Plantation of trees, flowering plants etc.: - Along the entire bridge alignment	Complied. The provisions for Landscaping-Plantation of trees, flowering plants etc.: - Along the entire bridge alignment has been made by MMRDA.
15	4 (XI) 15	Compensation and Capacity Building of Fisher folks due to Temporary and Permanent Loss of Fishing ground: - Compensating affected fisher folk community welfare, etc.	Complied. The Compensation Policy in respect of project affected fisher folks has been formulated. Necessary survey for identifying the affected fishermen is in progress and the Fisherman Compensation Committee has been constituted by MMRDA to ensure disbursement to PAPs through Fishery Department. The process for the same is ongoing and till end of June 2018, Fisheries Department has approved 1165 fisher folk (families) from Mumbai side fishermen villages and 1399 fisher folk(families) from Navi Mumbai side fisherman villages. Till so far an amount of Rs. 22.18 Cr plus Rs.27.65 Cr has been deposited with Fisheries Department for disbursement to the 2371 eligible PAPs. Till date, about 23,786 fishermen were surveyed and more than 5520 families were identified as eligible for compensation.

yes



SR. NO.	REF. NO.	SPECIFIC CONDITIONS	COMPLIANCE STATUS
16	A (I)	All the terms and conditions stipulated by the MCZMA in their letter No. CRZ 2015/CR236/TC 4 dated 26 th November 2015 shall be strictly complied with.	Noted and shall be complied.
17	A (II)	All the terms and conditions as mentioned in the earlier CRZ Clearance dated 19th July 2013, shall also be complied with in letter and spirit.	Noted and shall be complied
18	A (III)	The Environment Management Plan as presented during the meeting shall be implemented in consultation with all the stakeholders.	Noted and shall be complied
19	A (IV)	The project/activity shall be carried out strictly in accordance with the provisions of CRZ Notification, 2011, and shall not affect the coastal ecology of the area including flora and fauna.	Noted and is being complied
20	A (V)	The project proponent shall obtain all permissions from concerned authorities prior to commencement of the project and shall observe all safety requirements onshore and offshore.	Complied. MMRDA / contractors for all 3 packages have obtained all permissions from concerned authorities prior to commencement of the project and shall observe all safety requirements onshore and offshore.
21	A (VI)	The project proponent shall not undertake any blasting/construction activities during night hours.	Complied. MOEF vide their letter dated 28-08-2017 amended the condition for carrying out construction activities during night hours.
22	A (VII)	The proposal indicates the diversion of 47.417 ha forest land for which the proponent shall obtain the requisite Forest Clearance. The project may be executed in the entire stretch in non-forest land, and while making application to get the Forest Clearance, the execution of work on non-forest land shall not be cited as a reason for grant of FC and in case FC is declined, the forest land shall be maintained at its existing condition. The PP shall submit an undertaking to this effect at the earliest to the concerned Regional Office to this Ministry.	a) Stage I Forest Clearance (Working Permission) has been obtained by MMRDA from the Forest Department vide their letter no B/20/Jamin/637/2018-19. Dt. 16-05-2018 from DCF Alibaug for execution of work. b) Stage I Forest Clearance (Working Permission) has been obtained by MMRDA from the Forest Department vide their letter no kaksha-9/Jamin/136/2018-19 Dt. 11-04-2018 from DCF Kurla for execution of work. c) Stage I Forest Clearance (Working Permission) has been obtained by MMRDA from the Forest Department vide their letter no kaksha-9/Jamin/432/2018-19 Dt. 19-05-2018 from DCF Kurla for execution of work. d) Reply to queries received from DCF Alibaug in regard to stage II proposal has been submitted by MMRDA on date 1 st September 2017 vide letter No. MMRDA/ MTHL/ Forest Clearance/ Stage II / Queries / 17 and on date 10 th September, 2018 vide letter No. MMRDA/ MTHL/ Forest Clearance/ Stage II / Queries / 18.
23	A (VIII)	All the wildlife mitigation measures as proposed by BNHS in their report dated 23.09.2015 for original alignment shall be implemented with the following modification (a) Construction of jetty on both the ends passing through mud flats and mangroves must not exceed 30 months and construction of actual spans must not exceed more that further 12 months. (b) The distance between the supporting pillars shall remain 50 m as currently proposed by the MMRDA.	Noted and being complied

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SER. NO.	REF. NO.	GENERAL CONDITIONS	COMPLIANCE STATUS
		(c) MMRDA will partly bear the cost of setting of effluent treatment plant in the region as suggested by BNHS.	
24	A (IX)	The project proponent shall not undertake any blasting/construction activities during night hours.	Complied. MOEF vide their letter dated 28-08-2017 amended the condition for carrying out construction activities during night hours.
1	B (I)	Adequate provision for infrastructure facilities including water supply, fuel and sanitation must be ensured for construction workers during the construction phase of the project to avoid any damage to the environment.	Noted and shall be complied as per contract terms and conditions.
2	B (II)	Full support shall be extended to the officers of this Ministry/Regional Office at Nagpur by the project proponent during inspection of the project for monitoring purposes by furnishing full details and action plan including action taken reports in respect of mitigation measures and other environmental protection activities.	Noted and shall be complied
3	B (III)	A six-Monthly monitoring report shall need to be submitted by the project proponents to the Regional Office of this Ministry at Nagpur regarding the implementation of the stipulated conditions.	6 monthly progress reports from June 2016 till June 2019 will be submitted by GC by mid of January
4	B (IV)	MoEFCC or any other competent authority may stipulate any additional conditions or modify the existing ones, if necessary, in the interest of environment and the same shall be complied with.	Noted
5	B (V)	The Ministry reserves the right to revoke this clearance if any of the conditions stipulated are not complied with to the satisfaction of the Ministry.	Noted
6	B (VI)	In the event of a change in project profile or change in the implementation agency, a fresh reference shall be made to the MoEFCC.	Noted
7	B (VII)	The project proponents shall inform to the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of start of land development work.	Noted
8	B (VIII)	A copy of the clearance letter shall be marked to concerned Panchayat/ local NGO, if any, from whom any suggestion/ representation has been made received while processing the proposal	No comments received
9	B (IX)	A copy of the CRZ Clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The Clearance letter shall also be displayed at the Regional Office, District Industries centre and Collector's Office/Tehsildar's Office for 30 days.	Noted.
10	6	The above stipulations would be enforced among others under the provisions of Water (Prevention and Control of Pollution) Act 1974, the Air (Prevention and Control of Pollution) Act 1981, the	Noted

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		Environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification 1994, including the amendments and rules made thereafter.	223
11	7	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department, and clearances under the Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponents from the respective competent authorities.	Noted
12	8	The project proponent shall advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board and may also be seen on the website of the Ministry of Environment, Forest & Climate Change at. The advertisement should be made within Seven days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the Regional office of this Ministry at Nagpur.	Complied. Published in Loksatia and Indian Express on 30.01.2016
13	9	This Clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs Union of India in Writ Petition (Civil) No.460 of 2004 as may be applicable to this project.	Noted
14	10	Any appeal against this clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	Noted
15	11	Status of compliance to the various stipulated environmental conditions and environmental safeguards will be uploaded by the project proponent on its website.	Noted and will be implemented.
16	12	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parishad/Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the company by the proponent.	Vide letter No .ED/MTHL/CRZ Clearance/ Publish/60 dated 29.01.2016
17	13	The proponent Shall upload the status of compliance of the stipulated EC conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEF, the respective Zonal Office of CPCB and the SPCB.	Noted and will be implemented.
18	14	The project proponent shall also submit six monthly reports on the status of compliance of the stipulated EC conditions including results of monitored data (both in hard copies as well as by e-mail) to the respective Regional Office of MoEFCC, the respective Zonal Office of CPCB and the SPCB.	Noted and will be implemented.

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19	15	15. The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall also be sent to the respective Regional Offices of MoEFCC by e-mail.	224
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Noted and will be implemented.

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Rev. VII- 08.1.2020

**MUMBAI TRANS HARBOUR LINK PROJECT
CRZ MCZMA CHECKLIST**

Sr. No.	REF. NO.	SPECIFIC CONDITIONS	COMPLIANCE STATUS
1	9 (I)	MMRDA to ensure that mangroves restoration on the identified areas is undertaken immediately through Mangroves Conservation Cell, Mumbai.	Complied. MMRDA has deposited Rs. 5.05 Cr. to Mangroves Cell towards plantation of Mangroves over 200 Ha areas. Till date 105 Ha plantation has been completed as per letter enclosed.
2	9 (II)	MMRDA to explore the possibility of increase in the distance between two piers of viaduct in the mudflat area, which may be more than 50 m. This will minimize the disturbance in ecologically important mudflats and bird habitat area.	Complied. The GAD for packages 1 and 2 in the marine area contemplates pier distances of 60 m centre to centre.
3	9 (III)	The Sewri End of the Jetty should be used for transportation of construction material to avoid disturbance to the mudflats.	Complied. The Sewri Jetty area has been handed over to the contractor for transportation of construction material to avoid disturbance to the mudflats on 18.04.2018
4	9 (IV)	No reclamation is allowed in CRZ I & CRZ IV area except for viaducts & piers. MMRDA should ensure the same.	Complied. No reclamation is proposed in CRZ I & CRZ IV areas except for piers and viaducts.
5	9 (V)	MMRDA to install noise barriers of 3 m height on both side of the Sea link passing through CRZ I (mudflat & mangroves area) and CRZ IV area.	Complied. MMRDA has made provisions for installation of 3 m height on both side of the Sea link passing through CRZ I (mudflat & mangroves area) and CRZ IV area.
6	9 (VI)	Casting yard proposed on 16.15 ha on mangroves area on Navi Mumbai side should be shifted from CRZ I (mangroves area).	Complied. CIDCO has allocated 13.24 Ha casting yard area beyond CRZ I zone on Navi Mumbai.
7	9 (VII)	MMRDA to ensure that Construction activities near flamingo habitat area may be restricted to the season when flamingos are not on the site or not in larger flocks.	Complied. MOEF vide their letter dated 28-08-2017 has waived off the condition however with a suggestion that "MMRDA must exercise every possible effort to minimise disturbance to Flamingo habitat during construction phase of the project." However MMRDA is taking all measures to minimise the disturbance and the same is substantiated by photographs and videos of the site during construction showing Flamingos close to the construction site.
8	9 (VIII)	MMRDA to ensure that all construction equipment is fully fitted with mufflers and exhaust silencers to contain the noise levels. Machinery used during construction should be properly maintained to minimize the air and noise emissions.	Complied. All construction equipment are fully fitted with mufflers and exhaust silencers to contain the noise levels. Machineries used during construction are properly maintained to minimize the air and noise emissions. This is evidenced in the photographs attached.
9	9 (IX)	MMRDA to ensure that minimum damage is caused to mangroves ecosystem.	Noted. During the monitoring visits, the GC members are observing if there are any visible impacts on the mangroves.

WHS



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10	9 (X)	MMRDA to ensure that operations in the mudflats or intertidal zones will be done by using temporary jetty which will be parallel to permanent structure in the Right of Way for the transportation of labour, construction material, precast elements, machinery etc. on the either ends.	Complied. The Temporary access bridge is under construction to ensure that operations in the mudflats or intertidal zones are done by using the same which is parallel to permanent structure in the Right of Way for the transportation of labour, construction material, precast elements, machinery etc. in both packages 1 and 2.
11	9 (XI)	MMRDA to declare entire MTHL as 'No Honking area'	Noted and will be complied with the help of traffic police after commissioning.
12	9 (XII)	MMRDA to ensure that no hoardings are allowed to display on the MTHL to avoid disturbance due to light illumination to Marine flora, fauna and birds during night.	Noted and will be complied.
13	9 (XIII)	MMRDA should take the expert opinions from the BNHS regarding safeguards to be placed so as to mitigate the disturbance to flamingo's habitat.	Complied. MMRDA has appointed BNHS for Implementation of Flamingos and Birds mitigation measures & birds monitoring program and Mudflat restoration for the MTHL project and this assignment will be executed & monitored through Mangrove Foundation Mumbai. A tripartite agreement between MMRDA, BNHS and Mangroves Foundation has been signed. Accordingly, MMRDA has deposited Rs. 31.92 crore with the Mangrove and Marine Biodiversity Foundation for disbursement to BNHS on the basis of deliverable activities. As per recommendations of JICA Study Group and various suggestions from BNHS, Forest Department, MMRDA is implementing mitigation measures during the construction phase.
14	9 (XIV)	MMRDA to formulate an Environment Cell (EC) to monitor impacts on environment during construction as well as during operations, under Chairmanship of Additional Metropolitan Commissioner, MMRDA. The said Cell would comprise of internal cell with Joint project Director (Environment), MMRDA and the Chief Engineer, MMRDA and other members will be from Forest Department, Maharashtra Pollution Control Board, Environment Department and other Environmental Specialists.	Complied. MMRDA has constituted the EMC. 1st EMC was held on 20th of June 2018. 2nd EMC was held on 5th February 2019. 3rd EMC was held on 22nd August 2019. 4th EMC was held on 08th January 2020. The suggestions in the EC meetings are being complied with.
15	(XV)	MMRDA to set aside an amount of about 2% of the project cost towards mitigation measures; restoration & Conservation of mangroves/birds/flora/fauna and mudflats restoration.	Complied. MMRDA has year marked Rs. 325 Cr. towards implementation of Environment Management Plan. The details of EMP are mentioned in the CRZ clearance approval given by MOEF on 25.01.2016.
16	9 (XVI)	MMRDA to undertake training programmes for construction personnel regularly so as to cause minimum disturbance to birds, due to construction activities.	BNHS has held the first training workshop at the board room, 4th floor, MMRDA on 11th June 2019 and it was attended by key Engineers and Environmental Experts of all three packages. However, a mechanism has to be devised to ensure further training of workmen and staff who are actually engaged in construction process.
17	9 (XVII)	MMRDA to develop a nature interpretation centre in the appropriate place to create awareness about importance of conservation of flora and fauna and migratory birds.	Complied. An amount of Rs. 10 crores have been paid to Mangroves & Marine Biodiversity Foundation of Maharashtra towards establishing Marine Nature Interpretation Centre at Airoli, Mumbai. MMRDA to seek progress from Mangrove Foundation on the development of the interpretation centre.



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18	9 (XVIII)	MMRDA to consult expert agency to minimize the damage to the mudflats before commencement of the construction work near the mudflats.	Complied. BNHS has been appointed for suggestions and preparing blue print for restoration of Mudflats on completion of the project. The assignment is executed and monitored by Mangrove Foundation Mumbai. The process of constitution of Project Implementation Committee (PIC) is in progress. The Temporary access bridge is under construction to ensure that operations in the mudflats or intertidal zones are done by using the same which is parallel to permanent structure in the Right of Way for the transportation of labour, construction material, precast elements, machinery etc. in both packages 1 and 2.
19	9 (XIX)	MMRDA should obtain the Forest Clearance since; the proposed alignment of MTHL is passing through mangroves patches at Sewri and Nhava End of the project. Prior permission from the High Court of Mumbai should also be obtained as per the Hon. High Court order dated 27.1.2010 & 6.10.2005 in WP No. 3246/2004 & PIL 87/2006	Complied. Necessary permissions from Hon. High Court Mumbai has been obtained by MMRDA on 28.11.2015 and forwarded to MOEF in compliance of Forest clearance proposal. Thereafter, MMRDA has received Stage -I clearance from MOEF and Working Permission from Forest Department.
20	9 (XX)	MMRDA to consult and implement suggestions given by committee constituted for fisheries issues in the project area. Representative of fisheries commissioner, local fisherman community etc. should be appointed on the committee. The committee to ensure all mitigation measures for fisheries protection and issues of the local fisherman are considered and implemented during construction by conducting regular meeting during construction phase.	Complied. MMRDA has constituted a Coordination Committee on 08.10.2015 headed by Additional Metropolitan Commissioner and members- Commissioner of Fisheries, CEO MMB, Collector Mumbai City & Raigad, Dy. Police Commissioners from Mumbai and Navi Mumbai sides, Expert in fisheries and invite members- local Fisherman Cooperative Societies. This Committee has drafted and approved the Fishermen Compensation Policy in its 4th meeting held on 23.12.2015. Thereafter, MMRDA has so far surveyed about 8000 fisherman families likely to be affected due to construction of MTHL project.
21	9 (XXI)	MMRDA to ensure that no fishing activity is hampered during construction and operation phase of the project. Mudflats and creek are of vital importance to fisheries. Therefore, during construction and after completion of the project, MMRDA to assess the project affected fishermen and loss of business to fishermen that may occur due to the project.	Complied. The Compensation Policy in respect of project affected fisher folks has been formulated. Necessary survey for identifying the affected fishermen is in progress and the Fisherman Compensation Committee has been constituted by MMRDA to ensure disbursement to PAPs through Fishery Department. The process for the same is ongoing and till end of June 2018, Fisheries Department has approved 1165 fisher folk (families) from Mumbai side fisherman villages and 1399 fisher folk(families) from Navi Mumbai side fisherman villages. Till so far an amount of Rs. 22.18 Cr plus Rs.27.65 Cr has been deposited with Fisheries Department for disbursement to the 2371 eligible PAPs. Till date, about 23,786 fishermen were surveyed and more than 5520 families were identified as eligible for compensation
22	9 (XXII)	MMRDA to formulate project specific disaster management plan and standard operating procedures before commencement of the project.	Complied. All packages have the DMP in place to safe guard the underground utilities, fire, accidents, spillage of oil, grease paints etc.



23	9 (XXIII)	MMRDA to constitute Environmental monitoring committee over and above to internal environmental cell as proposed. This committee will ensure third party monitoring of implementation of ecological compliances. The structure of the committee should comprise experts from National Institute of Oceanography; Representative of BNHS; renowned expert in Ornithology; Director, Fisheries Institute, Versova, Andheri; Head of Coastal Engineering, IIT, Mumbai and Representative of Environment Department and Maharashtra Pollution Control Board. The officer of MMRDA will act as a Member Secretary to coordinate the quarterly meetings of the committee during construction phase.	Complied. 1st Environmental Monitoring Committee was held on 20th of June 2018. 2nd Environmental Monitoring Committee was held on 5th February 2019. 3rd Environmental Monitoring Committee was held on 22nd August 2019. 4th Environmental Monitoring Committee was held on 03rd January 2020. The suggestions in the EMC meeting are being complied with.
Sl. No.	Ref. No.	GENERAL CONDITION	COMPLIANCE STATUS
24	GC (I)	The MCZMA reserves the right to revoke this recommendation, if the conditions stipulated are not complied with to the satisfaction of the MCZMA or Environment Department.	Noted
25	GC (II)	The MCZMA or any other competent authority, MCGM may stipulate any additional conditions subsequently, if deemed necessary, for environmental protection, which shall be complied with.	Noted
26	GC (III)	A copy of the recommendation letter shall be marked to the concerned local body/ local NGO, if any, from whom any suggestion/ representation has been received while processing the proposal.	Noted The same has been sent to BNHS, Conservation Action Trust, etc., who had participated in the Public Consultation in the year 2015.
27	GC (IV)	The environmental safeguard measures should be implemented in letter and spirit.	Noted
28	GC (V)	This recommendation will be valid for 5 years from the date of issue of recommendation for commencement of construction & operation.	Noted
29	GC (VI)	The recommendation from CRZ point of view is being issued without prejudice to the action initiated under EP Act or any court case pending in the court of law and it does not mean that project proponent has not violated any environmental laws in the past and whatever decision under EP Act or of the Hon'ble court will be binding on the project proponent. Hence this recommendation does not give immunity to the project proponent in the case filed against him, if any or action initiated under EP Act.	Noted

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EXHIBIT L

1/229



MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
मुंबई महानगर प्रदेश विकास प्राधिकरण

No. ED/MTHL/CCF Mangroves/Payment/16

Engineering Division

Date: 09/05/2016.

To

The Chief Conservator of Forests (Mangroves),
A-Wing, 2nd Floor, SRA Building,
Anant Kanekar Marg, Bandra (E),
Mumbai -400051.

Sub: Mumbai Trans Harbour link

- Deposition of payment to for compensatory plantation of mangroves on 30 ha area.

Ref: 1) Your letter dated 30.12.2015 regarding identifying 223 ha area for compensatory mangrove plantation for MTHL project
2) Your letter dated 16.03.2016 raising demand of funds for plantation on 30 ha area .

You are aware that, MMRDA has been assigned the task of implementation of Mumbai Trans Harbour Link (MTHL) by the Govt. of Maharashtra. The total diversion of forest area comprises to 47.4170 ha. in this project.,

In this regard, MMRDA has requested you vide T. O. letters dated 17/04/2013, 26.08.2013 and 29.09.2015 to prepare a mangrove plantation program for the area likely to be affected due to construction of MTHL bridge structure. The details of mangrove affected land admeasuring 38.58 Ha were submitted

2. Accordingly, you have communicated to MMRDA vide their letter dated 30.12.2015 that you have identified suitable land parcels admeasuring total about 223 ha in Palghar, Thane, Mumbai Suburb and Ratnagiri forest area under your jurisdiction for proposed compensatory mangrove plantation related to MTHL project.

5. Pursuant to the your demand for funds raised amounting Rs. 49,59,822/- towards compensatory mangrove plantation on 30 ha area in the letter dated 16.03.2016 for year 2015-16 and pre-monsoon preparation, please find enclosed payment by cheque no. 217917 dated 04.05.2016 of amount Rs. 49,59,822/- (drawn from Bank of Maharashtra).

Acknowledge / receipt for the same is requested. You are also requested forward the plans and estimate for funds for the balance mangrove plantation contemplated in MTHL project at the earliest please.

Yours Faithfully,

(Signature)
(M. H. Paranjape)
Executive Engineer

Encl: Cheque no. 217917 dated 04.05.2016 (in Original)

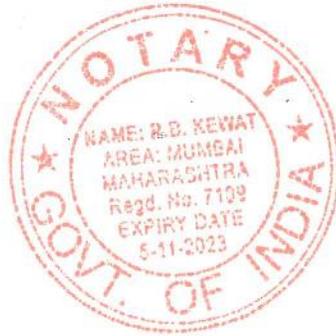
Bandra - Kurla Complex, Bandra (East), Mumbai - 400 051.

EPABX : 2659 0001 - 04 / 2659 4000 • FAX : 2659 1264 • WEB SITE : <https://mmrda.maharashtra.gov.in>

Received
Cheque No. 217917
dt. 4/5/2016
S.

Received
on 4/5/2016
Chief Conservator of Forests (Mangroves)
Kandivan Cell, Mumbai

230



बान्द्रा (पूर्व), मुंबई - 400 051
 BANDRA (EAST), MUMBAI - 400 051.
 IFSC MAHB0000164

JAD
 BND

Valid For Three Months From The Date Of Issue

3 4 0 5 2 0 1 6
 D D M M Y Y Y Y

No Payee Only
 Not Negotiable
 Pay अदा करें

CHIEF CONSERVATOR OF FOREST, MANGROVES CELL, MUMBAI

Or Order

या उनक आदेशपर

Rupees रुपये Forty Nine Lakh Fifty Nine Thousand Eight Hundred Twenty Two Only

अदा करें।

₹ 49,58,822.00

G. S. SAVALKAR & SONS, JAMNESH

खाता सं. A/c. No.	20045301020
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CBS

For MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY (MMRDA)

PAYABLE AT PAR AT ALL BRANCHES

[Signature]
 Authorised Signatory

[Signature]
 Authorised Signatory
 Please Sign above

⑈ 217917⑈ 400014043⑈

[Handwritten mark]



EXHIBIT M

231



MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

मुंबई महानगर प्रदेश विकास प्राधिकरण

No. ED/MTHL/CCF Mangroves/Balance payment/16

Engineering Division
Date: 17/10/2016.

To

The Chief Conservator of Forests (Mangroves),
A-Wing, 2nd Floor, SRA Building,
Anant Kanekar Marg, Bandra (E),
Mumbai -400051.

Sub: Mumbai Trans Harbour link

- Deposition of balance payment to for compensatory plantation of mangroves on 170 ha area and maintaining all 200 ha plantation.

Ref: 1) Your letter dated 16.03.2016 raising demand of funds for plantation on 30 ha area.
2) Payment for 30 ha plantation made by MMRDA vide T.O. letter dated 09.05.2016
3) Your letter dated 20.09.2016 regarding cost of balance 170 ha area and maintenance of all 200 ha for compensatory mangrove plantation for MTHL project.

Sir,

MMRDA had requested you to prepare a mangrove plantation program for the area likely to be affected due to construction of MTHL bridge structure. The details of mangrove affected land admeasuring 38.58 Ha were submitted. For the compensatory mangrove plantation related to MTHL project, you have identified suitable land parcels in Palghar, Thane, Mumbai Suburb and Ratnagiri forest area under your jurisdiction.

2. This office has received your letter dated 20.09.2016 referring the subject matter and this office has noted that the mangrove plantation area is revised to total 200 ha.
3. Pursuant to your demand letter, MMRDA had already deposited Rs. 49,59,822/- vide T.O. letter dated 09.05.2016 towards plantation on 30 ha area.
4. Now, you have raised demand of Rs. 4,56,29,600/- towards payment for balance compensatory plantation of mangroves on 170 ha area and maintaining all 200 ha plantation over period of next 4 years. Please find enclosed payment by cheque no. 216609 dated 13.10.2016 of amount Rs. 4,56,29,600/- (drawn from Bank of Maharashtra). Acknowledge / receipt for the same is requested.
5. In view to fulfill auditory requirements, your are requested to submit;
 - i) Plans and estimate for all 200 ha mangrove plantation and maintenance for next 4 years for MMRDA's record purpose.
 - ii) Quarterly progress report
 - iii) Quarterly Utilization Certificate on use of funds.

Yours Faithfully,

(Signature)
(M. H. Paranjape)
Executive Engineer

Encl: Cheque no. 216609 dated 13.10.2016 (in Original)

Bandra - Kurla Complex, Bandra (East), Mumbai - 400 051.

EPABX : 2659 0001 - 04 / 2659 4000 • FAX : 2659 1264 • WEB SITE : <https://mmrda.maharashtra.gov.in>

(Signature)
17/10/2016
लिपीक
मुख्य वनसंरक्षक (मंग्रोव)
कांदळवन कक्षा, मुंबई.

(Signature)

00164-MUMBAI BANDRA EAST
 CHIEF CONSERVATOR OF FORESTMANGROVES

13/10/2016
 D M Y Y Y Y
 216609

को या उनके आदेश पर/OR ORDER

CELL.MUMBAI *****

Four Fifty Six Lakh Twenty
 Nine Thousand Six Hundred only.

₹ ****4, 56, 29, 600.00

FOR VALUE RECEIVED

बैंक ऑफ़ महाराष्ट्र FOR BANK OF MAHARASHTRA

310819

बैंक ऑफ़ महाराष्ट्र, बैंक ऑफ़ महाराष्ट्र

310819

बैंक ऑफ़ महाराष्ट्र, बैंक ऑफ़ महाराष्ट्र

310819

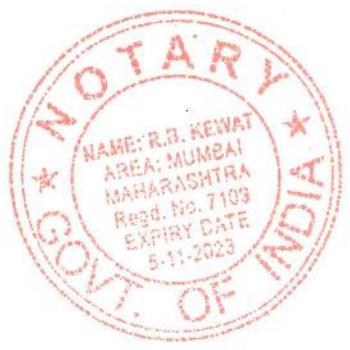
आदेशक/अधिकारी/AUTHORISED OFFICIAL/S
 Please sign above

01001-MUMBAI SERVICE BRANCH

MJL-2015

16

216609 000 44000



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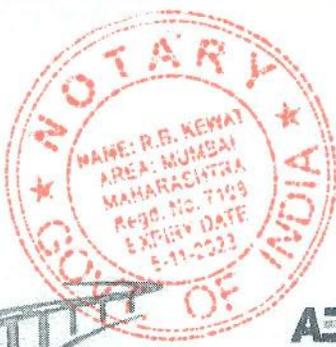


EXHIBIT N

AECOM

PADECO



dar al-hindesah
Mumbai and Pune

TYLIN 233
INTERNATIONAL

General Consultant for Mumbai Trans Harbour Link Project

Ref No: MTHL/GC/MMRDA/LT/ENV- 1092 /2019

6th December 2019

To,
The Chief Engineer
Engineering Division
Mumbai Metropolitan Regional Development Authority (MMRDA)
2nd Floor, New MMRDA Building,
Plot No R-06 & R-12, 'E' Block
Bandra Kurla Complex, Bandra (E),
Mumbai, Maharashtra, India 400051

**Sub: General Consultancy services for Mumbai Trans Harbour Link (MTHL) project -
Status report from Mangroves Cell**

Ref: MTHL/Forest land/CA/DCF Alibaug /Status Report/19/62 Dt. 16-10-2019

Dear Sir,

We had requested APCCF Mangroves Cell for status report on Mangroves Afforestation executed for MTHL vide letter under reference. We are in receipt of the report vide their Letter No. ja. kra. Kaksh-6/yojana/1867/2019-20 Dt. 04-12-2019 which is enclosed for your record and perusal.

Thanking you,

Yours faithfully,

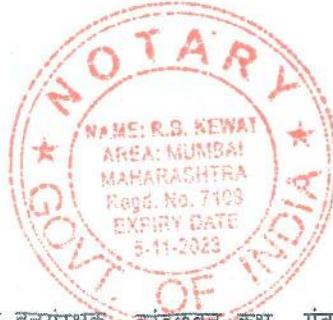
Mr. Sham 8 December 2019

[Signature]
Dr. S H Robin Sham, CBE
(BSc, PhD, DIC, FCGI, FRSA, CEng, FICE, FStructE, FHKIE)
The Engineer
General Consultant (MTHL)

Encl: As above

CC: Superintendent Engineer – MMRDA - Mr. Sakhalkar
Executive Engineer – MMRDA – Mr. Bhisikar
Executive Engineer – MMRDA – Mr. Vishal Jambhale

[Handwritten initials]



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अपर प्रधान मुख्य वनसंरक्षक, कांदळवन कक्ष, मुंबई यांचे कार्यालय,
एस.आर.ए. विल्डींग, ए-विंग, दुसरा मजला, अनंतर काणेकर मार्ग, बांद्रा (पूर्व), मुंबई-400 051.
फोन व फॅक्स-022 26591586, Email:-ccfmanagrove@mahaforest.gov.in/ccfmmumbai@gmail.com

विषय :- MMRDA अंतर्गत घेण्यात आलेल्या कांदळवन
रोपवनाच्या कामाबाबत.

जा.क्र.कक्ष-6/योजना/ 1867/ 2019-20
बांद्रा, मुंबई- 400 051, दि. 24/12/2019.

प्रति,

श्री. जी.जी.देशपांडे,

कार्यकारी अभियंता,

मुंबई महानगर प्रदेश विकास प्राधिकरण,

मुंबई.

- संदर्भ :-1) आपले कडील पत्र क्र.एमटीएचएल/फॉरेस्ट लॅण्ड/सीए/डीसीएफ अलीबाग/
स्टेट्स रिपोर्ट /18/87, दि. 21.06.2018.
2) आपले कडील पत्र क्र.इ.डी./एमटीएचएल/सीसीएफ
मॉग्रोव्ह/पेमेंट16/ दि.9.3.2016.
3) आपले कडील पत्र क्र.इ.डी./एमटीएचएल/सीसीएफ
मॉग्रोव्ह/पेमेंट16/ दि.17.10.2016.
4) आपले कडील पत्र क्र. एमटीएचएल/फॉरेस्ट लॅण्ड/सीए/डीसीएफ अलीबाग/
स्टेट्स रिपोर्ट/19/ 62/ दि. 16.10.2019.
5) या कार्यालयाचे पत्र क्र. कक्ष-6/ योजना/975/ दि. 27.07.2018.

आपले कडील उपरोक्त संदर्भिय पत्र क्र.2 व 3 अन्वये कांदळवनाकरिता 200.00 हे. रोपवनाचे उद्दिष्ट साध्य करण्याकरिता आपणाकडून रक्कम रु.5,05,89,422/- प्राप्त झालेले आहे. मुंबई महानगर प्रदेश विकास प्राधिकरण अंतर्गत मुंबई ट्रान्स हार्बर (MTHL) या योजने मध्ये एकूण 200.00 हे. रोपवन क्षेत्राचे उद्दिष्ट खालीलप्रमाणे वनविभागास वाटप करण्यात आले होते. त्यापैकी सन 2017-18 व 2018-19 च्या पावसाळ्यात 200.00 हे. क्षेत्रावर कांदळवनांचे रोपवन घेण्यात आलेले आहे. त्याचा तपशिल खालीलप्रमाणे.

अ.क्र.	वनविभाग	साध्य केलेले उद्दिष्ट						
		वर्ष	वनक्षेत्र		स. नं.	क्षेत्र	पूर्व पावसाळी व प्रथम वर्षी रोपवनावर झालेला खर्च रक्कम रु. (Preplantation operation+ First	2 ते 7 व्या वर्षाकरिता लागणारे अनुदान
1	डहाणू (रोपवाटीकासह)	2015-16	बोईसर	मोजे पामटेंभी ✓	161	15.00	2351479/-	
2			सफाळे	मोजे करवेला ✓	47	15.00	2608343/-	
3		2017-18	बोईसर	मोजे पामटेंभी	161	10.00	2044986/-	
4			बोईसर	सालवड	107	10.00	2044986/-	
5			बोईसर	चंडीगाव	729	10.00	2136455/-	
6			सफाळे	साकुणसार	283/अ व 247/2	20.00	4319819/-	

D/plan /plan 2019-20/MMRDA

YMS



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7	मुंबई कांदळवन संधारण घटक	2017-18	ठाणे खाडी फलेभिगो	काजूर	275 न.भू.क्र 657अ.	10.00	(प्रथम वर्ष) 1216996/- (द्वितीय वर्ष) 243336/-	
8				मुलूंड व भांडूप	157 न.भू.क्र 1318.	15.00	(प्रथम वर्ष) 1825494/- (द्वितीय वर्ष) 197101/-	
9	डहाणू वनविभाग	2018-19	डहाणू	पालघर	धनसार 64	45.00	2569984/-	2,76,67,879/-
10				सफाळे	करवेळा 47	20.00	2569984/-	
11				बोईसर	नवापूर 161	10.00	1284992/-	
12					सालवड 107	10.00	1284992/-	
13				पालघर	शिरगाव 1287	10.00	1284992/-	
	एकुण क्षेत्र					200.00	2,79,83,939/-	2,76,67,879/-
	एकुण एकंदर					200.00	5,56,51,818/-	

मुंबई महानगर प्रदेश विकास प्राधिकरण अंतर्गत घेण्यांत येणाऱ्या MTHL प्रस्ताव अंतर्गत कांदळवन कक्षामध्ये 200.00 हे. रोपवन लागवडीचे कामे झालेली आहेत. व त्यास आपणा कडून मंजुरी व एकूण अनुदान रक्कम रु.5,05,89,422/- प्राप्त झाले होते. परंतु हाती घेण्यांत आलेल्या 200.00हे. करिता अंदाज किती खर्चअपेक्षित राहिल याबाबत रोपवनाचे 1 ते 7 वर्षांचे अंदाजपत्रक तयार करून सोबत जोडण्यांत आले आहे. त्यानुसार अनुदानाची अपेक्षित राहिल. अंदाजपत्रकीय 1 ते 7 वर्षांचे एकूण रक्कम रु. 5,56,51,818/- अशी होते. व आपणा कडून रक्कम रु.5,05,89,422/- प्राप्त झालेली आहे. कृपया नमुद केलेली सदरची वाढीव रक्कम रु. 50,62,396/- मिळण्यास विनंती आहे.

तसेच या कार्यालयाचे पत्र क्र. कक्ष-6/योजना/975/ दि. 27.7.2018चे पत्रातील नमुद करण्यांत आलेल्या प्रत्येक रोपवन ठिकाणाचे आपणाकडून KML फाईलची संदर्भिय पत्राअन्वये मागणी केल्याप्रमाणे वरिल प्रपत्रात नमुद केलेल्या कांदळवन रोपवनाचे KML फाईल यासोबत सादर करण्यांत येत आहे. कृपया अवलोकन होण्यास विनंती.

अपर प्रधान, KML कार्यालय (ए.प.कोश)
अहमदनगर

अपर प्रधान मुख्य वनसंरक्षक,
कांदळवन कक्ष, मुंबई

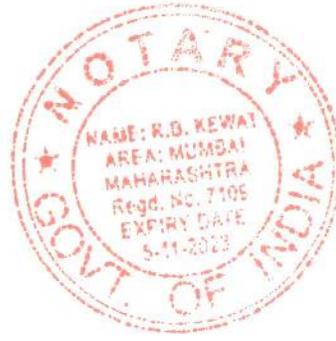


236

मुंबई महानगर प्रदेश विकास प्राधिकरण (MMRDA) अंतर्गत
घेण्यांत येणाऱ्या MTHL प्रस्ताव अंतर्गत घेण्यांत येणाऱ्या 200.00 हे. कांदळवन
रोपवनाचे 1 ते 7 वर्षांचे अंदाजपत्रक

गोषवारा

Sr.No.	Year	Amount
1	First Year	29320931
2	Second Year	9070370
3	Third Year	6361044
4	Forth Year	6852500
5	Fifth Year	5497684
6	Sixth Year	6047387
7	Seventh Year	665202
	Total	55651818 ✓

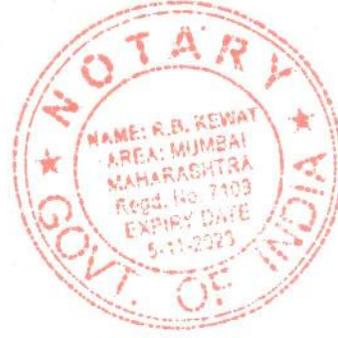


237

village
Spacing : 1.5 m x 1.5 m

First Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 360.76

Sr.No.	Item of work	1 ha.				200 ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	Preparation of site (including removal of weeds and climber etc.) and alignment etc.	25	8538.5	311	8849.5	5000	1803800	62200	1866000
2	Nursery cost	30	10246.2	1126	11372.2	6000	2164560	225200	2389760
3	Excavation of primary and secondary canals in hard stiff clay for letting in tidal waters (92 cmt/ha.)	140	47815.6	0	47815.6	28000	10101280	0	10101280
4	Transport of plants by Boat/Tempo from nursery to plantation site incl. loading etc.	12.54	4282.912	14000	18282.91	2508	904786.1	2800000	3704786
5	Planting incl. carrying of plants by headload	70	23907.8	0	23907.8	14000	5050640	0	5050640
6	Purchase of material (Ghamela, phawda, rope etc. plantation board etc.)	0	0	2500	2500	0	0	500000	500000
7	Casualty Replacement (20%) including carrying the plants by headloads.	20	6830.8	0	6830.8	4000	1443040	0	1443040
8	Removal of garbage and moss around the plants etc.	20	6830.8	0	6830.8	4000	1443040	0	1443040
9	Controlling of pests and insects by using pesticides and insecticides . Spraying nutrients for better growth of plants	0	0	1500	1500	0	0	300000	300000
10	Watch and ward, period 6 monts , 1 lab for 10 ha.	15.6	5328.024	0	5328.024	3120	1125571	0	1125571
11	Repairs of channels	7	2390.78	0	2390.78	1400	505064		505064
		340.14					24541781	3887400	28429181
12	labour welfare 3% on wages								736253.4
13	Contingencies 4% on M & S								155496
	Total								29320931



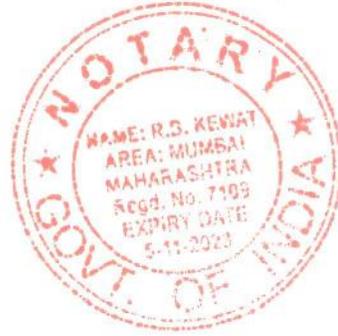
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village
Spacing : 1.5 m x 1.5 m

Second Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 376.98

Sr. No.	Item of work	1 ha.				200 ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	Nursery cost for 890 plants	6	2261.88	1800	4061.88	1200	452376	360000	812376
2	Transport of seedlings from nursery to planting site by vehicles incl. loading and unloading	2.5	942.45	2800	3742.45	500	188490	560000	748490
3	Casualty replacement incl. transport by headload	20	7539.6	0	7539.6	4000	1507920	0	1507920
4	Maintenance of canals	19	7162.62	0	7162.62	3800	1432524	0	1432524
5	Removing moss, algae and other litter around plants	20	7539.6	0	7539.6	4000	1507920	0	1507920
6	Controlling pestes by spraying pesticides	1	376.98	200	576.98	200	75396	40000	115396
7	watch and ward 1 watchman for 10 ha. For 12 months	31.2	11761.78	0	11761.78	6240	2352355	0	2352355
	total			0					8476981
	Equipment and contingencies 3% + labour welfare 4% Total 7%								593388.7
	Total								9070370

ms



239

village
Spacing : 1.5 m x 1.5 m

Third Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 414.67

Sr.No.	Item of work	1 ha.				200 ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	removing moss, algae and other litter around plants	20	8293.4	0	8293.4	4000	1658680	0	1658680
2	maintenance of canals	19	7878.73	0	7878.73	3800	1575746	0	1575746
3	controlling pastes by spraying pesticides	1	414.67	200	614.67	200	82934	40000	122934
4	watch and ward 1 watchman for 35 ha. For 12 months	31.2	12937.7	0	12937.7	6240	2587541	0	2587541
	total			0					5944901
	Equipment and contingencies 3% + labour welfare 4% Total 7%								416143.1
									6361044

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240

village
Spacing : 1.5 m x 1.5 m

forth Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 456.14

Sr.No.	Item of work	1 ha.				200/ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	Removing moss, algae and other litter around plants	20	9122.8	0	9122.8	4000	1824560	0	1824560
2	maintenance of canals	19	8666.66	0	8666.66	3800	1733332	0	1733332
3	watch and ward 1 watchman for 35 ha. For 12 months	31.2	14231.57	0	14231.57	6240	2846314	0	2846314
	total			0					6404206
	Equipment and contingencies 3 % + labour welfare 4% Total 7%								448294.4
	Total								6852500

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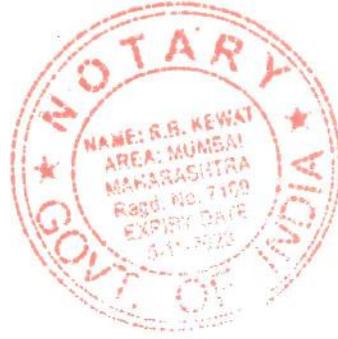
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Village
Spacing : 1.5 m x 1.5 m

Fifth Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 501.76

Sr.No.	Item of work	1 ha.				200 ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	Removing moss, algae and other litter around plants	20	10035.2	0	10035.2	4000	2007040	0	2007040
2	Watch and ward 1 watchman for 35ha. For 12months	31.2	15654.91	0	15654.91	6240	3130982	0	3130982
	total			0					
	Equipment and contingencies 3%+labour welfare 4% Total 7%								5138022
	Total								359661.6
									5497684

44



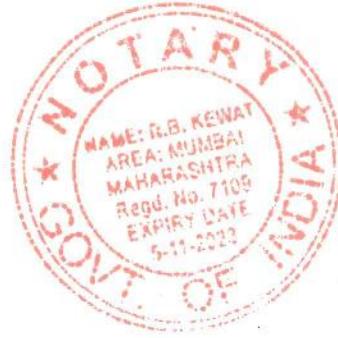
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village
Spacing : 1.5 m x 1.5 m

Sixth Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 551.93

Sr.No.	Item of work	1 ha.				200 ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	Removing moss, algae and other litter around plants	20	11038.6	0	11038.6	4000	2207720	0	2207720
2	Watch and ward 1 watchman for 35 ha. For 12months	31.2	17220.22	0	17220.22	6240	3444043	0	3444043
	total			0					5651763
	Equipment and contingencies 3%+labour welfare 4% Total 7%								395623.4
	Total								6047387

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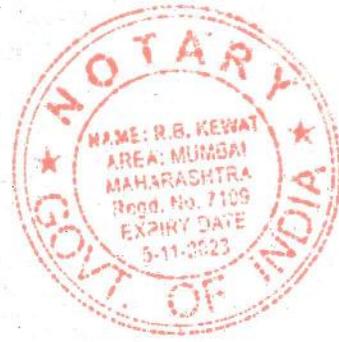
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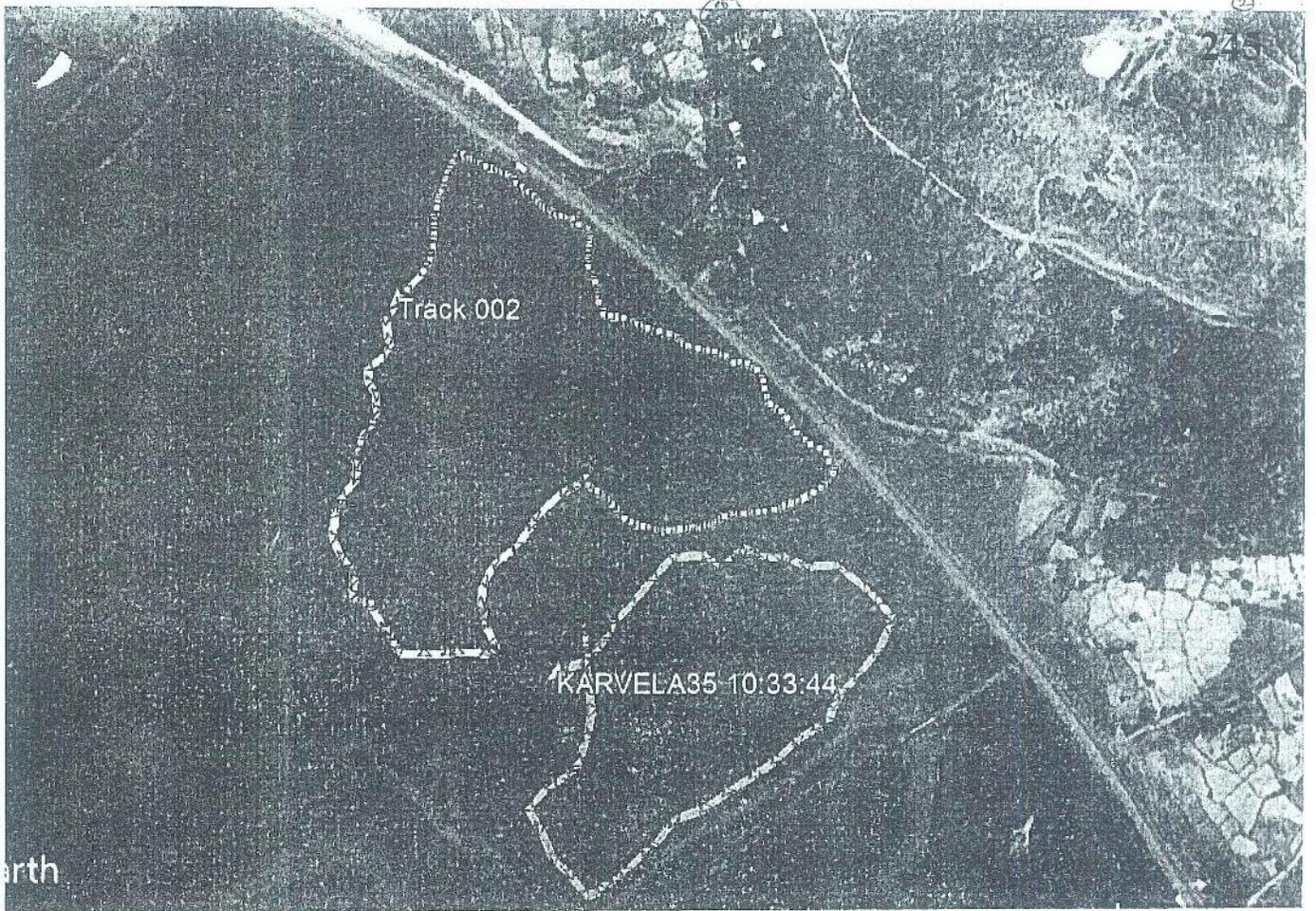
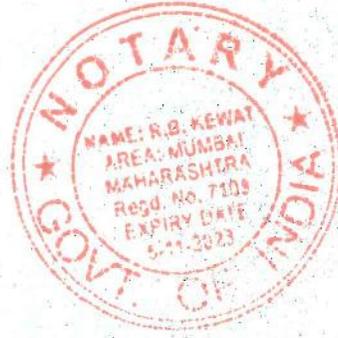
Seventh Year Operations
Estimate of Mangrove Plantation
Daily Wages rates - 607.13

Sr.No.	Item of work	1 ha.				200 ha			
		mandys	wages	m/s	Total	mandys	wages	m/s	Total
1	Removing moss, algae and other litter around plants	20	12142.6	0	12142.6	4000	2428520	0	2428520
2	Watch and ward 1 watchman for 35 ha. For 12 months	31.2	18942.46	0	18942.46	6240	3788491	0	3788491
	total			0					6217011
	Equipment and contingencies 3%+labour welfare 4% Total 7%								435190.8
	Total								6652202

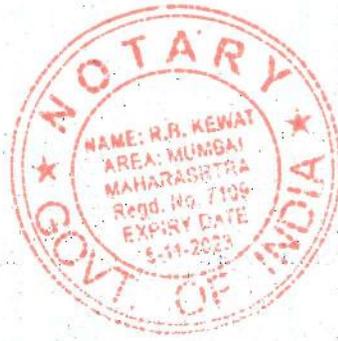
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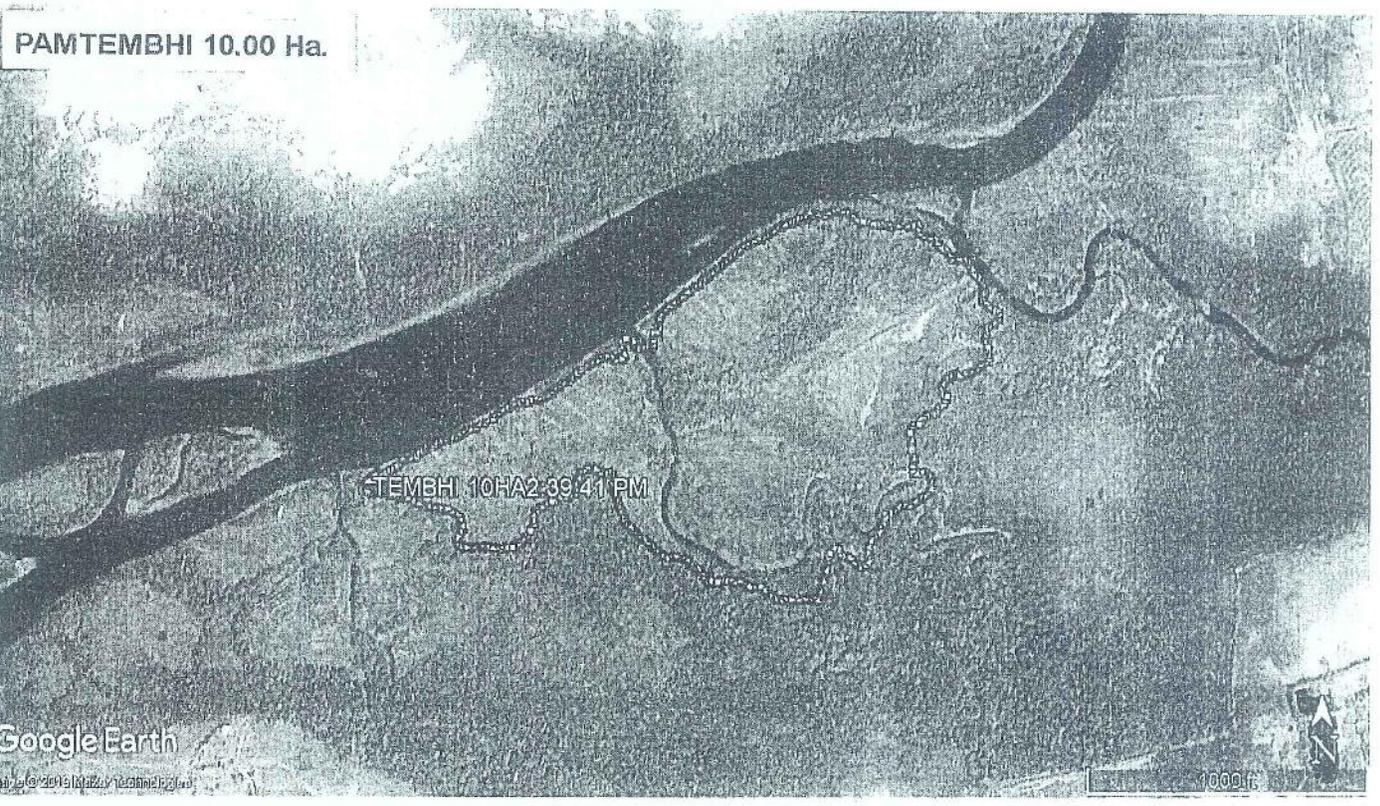


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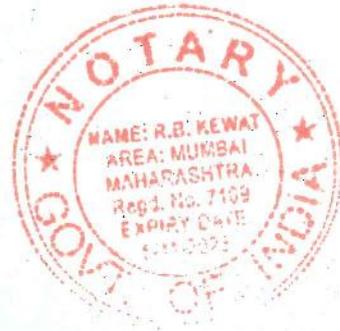


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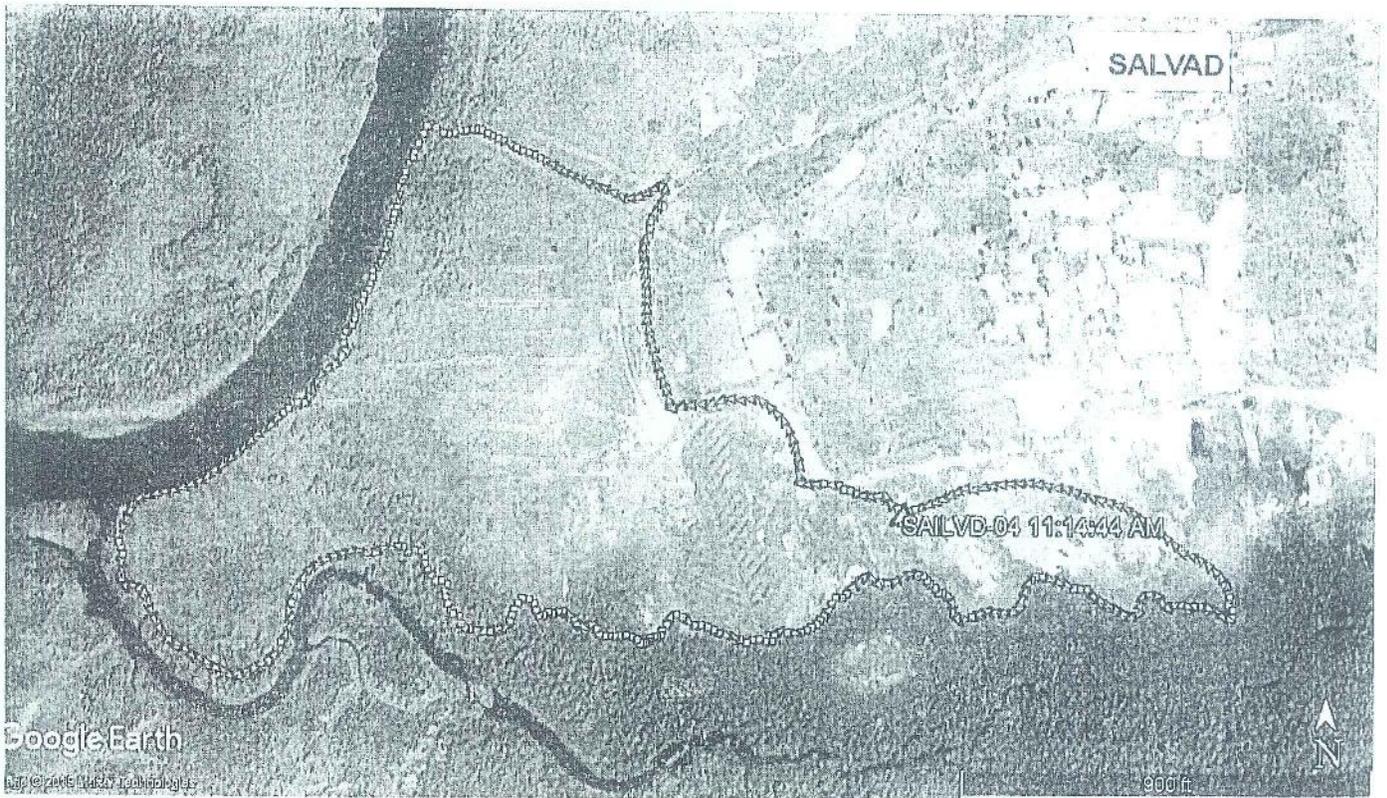


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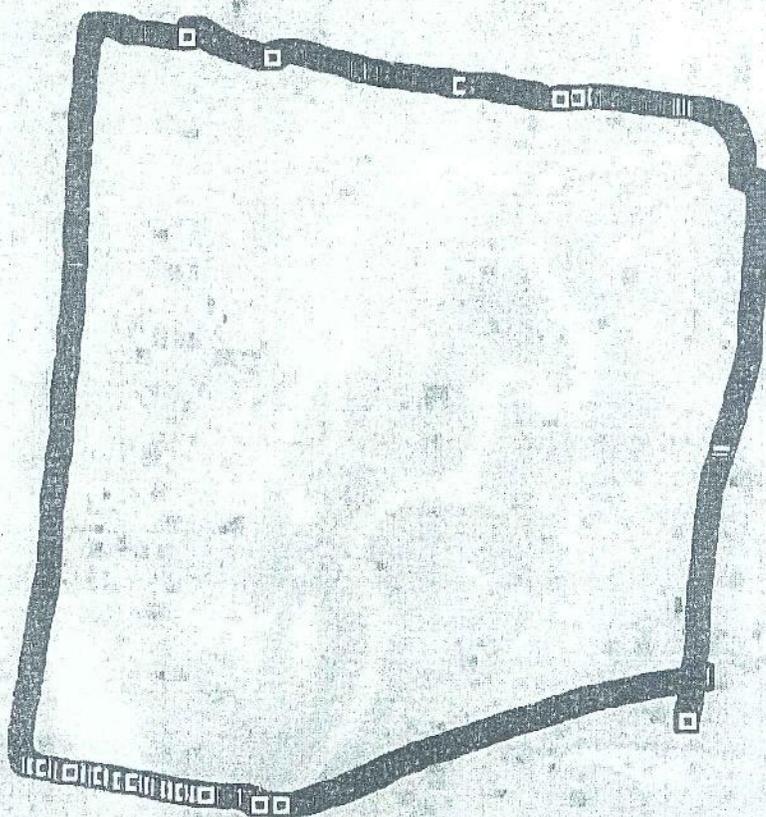
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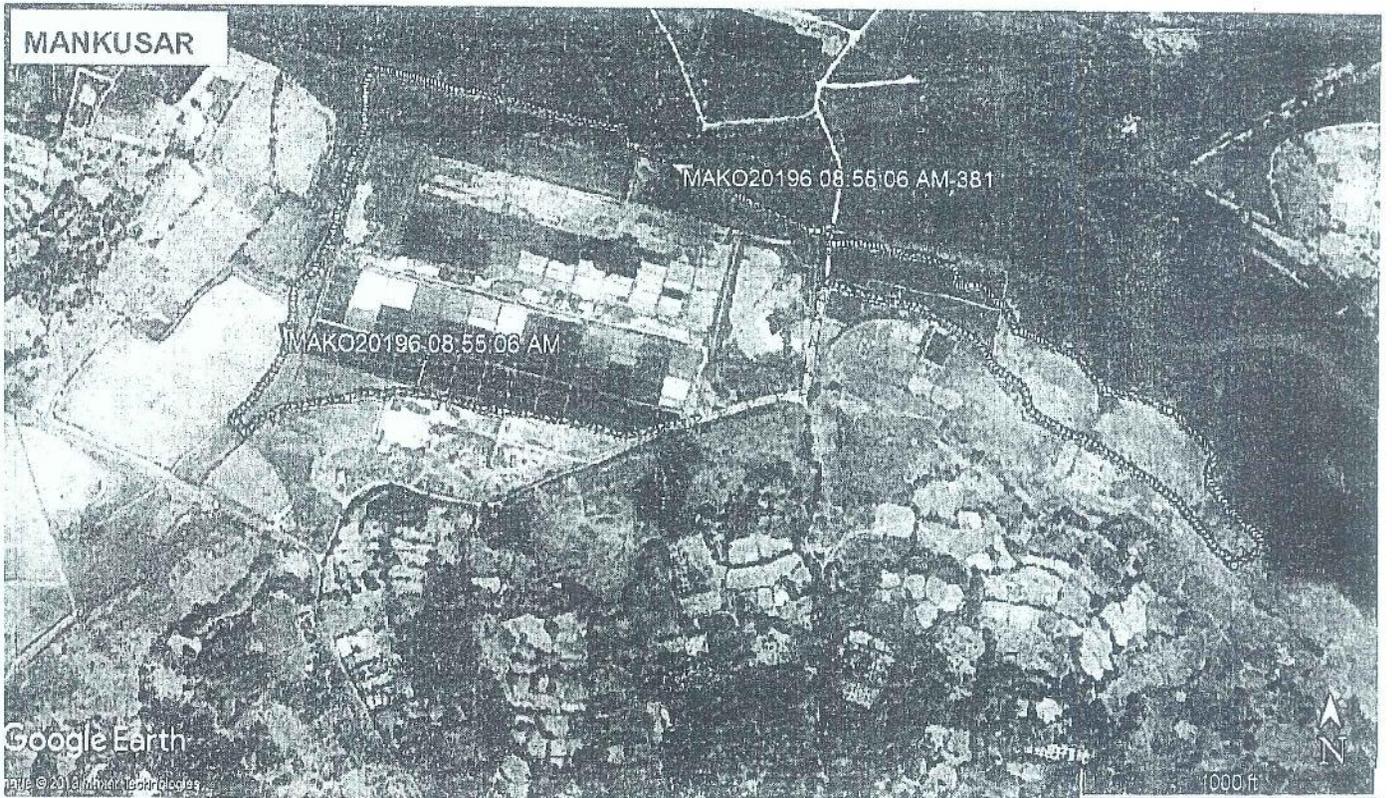


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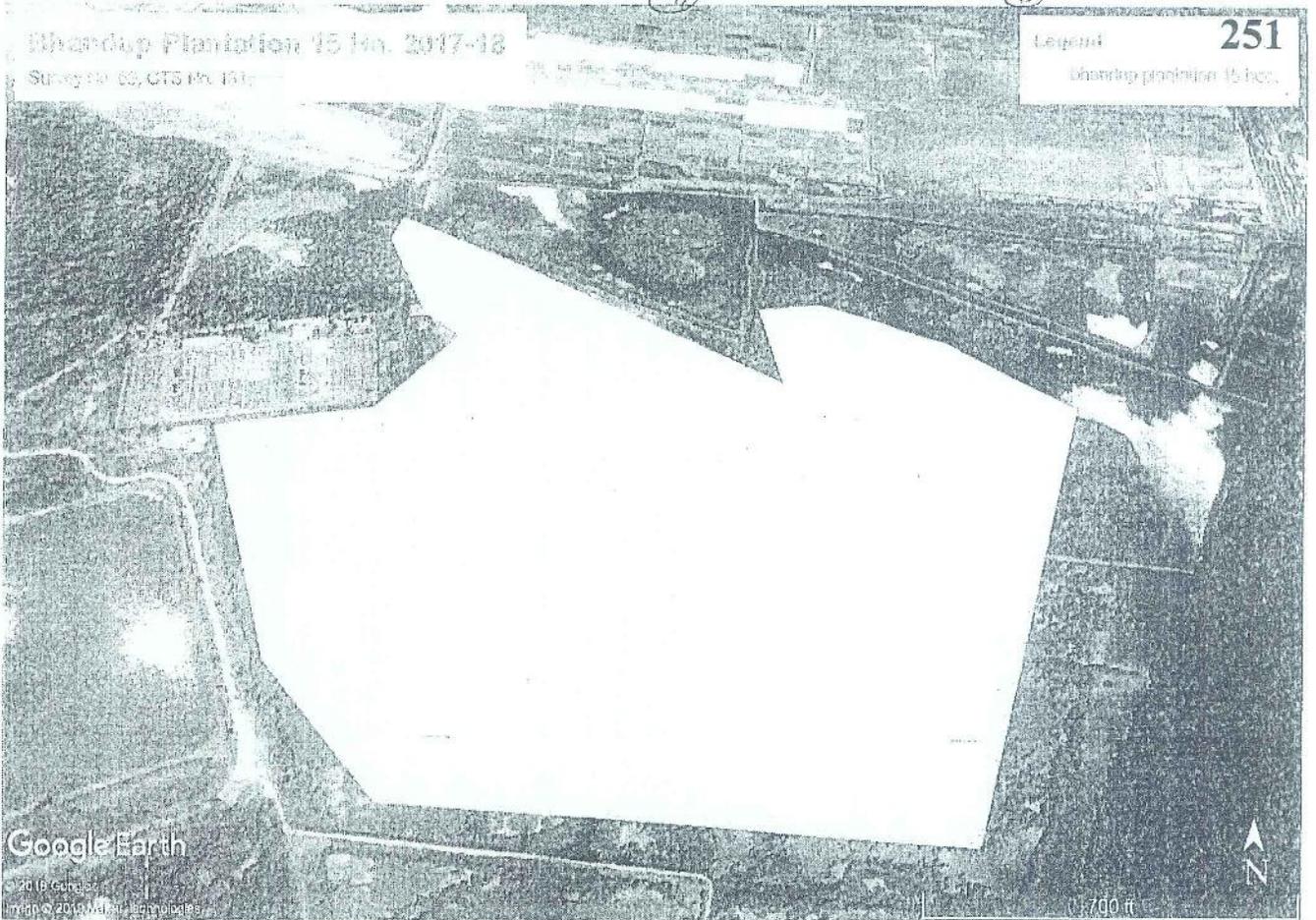
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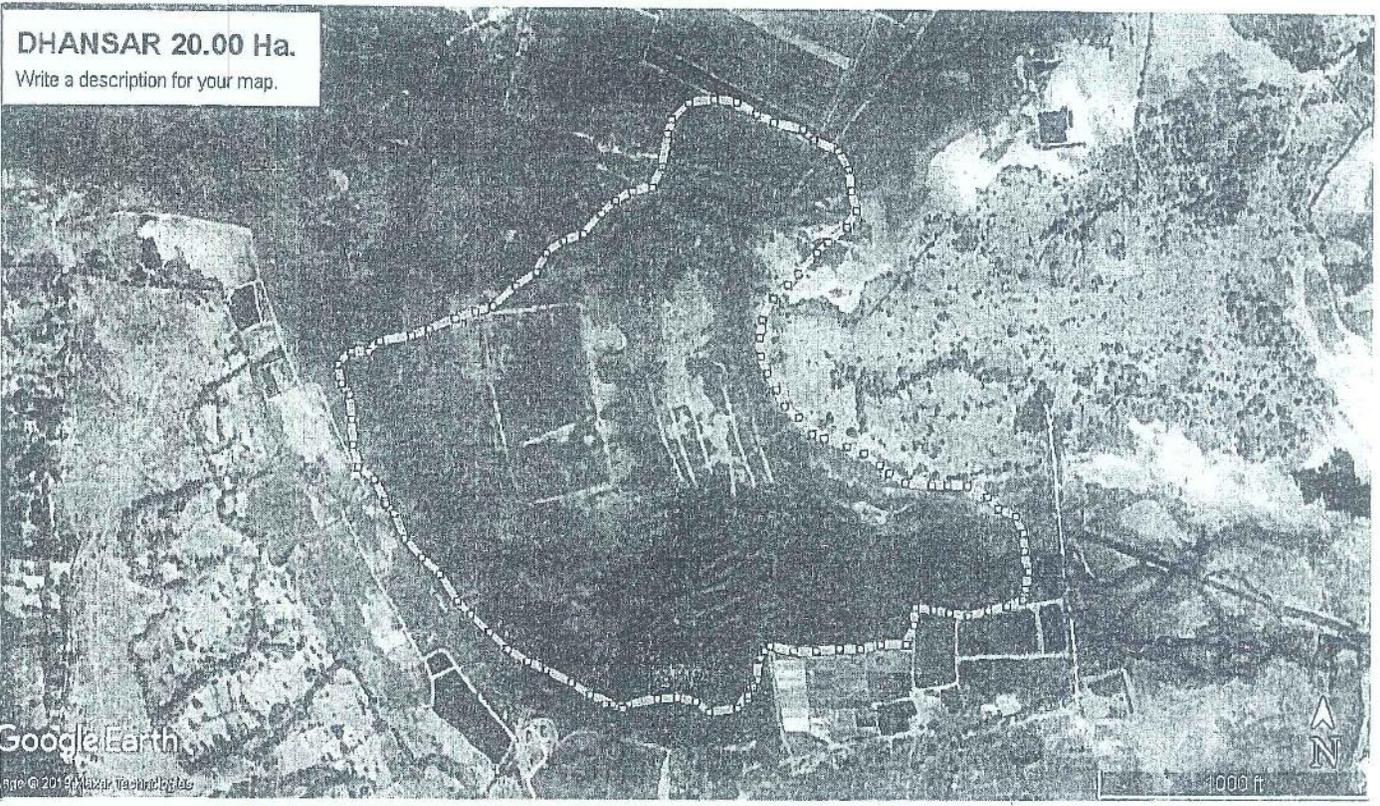


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9-8 20.00 252

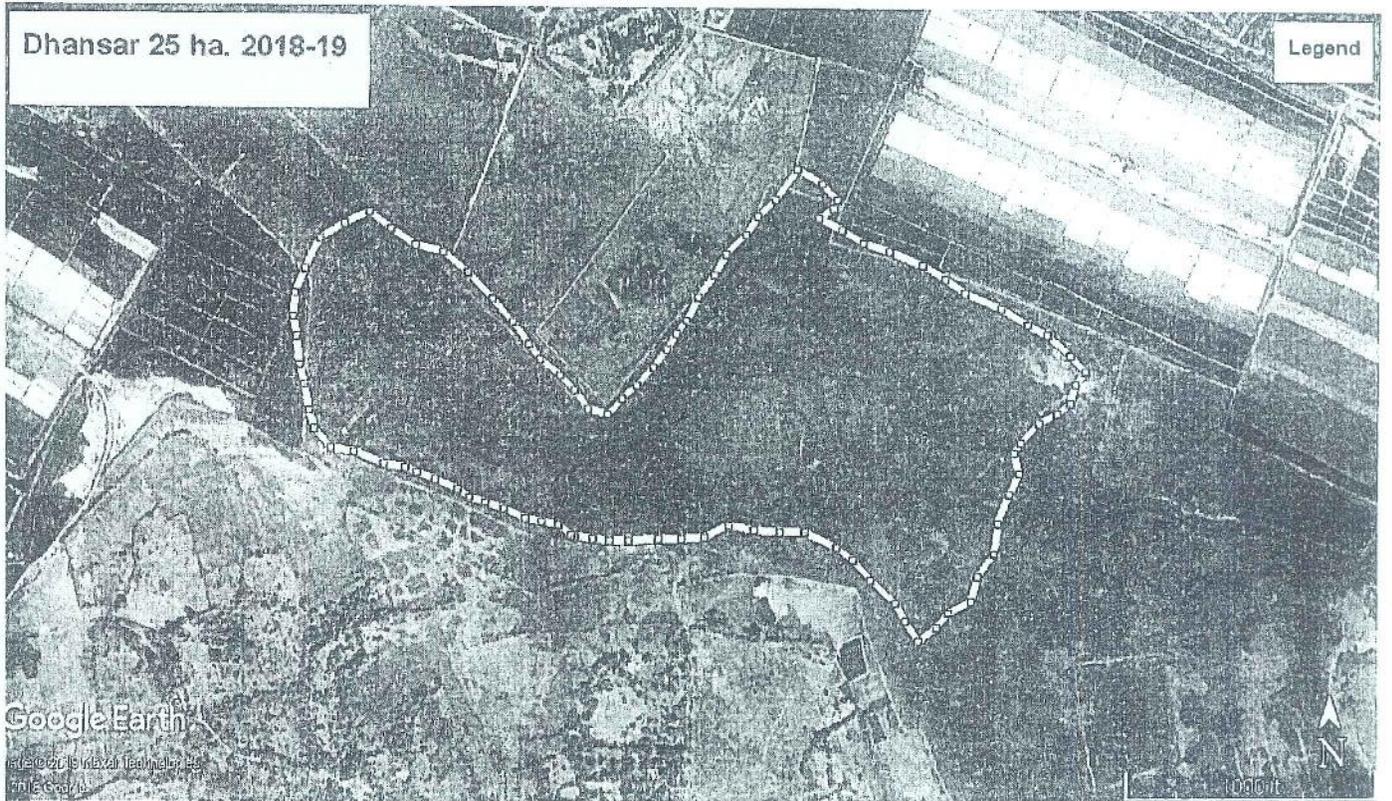


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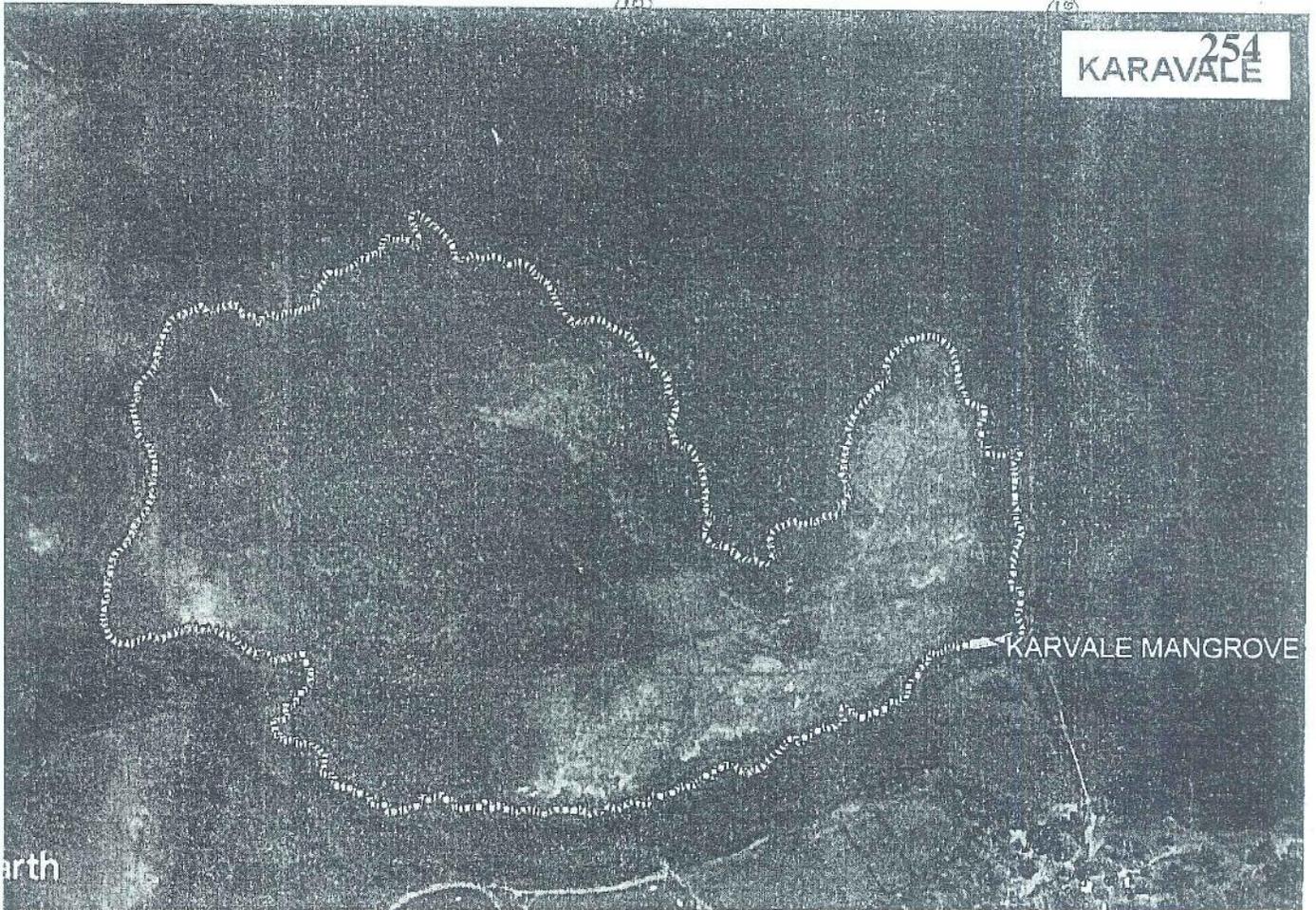
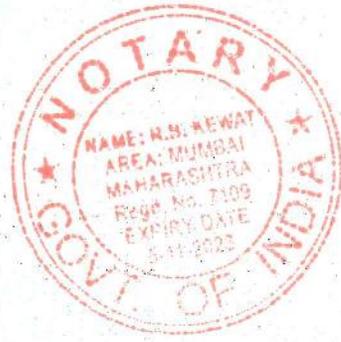


9-B - 2500 Ha

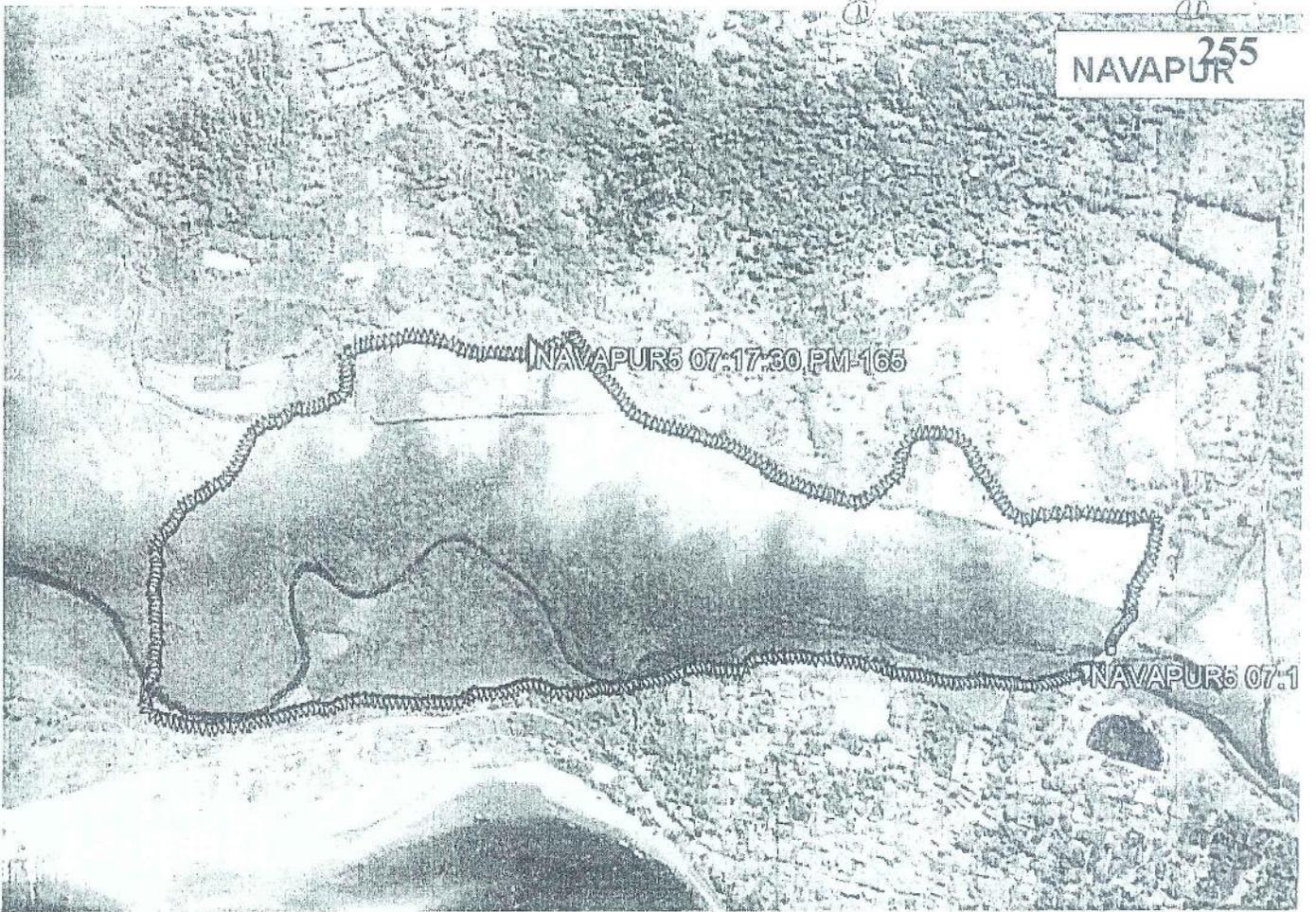
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EXHIBIT O



MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY मुंबई महानगर प्रदेश विकास प्राधिकरण

623/115
127/15
258
7/9

No. ED/MTHL/EMP/STP/Pollution study consultancy/Status/16

Engineering Division
Date: 26.12.2016

To,
Dr. Anil Dikshit
Professor
Center for Environmental Science & Engineering,
Indian Institute of Technology Bombay,
Powai Mumbai - 100076
Email: dikshit@iitb.ac.in

Sub: Conducting Mahul creek pollution level study from IIT Mumbai for preparing proposal of setting out Effluent Treatment Plants as recommended in Mumbai Trans Harbour Link Project
- Request for reporting on progress of assignment

Ref: 1) MMRDA's LOA to IIT Mumbai issued vide T.O. letter dated 20.10.2016

Sir,

Your proposal regarding consultancy assignment vide letter dated 30.08.2016 along with Technical Proposal and cost estimate of Rs. 4.98 Crores (Plus ST as applicable) for subject work is accepted by MMRDA.

MMRDA has issued a Letter of Award (LOA) on 20.10.2016 with terms and conditions stipulated therein. MMRDA has also deposited 50% of total fees on 11.11.2016 amounting Rs. Rs. 2.49 Crore plus 15% service tax.

One of the conditions is of the phase-wise time schedule for submission of deliverables shall be communicated to this office pursuant to your proposal. Your phase-wise time schedule is still awaited.

You are requested to forward phase-wise time schedule and report on progress of assignment.

Yours faithfully,

(M. H. Paranjape)
Executive Engineer, MMRDA.



259



बैंक ऑफ महाराष्ट्र
Bank of Maharashtra

बंदरा (पूर्व) - 400 051
Bandra (East), Mumbai - 400 051.
IFSC - MAH0000164

BND

CBS

दिनांक
Date

1 1 1 1 2 0
D D M M

Pay: Registrar, IT Bombay, P & C A/c

या धारक को 0

रुपये Rupees 100 crore eighty six lakh thirty five
Thousand Only.

अक्ष करे। ₹ 2,86,35,000/-

ब्रांच
A/c No. 60259778998

ADU

[Signature]

[Signature]

Please sign above this line

⑈579288⑈ 400014043⑈

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EXHIBIT P

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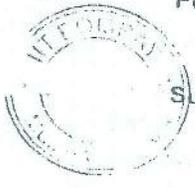
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
मुंबई महानगर प्रदेश विकास प्राधिकरण

No ED/MTHL/EMP/Mahul Creek/Consultancy/Balance payment/17

Engineering Division
Date: 06.09.2017

7/9/17

To:
The Registrar,
IIT Bombay P&C a/c
Powai Mumbai - 100076



Sub: Mumbai Trans Harbour Link project
Conducting Mahul creek pollution level study from IIT Mumbai for preparing proposal of Effluent Treatment Plants as recommended by State Board of Wildlife (Maharashtra)

- Ref:
- 1) Your proposal to MMRDA regarding consultancy assignment vide letter dated 30.08.2016 along with Technical Proposal and cost estimate
 - 2) MMRDA's Letter of Award to IIT Mumbai issued vide letter dated 20.10.2016.
 - 3) Payment of Initial 50% Consultancy fees vide T.O. letter dated 11.11.2016
 - 4) Demand from IIT Mumbai from for releasing balance 50% payment as per TOR vide email dated 05.07.2017

Sir,
As per conditions of Consultancy assignment mutually agreed between IIT Mumbai and MMRDA, please find balance 50% of payment for assignment vide MMRDA's Cheque No. 427759 dated 28.08.2017 amounting Rs. 2,93,82,000/- (inclusive of 18% GST) drawn from Bank of Maharashtra payable at Mumbai. Please send acknowledgement of receipt to MMRDA for accounting purpose.

It is requested to complete the Consultancy assignment as per agreed terms and conditions immediately.

Yours faithfully,

Encl: Cheque No. 427759 (Original)

M. H. Paranjape
(M. H. Paranjape)

Executive Engineer, MMRDA.

Copy for information to:
Dr. Anil Dikshit, Professor
Center for Environmental Science & Engineering, Indian Institute of Technology Bombay, Powai
Mumbai - 100076 Email: dikshit@iitb.ac.in

Copy to:
CE (T)
AMC (K)

7/9/17

MS

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बान्द्रा (पूर्व), मुंबई - 400 051
 BANDRA (EAST), MUMBAI - 400 051.
 IFSC MAHB0000164

JAD
 BND

Valid For Three Months From The Date Of Issue

2	9	0	9	2	0	1	7
D	D	M	M	Y	Y	Y	Y

A/c Payee Only
 Not Negotiable

Pay अदा करें **REGISTRAR, IIT BOMBAY, P&C A/C**

Or Order

Rupees रुपये **Two Crore Ninety Three Lakh Eighty Two Thousand Only**

या उनके आदेशपर

अदा करें।

₹ 2,93,82,000.00

खाता सं. A/c. No.	60259778998	CBS
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For M M R D FUND

PAYABLE AT PAR AT ALL BRANCHES

Authorized Signatory

Please Sign above

Authorized Signatory

⑈427759⑈ 400014043⑈

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EXHIBIT Q

262



Mangrove and Marine Biodiversity Conservation Foundation of Maharashtra

(An Autonomous Body under Revenue & Forests Department, Government of Maharashtra)
302, 3rd Floor, Wakefield House, Above Britannia & Co. Restaurant, Ballard Estate, Fort, Mumbai - 400001
Phone: 022 - 22694984 / 22694985, email id : ad.finance.mfn@gmail.com / mangrovefn@gmail.com

MFN/Finance/105/2020-21

Date: 11-09-2020

To,
Executive Engineer,
Mumbai Metropolitan Region Development Authority
Bandra Kurla Complex, Bandra (E)
Mumbai - 400051

Subject: Mumbai Trans Harbour Link (MTHL) Project - Details of Mangrove & Marine Biodiversity Conservation Plan, Nature Interpretation Centre and Corpus Fund referred in MTHL Project

Reference: Letter from your office - Letter No. ED/MTHL/CCF Mangroves/Master Conservation Plan/Status/20 PIU-MTHL dated 07-09-2020

Sir,

With reference to above letter following is the information on implementation of Master Plan by Mangrove Foundation:

Sr. No.	Particulars	Estimated Cost in Crore
1.	Creeklet drainage arrangement	INR 1.00
2.	Mangrove Research & Training Centre	INR 16.75
3.	Generation of Knowledge Base Study of the pressure on Mangrove Eco System in MMR	INR 1.00
4.	Mangrove Sanctuary	INR 4.60
5.	Mangrove & Marine Eco System Interpretation Centre	INR 10.0
6.	Mangrove Protection Framework	INR 22.96
7.	High Resolution Mapping of Mangrove Forests in MMR	INR 2.00
8.	Mangrove Conservation/Removal of Stressors	INR 3.00
9.	Corpus Fund to Mangrove Foundation	INR 25.00
	Total	INR 86.31 Crore

VPT (Signature)
Executive Director 11/9
Mangrove and Marine Biodiversity
Conservation Foundation of Maharashtra

WJ



MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

मुंबई महानगर प्रदेश विकास प्राधिकरण

No. ED/MTHL/CCF Mangroves/Master Conservation Plan/ Payment/ 17 Engineering Division
Date: 19.04.2017.

To
Executive Director,
Mangroves and Marine Biodiversity
Conservation Foundation of Maharashtra
C/o The Chief Conservator of Forests (Mangroves),
A-Wing, 2nd Floor, SRA Building,
Anant Kanekar Marg, Bandra (E),
Mumbai -400051.

Sub: Mumbai Trans Harbour link (MTHL) project

- Payment to Mangroves and Marine Biodiversity Conservation Foundation of Maharashtra for implementation of Mangrove & Marine Biodiversity Conservation Plan, Nature interpretation Centre and Corpus Fund.

- Ref:**
- 1) MoEF's Stage-I approval to diversion of forest for MTHL project dated 22.01.2016.
 - 2) MoEF's CRZ clearance to MTHL project dated 25.01.2016.
 - 3) MMRDA's letters to CCF (Mangroves) dated 15.02.2016, 21/07/2016, 22.03.2017
 - 5) Letter from CCF (Mangrove Cell) dated 19.01.2017 along with Mangroves and Marine Biodiversity Conservation Plan for MTHL (enclosed separate 2 booklets)
 - 6) Your reply to MMRDA dated 12.04.2017

Sir,

You are aware that, MoEF has awarded CRZ clearance and In-Principle Forest Clearance to MTHL project subject to fulfilling the terms and conditions stated therein.

2. Accordingly, MMRDA had requested you to prepare proposal for Mangrove & Marine Biodiversity Conservation Plan, Nature interpretation Centre and Corpus Fund and raise demand to MMRDA for funds.

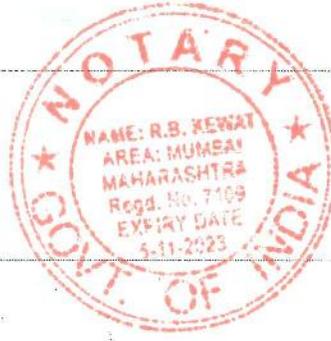
3. In response, you have submitted the Mangroves and Marine Biodiversity Conservation Plan, and raised the demand for funds as follows.

Sr No	Component	Cost	Reference in MTHL project.
i)	Mangrove Conservation Plan	Rs. 41.31 Cr	Stage-I Forest Clearance - Condition no. (xii)
ii)	Marine Biodiversity Plan	Rs. 10.05 Cr	Stage-I Forest Clearance Condition no. (xii)
iii)	Contribution to Corpus Fund of mangroves and Marine Biodiversity Conservation Foundation	Rs. 25.00 Cr	CRZ clearance by MoEF - Condition no. 8 in the EMP
iv)	Marine Interpretation Center at Airoli	Rs. 10.00 Cr	CRZ clearance by MoEF - Condition no. 11 in the EMP
	Total	Rs. 86.31 Cr	

Bandra - Kurla Complex, Bandra (East), Mumbai - 400 051.

EPABX : 2659 0001 - 04 / 2659 4000 • FAX : 2659 1264 • WEB SITE : <https://mmrda.maharashtra.gov.in>

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4. In view of above, please find enclosed payment by cheque no. 218534 dated 18.04.2017 for an amount of Rs. 86,31,00,000/- drawn from Bank of Maharashtra. You are requested to acknowledge the receipt of the same.
5. Also, in view to fulfill auditory requirements, you are requested to submit;
- Quarterly progress report
 - Quarterly Utilization Certificate on use of funds.

Yours Faithfully,

(Signature)
(M. H. Paranjape)
Executive Engineer

Encl: Cheque no. 218534 dated 18.04.2017 (in Original)

Copy for information to:

CE (T)

(Signature)
लिपीक
मुख्य वनसंरक्षक (मॅगरोव्ज)
कांदळ्यन कक्ष, मुंबई.

Cheque received.

(Signature)

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GULSHAN-MUMBAI SANDRA EAST

EXECUTIVE DIRECTOR MANGROVESAMRITHA

BIODIVERSITY CONSERVATION CORPORATION OF MAHARASHTRA

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EXHIBIT R



MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
मुंबई महानगर प्रदेश विकास प्राधिकरण

No. ED/MTHL/BNHS Assignment/Funds/Payment/17

Engineering Division

Date: 25/09/2017

To,
The Executive Director,
Mangroves and Marine Biodiversity Conservation Foundation Mumbai
C/o The Additional Principal Chief Conservator of Forests (Mangrove Cell),
A-Wing, 2nd Floor, SRA Building,
Anant Kanekar Marg, Bandra (E),
Mumbai -400051

Sub: Implementation of Flamingos & Birds related mitigation measures and birds' monitoring program for the Mumbai Trans Harbour Link (MTHL) project.

- Ref: 1. MMRDA's Letter of Award to BNHS dated 15.05.2017.
2. Modified instructions from CCF Thane Working Permission dated 28.06.2017.
3. MMRDA's letters to Mangrove Foundation dated 06.07.2017 and 04.08.2017.
4. Your reply dated 12.09.2017

Sir,

The Ministry of Environment and Forest (MoEF), on 22.01.2016, has awarded in-principle clearance for diversion of forest land to non-forest use for the Mumbai Trans Harbour Link (MTHL) project subject to fulfilling the terms and conditions stated in the clearance. On fulfilling the terms and conditions the Working Permission from Forest Department is issued on 22.05.2017. According to the amendment dated 28.06.2017 in the condition related to BNHS assignment in the Working Permission, MMRDA has been directed to deposit the amount of BNHS assignment to the "Mangrove & Marine Biodiversity Foundation Mumbai". The final accepted cost (negotiated) of BNHS assignment for 10 years period is Rs. 31,92,73,240/-.

2. You have clarified MMRDA vide your letter dated 12.09.2017 to deposit the total funds in lump-sum mode.
3. Accordingly, MMRDA is depositing Rs. 31,92,73,240/- (Full amount of assignment with BNHS) vide enclosed Demand Draft No. 632710 dated 24.08.2017 drawn from Bank of Maharashtra. You are requested to acknowledge the receipt of the same.

Thanking you,

Yours Faithfully,

(M. H. Paranjape)
Executive Engineer

Encl: DD No. 632710 dated 24.08.2017
(in Original)

Bandra - Kurla Complex, Bandra (East), Mumbai - 400 051.

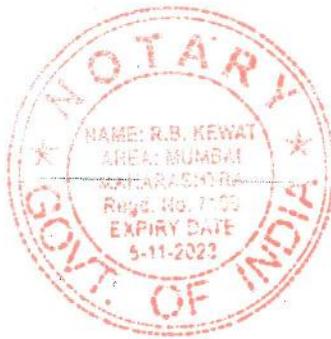
EPABX : 2659 0001 - 04 / 2659 4000 • FAX : 2659 1264 • WEB SITE : <https://mmrda.maharashtra.gov.in>



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Copy submitted for information to:

- i) **The Secretary (Forests), GoM, 4th floor, Main bldg. Mantralaya, Mumbai 400032**
Fax: 22023624
- ii) **The Additional Principle Chief Conservator of Forest & Nodal Officer Maharashtra State, Nagpur**
- iii) **The Chief Conservator of the Forests, Near Micro Wave Tower, Bara Bungalow Area, Thane (East) – 400603. ccfthane@mahaforest.com**
- iv) **The Deputy Conservator of the Forests, Near Hirakaot Talav, Alibag, (Dist. Raigad) – 402201. dycfalibag@mahaforest.gov.in**



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EXECUTIVE DIRECTOR MANGROVES SHARINE

BIODIVERSITY CONSERVATION FOUNDATION OF MAHARASHTRA

ON DEMAND PAY

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Seventy Three Thousand Two Hundred

Forty only.

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₹ 31,92,73,240.00

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EXHIBIT S

269

Monitoring and Mitigating the Impacts of
Mumbai Trans-Harbour Link on Flamingos and
Other Avifauna and Formulating a Conservation
Blueprint for the Sewri–Nhava Seascape.

October 2019 to March 2020
Update

Submitted to

Mangrove and Marine Biodiversity Conservation Foundation of Maharashtra



Bombay Natural History Society
Hornbill House
Opp. Lion Gate
Dr. Salim Ali Chowk
S. B. S. Road, Fort
Mumbai 400001

Phone – 022 22821811

Fax – 022 2222837615

Website – www.bnhs.org

Email – director@bnhs.org



Recommended Citation:

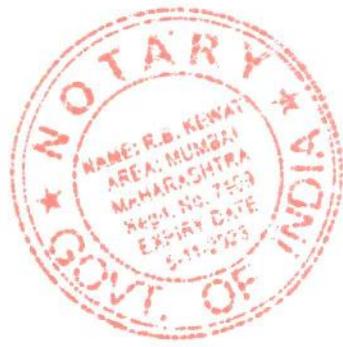
Apte, D., R. Khot, S. Bajar, M. Prabhu, R. Pitale, S. Jain, K. Chandel, R. Muni, M. Shukla, N. Chaudhary, R. Duggal, B. Desai, S. Dalvi, & S. Bhawe (2019): Monitoring and mitigating the impacts of Mumbai Trans-Harbour Link on flamingos and other avifauna and formulating a conservation blueprint for the Sewri–Nhava seascape. Half yearly report (October 2019 to March 2020). Submitted to Mangrove and Marine Biodiversity Conservation Foundation of Maharashtra, pp. 1-56.

Acknowledgement

We are thankful to PCCF Maharashtra Forest Department, for providing bird ringing and flagging permissions, Shri. N Vasudevan (IFS) and Shri. Virendra Tiwari (IFS) APCCF and Director Mangrove and Marine Biodiversity Conservation Foundation of Maharashtra and his team, MD and Executive Engineer of MMRDA, Commissioner of Police, Mumbai and Navi Mumbai for their respective permissions and cooperation to execute the project. We would like to extend our thanks to following BNHS staff Mr. Vishwas Shinde, Mr. Rajendra Pawar, Mr. Vikas Pisal, Mr. Ashok Pisal, Mr. Akash Patil, Mr. Vithoba Hegde, Mr Shyam Jadhav, Administration and Account department BNHS for their constant support and assistance during the field work and day to day functioning of the project work

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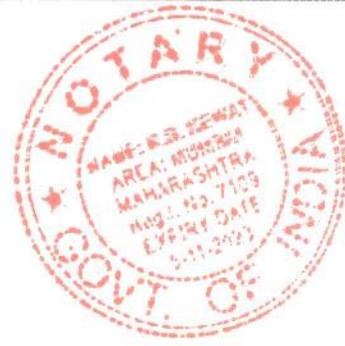
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Disclaimer

The observations represented in this report are based on study duration mentioned in the report. The observations may change or vary depending upon on further surveys.

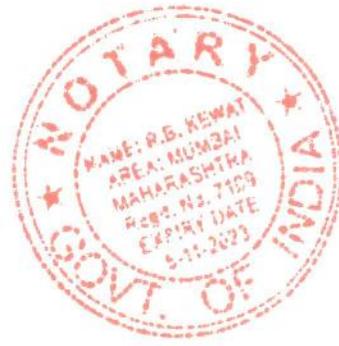
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Summary

During October 2019 to March 2020, the abundance and distribution of flamingos and other avifauna were estimated by conducting various population monitoring surveys at different wintering sites. Additionally, the behavioral surveys carried out at different high-tide roosting and low-tide feeding sites shed some light on the behavioral response of shorebirds especially towards disturbances at the construction sites. Simultaneously, bird ringing sessions were also carried out at different roosting sites to understand avifaunal migratory patterns. We also collected and analyzed macrobenthos and plankton samples from the study area.



1. Methodology

1.1 Study site

This study was carried out in four inland wetland sites (high tide roosting sites) that includes Training Ship Chanakya (TSC), Bhandup Pumping Station (BPS), Non-Residential Indian (NRI) complex and Belpada mangrove and three mudflat sites (low tide feeding sites) - Thane Creek, mudflats of Sewri and Nhava-Sheva.

2. Bird sampling

2.1 Bird counts

The total count method was used for sampling birds (Bibby et al., 1998) and adopted different sampling strategies for wetlands, creek and flamingos, viz., wetland count surveys (WCS), transect count surveys (TCS) and flamingo count surveys (FCS).

WETLAND COUNT SURVEYS (WCS): Surveys were conducted simultaneously in all four wetlands during the high tide timings when shorebirds inhabit the inland wetlands for their roosting purpose. The total number of birds observed was counted an hour before and after the high tide. The count was taken for three consecutive days and an average estimation of the total population was calculated.

TRANSECT COUNT SURVEYS (TCS): In TCS, all the species of birds observed in the creek were recorded and their population was estimated. before the commencement of the census, almost the whole of the Thane Creek was divided into 40 transects that differed by a distance of 1 Km. These transects were allotted to a team of researchers, who surveyed it on hand rowed boats. Whereas, ground surveys were carried out at Sewri and Nhava-Sheva jetties. Observer counted and estimated the bird population using Nikon binoculars. Low tide timings were preferred for these counts when the birds feed on the exposed mudflats.

FLAMINGO COUNT SURVEYS (FCS): The census was carried out on three consecutive days in a month to know the abundance of Lesser Flamingo (*Phoeniconaias minor*) and Greater Flamingo (*Phoenicopterus roseus*) by conducting boat surveys at Thane Creek and ground surveys at Sewri and Nhava-

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Sheva jetties during low tide. The eastern and western banks of the Creek were divided into 40 transects. Before the census, the Creek was divided into eight stations (each having respective transect IDs): 1. Airoli to Vitava (East), 2. Airoli to Vitava (West), 3. Ghansoli to Airoli (East), 4. Ghansoli to Airoli (West), 5. Ghansoli to Vashi (East), 6. Ghansoli to Vashi (West), 7. Vashi to NRI (East), 8. Vashi to Trombay (West).

The simultaneous counts were taken by direct observations using binoculars by multiple teams of researchers and assistants in hand rowed boats. Observer from each team independently counted and estimated the numbers of birds using blocks of 100, 500, 1000, etc. according to the size of the flock (Bibby, et al. 1998).

2.2 Bird Behavior

To study the behavioral ecology of shorebirds, particularly in response to disturbances, the study sites were divided into 3 categories - Roosting, Feeding, and Construction. Roosting sites include four inland wetlands (high tide dependent) - Training Ship Chanakya (TSC), Bhandup pumping station (BPS), Non-Residential Indian (NRI) complex and Belpada mangrove. Thane Creek is considered a feeding site as it provides a huge area of exposed mudflats that are rich in cyanobacteria and marine benthic fauna during low tide. Sewri and Nhava-Sheva are the construction sites where behavioral surveys were conducted to study bird response to construction activities happening due to Nhava- Sheva sea link construction.

The target species for behavioral observations were decided beforehand based on their abundance within the study sites. These species have been utilizing these sites as their wintering grounds for many years. The species are as follows;

1. Black-tailed Godwit (*Limosa limosa*)
2. Common Greenshank (*Tringa nebularia*)
3. Common Redshank (*Tringa totanus*)
4. Curlew Sandpiper (*Calidris ferruginea*)
5. Lesser Sandplover (*Charadrius mongolus*)
6. Little Stint (*Calidris minuta*)

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7. Eurasian Curlew (*Numenius arquata*)
8. Whimbrel (*Numenius phaeopus*)
9. Greater Flamingo (*Phoenicopterus roseus*)
10. Lesser Flamingo (*Phoeniconaias minor*)
11. Pied Avocet (*Recurvirostra avosetta*)

We have classified the behaviour into 11 major categories (Bensaci *et al.*, 2015; Eduardo, G., & G. A. Baldassarre, 1997; Felicity, A., & Baldassarre, G. A., 1995; Kumssa, T., & A. Bekele, 2014) viz. Feeding, Movement, Maintenance, Resting, Vigilance, Aggression, Defecation, Flying out, Alert, Courtship, and Standing.

As the behavioral study is aimed to understand the response of target species towards disturbances, the disturbance sources have also been grouped into human disturbances, avian predators, other animals, and vehicle categories. Human disturbances include bird watchers, fishermen, construction activities, etc. Avian predators include Black Kite (*Milvus migrans*), Osprey (*Pandion haliaetus*), etc. Vehicular disturbances include aircraft, trains, boats, traffic noise, etc. Other animals include dogs, cattle, etc. Noticeably, most of these disturbances are occurring at the roosting, feeding, and construction sites continuously. Hence, it needs to be monitored for further implementation for the conservation of migratory species.

Following covariates were also noted while behavioural video recording:

- Total duration of disturbance
- Distance between the disturbance source and focal bird
- Distance between the focal bird and observer
- Flock size and composition

We adopted Focal Animal Sampling (Altmann, 1973) for understanding the behavioral ecology of shorebirds. Focal individuals were selected arbitrarily and videotaped for 1 minute. As far as possible, different focal birds were selected for subsequent observations. In cases where a few individuals of a species were present,

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there was a 5 minutes interval between two observations of the same individual. Each observation was treated as independent during transcribing.

The observations were carried out at least one hour before high tide at roosting sites while one hour before low tide at feeding and construction sites. Videos were also recorded if the birds were present even after the high or low tides within the study area.

Videos were transcribed using BORIS v.7.5.3. (Friard & Gamba 2016). An ethogram was created for the behavior of birds in BORIS to assess the time spent by individuals in each activity. We took behaviors or events of short duration, such as defecation and flying out, as point events in the ethogram. Other long-duration behaviors were considered as state events. A state event for no observation was also created in the ethogram which was used when the focal individual was out of the frame. Videos having more than 10 seconds of no observation were discarded during transcribing.

2.3 Bird ringing

Bird ringing was conducted between November 2019 and March 2020 at high tide roosting sites viz., TSC Wetland, NRI wetland, and saltpans around BPS. We used 3-4 wader nets (size 11.5 cm; dimensions 2m × 100m) for capturing birds for ringing. Three to four nets were deployed considering water depth, wind direction, and movement of the waders. Birds were extracted from the nets by experienced trappers and then ringed by experienced ringers to minimise stress and injury to birds. We followed the Indian Bird Banding Manual (Balachandran. S., 2002) for ringing and recording morphology and morphometry of the waders.

In this entire period, from October to March, we could not conduct some of the surveys due to the rain, rough sea condition, and COVID 19 pandemic (Table 1)



Table 1 Summary of surveys conducted in six consecutive months

Surveys	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020
Wetland count Survey	3 (Dates; 08, 09, 10)	3 (Dates; 07, 09, 10)	3 (Dates; 07, 08, 09)	3 (Dates; 07, 08, 09)	3 (Dates; 09, 10, 11)	NA
Transect count survey	1 (Dates; 05, 06)	1 (Dates; 02, 03, 04, 05, 06, 09, 10)	1 (Dates; 10, 11, 17, 18, 19, 20, 21)	1 (Dates; 14, 15, 16, 17, 18, 19, 20)	1 (Dates; 12, 13, 14, 15, 16, 17, 18)	1 (Dates; 12, 13, 14, 15, 16)
Flamingo census	1 (Date; 03)	NA	3 (Dates; 02, 03, 04)	3 (Dates; 02, 03, 04)	3 (Dates; 04, 05, 06)	3 (Dates; 03, 04, 05)
Behavioural survey	14 (Dates; 02, 04, 07, 10, 11, 14, 15, 16, 17, 18, 23, 24, 25, 31)	6 (Dates; 01, 07, 09, 10, 12, 26)	8 (Dates; 07, 08, 09, 10, 13, 28, 29, 30)	13 (Dates; 03, 04, 08, 09, 20, 28, 29, 30, 31)	11 (Dates; 02, 03, 17, 18, 19, 20, 25, 26, 27, 28)	6 (Dates; 03, 04, 07, 09)
Ringling sessions	NA	8 (Dates; 03, 06, 07, 08, 09, 10, 11, 12)	9 (Dates; 08, 09, 10, 11, 12, 13, 26, 27, 28)	10 (Dates; 10, 11, 12, 13, 20, 21, 22, 23, 24, 25)	15 (Dates; 3, 4, 5, 6, 7, 8, 10, 18, 19, 20, 21, 22, 23, 24, 25)	5 (Dates; 6, 7, 8, 11, 13)

3. Observations

3.1 Wetland count survey (WCS)

The total number of species recorded from the inland wetlands was 74; 46 migratory (including 27 wader species) and 28 non-migratory species. The observations revealed a gradual increase in avifaunal species richness and abundance throughout the six months. The maximum population was recorded 30188 individuals (of 50 species) in February 2020 and the minimum was recorded 2454 individuals (of 46 species) in November 2019 (Table 2).



Table 2 Species richness and maximum population recorded in all inland wetlands

	Oct, 19	Nov, 19	Dec, 19	Jan, 20	Feb, 20
Total species richness	40	46	49	50	50
Total migratory species richness	26	29	30	31	31
Total resident species richness	14	17	19	19	19
Total no. of individuals	26057	2454	4736	13013	30188
Total no. of migratory individuals	25674	2145	4236	12387	29393

The species richness of migratory birds has increased from October 2019 to February 2020 with the highest of 31 species in February. It was observed that the diversity of migrants has shown a distinct pattern in different inland wetlands. In BPS, the species richness increased and decreased for alternate months with an average of at least 28 species. There was a sharp decline in the population at BPS between October and November 2019. Afterward, it increased gradually till February 2020. A gradual increase in the species richness was observed at NRI from October 2019 to February 2020 with the highest species richness (31) recorded in February 2020. From November 2019 to January 2020 the species richness and the population visiting TSC increased and then the numbers dropped from February 2020. In Belpada, it increased from October-November, 2019, and remained more or less the same till January 2020. Later, a drop in species richness was noticed in February 2020 (Table 3 & 4).



Table 3 Species richness recorded in five consecutive months at different inland wetlands

	BPS	NRI	TSC	Belpada
Oct 2019	26	22	23	21
Nov 2019	25	25	30	25
Dec 2019	31	28	29	25
Jan 2020	29	27	32	26
Feb 2020	31	31	27	21
Average	28	27	28	24

Table 4 Average (maximum-minimum) estimated individuals of migratory birds (excluding flamingos)

Site	Oct, 19	Nov, 19	Dec, 19	Jan, 20	Feb, 20
BPS	19353(25041-15189)	56(64-40)	1883(2860-1293)	1500(1789-1115)	7495(15630-1696)
NRI	128(154-102)	553(681-328)	221(253-201)	3415(4141-2225)	8733(12505-5215)
TSC	157(185-123)	753(1179-511)	623(712-574)	3053(5615-873)	922(1093-712)
Belpada	110(294-16)	159(221-119)	350(411-274)	586(842-329)	152(165-133)

Since last year (October 2018-March, 2019), both diversity and abundance have declined in the wetlands. Several factors may have caused this. For instance, firstly, Panje was one of the larger wetlands, used to support a huge population of migrants. Now, as Panje is disturbed due to inconstant water flow. It can be assumed that the avifauna that was coming to Panje, might have started using the other suitable sites. Secondly, the fluctuations in water level due to rain and human control were making

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wetlands unsuitable for roosting. Thirdly, BPS, where the highest number of species was recorded, became highly disturbed due to salt extraction during November-February.

During this period, a single individual of one of the rare birds was recorded from BPS; Long-billed Dowitcher (*Limnodromus scolopaceus*) between January and March 2020. This species was also reported by bird photographers in 2017 from mudflats of BPS channel in the Thane Creek.

3.2 Transect count survey (TCS)

In all, a total population of 18650 and 59754 individuals of avifauna (excluding flamingos) were estimated in November and December respectively. These populations comprised 16864 and 57527 individuals of migrants (including waterbirds and raptors) recorded in their respective months. A remarkable increase was observed in the estimated population of January and February i.e., 87984 and 94224 individuals respectively. Among these, 86335 and 93142 were migratory shorebirds and raptors in their respective months. Comparatively, a slight decline was seen in avifaunal abundance in March. Results indicate that a significant addition of numbers was found in the population of waders between November and January. Notably, Little Stint was the most abundant wader species throughout the survey with the highest count (39992) recorded in January. Whereas, Green Sandpiper, Wood Sandpiper, Ruddy Turnstone and Whimbrel were the least counted waders in different months. (Table 5).



Table 5 Species richness and abundance recorded in the Thane Creek

Site	Thane Creek					
	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Months						
Total species number	NA	44	50	51	50	45
Total number of migratory species recorded	NA	29	34	32	35	30
Total number of resident species recorded	NA	15	16	19	15	15
Total population recorded	NA	18650	59754	87984	94224	77240
Total population of migrants	NA	16864	57527	86335	93142	75466
Total population of residents	NA	1786	2227	1649	1082	1774

By contrast, results showed that mudflats of Sewri and Nhava-Sheva supported lower species richness and abundance of migratory as well as resident birds throughout the survey period (Table 6).

Table 6 Species richness and abundance recorded in Sewri and Nhava-Sheva mudflats

Site	Sewri mudflat						Nhava-Sheva mudflat					
	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Total species number	11	14	19	17	15	NA	12	10	12	13	19	NA
Migratory species	8	8	11	10	10	NA	7	5	7	7	8	NA
Resident species	3	6	8	7	5	NA	5	5	5	6	11	NA
Total population	341	1053	227	1410	8305	NA	222	161	322	2642	4500	NA
Migratory population	318	1011	156	1340	8249	NA	136	12	198	2518	4340	NA
Resident population	23	42	71	70	56	NA	86	149	4	124	160	NA



3.3 Flamingo Census (FCS)

In FCS, we estimated the abundance and distribution of Greater flamingos and Lesser flamingos in the Thane Creek, Sewri and Nhava-Sheva mudflats. Due to prolonged monsoon we could survey once in October. Later we sampled for three consecutive days of every month till March 2020. Initially, in Thane Creek, we counted fewer Greater flamingos, 835 individuals in October which increased to 29219 individuals in March 2020. Lesser Flamingo count on the other hand was nil in October which increased to 61,802 in March 2020. Observations showed that the subadult population of both species was comparatively less than adults during the entire survey (Table 7).

Table 7 Population of flamingo species recorded from the Thane Creek

	Age	Thane creek					
		Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Greater flamingo	Adult	26	NA	4287	7020	16710	23671
	Sub-Adult	809	NA	1128	1108	8353	5548
	Total	835	NA	5415	8128	25063	29219
Lesser flamingo	Adult	0	NA	9	10357	26770	53462
	Sub-Adult	0	NA	1	4145	7735	8340
	Total	0	NA	10	14502	34505	61802

Results revealed both populations of Greater and Lesser flamingos inhabited the mudflats of the East bank throughout this period of surveys, mainly congregated towards upstream, near Ghansoli channel (Tr IDs; T1-T2 & T37-T40) and downstream regions (Tr IDs; T35-T36 & T29-T34). Later, from January till March, it was observed that the abundance of flamingos was also distributed abundantly over the mudflats of the West bank towards upstream-downstream regions (Tr IDs; T14-T18 & T26).



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It was observed that relatively fewer Greater and Lesser flamingos inhabited the mudflats of Sewri and Nhava-Sheva from January to March (Table 8).

Table 8 Population of flamingo species recorded from Sewri and Nhava-Sheva mudflats during FCS

Species	Age	Sewri mudflat						Nhava-Sheva mudflat					
		Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
GF	Adult	NA	NA	NA	0	NA	287	NA	NA	NA	0	NA	1500
	Sub-Adult	NA	NA	NA	0	NA	0	NA	NA	NA	0	NA	0
	Total	NA	NA	NA	0	NA	287	NA	NA	NA	0	NA	1500
LF	Adult	NA	NA	NA	2335	NA	2838	NA	NA	NA	0	NA	25
	Sub-Adult	NA	NA	NA	2060	NA	1268	NA	NA	NA	0	NA	0
	Total	NA	NA	NA	4395	NA	4106	NA	NA	NA	0	NA	25

3.4 Bird Behavior

A total of 3017 observations were recorded from October 2019 to March 2020 and 1071 observations have been transcribed in BORIS (Table 9). A monthly and species wise number of observations for each site category is given in Table 10. Pied avocets were not seen at construction sites whereas Whimbrel was not seen at any of the sites during behavioral surveys.

Table 9 Number of observations in each site category

Site category	Oct 19	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20
Roosting	316	148	239	126	219	172
Feeding	386	0	492	157	188	0
Construction	0	80	20	340	114	20



Table 10 Species wise number of observations in each site category

Species	Feeding	Roosting	Construction
Black-tailed Godwit	178	88	5
Common Greenshank	14	173	23
Common Redshank	151	203	142
Curlew Sandpiper	130	83	42
Eurasian Curlew	22	218	50
Greater Flamingo	140	119	26
Lesser Sandplover	145	16	70
Little Stint	183	115	25
Whimbrel	0	0	0
Lesser Flamingo	120	184	191
Pied Avocet	140	21	0

The behavior surveys were started from September 2019 and September to November was considered as the post-monsoon season, December to February as winter and March to May as summer season. Here we have plotted the activity budget of species that had a minimum of 30 observations during post-monsoon season. These species include Common Redshank, Little Stint, Eurasian Curlew, Black-tailed Godwit, Common Greenshank, Curlew Sandpiper, Greater Flamingo, and Lesser Sand Plover. Out of these species, only Common Redshank has a minimum of 30 observations at each site category i.e. feeding, roosting, and construction sites. Little Stint and Curlew Sandpiper have it on feeding and roosting sites. The rest of the species have their activity budgets plotted only at one of the site categories.

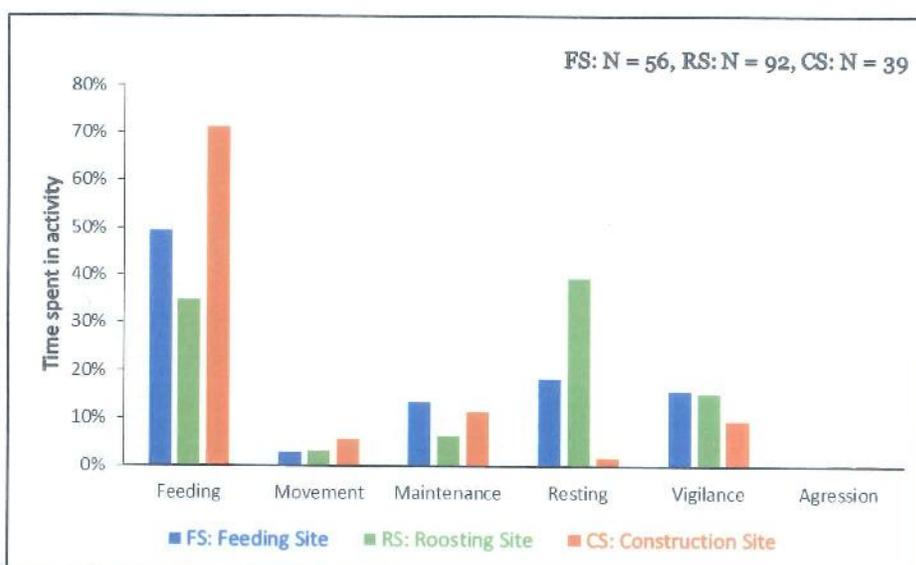
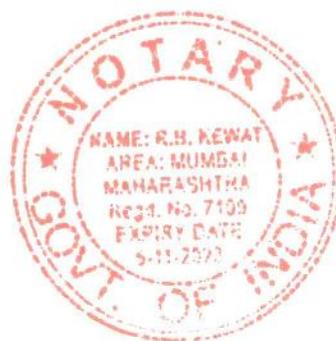


Figure 1 Activity budget of Common Redshank at feeding, roosting, and construction sites

Fig 1: shows the activity budget of Common Redshank at all of the sites and we can see that it spends most of its time feeding at construction (Sewri and Nhava-Sheva). The mudflats of Sewri and Nhava-Sheva provide one of the major foraging grounds for these birds. The proportion of time spent in feeding by Common Redshank is higher at construction sites as compared to feeding and roosting sites. Whereas, time spent in vigilance is lower at construction sites than that of feeding and roosting sites. This suggests that this species is not affected by the construction activities and may have habituated to such anthropogenic activities. Birds can become habituated to disturbances (Fitzpatrick & Bouchez, 1998) because birds can learn and identify the predictable patterns of human activities that do not pose any threat to them (Burger, 1989; Burger & Gochfeld, 1991). Similar results were observed for Common Redshank by Rosli & Nor Atiqah, 2017 where the birds ignored sound produced by vehicles and continued feeding until the vehicles came very close. It has also been observed during the behavior surveys that other waders also come as close as up to 5 meters to the under-construction bridge. However, we have seen a decline in the wader population at the construction sites. So even though the birds are getting

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accustomed to the construction, the construction activities could still be impacting the overall population of waders. If this impact is temporary or permanent can be inferred only after 5 years of post-construction monitoring. The impact of disturbance on the populations of birds also depends upon the availability of an alternative habitat (Burton, 2003). The decision for moving to a new site depends on the availability and quality of the new site (Ydenberg and Dill, 1986). However, in some cases, birds might continue to feed in areas where the food is sufficient even in the presence of human disturbances (Rosli & Nor Atiqah, 2017), as seen in the case of Common Redshank at construction sites. This is done to optimize the energy expenditure as flying to a new foraging site will require more energy (Lafferty, 2001).

Waders such as Little Stint, Black-tailed Godwit, Curlew Sandpiper, Lesser Sand Plover and Common Greenshank were almost equally engaged in resting and vigilance at the roosting sites indicating a high degree of predation and disturbance at these sites (Fig 2, 3, 4, 5, 6 & 7). Spending much time in vigilance at roosting sites can negatively impact the fitness of these birds as it reduces the time available for fitness-enhancing activities such as resting, maintenance, and foraging (Fritz, 2002). This can also increase their energy expenditure which can affect their ability to build fat reserves to fulfill their annual cycle of moult, migration, and breeding (Spencer, 2010). In the case of Greater Flamingo at roosting sites, it spent most of its time on maintenance followed by feeding and vigilance indicating that it is not affected by the disturbances, unlike the smaller waders. The flamingos may have habituated to the human disturbances and avian predators such as Black Kites and Marsh Harriers pose no threat to these large birds (Fig 8). All these species also devote much of their time in feeding at the feeding sites followed by maintenance and vigilance as seen in the graphs.

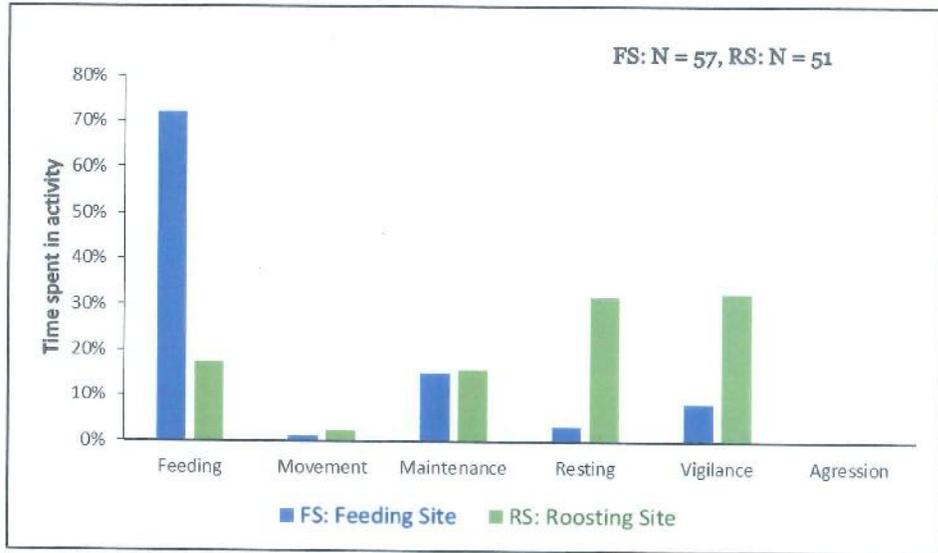


Figure 2 Activity budget of Little Stint at feeding and roosting site

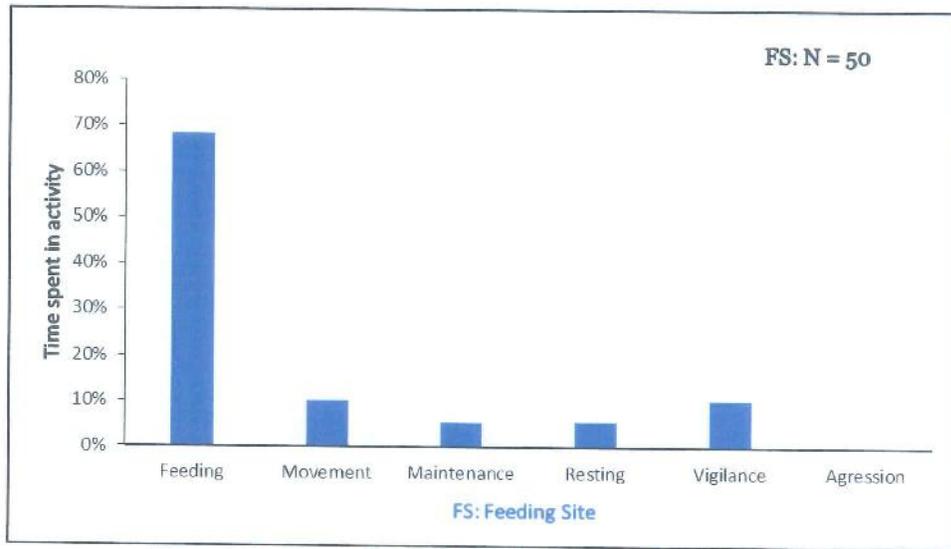


Figure 3 Activity budget of Black-tailed Godwit at feeding site

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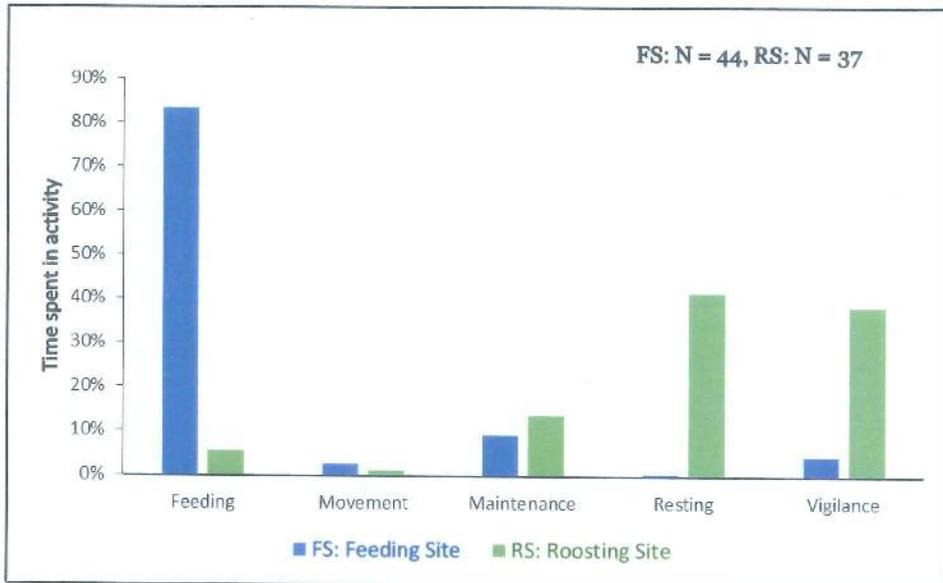
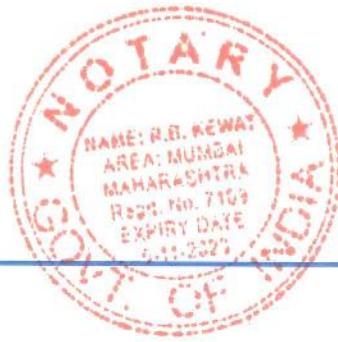


Figure 4 Activity budget of Curlew Sandpiper at feeding and roosting sites

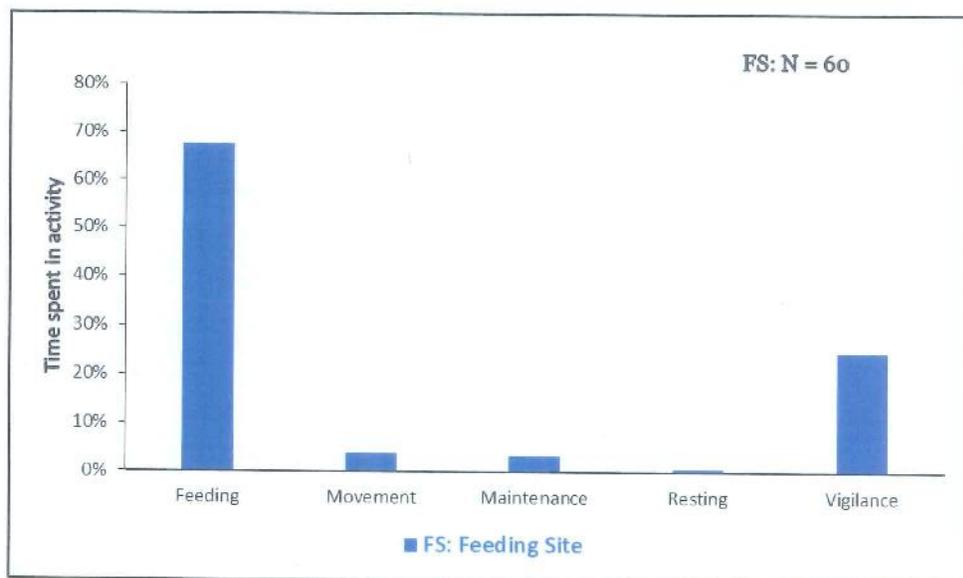


Figure 5 Activity budget of Lesser Sand Plover at feeding site

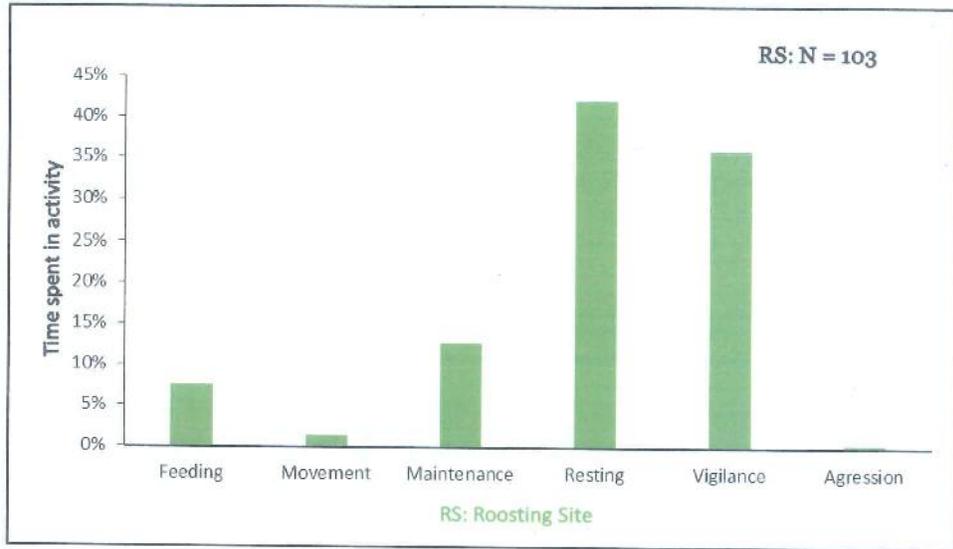
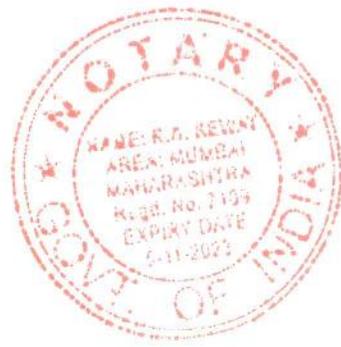


Figure 6 Activity budget of Common Greenshank at roosting site

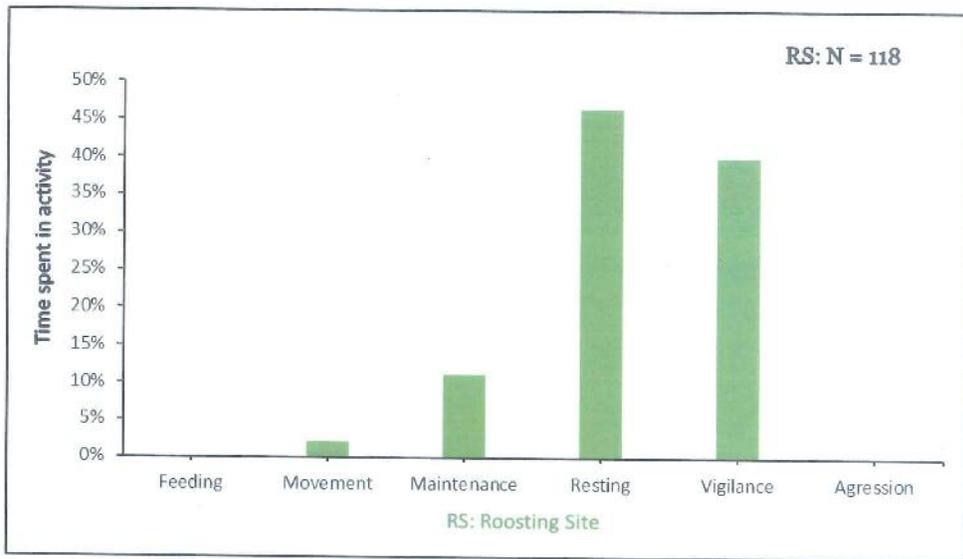
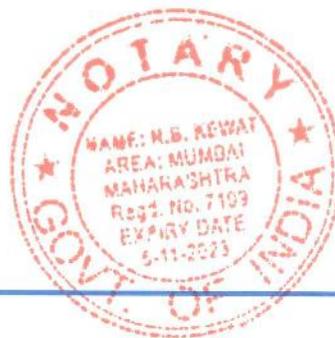


Figure 7 Activity budget of Eurasian curlew at roosting site

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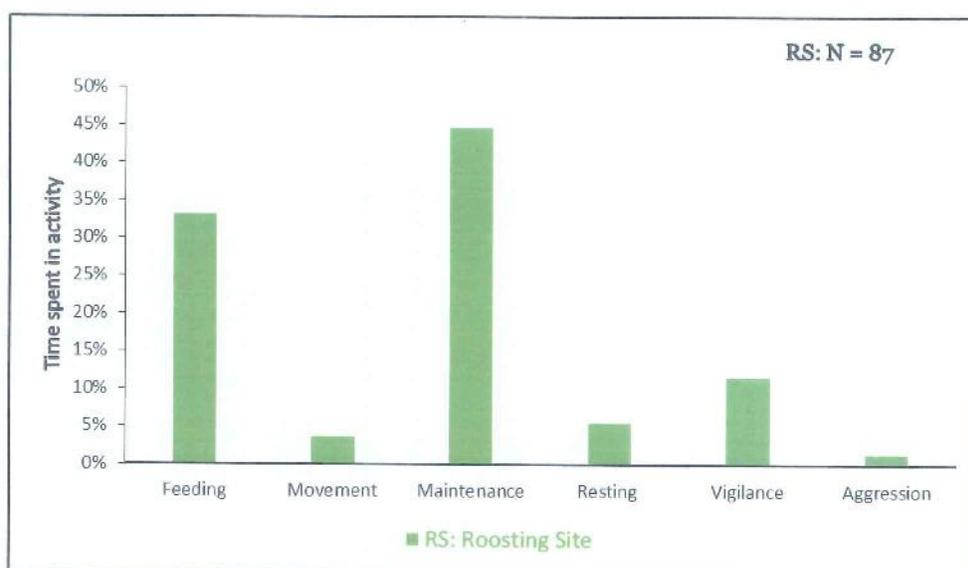


Figure 8 Activity budget of Greater Flamingo at the roosting site

3.5 Bird ringing

We conducted 49 trapping sessions from September 2019 to March 2020. All these trapping sessions were done mainly at two sites BPS and TSC. We were successful in trapping 5356 birds during these sessions of which 5318 were small waders and 38 Flamingos. We also got 385 recaptures during these trapping sessions. Details are as below.

Table 11 Ringing and colour flagging details

Date of ringing session	No. of Individual s ringed	Recapture s	Recaptured Species
3-11-2019	51	8	7 Common Redshank, 1 Curlew Sandpiper
6-11-2019	94	21	17 Common Redshank, 1 Green Shank, 2 Lesser Sand Plover, 1 Curlew Sandpiper
7-11-2019	101	13	8 Common Redshank, 1 Little Stint, 4 Curlew Sandpiper
8-11-2019	23	3	3 Common Redshank
9-11-2019	170	1	1 Common Redshank



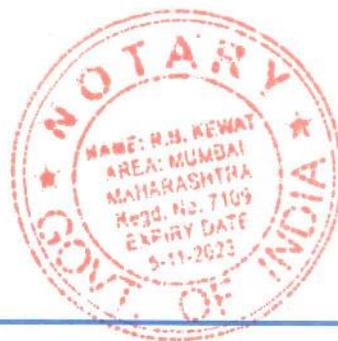
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10-11-2019	147	1	1 Terek Sandpiper
11-11-2019	111	0	
12-11-2019	136	11	2 Curlew Sandpiper, 1 Little Stint, 8 Common Redshank
8-12-2019	287	7	4 Terek Sandpiper, 2 Lesser Sand Plover, 1 Curlew Sandpiper
9-12-2019	269	5	3 Terek Sandpiper, 1 Little Stint, 1 Lesser Sand Plover
10-12-2019	197	9	7 Common Redshank, 1 Curlew Sandpiper, 1 Terek Sandpiper
11-12-2019	121	7	3 Curlew Sandpiper, 3 Common Redshank 1 Lesser Sand Plover
12-12-2019	152	5	3 Lesser Sand Plover, 1 Common Sandpiper, 1 Little Stint
13-12-2019	156	11	2 Terek Sandpiper, 1 Common Redshank, 2 Lesser Sand Plover, 6 Little Stint
26-12-2019	94	0	
27-12-2019	45	0	
28-12-2019	180	2	1 Common Redshank, 1 Lesser Sand plover
10-1-2020	151	5	4 Common Sandpiper, 1 Terek Sandpiper
11-1-2020	14	0	
12-1-2020	36	6	5 Common Redshank, 1 Lesser Sand Plover
13-1-2020	170	6	3 Common Redshank, 2 Terek Sandpiper, 1 Curlew Sandpiper
20-1-2020	149	14	1 Common Redshank, 1 Common Sandpiper, 4 Lesser Sand Plover, 2 Little Stint, 6 Terek Sandpiper
21-1-2020	144	7	4 Common Sandpiper, 2 Lesser Sand Plover, 1 Little Stint
22-1-2020	139	9	5 Common Redshank, 3 Curlew Sandpiper, 1 Terek Sandpiper
23-1-2020	91	5	2 Terek Sandpiper, 1 Common Redshank, 2 Curlew Sandpiper
24-1-2020	88	0	
25-1-2020	136	11	3 Common Sandpiper, 3 Curlew Sandpiper, 2 Lesser Sand Plover, 3 Little Stint
3-2-2020	139	06	2 Little Stint, 1 Kentish Plover, 1 Lesser Sand Plover, 1 Curlew Sandpiper, 1 Terek Sandpiper



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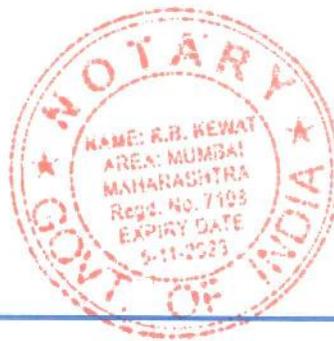
4-02-2020	117	2	1 Lesser Sand Plover, 1 Curlew Sandpiper
5-02-2020	76	11	7 Curlew Sandpiper, 4 Common Redshank
6-02-2020	76	28	19 Common Redshank, 3 Lesser Sand Plover, 1 Little Stint, 5 Curlew Sandpiper
7-02-2020	13	0	
8-02-2020	67	0	
10-02-2020	103	8	3 Terek Sandpiper, 1 Little Stint, 1 Common Redshank, 1 Lesser Sand Plover, 1 Common Sandpiper, 1 Curlew Sandpiper
18-02-2020	25		
19-02-2020	7		
20-02-2020	80	6	4 Common Sandpiper, 2 Lesser Sand Plover
21-02-2020	91	7	7 Common Redshank
22-02-2020	103	11	11 Common Redshank
23-02-2020	122	16	12 Common Redshank, 2 Little Stint, 1 Common Green Shank, 1 Terek Sandpiper
24-02-2020	81	12	4 Common Redshank, 7 Terek Sandpiper, 1 Lesser Sand Plover
25-02-2020	200	28	26 Common Redshank, 1 Marsh Sandpiper, 1 Grey Plover
06-03-2020	159	28	1 Terek Sandpiper, 27 Common Redshank
07-03-2020	69	7	6 Curlew Sandpiper, 1 Little Stint
8-03-2020	129	25	2 Curlew Sandpiper, 20 Common Redshank, 2 Lesser Sand Plover, 1 Terek Sandpiper,
11-03-2020	161	23	15 Common Redshank, 1 Curlew Sandpiper, 6 Terek Sandpiper, 1 Lesser Sand plover
13-03-2020	102	7	3 Common Redshank, 2 Curlew Sandpiper, 1 Lesser Sand Plover, 1 Terek Sandpiper



4. Benthic Fauna

The diversity and dynamics of a population and their interaction with the environment play a vital role in understanding community ecology. The shoreline also known as the intertidal zone is subjected to rhythmic rise and fall of water level which eventually causes gradient display of organisms having elastic ability to survive through changing temperature and salinity. In this system, primary and secondary consumers are benthic fauna, which in turn are consumed by top predators such as epibenthic crustaceans, fishes, and shorebirds (Raffaelli and Hawkins, 1999). Many studies have revealed a positive correlative between shorebird abundance and their invertebrate prey availability (Boettcher et al., 1995) at muddy intertidal mudflats. This aide the study of diversity and distribution of macrobenthic fauna to very essential in the present study. Additionally, the benthos is regularly monitored as a pointer of conceivable changes within the system. Being closely associated with the sediment and relatively long-lived, benthic fauna indicates the effects of environmental changes at a particular place over a long period.

Wetlands in coastal areas are crucial natural resources and are gaining importance in recent years. The coastal wetlands comprise of critical transition zones between continental landmasses, freshwater habitats, and marine habitats and are ecologically sensitive systems (Ghosh, 2017, Turner et al. 2000). These transition zones facilitate ecosystem services like shoreline protection, organic decomposition, carbon sequestration, flood control, nutrient cycling, water quality improvement, habitat for migratory and resident animals, and regulation of fluxes of nutrients, water, particles, and organisms between land, rivers, and the ocean (Costanza et al. 1997; Levin et al. 2001).



5. Methodology

Macrobenthos samples were collected from intertidal mudflats of the Thane Creek, Sewri, Nhava, Wetlands from October 2019 to March 2020. Due to prolonged rains, Thane Creek was not sampled during October. Along with this, macrobenthos samples were also collected from the sub-tidal area of the Thane Creek from December 2019 to March 2020. The sampling period has been divided into four phases namely Phase I (October), winter (November, December, and January), Phase II (February), and summer (March) to represent seasons. Thane Creek was divided into forty transects at an interval of 1 km along both banks of the Creek for the estimation of macrobenthic density, biomass, and diversity of Polychaete families. Two transects from Sewri and Nhava-Sheva were sampled monthly along with the creek sampling during the study period. In January and February 2020, three transects were sampled from Sewri whereas in Nhava-Sheva, one additional transect was laid during February 2020. Intertidal mudflats were divided into 3 zones i.e. Mangrove line (Zone A), mid-water line (Zone B), and low-water line (Zone C), to study the changes in the macrobenthic distribution at different tide levels. To explore the distribution and composition of macrobenthic groups within the upper 15 cm of the substratum, the core has been sectioned into five strata (2cm, 4cm, 8cm, 11cm, and 15cm). These sections were also created based on the beak size of the shorebirds inhabiting the mudflats for feeding. This later component also aids in correlating the vertical stratification of macrobenthic groups and food preference of the bird species.

Van Veen grab (0.02 m²) was used to collect macrobenthos samples from the middle channel of the Thane Creek as subtidal samples. The samples were collected from the channel from 10 locations each 2km apart and which also coincides with the transects laid over the mudflats.



The present study was carried in five wetlands- BPS, TSC, NRI complex, and Belpada. In the case of wetlands, quadrat (20*20cm) was used to collect sediment samples from four different directions of the wetland.

A total of five sites (P1 to P5 and Z1 to Z5) were sampled in the Thane Creek every month from October 2019 to March 2020 for the collection of phytoplankton and zooplankton with the help of plankton nets. Due to bad weather conditions, only three sites were sampled in November 2019. Analysis for January, February, and March is under process and will be included in future reports.

6 Results

6.1 Thane Creek

An overall seasonal trend in the macrobenthic density and biomass has been observed during the study period. Macrobenthic density has shown a considerable decrease from winter (15343/m³) to Phase II (4108/m³). A similar trend was observed in the case of macrobenthic biomass with average values 14.96g/m³ during winter which declines to 4.18 g/ m³ during Phase II. Overall a decline in the average density of Polychaetes and Gastropods has been observed from winter (2966/m³; 15343/m³) to Phase II (1800/m³; 4108/m³). A similar trend was observed in terms of macrobenthic biomass for Polychaetes (winter-0.97 g/m³; Phase II-0.53 g/m³) and Gastropods (winter-1.77 g/m³; Phase II-0.29g/m³) during the study period. In winter, Gastropods (1287/m³) dominated the macrobenthic composition followed by Polychaetes (975/m³), Phoronida (29/m³) and Bivalve (11/m³). Whereas during Phase II (Fig. 9), Polychaete (401/m³) dominated the macrobenthic composition followed by Gastropod (239/m³), Phoronida (3/m³) and Bivalve (2/m³). In the case of macrobenthic biomass (Fig. 10), Gastropods (1.77g/m³) displayed maximum biomass followed by Polychaetes (0.9g/m³), Chordates (0.1g/m³) during winter. In Phase II, Polychaetes (0.53g/m³) exhibited the highest biomass followed by Arthropods (0.04g/m³) and Flatworms (0.4g/ m³). East bank has shown highest density and biomass (avg. 15343/m³; 14.96g/ m³) in Tr 39 during winter whereas in Phase II West bank displayed the highest density and biomass (4108/m³ ; 4.18 g/

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m3) in Tr 20. Overall, during the study period, 10 Phylum and 20 groups of invertebrates were observed in the Thane Creek. Winter exhibited higher macrobenthic diversity with the presence of 18 faunal groups whereas, Phase II exhibited 16 faunal groups. Arthropoda was the most diversified phylum comprising of 9 groups namely Brachyura, Barnacle, Shrimp, Anomuran, Amphipod, Taniads, Cumacean, Pycnogonid, Insect larvae.

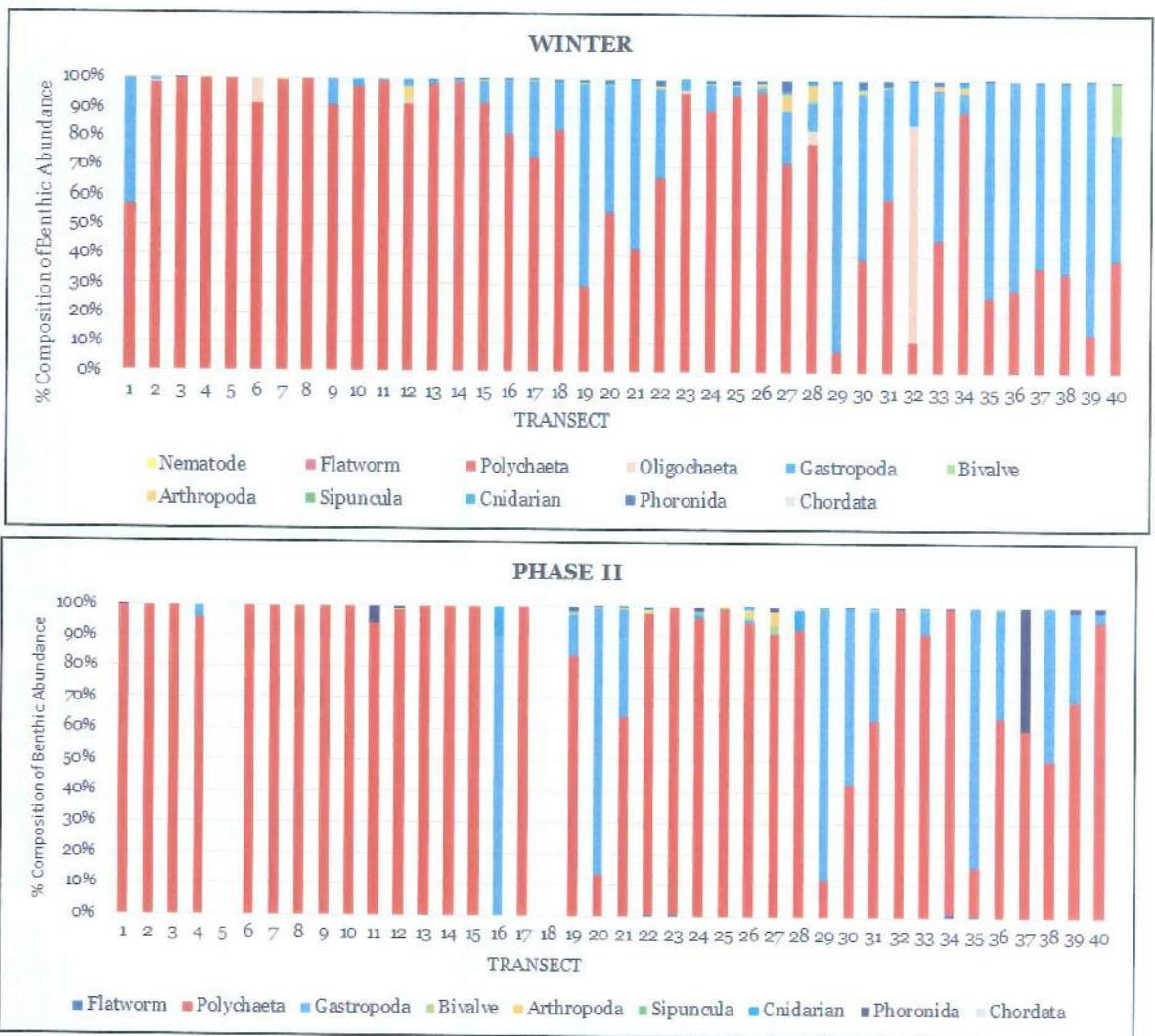


Figure 9 Seasonal variation in the percentage composition of macrobenthic density in different transects of the Thane Creek

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Figure 10 Seasonal variation in the percentage composition of macrobenthic biomass in different transects of the Thane Creek

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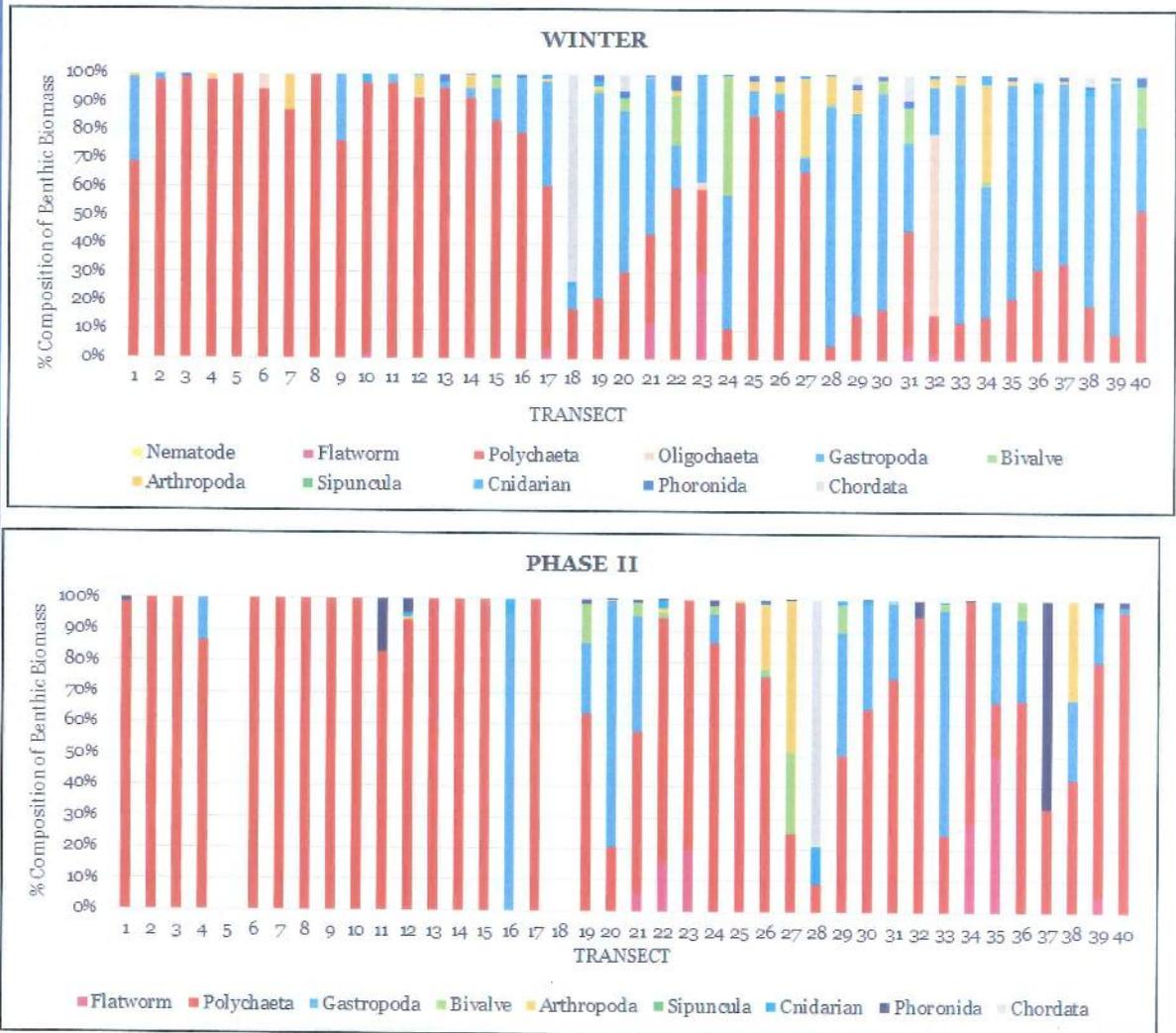
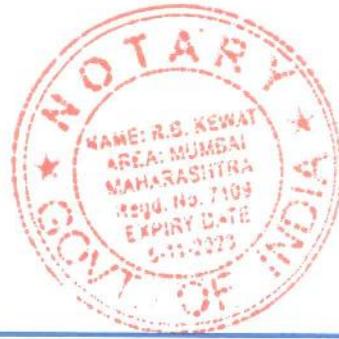


Figure 11 Seasonal variation in the percentage composition of Polychaete families in different transects of the Thane Creek

During the present study total, 15 Polychaete families (Fig. 11) were recorded from intertidal mudflats of the Thane Creek. The maximum number of Polychaete families was observed during December (11 families) followed by January (10 families) and February (10 families) and November (9 families). Based on their density Spionidae found to be the dominating family followed by Pilargidae, Nephytidae, Nereidae, and Capitellidae. The Percentage composition of Spionidae has declined from 86% in winter to 73 % during Phase II whereas an increasing trend was observed in the case

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of Pilargidae (winter- 5% to Phase II- 13%) and Nephytidae (winter- 3% to Phase II- 9%).

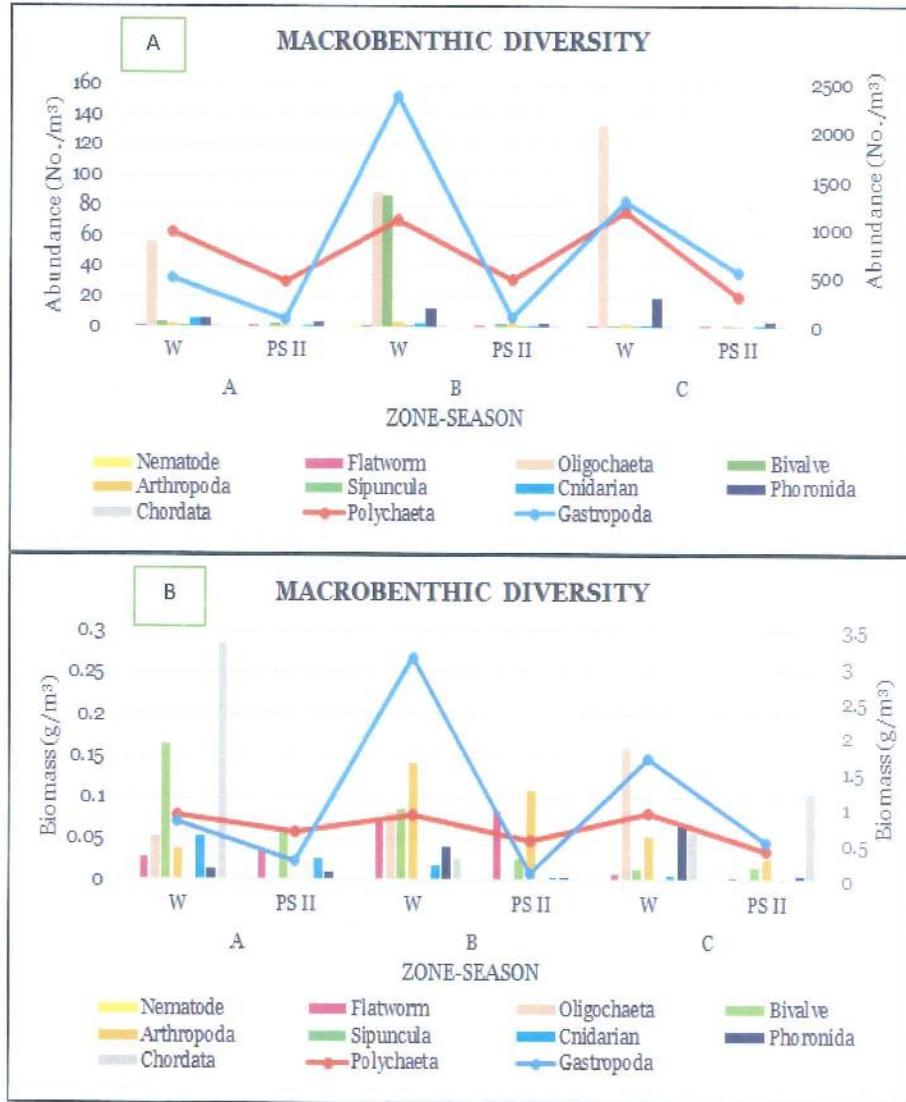


Figure 12 Zonal variation in macrobenthic density (A) and biomass (B) in different seasons along the Thane Creek

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Macrobenthic diversity shows variation along with zones and different stratum. Presently no specific observations were obtained in terms of zonal distribution and biomass of the macrobenthic groups. Zone A (Fig. 12) exhibited dominance of Polychaetes both in terms of abundance (winter-980/m³; Phase II- 505/m³) and biomass (winter-0.9g/m³; Phase II-0.8/m³) followed by Gastropods during both seasons. Whereas Zone C contradicts the observations obtained at the Zone A as instead of Polychaetes, Gastropod dominates the macrobenthic composition in terms of density and biomass.

Zone B exhibits dominance of Gastropods in terms of both abundance and biomass during winter whereas Polychaete dominates in Phase II. Overall Zone B (10 No.) exhibits more faunal diversity followed by Zone A (8 No.) and Zone C (7 No.).

Maximum macrobenthic diversity was observed in stratum 4 and all other strata showed consistent diversity (Fig. 13). Macrobenthic density and biomass declined vertically downwards from the stratum 2cm to stratum 15cm. Polychaete dominates the benthic abundance followed by Gastropods in all stratum during both seasons except for stratum 2cm in the winter season, which exhibits an opposite trend. Polychaetes dominate in terms of macrobenthic biomass in all stratum except for stratum 2cm for both seasons.

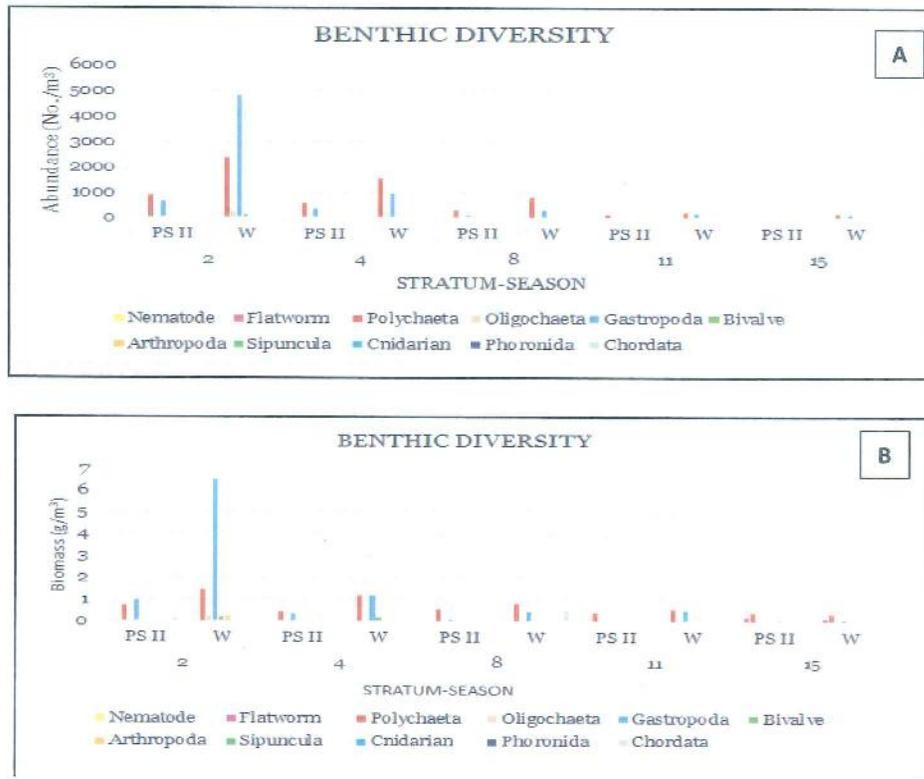


Figure 13 Vertical variation in macrobenthic density (A) and biomass (B) in different seasons along the Thane Creek

6.2 Subtidal

Polychaetes, Gastropods, and Phoronids found dominating the macrobenthic composition within the subtidal zone. Polychaetes dominate in terms of density at all the sampling points and in both the seasons followed by Gastropods and Phoronids. The density of macrobenthos (Fig. 14 A) was found to be highest in the winter season (avg. 233/unit volume) which declined during Phase II (avg. 135 per unit volume). The summer season (represented by the month of March) depicted a slight rise again in the macrobenthic density (avg. 204 per unit volume). The overall abundance of Polychaetes was highest in winter (avg. 233/unit volume) followed by summer (avg. 126/unit volume) and least during Phase II (avg. 126/unit volume). Whereas an opposite trend has been observed in case of Gastropods (winter- avg. 81/unit volume; summer- avg. 50/unit volume; Phase II- avg. 135/unit volume) and

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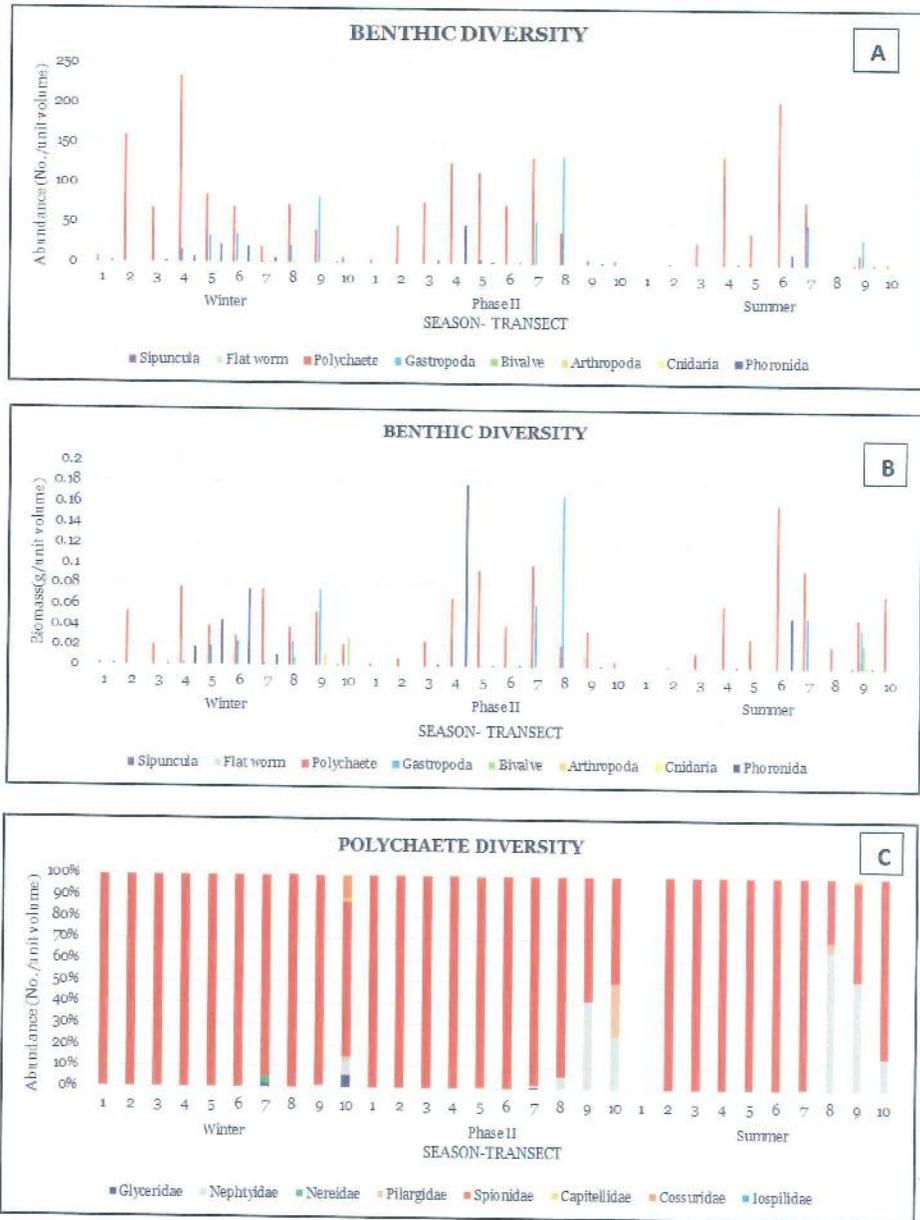
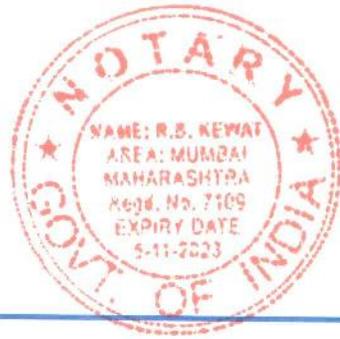


Figure 14 Seasonal variation in Macrobenthic abundance (A), biomass (B) and Polychaete families (C) along the subtidal area of the Thane Creek

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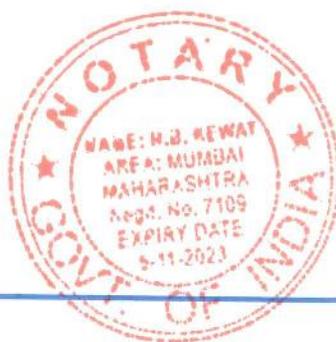
Phoronids (winter- avg. 22/unit volume; summer- avg. 14/unit volume; Phase II- avg. 49/unit volume). Phase II exhibited maximum biomass (Fig. 14 B) as compared to the other two seasons. Polychaetes dominate in terms of biomass during winter (0.07g/unit volume) and summer (0.16g/unit volume) followed by Phoronids and Gastropods. Whereas in Phase II, Phoronids (0.15g/unit volume) exhibits the highest biomass followed by Gastropods and Phoronids.

During this study period total of 7 invertebrate phyla and 9 groups were recorded from the sub-tidal area. Winter displayed maximum faunal diversity (9 groups) followed by Phase II (8 groups) and summer (8 groups).

Pertaining to Polychaete diversity (Fig. 14 C) about, 8 families were observed, of which 6 families showed their presence consistently in all three seasons. The family Spionidae was predominant throughout the seasons followed by the family Nephtyidae when compare to the other families which were in less numbers.

6.3 Sewri and Nhava-Sheva mudflats

At these two mudflats, among all seasons, winter exhibits maximum macrobenthic abundance (Fig. 15 A) (Sewri-1236/m³; Nhava-Sheva-278/m³) and diversity (Sewri- 7 No.; Nhava-Sheva- 8No.) followed by Phase II and Phase I. Phase II has depicted maximum biomass (Fig. 15 B) (Sewri-1.91g/m³; Nhava-Sheva-3.16g/m³) in both sampling places followed by winter and phase I. Overall 8 invertebrate phylum and 12 groups and 8 invertebrate phylum and 10 groups were observed during the study period from Nhava-Sheva and Sewri respectively. Polychaetes dominate in terms of abundance in both Sewri (1236/m³) and Nhava-Sheva (278/m³) during all sampling seasons followed by Gastropods and Arthropods. Gastropods depicted maximum biomass during Phase I (0.1 g/m³) and winter (1.914 g/m³) whereas Bivalve showed (1.9 g/m³). In the case of Nhava-Sheva, Bivalve exhibits maximum biomass during Phase I (0.01 g/m³) and Chordata count maximum during winter (1.57 g/m³) and Phase II (3.17g/m³). Overall, Sewri exhibits more abundance of benthic fauna whereas Nhava-Sheva shows more diversity.



Zone C exhibits maximum benthic density (Sewri-1495/m³; Nhava-Sheva- 293/m³) followed by Zone B irrespective of seasons. In terms of biomass, Zone C shows the highest value (13.1g/m³) in Sewri followed by Zone B (5.7g/m³) whereas Zone B (9.5g/m³) dominates in case of Nhava-Sheva followed by Zone C. Zone A exhibits less density (Sewri-902/m³; Nhava-Sheva- 330/m³) and biomass (Sewri-0.8/m³; Nhava-Sheva- 0.6/m³) during both seasons at both places. In terms of diversity, Zone A (8 No.) depicts maximum diversity in Nhava-Sheva whereas in Sewri Zone C (7 No.) exhibits more diversity as compared to other Zones. In Nhava-Sheva, Zone C was not sampled during Phase I due to less exposure of mudflat. Overall, winter exhibits maximum abundance in all zones at both sites except for Zone A of Sewri mudflats.

During the study, it was observed that Polychaetes dominates in all stratum followed by Gastropods. Overall, the maximum density of macrobenthos was observed within the upper 2 cm stratum-which further declines and found the lowest value of density at the 15cm stratum. In Sewri, maximum biomass was observed in stratum 2 (21.824g/m³) followed by stratum 15 (5.5g/m³), stratum 11 (1.4g/m³) whereas in Nhava-Sheva stratum 8 showed maximum value (15.84g/ m³) followed by stratum 2 (10.13g/ m³), stratum 15 (1.1g/ m³). Biomass does not show any such trend. Stratum 8 exhibits maximum diversity (9 No.) whereas all other stratum shows consistent faunal diversity.



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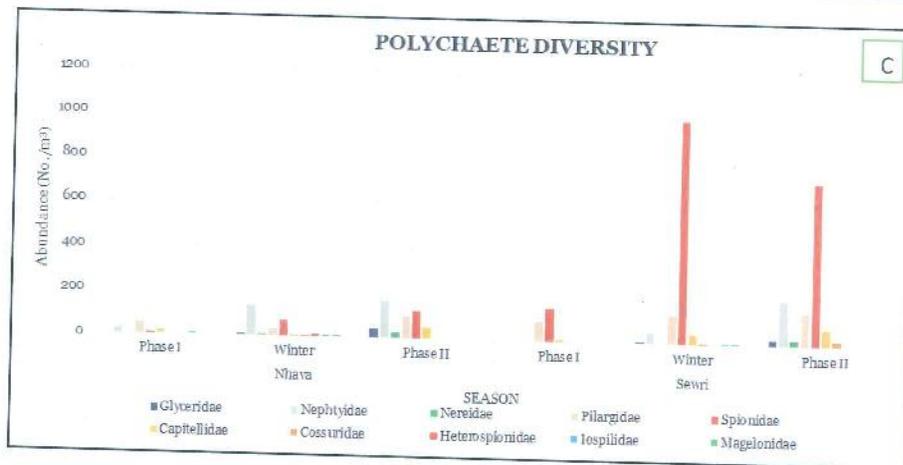
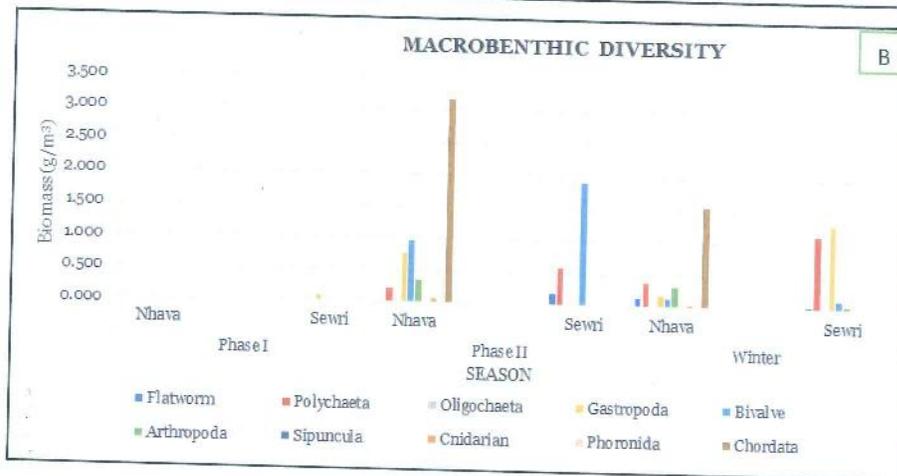
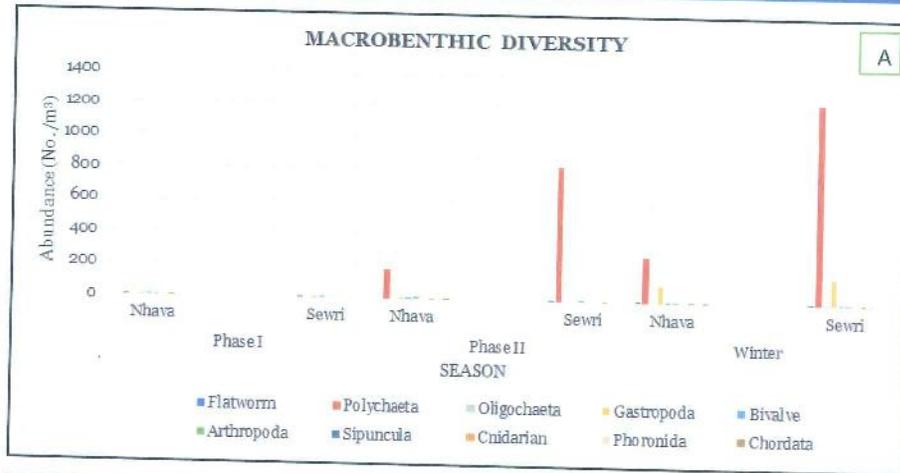


Figure 15 Seasonal Variation of macrobenthic abundance (A), biomass (B) and Polychaete diversity (C) along Sewri and Nhava

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terms of the composition of Polychaete (Fig. 15 C), Nhava-Sheva exhibits more diversity as compared to Sewri. Overall, 10 families were recorded during three seasons and four families were prevalent Spionidae, Pilargidae, Nephytidae, and Capitellidae. Although Phase I showed the least diversity in terms of Polychaete composition however winter season exhibits maximum Polychaete diversity in both sampling areas followed by Phase II.

At Sewri, Spionidae was the most dominating Polychete family during all seasons followed by Pilargidae and Capitellidae during Phase I and winter. Whereas during Phase II second dominating family was Glyceridae and Pilargidae.

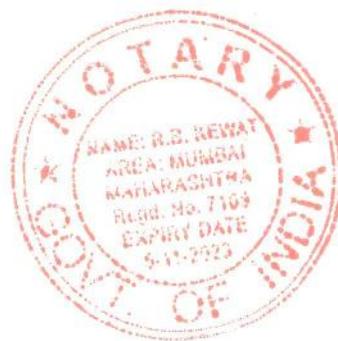
At Nhava-Sheva, during Phase I, Pilargidae was the dominating family followed by Nephytidae and Capitellidae. Nephytidae dominated Polychete composition followed by Spionidae, Pilargidae, and Capitellidae during winter and Phase II.

6.4 Wetlands

Belpada: This wetland exhibits maximum macrobenthic density ($1753/m^3$) and faunal diversity (4 No.) during winter followed by Phase II and Phase I. Whereas maximum biomass ($2.9g/m^3$) was observed during Phase I followed by winter and Phase II.

BPS: In the case of BPS, Phase II recounts maximum density ($1931/m^3$) followed by Phase I ($1683/m^3$) and winter ($334/m^3$). Benthic density was higher during Phase I ($3.7g/m^3$) and declines with seasons from winter ($2g/m^3$) to Phase II ($0.5g/m^3$). Winter exhibit more diversity of benthic fauna in BPS during winter while the other two seasons have equal diversity.

NRI: Phase I showed a maximum density ($451/m^3$) with a continuous decline from winter ($286/m^3$) to Phase II ($50/m^3$). Benthic biomass and diversity displayed



similar trends in NRI, being maximum during winter (3.6g/m³; 5 No.) followed by Phase I (1.6g/m³; 3 No.) and Phase II (0.5g/m³; 1 No.).

TSC: Phase I showed the least benthic density (440/m³) in TSC and a seasonal increase in density was observed from Winter (647/ m³) to Phase II (731/m³). Whereas maximum benthic biomass was observed in Phase I (14g/ m³) followed by Phase II (10.8g/m³) and winter (3.3g/ m³). Winter (5No.) supported maximum diversity in TSC followed by Phase I (4 No.) and Phase II (2 No.).

Overall, 5 Phylum and 9 benthic groups (Fig. 16) were observed in all wetlands. Arthropoda is the most diversified phylum comprising the presence of 4 groups- Amphipods, Shrimp, Chironomus larvae, and Tanaids. Arthropods contribute to maximum benthic density in NRI and BPS during Phase I and in TSC during Phase II whereas Gastropods exhibits maximum contribution during winter. Overall, Polychaetes were present in all sites and during all seasons. In total, 5 Polychaete families (Fig. 16 C) were observed in wetlands during all seasons. Belpada being the most diversified wetland supports 5 families in winter and 3 families during the other two seasons. There was no diversity and seasonal variation observed in NRI as only Nereidae was found during all seasons. In BPS, Phase I exhibited the presence of Nereidae, whereas both Spionidae and Nereidae were observed during winter and Phase II. Similarly, TSC also showed the presence of only Nereidae during Phase I and Phase II whereas Spionidae and Nereidae being present in winter. Nereidae was found at all sites during all seasons and dominates other families at all sites during Phase I. During winter and Phase II, Capitellidae dominated Belpada and Spionidae in BPS.

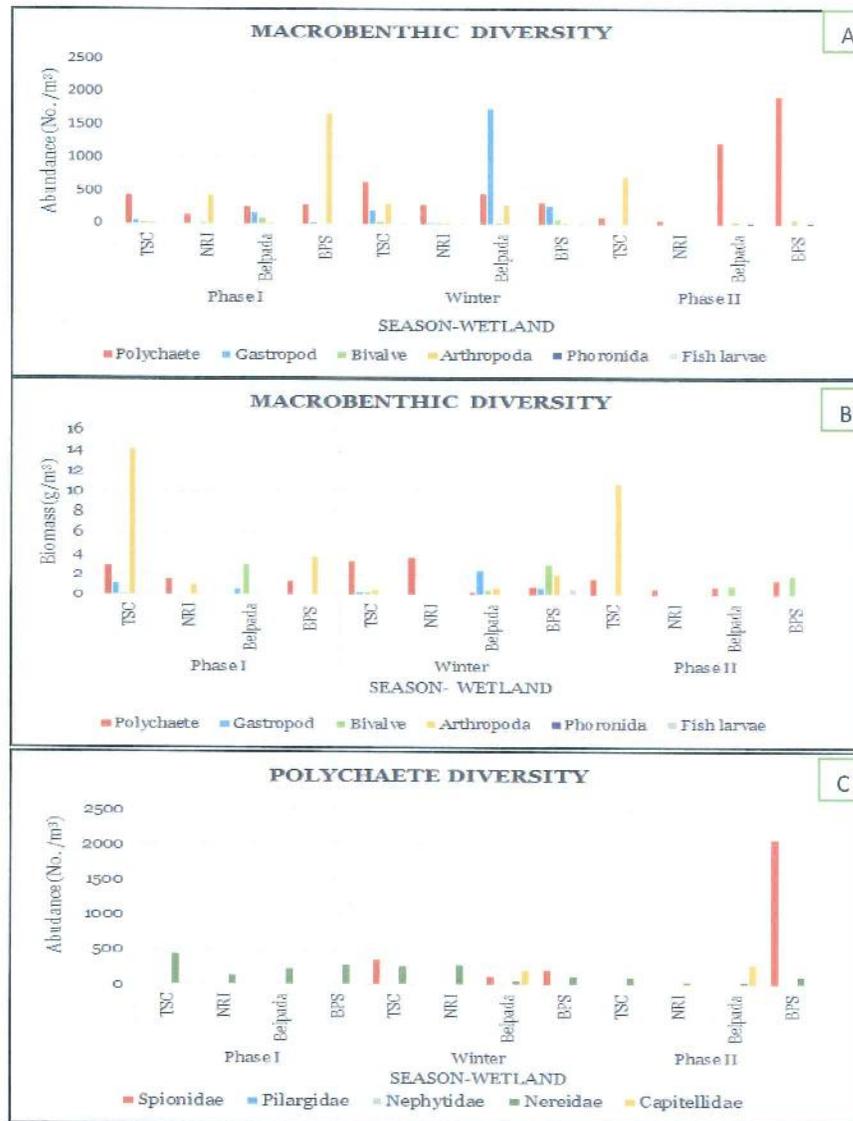
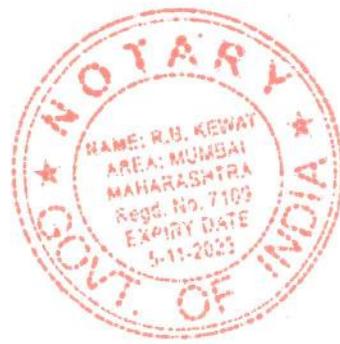
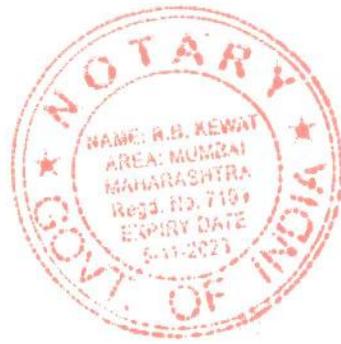


Figure 16 Seasonal Variation of macrobenthic abundance (A), biomass (B) and Polychaete (C) diversity in different wetlands

6.5 Planktons

A total of 23 species of phytoplanktons were found during both seasons (Fig. 17). In Phase I, *Skeletonema costatum* (39%) dominates followed by *Coscinodiscus granii*

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(17%) and *Navicula* sp., all other species contribute less than 10% to phytoplankton composition. During winter, *Skeletonema costatum* (21%) dominates the composition followed by *Odontella* sp. (20%) and *Thalassiosira* sp. (11%) and rest all species account less than 10% to plankton composition. *Dinophysis miles*, *Ornithocercus* sp., *Thalassionema* sp. were found only during Phase I whereas *Cyclotella* sp., *Cylindrotheca closterium* and *Thalassiothrix* sp. were observed in only during winter season. Overall, 20 phytoplankton species were found in Phase I and 19 during winter. Except for *Leptocylendricus* sp., *Odontella* sp., *Surirella* sp., and *Thalassiosira subtilis*, all other phytoplankton species exhibited a seasonal decline in percentage composition from Phase I to winter.

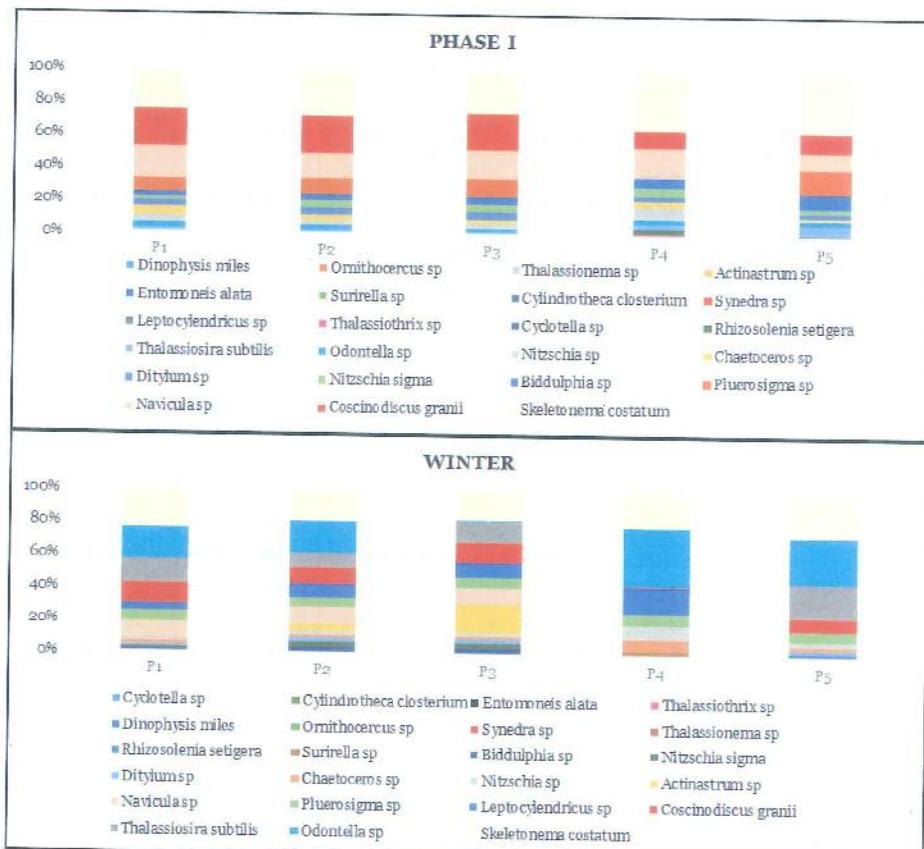


Figure 17 Seasonal variation in percentage composition of Phytoplankton along the Thane Creek

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A total of 18 Zooplankton (Fig. 18) groups were found during both seasons. Medusa (Phase I-61% and winter-28%) was the most dominating group during both seasons followed by Copepod (Phase I-20%, winter-26%) Decapod larvae (14%) was third dominating group during Phase I whereas in winter *Acetes* sp. (14%) was the third dominating group followed by Decapod larvae (12%). All other groups during both seasons contribute less than 10% to the composition. With seasonal change rise in zooplankton diversity was observed from Phase I (12 No.) to winter (18 No.)

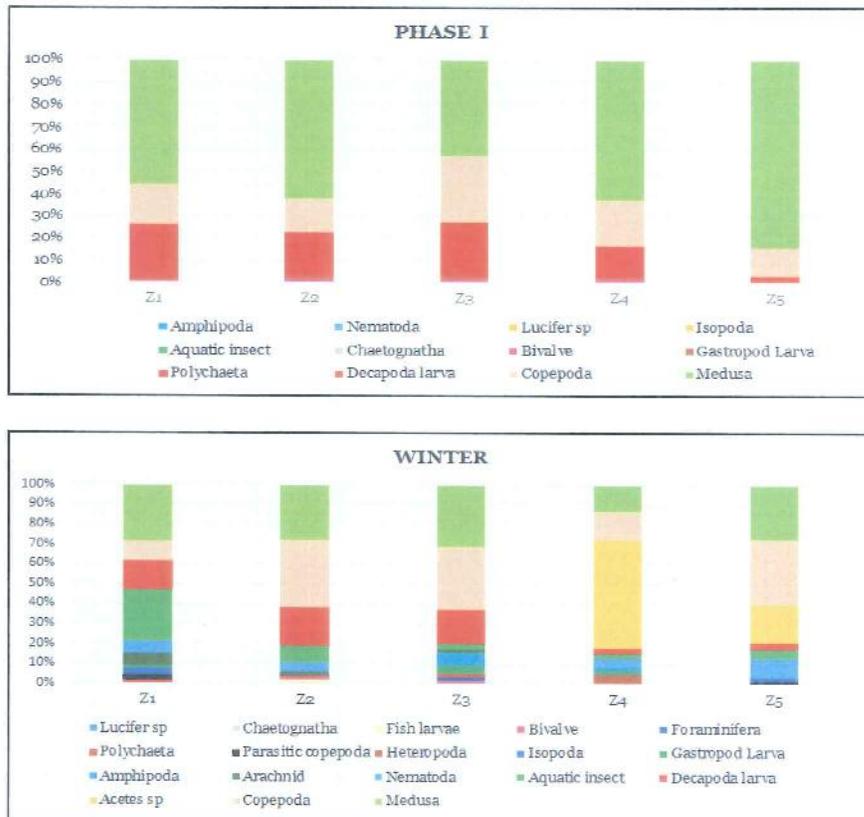


Figure 18 Seasonal variation in percentage composition of Zooplankton along the Thane Creek

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